High-speed trains in Sweden – a good idea?*

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ABSTRACT

The demand for both passenger and freight rail transport in Sweden has never before been higher than in the year 2008. There is now serious lack of capacity and big delays, and need for massive investment in rail. High-speed trains may be a way to relieve track congestion, reduce travel times and improve the environment through less air and car travel.

The Swedish National Rail Administration has initiated a number of studies on the value of high-speed trains over the last years. The Swedish government has initiated a study that was finished 14th of September 2009 and suggested to build a separate high speed tracks in Sweden.

The paper describes the main findings of the study and the models employed. The latter is of importance since two models gave significantly different results, even though both showed a positive socio-economic net return. The cost-benefit calculations have also been subject to scepticism. These scepticisms are also described and commented.

1 INTRODUCTION

There have been a number of high-speed rail evaluations in Sweden over the last five years. This paper will focus on the latest study on behalf of the Swedish Government carried out in 2009 and which was published on the 14th of September 2009 as a Governmental public study (SOU 2009:74). Since then some elaborations of the calculus have been carried out. Political considerations and requests for viewpoints commence early 2010.

The paper is organized as follows. Section 2 gives a background to Governmental interest in assessment of high-speed rail and a brief overview of international experiences. In section 3 we discuss the scope for high-speed trains in Sweden. Section 4 describes various prerequisites for the study, including how the two methods were used. Section 5 provides the basic results of the published report (SOU 2009:74). Section 6 gives more detailed results from the elaborations carried out after publication of the official report, in terms of demand, consumer surplus, producer surplus, public sector finances, external effects and the overall cost-benefit evaluations. In section 7 we describe some of the sceptical views that have been put forward, among other in Swedish newspapers. Section 8 summarizes the main conclusions.

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2 BACKGROUND

2.1 Railway development in Sweden

The development of passenger traffic on the railways in a long-term perspective is shown in figure 1. Between 1950 and 1970 private motoring expanded fast and train demand fell steadily. Rail travel then increased during the energy crisis in 1974 and 1979. Airlines expanded in the 1980´s and travelling decreased 1991 when VAT on travel was introduced.

A new transport policy in Sweden was introduced 1988 including separation of infrastructure and operation. Socio-economic calculations of investments for railways commenced something that had always been made for roads. This led to a continuous demand increase because of new tracks and new trains. In 2008 both passenger traffic and freight transport set new records in Sweden.

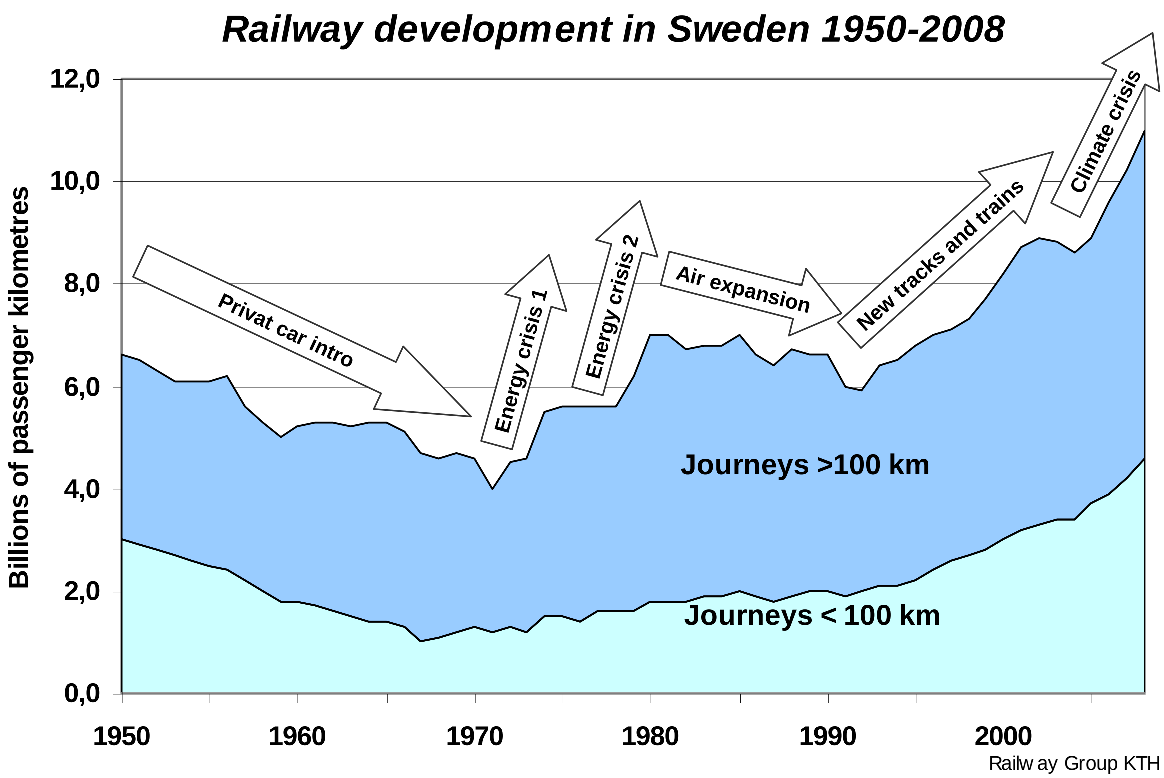

Figure1 - Development of passenger demand on the railways, 1950-2008.

This development means that some lines were congested and were declared overloaded by the Swedish Rail administration. The capacity problems in combination with the climate crisis actualized political interest for real high-speed rail lines in Sweden.

2.2 What are real high-speed trains?

The table below shows our definitions of characteristics of conventional and real high-speed railways respectively. Conventional lines are the original lines most of them built in the 1900th century. They are adopted for mixed passenger and freight traffic and mostly restricted to a maximum speed of 200 km/h. By upgrading the track and use of tilting trains the speed may increase to 250 km/h. The curve radius is modest and the grades must be low to permit heavy freight trains. There are level crossings with roads.

Real high speed lines are adopted to fast passenger trains for more than 250 km/h, nowadays mostly 300-350 km/h. They are like the fast lanes on a motorway but mostly not following the old lines. Building them in a new corridor will make it possible to allow higher speed and to reach new markets. The curve radius is large but the grades may be steep because there is no heavy freight. There are no level crossings by roads and there is always a traffic control system with ATC (Automatic Train Control).

	Conventional railways	**High-Speed railways HST**
Definition	Old, new or upgraded track for passenger and freight trains	Newly built railway designed for fast passenger trains
Maximum speed	200-250 km/h	250-350 km/h
Average speed (long distance)	120-160 km/h	200-250 km/h
Train types	Express trains, Local and regional trains, Light and heavy freight	Express trains, fast regional trains, fast freight trains
Track geometry	Modest curve radius Modest grades	Big curve radius Steep grades
Level crossings road-rail	Existing	None

Table 1- Characteristics of railways

Real high-speed lines began with the Tokyo-Osaka line in Japan 1964 for 210 km/h. The first line in Europe was opened in France 1981. Spain has today the most ambitious investments plans for high-speed railways in Europe. The goal is that 90% of the inhabitants in Spain will have at most 50 km to a high-speed line in 2020. Among all countries China is now building most high-speed lines.

The world high speed train record is 575 km/h, not so far from magnetic levitation train record 581 km/h. Operating speed for magnetic levitation trains is still higher, 430 km/h, but operating speed for high speed trains have successively been improved and is today 350 km/h and there are plans for 380 km/h. The advantage with high-speed trains on conventional rail compared with magnetic levitation lines is that they also can use old lines to come into City centres and go further on old lines with more network effects.

2008 Kilometres	In Service	Under Construction	Planned	Total 2025
Sweden			700	700
Europé	5 600	3 500	7 800	16 900
Asia	4 000	4 800	7 800	16 600
Other world	400		2 400	2 800
Grand total	10 000	8 300	18 700	37 000

Table 2 - High Speed lines in the world. Source: UIC

2.3 International experiences

This part of the background summarizes the viewpoints taken by researchers at the Railway group at the department of Transport and Logistics at the Royal Institute of Technology, Stockholm (KTH) and also other references.

The diagram in figure 2 shows the international experience of market share rail-air depending of rail travel times according to Nelldal-Troche, (2001). Based on this study there seems to be a stable relation between travel time by train and the rail-air market share. At 3 hours travel time rail will have higher market share than air and at 2 hours travel time rail will totally dominate the market and sometimes the airlines close down. Also in Sweden, when the faster trains (X2000) were introduced between Stockholm and Gothenburg and train travel time was reduced from 4 to 3 hours, the market share for rail grew from 40 to almost 60 per cent.

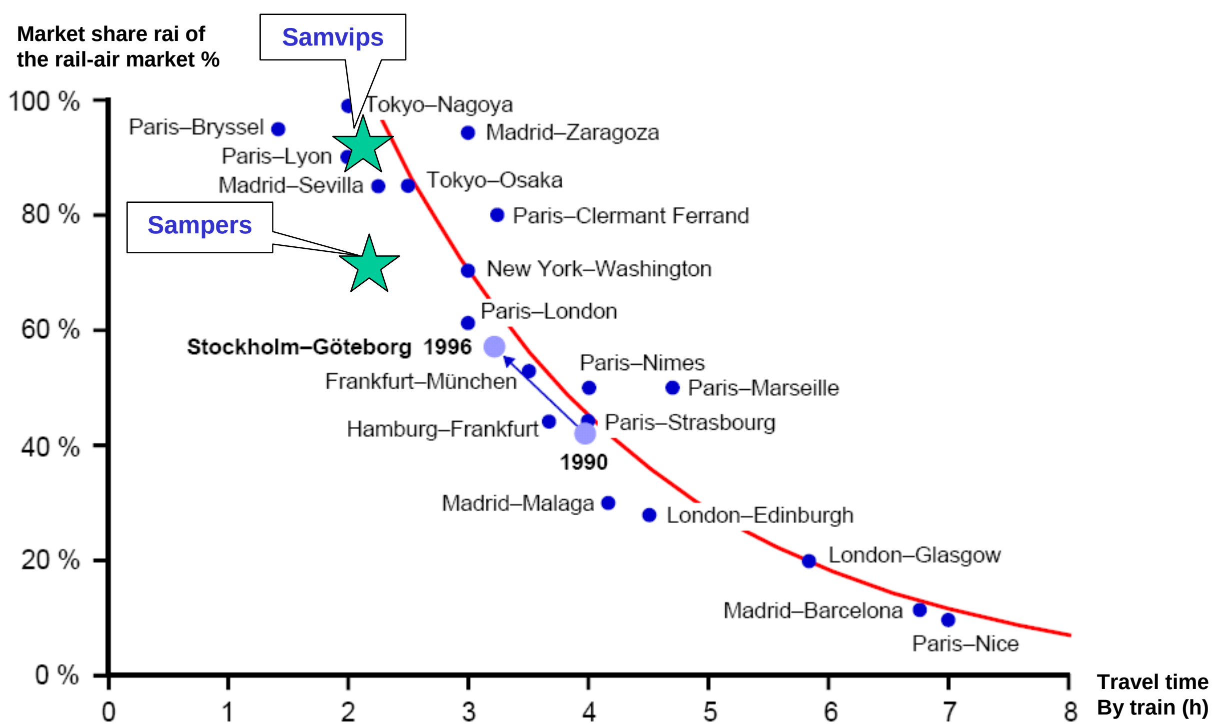

Figure 2 - Market shares rail-air as function of rail travel times around year 2000. Source: Lopez Pita, Mathieu, SNCF, Amtrak, Troche and others. The marks for Samvips and Sampers refer to the result of the forecasts model described in chapter 4.

The relation between rail and air is very direct: When travel time by train will be shortened more customers change mode to train. When the air market decrease the departures will be reduced and even more customers use the train. After some years the market is stabilised.

In figure 2 Sampers and Samvips denote two methods for model estimation of the rail market share Stockholm-Göteborg if high-speed rail were introduced. Of these two methods we have more confident in Samvips, se further in section 4.

Transek AB ((2002) includes a statistical analysis of all national air and rail journeys to and from Stockholm and separate models were developed for city-to-city journeys and transfer journeys. The result shown in a graph is very close to that in figure 2. One conclusion was that travel time is the most important factor while price is less important.

On market shares rail/air Steer Davies Gleave (2006) writes:

> "the rail journey time was the single most important factor determining market share, but nonetheless there could be significant variation even where the journey times were similar: for example, routes with rail journey times of about 2 hours 30 minutes had rail shares varying from 44% to 85%. This variation arose because:
>
> • Other factors related to the schedule offered or the effective journey time, such as the frequencies offered by each mode and average access times, influence market share
> • Other factors not related to the schedule, including price and service quality, also influence market share
> • Definitions of the markets varied between routes, and were sometimes different for air and rail on the same route."

In a paper by Jorritsma (2009) substitution opportunities of high speed train and air in Netherlands were investigated. The conclusion is that the most important factor is the travel time by train. Other factors mentioned are relative prices frequency, service, availability to airports and railway stations, service quality and punctuality. A model which describes the connection between the travel time by train and the rail/air market share is presented.

A study has also been made of the market for high speed trains in Norway by Kjørstad-Norheim, (2009) with stated preferences interviews with air passengers. In this study the travel time was found to be the most important factor for choice of train, while price and frequency were less important. Because the investigation was made only with air-passenger, most of them business travellers, the result may be biased.

In a report by Lundberg (2010), actual statistics from international market shares between high speed trains and airplanes similar to figure 2 were gathered once again. Statistical analysis was made by market share depending on travel time, frequency and price. The result shows a very strong relationship with travel time, but almost no or very weak relationship with frequency and price. A model which describes the connection between the travel time by train and the rail/air market share were carried out, which show high accuracy.

There is also a substantial impact on private car use, trips generation and choice of destination. The effects of fast regional trains between Stockholm and Eskilstuna opened in 1997 have been evaluated ex post ex ante Fröidh, (2003). Travel time was shortened from 1:40 to 1:00 and made daily commuting possible. The demand for rail transport increased 6 times compared with the old line. The rail service's market share increased from 6% to about 30% for regional journeys. Most of the new rail customers were former car riders and many new trips were generated because daily commuting was possible.

The figure 3 below exemplifies mode changes from 1993 to 2001 due to traffic measurements for regional travels along this rail line.

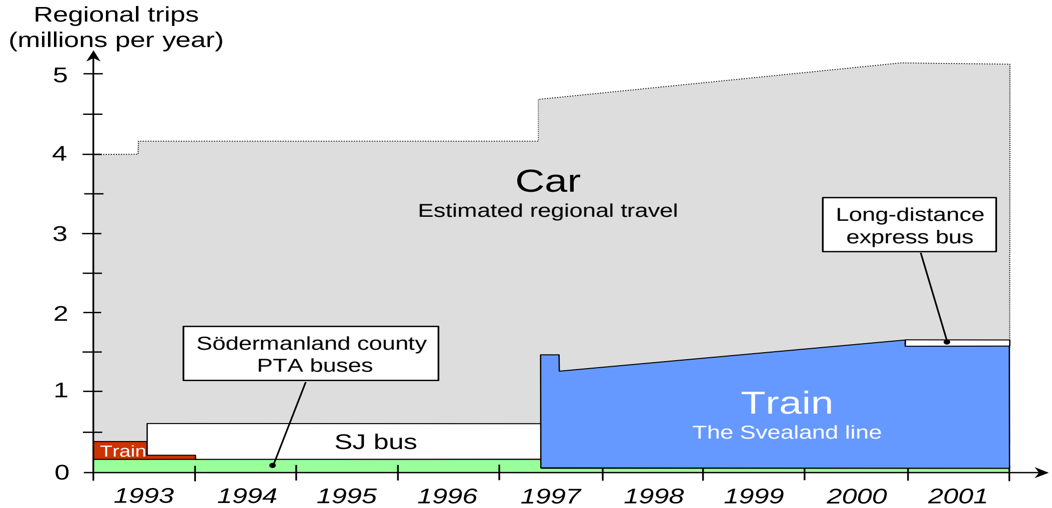

Figure 3 - Estimated total regional travelling across the border between the counties of Södermanland and Stockholm (Läggesta–Nykvarn section), 1993-2001

The Swedish Inquirer in command on behalf of the Government summarizes for example the following effects and experiences of international high-speed rail services.

- Improved competitiveness in relation to car and air,
- Improved profitability for the operators,
- Ambitions to knot countries together,
- Relief of capacity on existing tracks,
- Town development around the new high-speed tracks

2.4 Conclusions

Investigations and statistical analyses demonstrate a very strong relationship between rail travel time and rail/air market share. Publications by Nelldal-Troche 2001, Transek 2002, Steer Davis Gleave 2006, UIC 2008, Jorritsma 2009; Kjørstad-Norheim 2009 and Lundberg 2010 show a similar pattern. Models developed by Transek 2002, Jorritsma 2009; and Lundberg 2010 are consistent.

One conclusion is that with a rail travel time on three hours rail will have higher market share than air. At three hours travel time from city to city is almost equal by air including feeder transports and terminal times. At two hours travel time the rail will beat the airplanes and will be faster except for some transfer journeys, and airline supply will be reduced or abandoned.

Price and frequency have less importance than travel time. In addition, distance and travel time to the airport as well as terminal times will also affect the relative travel time by air compared with rail. One problem when analysing air-rail-journeys is the definition of the markets. Another problem is if the market is saturated ore not. When high speed train will be introduced it will take some years for air to adopt the supply to the new market situation.

Competing with car is more complex than air. There are many other factors affecting car travel. Here also price and frequency is more important and car ownership affects the choice. On shorter distances high speed trains can induce new rail demand when reaching 1 hour travel time, which allows daily commuting, as has been showed by Fröidh (2003).

3 SCOPE FOR HIGH SPEED LINES IN SWEDEN

3.1 Total demand for transport

The demand for transport has not the density in Sweden as in central Europe. We have analysed the demand in Sweden and we believe that the following criteria have to be fulfilled in order to make real high speed lines economically feasible in Sweden:

- There must be a big long distance end-point-market
- There must be big sub-markets between towns along the line
- There must be big demand for freight trains so there is a need for separation of freight and passenger trains

The diagrams below show total passenger travel demand for long distance travels in Sweden (more than 100 km) assigned on the road network and the proposed high Speed network.

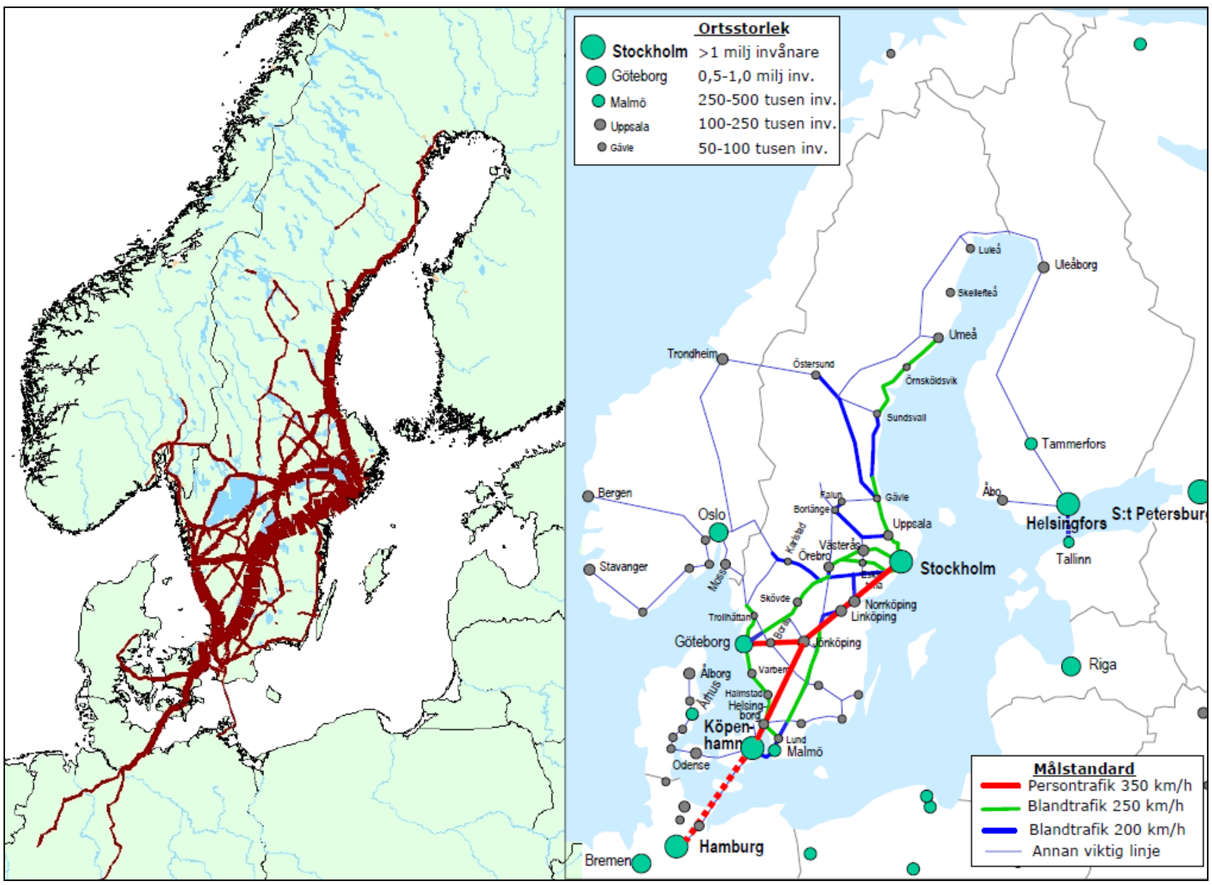

Figure 4 - To the left: Total demand for long-distance travels in Sweden with all modes assigned to the road network and to the right: The proposed high-Speed-Network in Sweden (red).

Apparently the relations that may fulfil the demand requirements are Stockholm-Gothenburg and Stockholm-Malmö and in the same corridors there is also substantial demand for freight transport. The High Speed lines has been defined with a common line from Stockholm to Jönköping and from there one line to Gothenburg and one line to Helsingborg/Malmö-Copenhagen with possibility to continue to Hamburg via the bridge over Fehmarn Bält which is planned to open in 2018.

The High-Speed Line also releases capacity on the Southern and Western Main Trunk Lines for freight and fast regional trains. At the moment there are conflicts here, especially between high-speed trains on the one hand and regional and heavy goods trains on the other. With high-speed trains using the High-Speed lines, the Southern Main Line can satisfy the industry's growing need for efficient export and import of raw materials. It is important for the industry to be able to offer direct, high-capacity, highly punctual trains to the continent.

3.2 Requirements for travel times and supply

3.2.1 Availability

The objective to reach availability can be set by two rules dependent on human time-budget constraints:

- Three hours travel time for business travels in each direction
- One hour travel time for daily commuter travels in each direction

No more than three hours travel time for long distance journeys is necessary to avoid overnight at a hotel and will increase availability and improve productivity.

Competition by car and air will also require short travel times to attract enough passengers in order to achieve profitable operation as well as socio-economic surplus. In order to achieve competitiveness in long term the following targets have been set

- 50% faster than travel by car from city to city to take into account that many car trips do not start at the station
- 30 minutes faster than travel by airplane from city to city including feeder transport

3.2.2 Supply and travel times

From Stockholm, two high-speed services per hour and direction are proposed, to Gothenburg and to Malmö-Copenhagen respectively. One train will be fast with few stops; the other will stop at some more stations. This means that there will be four trains an hour between Stockholm and Jönköping, and one train every 30 minutes serving the intermediate stations. Typical journey times are given in the following table.

The targets mentioned above will be reached for all towns along the line and also for some towns beside the lines. From Stockholm to Gothenburg 2:00 h: travel time is offered, from Stockholm to Malmö 2:27 h and to Copenhagen 2:51 h. Some trains will run on both the old and the new tracks. For example, journey times from Eastern Småland to Stockholm will be reduced by over 20%;

The extension to Copenhagen and Hamburg means journey times between Stockholm and Copenhagen of 2 hours 50 minutes and between Stockholm and Hamburg of 4 hours 40 minutes. The European Line therefore links together many places in Southern Sweden and gives new commuting possibilities in larger integrated regions. At the same time, it ties Sweden together with Denmark and the Continent.

The table below give examples of travel times.

From Stockholm To (h:min)	Objective travel time	Fastest train 2009	Fastest High Speed Train
Linköping	1:05	1:39	0:59
Jönköping	1:45	3:15	1:23
Gothenburg	2:20	2:45	2:00
Växjö	1:50	3:25	2:15
Helsingborg	2:40	5:03	2:13
Malmö	2:30	4:25	2:27
Copenhagen	3:00	5:20	2:51
Hamburg	-	9:55	4:40
Berlin	-	12:12	5:30

Table 3 - Example of travel times between some towns along and beside the European Corridor

3.3 Swedish Governmental considerations

This part of the background is taken directly from the Inquirer in command on behalf of the Government, Gunnar Malm, through direct quotation.

> "In line with the Inquiry's terms of reference, my proposals start from the transport policy objectives, current principles for financing infrastructure investments and the forms for levying track access charges. The ongoing introduction of new rules for market access for rail traffic has also been taken into account in the work of the Inquiry. With regard to the possibility of co-financing, I have followed work on the revision of the regulatory framework concerning the Trans-European Transport Network (TEN-T). In this report the term high-speed railways means railways dimensioned for speeds of over 250 kilometres per hour.
>
> The present Swedish railway network and its main lines were planned and began to be built in the middle of the 19th century. Large parts of the 20th century saw a very substantial concentration of population, especially in the metropolitan areas. The growth of the metropolitan cities in combination with better communications has led to the expansion of labour market region and made it possible for people to settle further and further from their workplaces. This has, in turn, led to more traffic and new traffic systems. The present metropolitan areas are expected to account for 80 per cent of population growth up until 2030. In the longer term Linköping and Norrköping are also expected to make up a metropolitan region.
>
> To meet the future demand for transport and the challenges facing society, it is my view that we are standing at a crossroad where more investment in infrastructure, and not least in railways, in Sweden is a very important factor. We have to meet tomorrow's needs for transport in terms of cost-efficiency, capacity and development.
>
> In my view, building high-speed railways in Sweden would create the conditions for a completely new transport system with better potential for effective goods and passenger transport that will make a crucial contribution to the development of the country. This applies not least to goods transport, since the capacity released in the present railway system will be of very great importance for the possibility of increasing the share of goods transport taken by rail. My assessment is that competitive travel times can be achieved on many routes with traffic using both high-speed railways and conventional tracks. The

traffic alternatives I outline will lead to marked improvements in the accessibility of a large number of communities, even beyond the high-speed network itself.

As a result of the shorter travel times, labour market regions will expand, thus creating conditions for growth and development. The role of the metropolitan cities as communications centres with links to Arlanda, Skavsta, Landvetter and Kastrup will be strengthened. I see an introduction of high-speed railways as a social infrastructure project that will also influence society and its structures as a whole, over and above its direct effects in the form of a very efficient system of passenger transport and a more efficient system of goods transport.

At the same time, we should be aware that high-speed railways involve a very substantial investment and that the negative impacts of the project and its risks are not negligible.

In accordance with my terms of reference, I have compared the development of separate high-speed railways with upgrading and expanding existing railways. A proposal for action to upgrade the southern and western main lines has been prepared. However, it has not been possible, within the time limit for the Inquiry, to carry out a cost-benefit analysis for this alternative. My evaluation of both the alternatives is therefore based on the extent to which they contribute to the fulfilment of the objectives of transport policy. I have had cost-benefit analyses done for the construction of separate high-speed railways between Stockholm and Malmö and Stockholm and Göteborg. In accordance with my terms of reference, the analyses have been carried out using generally accepted calculation methods, which means, in practice, the same methods as are used by the traffic agencies as part of their ongoing planning of measures. The Swedish Rail Administration has calculated the cost of the construction of the two railways in line with my proposals at SEK 125 billion."

4 PREREQUISITES AND ASSUMPTIONS

4.1 Methods employed and demand

The Governmental inquirer chose the Samvips model instead of the Sampers model for the forecasts because it could give a more correct estimation of demand for high speed trains. The business economic calculation was very important so in this case it was considered more important to have as a correct forecast as possible rather than be comparable with other forecasts made by Sampers. Important reasons were also that there was no model for international journeys in Sampers and that it also have unrealistically low elasticities between modes. Samvips has solved these problems and has also the possibility to take into account a more segmented market depending on values of times, competition between lines, price differentiation and journeys that need combinations of modes.

The method for estimation of consumer surplus for the published report from September 2009 was Samkalk, a module in the Swedish model Sampers. This module takes into account effects of changes of rail, only for those who use rail both in the existing situation (ES) and the new situation (NS).

The alternative method employed was Vips also for consumer surplus estimations. With this method the effects of the rail changes are taken *into account for all routes and modes* for both ES and NS.

Demand in total in Samvips originates from synthetic estimations by the Swedish model Sampers. These estimations were in turn based on the Swedish national passenger survey from

2002. The matrices have been adjusted and the model has been calibrated for each mode for the year 2007 before the forecast was made.

Since demand originates from Sampers while calculations are carried out by use of Vips, this combination has been called Samvips. For the Vips calculations of demand per route and mode the total matrix for all modes was used per passenger group.

On this demand basis the method for calculation of demand per route and for travel time components and price for each origin-destination pair (O-D pair) was the network model Vips, both for the existing situation (ES) and for the new situation with high-speed trains (NS). We then segmented the matrix into 13 different passenger categories, which differ with respect to value of time, perceived convenience of modes, car availability, prices for different modes etc.

The table below gives an aggregated view of assumed values of time and the estimated basic demand for these segments at the year 2007.

Category			Value of time SEK/h	Shares of travellers	Number of travellers (millions)	Number of regions in matrix
Regional						
Work	All		51	37%	2 033	683
Other	All		51	59%	3 203	x
Business	All		275	4%	236	683
Sum				100%	5 471	
Interregional domestic						
Private	working	Car available	124	48%	50	
	working	No car	124	3%	3	
Private	pensioners	Car available	62	10%	10	683
	pensioners	No car	62	1%	1	x
Private	Students	Car available	62	15%	15	683
	Students	No car	62	3%	3	
Business	All		450	21%	22	
Sum				100%	103	
Internationell						
Private	All	Car available	150	50 %	13	683
Private	All	No car	200	26 %	6	x
Business	All		800	24 %	6	270
Sum				100 %	25	
Totalt					5 600	953

Table 4 - Aggregation of segments and number of travellers for 2007.

4.2 Our preferred method

We have more confidence in the method where Vips is used straight through, also for consumer surplus calculations. In brief the arguments are as follows.

Samkalk calculates consumer surplus by only taking into account the mode that has been subject to change, in this case rail mode. Existing passengers then gain the change in generalized cost. Addition rail passengers gain half of that (rule-of-the half). This way to calculate consumer surplus is not correct if headway is changed, which it is in this case, besides shorter ride times. A proof of this is found in Jansson et al. (2008).

Samkalk takes into account "main modes" only, meaning that measures where combinations of modes are used to reach the destination cannot be evaluated Thus, complementarities are not taken into consideration for any main modes. If for example certain journeys require an airline or a regional bus first before they board a train, this combination is disregarded. This means that all such journeys where people board a high-speed train after having used another mode will gain nothing.

. This is illustrated by the following example in figure 5:

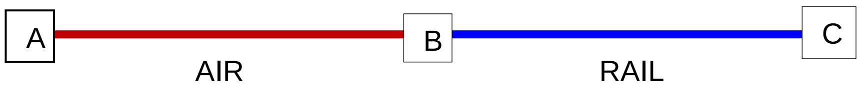

Figure 5: Travelling between A and C

Between A and B there are airlines. Between B and C there are rail lines. Assume that we want to evaluate the effects of high-speed rail between B and C for passengers going from A to C via B. The change in consumer surplus according to Vips is quite large but zero according to Samkalk. The reason is that Sampers does not take into account the possibility to go by air between A and B and then by rail between B and C. Since air is not taken into account when rail is subject to change, Samkalk cannot calculate the effect.

Samvips takes into account all routes (lines) and modes simultaneously.

Trusting in the Samvips method and results in turn means that the high-speed rail is much more beneficial than what the report published in September 2009 concluded.

Steer Davies Gleave (2006) analysed air and rail competition and complementarities, finding that complementarities is valuable in many cases, for example:

> "At two European airports, Frankfurt and Paris CDG, there are high speed rail stations at the airport and there is the potential for rail and air services to complement each other rather than compete. Instead of taking a short distance flight to the airport, in order to connect on to a longer distance flight, passengers can travel by high speed rail to/from the airport, and on certain routes can purchase tickets which include both a rail sector and the air sector".

However, Steer Davies Gleave (2006) also concludes:

> "According to our analyses, the differences in air and rail reservation systems are the main obstacle to marketing complementary air-rail services. Air and rail services in France, Germany and the United Kingdom are currently operating as two separate products. Joint ticketing would support the consumer appeal of the complementary services, but this is expensive and operationally complex".

In Sweden there is in some cases ticket coordination between air and rail operators. For complementarities between regional buses and trains there is Samtrafiken i Sverige AB (the Swedish Public Transport Coordinator), in charge of integration of Swedish transport lines and modes in order to facilitate travelling and ticket purchase where several modes or operators are involved. It is owned by 32 transport companies or authorities, among them all 21 County Transport Authorities (Länstrafikbolag) who operate regional buses, all Swedish Rail operators, ferry operators and Express bus operators.

4.3 Assumed parameter values

Values of time, values of external effects, taxation effects etc. are all taken from the Swedish Institute for Transport and Communications analysis.

5 RESULTS OF INQUIRERS PUBLISHED REPORT

The results presented here are taken directly from the Inquirer in command on behalf of the Government, Gunnar Malm, through direct quotation.

> "In accordance with my terms of reference, I have compared the development of separate high-speed railways with upgrading and expanding existing railways. A proposal for action to upgrade the southern and western main lines has been prepared. However, it has not been possible, within the time limit for the Inquiry, to carry out a cost-benefit analysis for this alternative. My evaluation of both the alternatives is therefore based on the extent to which they contribute to the fulfilment of the objectives of transport policy.
>
> I have had cost-benefit analyses done for the construction of separate high-speed railways between Stockholm and Malmö and Stockholm and Göteborg. In accordance with my terms of reference, the analyses have been carried out using generally accepted calculation methods, which means, in practice, the same methods as are used by the traffic agencies as part of their ongoing planning of measures.
>
> The Swedish Rail Administration has calculated the cost of the construction of the two railways in line with my proposals at SEK 125 billion.
>
> The result of the cost benefit analysis shows a positive net benefit-cost ratio of 0.15. This means that the social benefits of the project are somewhat larger than the social costs. However, in view of the size of the project and the risks associated with this, I consider that further study should be made of the cost-benefit analysis presented here.
>
> In my view, the positive effects that cannot be quantified in the cost-benefit analysis are important to consider. The private profitability of the traffic is assessed as good, which means that the traffic can help to pay for the railway investments.
>
> My conclusion from the result of the cost-benefit assessment and an evaluation of the achievement of transport policy objectives is that high-speed railways are a better alternative than upgrading and expanding the main rail lines. My proposal is that separate high-speed railways for passenger traffic should be built between Stockholm-Malmö and between Stockholm-Göteborg."

6 RESULTS AFTER ELABORATIONS

For the purpose of this paper we have found it more informative to provide details of the results after the elaborations had been made since some figures then changed to a significant extent, without violating the basic result given in section 4. We were in this process also able to estimate the effects of upgrading of the present trunk rail lines, as an alternative to high-speed rail alternative.

In this section instead of mentioning the methods used, we sometimes use WSP for the consultant who used Samkalk and KTH for the Royal Institute of Technology, Stockholm, who used Samvips all through.

6.1 Demand

The table below shows demand 2007 and the forecasts for 2020, for the basic alternative with ordinary investment in rail, for the upgraded trunk line alternative and for the high-speed rail alternative.

Billions passenger kilometres	Situation 2007	Samvips 2020			Differens	
		Base-alternative	Trunk line alternative	High Speed alternative	Trunk-Base	High-Speed-Base
Rail	10,6	16,8	19,9	24,4	3,1	7,6
Air	3,3	3,5	2,4	2,3	-1,1	-1,2
Coach	1,9	1,7	1,6	1,3	-0,1	-0,4
Boat	0,3	0,3	0,3	0,3	0,0	0,0
Local public transport	12,6	15,1	15,2	15,3	0,1	0,2
Private car	103,3	112,4	111,6	109,3	-0,8	-3,1
Walk, cycle, mc	5,4	5,8	5,8	5,8	0,0	0,0
Total	137,4	155,6	156,8	158,7	1,2	3,1

Table 5 - Demand 2007 and forecasts for 2020

The high-speed alternative is estimated to give 50 % increase in rail demand comparing with 20 % for trunk line alternative. The high-speed alternative is estimated to reduce car traffic 4 times more than the trunk line alternative.

Figure 6 below shows the estimated demand along rail lines for the trunk line alternative and the high-speed alternative respectively. The volumes in millions of passengers per year along specific sections are marked in rectangles. One can clearly see the higher demand along all sections in the high-speed alternative.

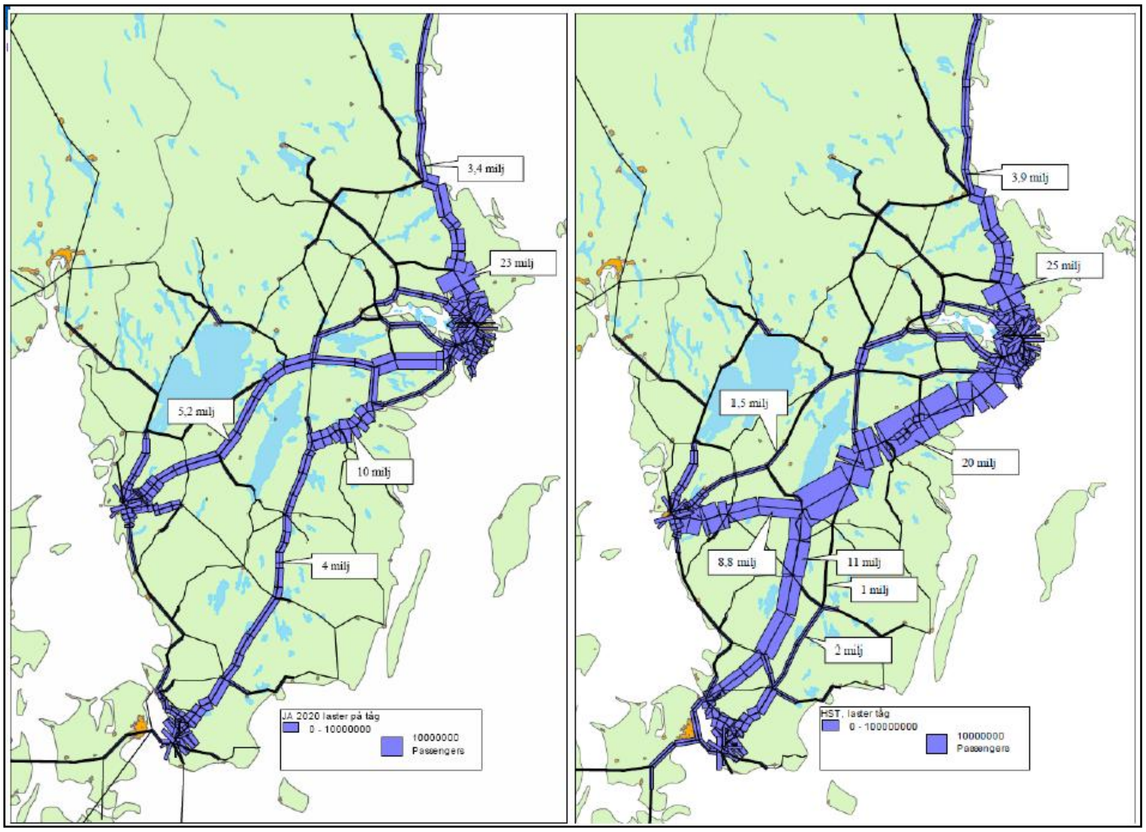

Figure 6 - To the left: Demand according to trunk line alternative.
To the right: Demand for the alternative with separate high speed lines

Figure 7 below shows the estimated demand changes for the trunk line alternative and the high-speed alternative respectively. Green means increases and red decreases. The tiny straight lines show the air demand reduction.

In the high-speed alternative most of the demand will be moved from the trunk lines to the high speed lines and increase. The biggest demand change will be on the common line from Stockholm to Jönköping where the two flows are gathered and then spitted up in two directions.

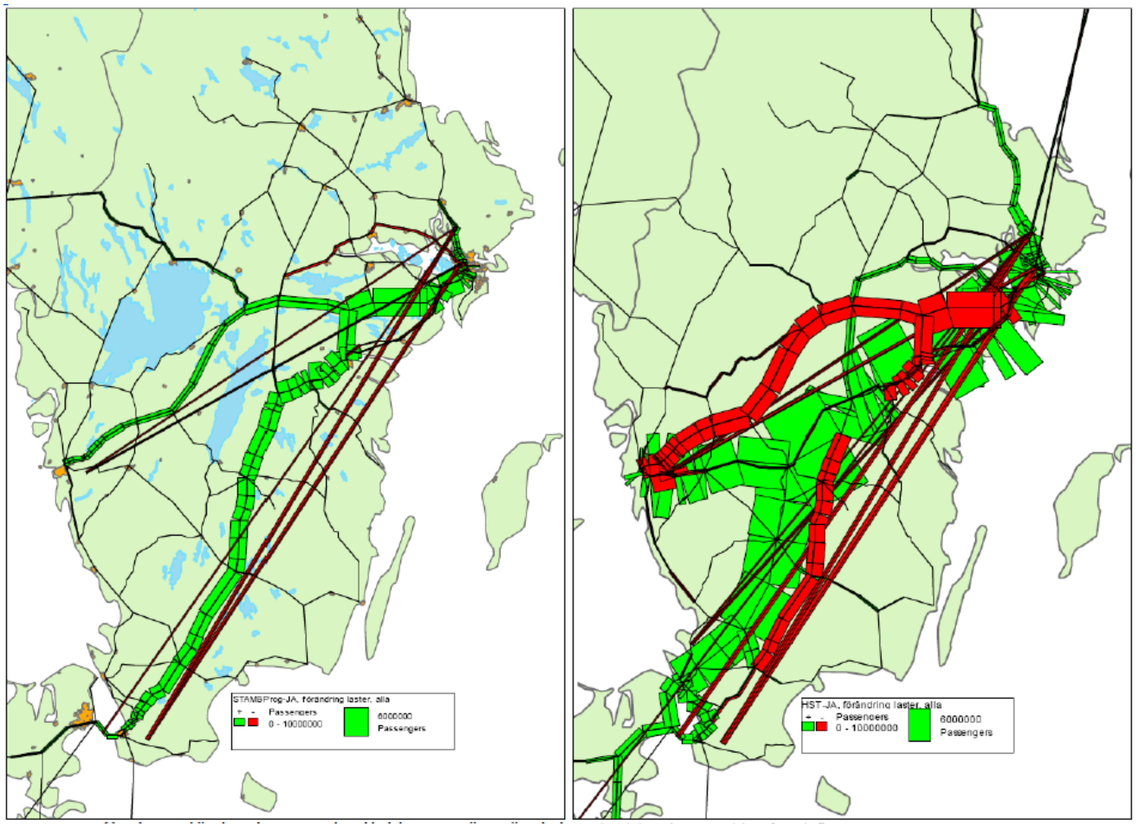

Figure 7 - To the left: Increase (green) and decrease (red) in demand of rail and air network for the trunk line alternative and to the right the same for the high-speed alternative

6.2 Geographical distribution of passenger effects

The two diagrams in figure 8 below illustrate the changes in generalized cost per traveller for geographical areas, for the trunk line alternative and the high-speed alternative respectively. Green circles mean reductions (improvements) and red circles increases (deteriorations).

We note the substantially larger improvements of the high-speed alternative and more deterioration for the trunk line alternative. The large passenger benefits of the high-speed alternative do not only appear along the new rail tracks, but also in other areas that can reach the tracks by various bus and rail feeder lines. The few areas that will lose are harmed by the inevitable reduction of airline frequencies, which is a consequence of reduced demand for air. Note that the reduction of level of service because of this reduction is taken care of in the computation of consumer surplus.

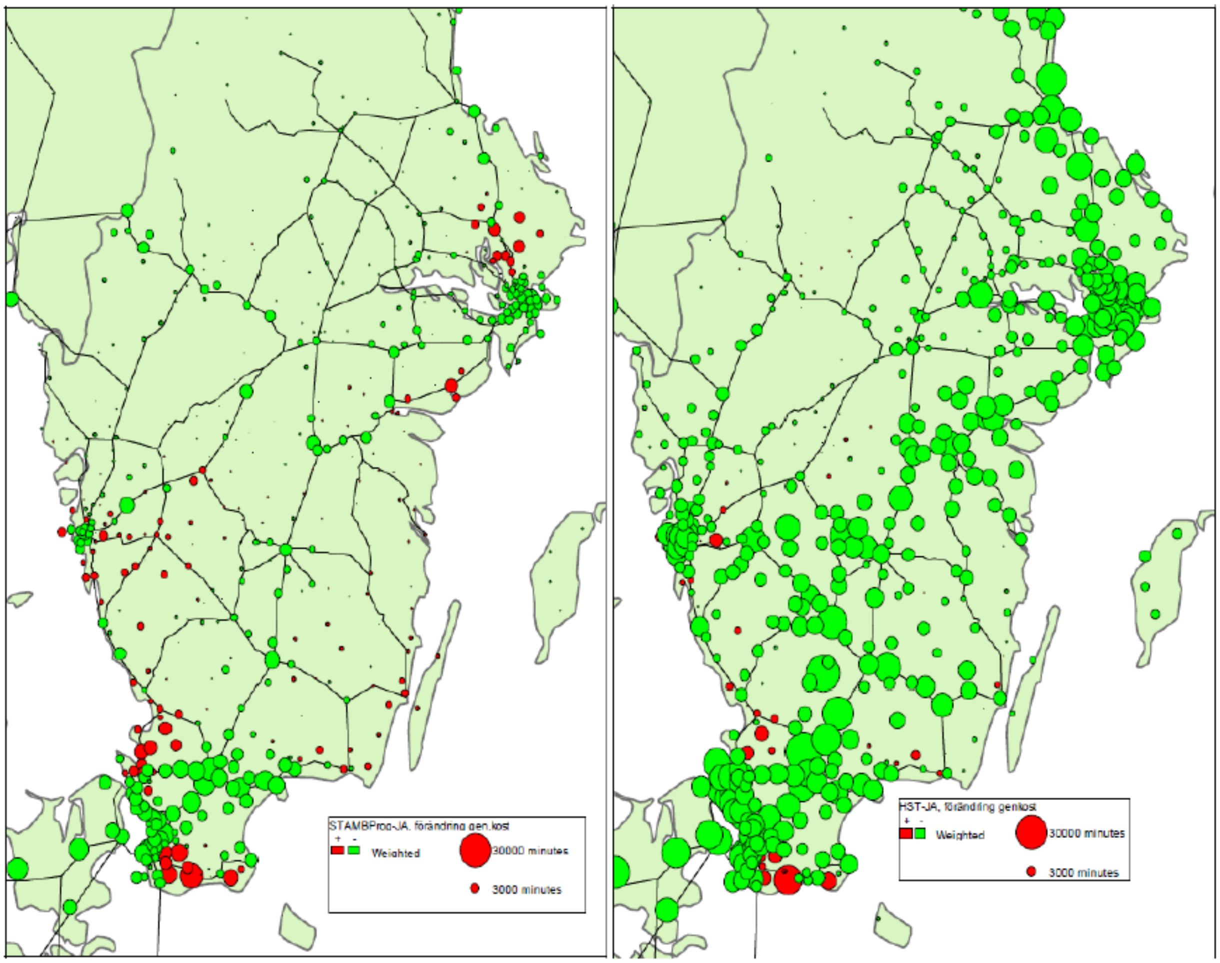

Figure 8 - To the left: Change in generalized cost per area, trunk line alternative. To the right: Change in generalized cost per area, high-speed alternative

6.3 Cost-benefit results

The economic calculations have been carried out by the consultant WSP by use of Samvips plus Samkalk and by the Royal Institute of Technology (KTH) by use of Samvips straight through.

The trunk line alternative has an estimated cost of SEK 54 billion, where the trains can reach 250 km/h and where more tracks and more pass-by stations are included.

The high-speed alternative has an estimated cost of SEK 125 billion, where the trains can reach 320 km/h. In this case the capacity for freight trains and regional trains on the ordinary trunk lines would increase.

The table 6 below shows the calculation results by WSP and KTH respectively. Due to the arguments put forward in section 4.2 we have much more confidence in the calculations by KTH by use of the Samvips method all through. For this reason the following comments refer to that calculation result. It is worth mentioning that the results presented in table 6 assume that the remaining investment value (assumed value of investment after the calculation period) has been put as an extra benefit. The alternative is to put this value as a reduction of the investment cost, which the Swedish Rail Administration recommends. In the latter case the net present value ratio is 0.4 for the trunk line alternative instead of 0.2 and 0.9 for the high-speed alternative instead of 0.8.

In the high-speed alternative the passenger traffic would get 88 % of the benefits and the freight traffic 12 %. For the passenger traffic consumer surplus comprises 50 %, producer surplus 40 %, positive external effects 15 % and the negative public sector finances minus 10 %. The producer surplus can partly be used for financing of the infrastructure.

The high-speed alternative has a far better economic outcome than the trunk line alternative. The investment is thus almost paid twice during the assumed calculus period 40 years. Note also that the trunk line alternative would give substantially lower capacity increase compared to the high-speed alternative.

If the trunk line alternative would have the same capacity as the high speed alternative it would be necessary to build four tracks along the whole trunk lines. Besides the original 54 billion SEK investments this would in addition cost 125 billion SEK and that is what the whole high-speed alternative is calculated to cost. At the end the capacity would be the same but the travel times would still be longer and the construction works would cause severe disturbances and longer ride times during the construction period.

Billions SEK Discounted to present value 40 years calculation period	Trunk line alternative WSP Samkalk	 KTH Samvips	High Speed alternative WSP Samkalk	 KTH Samvips
Passenger transport				
Consumer surplus	***17,8***	***13,3***	***44,7***	***81,8***
Travel times	17,8	13,3	44,7	63,1
Prices		-0,1		18,8
Producers surplus	***17,1***	***30,4***	***52,6***	***65,7***
Ticket revenue rail	61,3	46,4	132,6	133,4
Costs rail	-27,8	-14,1	-58,2	-65,1
Ticket revenue air	-48,5		-59,9	
Costs air	32,1	-1,7	38,1	-2,2
Other operators net revenue costs		-0,2		-0,3
Public sector finances	***-5,9***	***2,3***	***-22,7***	***-14,1***
Taxes road traffic	-6,8		-18,1	
Vehicles costs	0,9		-4,6	
External effects	***11,4***	***7,7***	***26,6***	***24,1***
Air pollution and climate gases	7,9		13,5	
Traffic accidents	3,2		13,0	
Marginal damagage roads	0,3		1,3	
Marginal damagage public transport	0		-1,2	
Sum passenger transport	**40,4**	**53,7**	**101,2**	**157,5**
Freight transport	***4,3***	***7,7***	***14,2***	***20,2***
Time gains		0,3		0,8
Transportation costs	2,1	3,4	6,4	8,9
External effects	2,2	4,0	7,8	10,5
Infrastructure				
Operation, maintenance, reinvestments	***-3,7***	***-2,1***	***-7,5***	***-5,7***
Remaining investment value	***2,6***	***2,7***	***10,7***	***10,7***
Sum benefits	***43,6***	***62,0***	***118,6***	***182,7***
Investment costs				
Tracks	-42,9	-44,8	-98,9	-98,8
Freight terminals	-1,3	-1,4	-4,1	-3,9
Sum investments	**-44,2**	**-46,2**	**-103,0**	**-102,7**
Benefit-costs	**-0,6**	**15,8**	**15,6**	**80,1**
Net present value (benefits-costs)/investments cost	**0,0**	**0,3**	**0,2**	**0,8**

Table 6 - Cost benefit results according to the two methods for the two alternatives

7 SKEPTICISMS

In order to show that our conclusions and those of the Governmental inquirer are not undisputed we summarize here some sceptical viewpoints, put forward in the published report and in newspapers. For each of these we also give our comments.

Per Andersson, member of the expert panel in the investigation (reservation in the published report)

The alternative to invest in upgrading of the existing trunk rail network should have been subject to a cost-benefit analysis along with the analysis of high-speed rail in order to compare.

Our comment

We agree, and this comparison is made in the elaborations

Lars Hultkrantz, member of the expert panel in the investigation (reservation in the inquirers published report)

Some costs have been ignored, such as necessary capacity improvements in Stockholm and Göteborg,

Positive environmental effects are small and some environmental worsening is ignored.

One should have applied an excess burden effect of public finances.

The transport volumes are exaggerated, for example due to that probable price increases are ignored.

Our comment

The improvement in Stockholm and Gothenburg must be done mostly for regional traffic and even if there are no high speed lines.

The environmental factors which are possible to quantify are valued in the socio-economic calculation at the stipulated values and stand for approx 15% of the benefit.

The excess burden effect of the public finances is also calculated with the method employed.

The transport volumes are not exaggerated since present prices for car and airplanes have been used and rising oil prices have not been taken into account. The demand for high speed trains is consistent with international experiences.

Roger Pyddoke, Jan-Erik Nilsson, report to the Ministry of Enterprise, Energy and Communications

The socio-economic profitability of high speed investments is low and probably negative. Investments in existing lines are more efficient.

The big investments in high speed rail cannot be motivated by climate-effects. There are more efficient measures to reduce Carbon-dioxide.

Our comment

The analysis they refer to concerns only a part of the high-speed rail network (Götalandsbanan). The forecast was made by Sampers, which underestimated the effects. Investments in existing lines will be more expensive than they think and will not get the same capacity and as short travel times as high-speed trains.

We agree that one cannot invest in high-speed lines only because of the environmental effect. The main reason is increased availability though shorter travel times and increased capacity for freight, and one gets the environmental effect as a bonus.

Per Kågeson in the daily newspaper Dagens Nyheter

Transfers from airplanes are overestimated.

The travel time gains of high-speed trains are not much more than the travel time gains of upgrading of the existing trunk lines.

The climate effects are small.

The alternative to invest in conventional main lines may be more efficient

Our comment

The international experience from rail-air market share depending on travel time by train is very strong. It has been proved in many cases and reports and is the most foreseeable effect which is possible to calculate without advanced forecast models. Our Samvips forecast is consistent with international experience.

The calculations indicate that the travel time gains of high-speed trains are three times those that upgrading of the trunk lines would give. Kågesson is also ignoring the fact that high-speed tracks would very much increase the capacity on the existing trunk lines, to the benefit of travellers and to freight transport on these lines.

With respect to climate effects and other external effects Kågesson is right in saying that they are small in the short time perspective. But they can be more important in a long term perspective taking into account structural effects. Anyhow the main benefits originate from time savings and larger producer surplus for the rail operators.

8 CONCLUSIONS

We agree with the Governmental inquirer’s conclusion that high-speed rail investment is a good idea for Sweden.

Our analysis has shown that this conclusion can even be strengthened if a method is used where all modes are taken into account, not only rail.

We also conclude that investment in high-speed rail is much more beneficial than investment on trunk lines. It is of great value that high-speed rail also allows a capacity increase on the ordinary trunk lines, both for passengers and freight, and this aspect has not been quantified.

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