KUNGL. TEKNISKA HÖGSKOLAN
Royal Institute of Technology

DEPARTMENT OF INFRASTRUCTURE

TRITA-INFRA 03-041
ISSN 1651-0216
ISRN KTH/INFRA--03/041--SE

Introduction of regional high speed trains

A study of the effects of the Svealand line on the travel market, travel behaviour and accessibility

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Ph. D. Thesis
Division of Transportation and Logistics
Stockholm 2003

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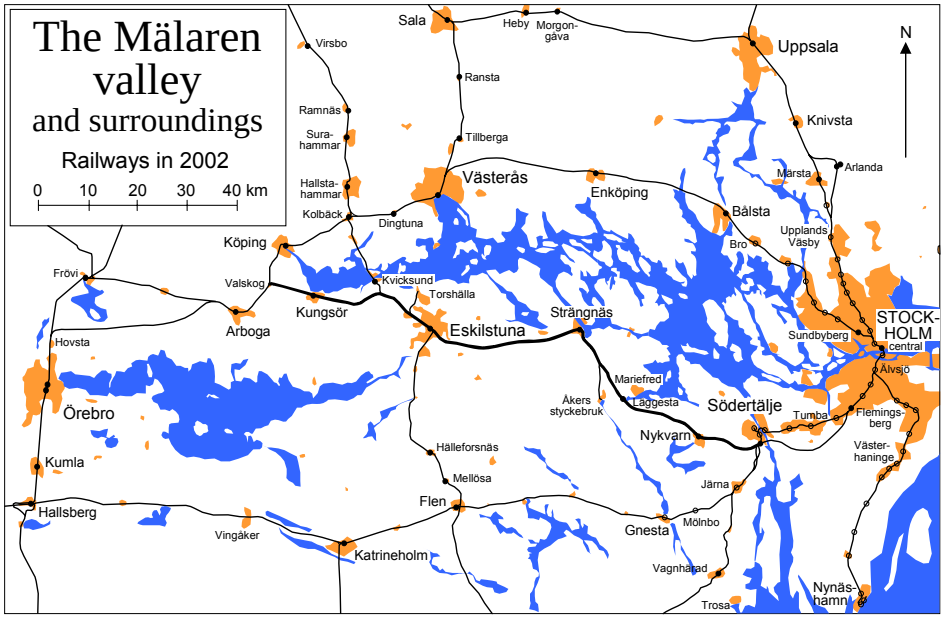
English translation: Ian Hutchinson (except ch. 10, appendices 1-6 and 9 by the author)
Swedish title: Introduktion av regionala snabbtåg. En studie av Svealandsbanans påverkan på resemarknaden, resbeteende och tillgänglighet. KTH TRITA-INFRA 03-040. Stockholm, 2003

ISBN 91-7323-041-3
Printed in Sweden by Universitetsservice US AB, Stockholm 2003



The Svealand line is shown in semi-bold.

This thesis is dedicated to the women and men
whose time and effort have made the Svealand line a reality

Next page: A high speed train to Stockholm on the Svealand line at Läggesta in 1997. Läggesta station can just be seen in the background.

Bild_lg.tif

Helsida, UTFALLANDE

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Foreword

This thesis is one of the results of the research project entitled "The establishment of new train services – their effect on travel demand and social structure. The Svealand line". The project was run from 1996 until 2002 at the Division of Transportation and Logistics of the Royal Institute of Technology, Kungliga Tekniska Högskolan (KTH), in Stockholm. A research report of the results was presented at the halfway point in 1999.[1] The present thesis constitutes the concluding report of the research project. The thesis is published in English, while a corresponding research report is available in Swedish.

My principal supervisor over the course of writing the thesis was adjunct professor Bo-Lennart Nelldal, assisted by Karl Kottenhoff and professor Lars-Göran Mattsson. All the material in the thesis has been produced by the author, with the exception of the accessibility studies using the Sampers modelling system for forecasting travel demand where a consulting firm, Transek AB, were responsible for making the analyses.

The project was principally financed by Banverket (the National Rail Administration) and the Swedish Agency for Innovation Systems (Vinnova, previously KFB). The Swedish Institute for Transport and Communication Analysis (SIKA), Trafik i Mälardalen (TiM; a company jointly owned by SJ and the other local public transport authorities to cooperate on tickets), the Södermanland county administrative board, Stockholm and Södermanland county councils and the local authorities of Södertälje, Nykvarn, Strängnäs, Eskilstuna and Nyköping have also contributed with financial support for the surveys.

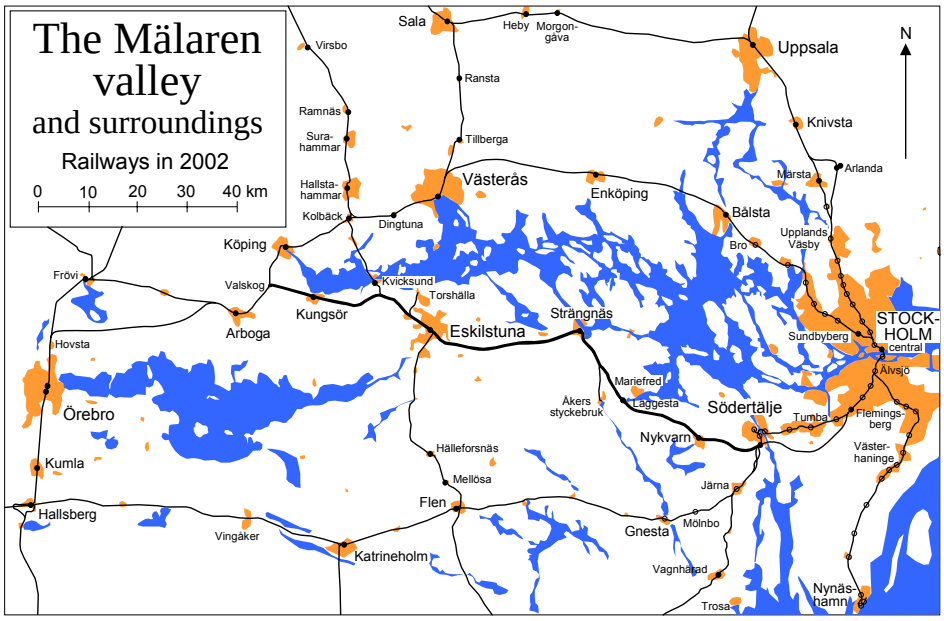
My sincere thanks are due to all the people, who must remain anonymous, who filled in the questionnaires and participated in computer-based interviews in the surveys, without whom the thesis would not have been possible. My thanks also to all my contacts at the local authorities and others who have helped me by freely giving of their information and knowledge and making comments on the thesis.

Finally, I would also like to thank Bolle, Kalle and Lars-Göran for their help as supervisors over the course of the project, which proved invaluable for teaching an engineer to be a researcher.

Stockholm, February 2003

Oskar Fröidh

[1] Fröidh (1999)



The Svealand line (shown in semi-bold) opened in 1997 and has led to a marked increase in travelling by public transport.

Summary

Introduction and methodology

Background

The Svealand line was opened in 1997 and replaced an older, less adequate line. It consists of a newly built, and for the most part single-track, line from Södertälje to Eskilstuna (79 km), and a modernised stretch from Eskilstuna west to Valskog (35 km). Trains can thus continue towards Örebro and Hallsberg. From 2000 on trains also run north of Stockholm, via Arlanda airport to Uppsala. Together with other infrastructure investments in the Stockholm area, this means that regional high speed trains can cover the distance between Eskilstuna and Stockholm (115 km) in just an hour, making five stops along the way.

Considerable sums have been invested in improvements to the Swedish rail network since the 1990s. In the Mälaren valley in particular several new lines have been built or older lines modernised to cope with speeds of up to 200 km/h. The main aims were to facilitate daily commuting so that the people living in the region can live and work in different places, thus evening out imbalances in the housing and labour markets, and to spread the economic growth from Greater Stockholm

to the surrounding area through improved accessibility. Such investments in regional high speed trains to achieve these ends are very rare in an international perspective.

Aim

The market effects of the introduction of the regional high speed trains on the Svealand line have been studied in a case study in a research project run at the Royal Institute of Technology, Kungliga Tekniska Högskolan (KTH), in Stockholm from 1996 to 2002.

The aim of the research project was to find general market effects arising from the improved market supply, i.e. the connection between a radically improved supply of train services on the one hand and travel demand and accessibility on the other. The general market effects that can be expected to occur can be used as indicators that changes in the social structure will become apparent in the long term. The knowledge will be able to be used to improve and further develop various models for transportation and social structure, may be used in drawing up the decision-making bases for other infrastructure investments that may be considered in the future, and to identify areas where further research would improve the basic information underlying social planning, and contribute to a better understanding of the problem.

Theory and model

Underpinning the analyses are theories and models of the effects of infrastructure investments on regional economic development, and the linkage between traffic and social structure. The effects occur over varying lengths of time, and the effects of traffic are generally seen more quickly than the effects on the social structure. Through the mutual interaction between traffic and social structure the effects of a radical change in supply will be observed in a change in demand over a prolonged period of time, until a new theoretical equilibrium emerges.

Methodology

The research project was carried out as a before and after-study (ex ante, ex post) of the supply and its influence on demand and accessibility. The study included quantitative field surveys with questionnaires sent by post to people living along the line, and interviews with public transport users with the aid of portable computers on the buses and trains along the stretch in question. Both the Stated Preferences (SP) and Revealed Preferences (RP) methods were used in the interviews to study individuals' knowledge and valuation of the supply and travelling behaviour.

The postal questionnaires were sent each year the surveys were made to a sample consisting of 2 400-3 000 people between the ages of 16 and 74 who live along the line, principally in the urban areas of Nykvarn (6 000 inhabitants), Mariefred (3 700 inhabitants), Åkers styckebruk (2 800 inhabitants), Strängnäs (14 000 inhabitants) and Eskilstuna (58 000 inhabitants). The surveys were carried out three times; in 1997, for bus traffic before the Svealand line was opened, and in 1998 and 2000 for high speed trains. At the same time, each year surveys were made, some 500 interviews were carried out, using portable computers, among bus and rail passengers.

The same surveys have also been carried out of people living in the reference population centre, Nyköping, and on the Nyköping line. Nyköping (27 000 inhabitants, 105 km south west of Stockholm) has not seen the radical change in public transport supply over the period, but otherwise has comparable characteristics.

The change in accessibility when the line was opened has been calculated by a consultant, Transek AB, using the Sampers forecasting system.

Supply and demand

The improved public transport supply between Eskilstuna and Stockholm brought about by the new railway line has led to substantial increases in travelling.

Supply and demand, regional travel on SJ between Eskilstuna and Stockholm

Period	*No. of services Mon-Fri, each dir.*	*Travelling time (hrs:mins)*	*Fare, single, 2nd class (Skr)*[1]	*No. of journeys (000's/yr)*[2]	*Incr. factor*
Up to spring 1993	8 trains	1:40	115	230	1
Autumn 1993-spring 1997	18 buses	1:55-2:20	105-120	440	2
Summer 1997	17 HS trains	1:00	55	1 400	6
Autumn 1997	17 HS trains	1:00	110	1 200	5
2001	18 HS trains	1:02	113-135	1 600	7

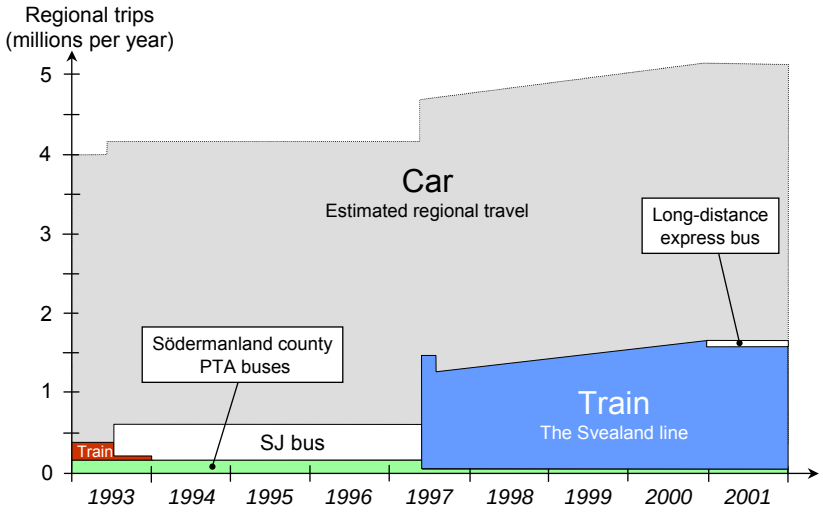
[1] Fares are shown in current prices

[2] Regional travel over the county border (Läggesta–Nykvarn section)

There had been a railway on this route for a long time but supply was far from good with long travelling times and infrequent trains. While the Svealand line was being built, the old train service was discontinued and replaced by buses operated by SJ, with, in principle, the same frequency as for the new trains on the Svealand line. All the buses went

via Strängnäs, unlike the old rail service which required a connection from Åkers styckebruk.

Total regional travel over the county border, 1993-2001



Estimated total regional travelling across the border between the counties of Södermanland and Stockholm (Läggesta–Nykvarn section).

When the new trains began operating, both SJ's bus service and the county transport authority's bus service that operated in parallel with SJ's, were discontinued and travelling times were halved. Frequency is one train an hour, with some extra trains at peak periods. During the first few years the service was operated with comfortable high speed trains of the X 2000 type, and a travelling time of one hour between Eskilstuna and Stockholm. This resulted in a marked increase in demand with regard to regional travel by public transport. Travel by train between Eskilstuna and Stockholm increased to 1.6 million trips across the county border in 2001, seven times as many as with the train service on the old line in 1993. To this increase should be added the inter-regional travel that takes place without crossing the county border and the inter-regional travel between Örebro and Stockholm that previously had mainly gone by way of Hallsberg.

Regional car traffic fell when the high speed train service began on the Svealand line, but has subsequently increased, among other things through the conversion to motorway of the E20 road that runs parallel. The rail service's market share has increased from 6% to about 30% for regional trips (between Eskilstuna and Stockholm or shorter) in the E20/Svealand line corridor. For travel that involves a connection to reach the most important destinations, principally via the Läggesta (change from Mariefred and Åkers styckebruk) and Södertälje South

stations, the market share for train travel is noticeably lower. However, for trips to and from Stockholm especially, the Svealand line has meant increased travelling.

Approximately half of the passengers on the Svealand line in 1998 had previously been bus passengers, while the other half were newcomers to public transport. The new rail passengers are estimated to have come from SJ's former bus service (30%), the regional public transport authority's former bus service (25%), car travellers (15%) and new travellers (30%).

Knowledge, valuation and behaviour

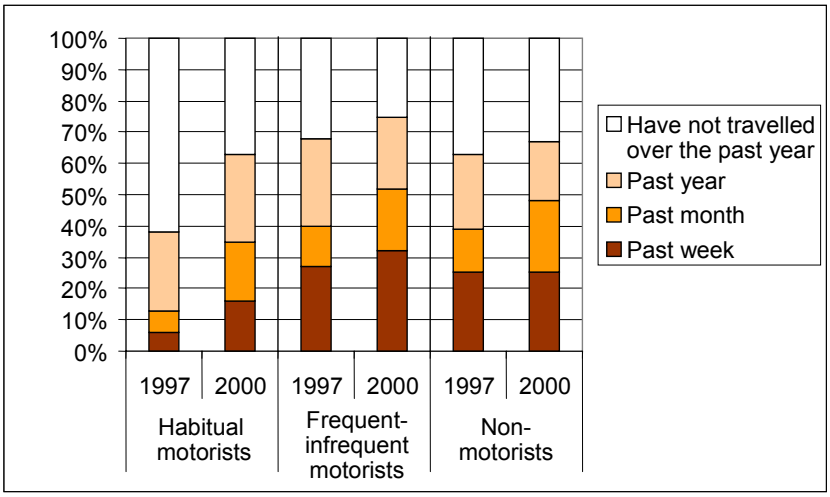
Knowledge of the train service supply is good among residents along the line. Of the respondents living in Eskilstuna, 70% stated in the course of the surveys conducted before the service began in 1997 that the frequency of service on the Svealand line would be one train an hour. Their knowledge of the bus service was not nearly as good. In 2000, 90% presumed that the trains ran once an hour.

Valuation of the train service supply is dependent upon where people live and their socioeconomic group, but in general valuation has risen during the period the surveys have been conducted. In 2000 travelling time was valued at 50-70 Skr/h by people living along the Svealand line, and higher in places with a large proportion of commuters, but at only 35 Skr/h by people living in Nyköping. The value of the high speed trains, and to a certain extent normal trains compared to buses, is higher for long trips than for short ones. The difference, on the other hand, is not significant for people living in Mariefred and Åkers styckebruk who have a connecting service to the station in Läggesta.

Motorists especially value the high speed trains highly, both because they are fast and because they are very comfortable, while normal trains are less attractive and buses hardly attractive at all to motorists.

Both before and after the opening of the Svealand line, travel by public transport was greatest among those who have access to a car at times, i.e. the infrequent motorists. This group contains many people with a relatively high degree of mobility who live in a household with a car, but who do not have access to the car all the time. The group therefore consists predominantly of married and cohabiting women, but also a number of young people living with their parents.

Last trip by public transport on the E20/Svealand line made by people living in the communities along the route



Last trip by public transport on the E20/Svealand line made by people living in the conurbations along the Svealand line, before and after opening of the Svealand line. Habitual motorists always have access to a car, non-motorists never. By access to car.

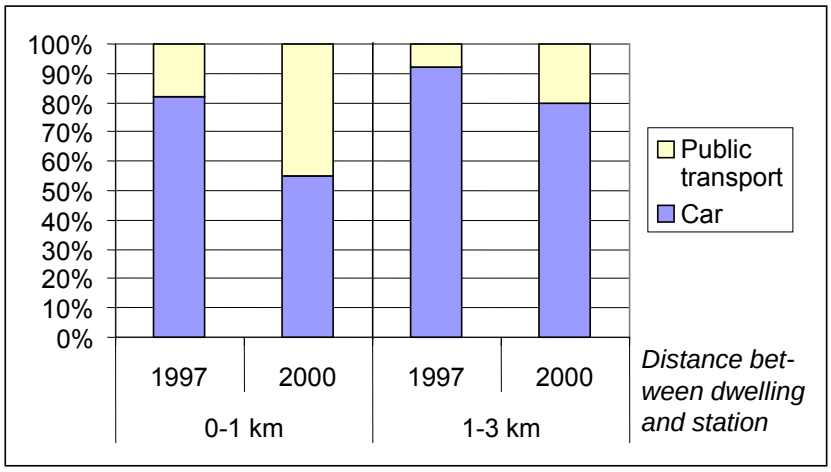
The survey shows that it is people who always have access to a car, the habitual motorists, who have proportionally increased their travelling by public transport most. This group consists predominantly of married or cohabiting middle-aged men. The non-motorists include many single people who for financial or health reasons often lack the prerequisites to acquire a car. For all groups, trips made more seldom (in the past month) have increased since the regional high speed trains began operating, which indicates an increase in social and cultural contact outside peoples' home areas through the use of public transport.

The proportion of households with two or more cars has not increased along the Svealand line since the train service began, while the proportion increased by 3 percentage units for the country as a whole between 1997 and 2000. For the latter year, consequently, there are significantly fewer households with more than one car in the centres of population along the Svealand line, and this trend can be seen most clearly in the central parts of Eskilstuna and Strängnäs.

The socioeconomic factors that give significant increases in travel by public transport include men, age group 25-44, self-employed, full-time employed or university educated people. Significant reductions in car travel among full-time employed or secondary school educated people can also be seen. One conclusion is that many people of a productive age with access to a car have begun to travel by train. The train service

has also contributed to an equalisation of general differences between men's and women's travelling by car and public transport.

Distribution of travel mode for people living in Strängnäs



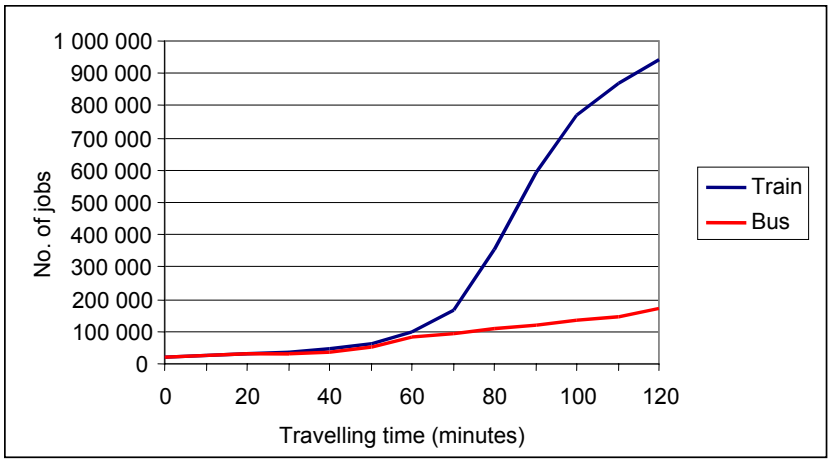
Travel mode distribution for Strängnäs residents for trips along the E20/Svealand line corridor. Walking distance 0-1 km, cycling distance 1-3 km from the railway station.

The improvement in the supply and the greater accessibility with public transport as a consequence of the Svealand line train service has given rise to differences in the generation of journeys, in car-ownership, in distribution of mode of transport and to a certain extent also in the choice of destination. The effects are most apparent among residents close to the railway stations, within walking distance of the stations in Eskilstuna and Strängnäs. For example, they have changed the distribution of transport mode for journeys on the E20/Svealand line from 20-25% public transport in 1997 to 45-50% public transport in 2000. Further from the stations, the proportions using public transport are substantially smaller.

Accessibility

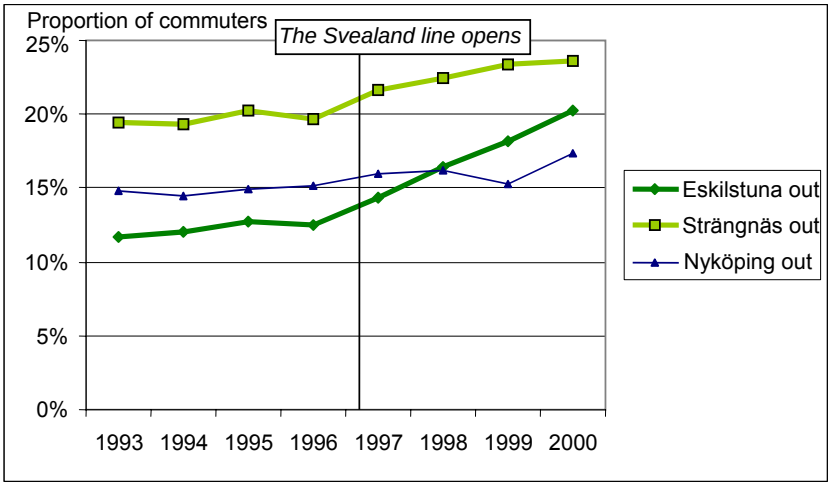
Travelling times with public transport along the Svealand line were significantly shorter once the line had opened, just as the new, comfortable trains raised the level of comfort. For a trip from the central parts of Eskilstuna, Strängnäs and Nykvarn to the centre of Stockholm the train is always faster than the car. The potential accessibility of, first and foremost, Stockholm's large labour markets has been influenced by the faster public transport connections.

Accessibility of places of work from the centre of Eskilstuna, two-hour trip



The number of places of work within 120 minutes' travelling time using public transport from the station in Eskilstuna compared with bus before, and with high speed train on the Svealand line.

Proportion of commuters to the municipality of Stockholm of total commuters



Proportion of commuters to the municipality of Stockholm from the municipalities of Eskilstuna and Strängnäs along the Svealand line, and from the reference population centre, Nyköping. Source: SCB

High speed trains make it possible to reach more places of work than was possible with the bus service within 60 minutes' door-do-door travelling time from the centre of Eskilstuna. The increase within an hour's travelling time, which is most frequent for travelling to and from work, is therefore comparatively modest. Half a million places of work can be reached within an hour and twenty-five minutes by high speed train. Longer journeys to work than this are unusual, and a large proportion of

Stockholm's labour markets are thus too far away, despite the regional high speed trains on the Svealand line.

In spite of the relatively long travelling times for commuting, it shows a substantial increase. The number of people commuting to the municipality of Stockholm from Eskilstuna increased by 125% between 1996 and 2000. Commuting to Eskilstuna from Stockholm also increased, but from a lower level. Commuting to and from Strängnäs was greater from the outset and has increased by 40-60% in four years. The high speed trains have contributed to the substantial increase in the number of commuters.

Conclusions

Regional high speed train services

- When planning traffic systems it is important to identify critical intervals and leaps in the effects on travelling and social structure to ensure the best results of the investments. Evaluations and effects tend to be non-linear. At certain threshold values, therefore, a good supply is evaluated more highly than a poor one.
- Evaluations of the supply vary between different types of trip and between different socioeconomic groups. In order to take into account the distribution aspects of changes in supply, the groups in the analyses need to be separated.
- The collective effects on demand of a radical improvement in supply through the use of regional high speed trains are relatively large, given that the supply is sufficiently good compared to other travel opportunities.
- Short travelling times, high frequency, and a reasonable price are decisive for train services' ability to take a greater market share and generate new regional journeys.
- The trains' soft supply factors, high comfort, good service and modern design, contribute to their attractiveness and lead to more travelling.
- People with access to a car often prefer regional high speed trains because of their attractive characteristics, while an unsatisfactory supply of train or bus services will to a great extent only serve as a reserve alternative to the car.
- Walking distance to and from the railway station is important for the attractiveness of the train service supply in the case of regional travel.
- Falling generalised travel costs in the regional high speed trains' niche increase both the number of trips made and their length. Travelling times also tend to be longer than would otherwise be regarded as acceptable for daily trips.

- Many journeys are transferred from the car to regional high speed trains, which also has an effect on car-ownership.
- Regional high speed trains contribute to expand the region as daily commuting is possible over greater distances than the range of the car permits. This generates a relatively large proportion of new train journeys compared to journeys transferred from the car.
- The high concentration of places of work and the congestion on the roads in the centre of the region are factors that contribute to promote regional high speed train services in metropolitan conurbations.
- Regional high speed trains contribute to better accessibility as a whole in the region, and can thus provide a stimulus to the economic development of the region if the necessary prerequisites exist.

Methodology issues

Several methods need to be used to take into account the full effects of an improved supply. The methods give different results and are appropriate in different areas.

The modelling system for forecasting travel demand, Sampers, underestimates the effects, and consequently also the accessibility, of high speed rail connections in the Mälaren valley.

Future research

The project identified a number of interesting areas for further research. The ability of the forecasting models to handle major changes in supply and dynamic effects on demand must be improved.

Continued research into the regional effects of the Svealand line would clarify how far the increased accessibility engendered by the improved supply can contribute to regional economic development.

The Svealand line research project primarily studied its introduction and the time aspect of the change in supply in a given location. Continued research might focus on a general study of regional high speed trains in different geographical locations.

1. Introduction

1.1 Background

1.1.1 Transportation in Sweden

During the post-war period, travelling has increased both with regard to the number of journeys and the length of the journeys. The total transportation has thereby increased drastically. Over the same period, society has invested large sums in the traffic systems, principally the road network where the standard has been raised and capacity increased continuously. The car has become the property of everyman, even if ownership (and mobility) are not evenly distributed among different socioeconomic groups.[2] [3] Road traffic is now the major form of transportation all types of traffic considered and in 2000 accounted for 81% of all domestic passenger traffic in Sweden.[4]

Through its overall predominance as a means of travel since 1955, road traffic has contributed greatly to the transformation of our society over the last half-century. Air traffic has also grown extensively over the same period, it is true, but its primary importance is for long-distance domestic business trips and for international travel.

Railway traffic, on the other hand, has stagnated during the post-war period and its development has been mainly characterised by closures and various measures to rationalise both goods and passenger traffic. Sweden changed course with the adoption in 1988 of a new rail transport policy, which separated rail services from the infrastructure with the formation of Banverket (the National Rail Administration). The railways were thus given a liability for costs similar to that which applies for road traffic, a so-called road traffic model, which means that the infrastructure is administered according to social economic principles while the transportation companies (the operators) are commercial enterprises with a stipulated return requirement.

In combination with the major investments in new, modernised lines that began during the 1990s, the railway network is gradually being aligned to new market conditions. The replacement of old, slow trains

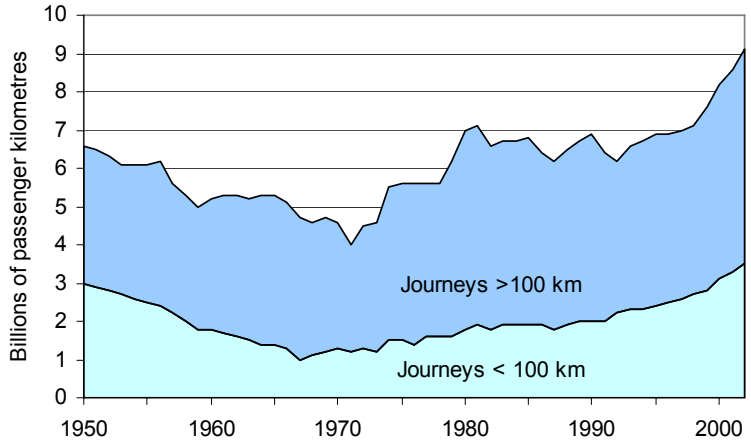
[2] Married men (with higher incomes) have considerably higher car ownership than for example single people, women, young people and pensioners. Figures from Statistics Sweden

[3] Krantz (1999)

[4] Uppföljning av de transportpolitiska målen, *Follow-up of the goals of the government's transport policy* (2001)

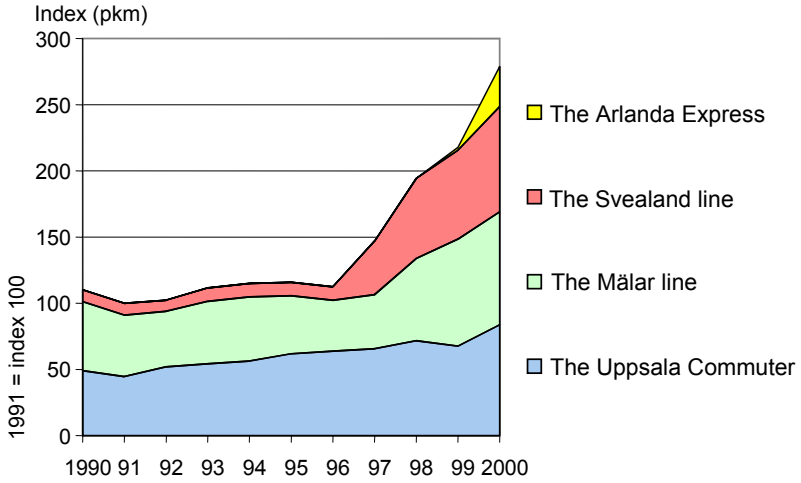
with new, fast, comfortable trains with a high frequency of service creates new travel opportunities for regional and long-distance journeys. The railways have thereby now left behind the contraction phase of the post-war period and entered a phase of expansion.

Development of rail travel 1950–2002



Domestic rail traffic transportation in Sweden 1950-2002 in billions of passenger kilometres (pkm), divided into journeys up to 100 km (local and regional travel), and journeys longer than 100 km (interregional travel). Source: Nelldal (2002)

Regional travel by train on some lines in the Mälaren valley 1990-2000



Rail travel index (transportation, pkm) in the Mälaren valley. Source: Nelldal and Troche (2001a)

Train services became attractive for daily commuting, business trips and other medium to long-distance journeys, and consequently took a larger market share. The late 1990s saw a particularly large increase in

rail travel, which coincided with the start of the train services on the Svealand line and the completion of a number of other new investments.

1.1.2 The Svealand line's effects on society

Several major investments in new infrastructure were made in the Lake Mälaren valley during the 1990s. The Arlanda line, a new stretch of railway via Arlanda airport, the Mälar line between Stockholm, Västerås and Örebro north of Lake Mälaren and the Svealand line via Eskilstuna south of Lake Mälaren are a few of the new and modernised lines. An explicit goal of the investments in the new lines was to create prerequisites for greater economic growth and regional development. This can be achieved by new trains with short travelling times contributing to improved accessibility. This in turn makes it possible for people to live and work in different places, which contributes to an equalisation of differences in the housing and labour markets, supports companies' competence supply and counters the effects of fluctuations in the local labour markets.

The train services on the Svealand line link Stockholm and Södertälje with Strängnäs, Eskilstuna and Arboga, and connect to the Mälar line to Örebro. In Eskilstuna, a regional centre, many places of work in traditional manufacturing industries disappeared in a structural change and a deep economic recession during the 1980s and the beginning of the 1990s. The Svealand line would be able to contribute to alleviate these effects for the inhabitants by making it possible to commute to work, and through new companies setting up in the area. Local and regional support for building the line was quite naturally substantial here.

1.1.3 Insufficient knowledge about the effects

Knowledge about the effects on the market of new train systems for fast regional travel was insufficient. A radically changed supply can be assumed to give rise to dynamic effects on travel demand, something which can not be adequately calculated with conventional forecasting models. There were also many who doubted that the new supply would really produce an increase in travelling of the magnitude implied by the forecasts.

A major improvement in supply means that accessibility in the area also improves generally speaking, which with the proper prerequisites in other respects can provide the stimulus for regional economic development. Accessibility by car in the existing road network was already good, and another question was consequently how far general accessibility could be improved with new rail connections. If accessibility improves

relative to the situation at the start, it can be assumed that the improved supply will have an impact on the social structure in the long term.

The primary issue was to follow the linkage between supply, demand and accessibility. An increase in travelling is an indication that the supply has led to better accessibility on the whole. The question of whether better train services can attract commuters is of especial interest.

1.1.4 Case study of the Svealand line

The Svealand line was opened in 1997. The new train services replaced bus services, which in turn had a few years earlier replaced the train services on the old line when construction of the new line commenced. The radical approach of building a new line and an emphasis on short travelling times in regional traffic gives a unique possibility to study and evaluate the effects on the travel markets and the accessibility of new, modern train services. There are several reasons why the Svealand line is a good opportunity to study these questions;

First, the train services on the Svealand line that replaced SJ's and the local public transport authority's regional bus services, can be regarded as a rare, full-scale experiment. The fares and frequency of service with SJ's buses were by and large the same as with the new train services, which reduces the number of factors that influence travel demand. This provides an excellent possibility to study the effects of high speed train services on the regional passenger transport market.

Second, market effects that are often difficult to interpret can be expected to become clear with the sudden, dramatic change in public transport supply that occurred when the train services began operating. Gradual minor changes do not have the same distinct effect. In this case, there is therefore a clear difference between "before" and "after".

Third, the Svealand line was planned mainly for regional journeys, and perhaps foremost, commuting over slightly longer distances with up to an hour's travelling time by train between Eskilstuna and Stockholm (a distance of 115 km). New railways for local short-distance train systems, or high speed trains for longer distances have been built in several places around the world during the post-war period, and these train systems can also to a certain extent be used for longer regional commuter journeys. The new investment in the Svealand line's primary market niche, on the other hand, is extremely rare in an international perspective.

Fourth, before and after studies (ex ante, ex post) of travel demand and accessibility as dependent variables of supply are rare, at any rate as regards regional high speed train services, which allows the possibility to verify changes that can be predicted using theoretical models. Accessi-

bility here can be regarded as a link between studies at micro-level (the travel market) and macro-level (the social structure).

For these reasons, a research project was carried out at the Royal Institute of Technology, Kungliga Tekniska Högskolan (KTH), in Stockholm between 1996 and 2002, using the Svealand line as an example of the effects that can result from investment in regional high speed train services.

The largest effects, especially as regards commuting, can be expected on the Eskilstuna–Stockholm section. Travelling time on the new line to the capital is one hour, and being a regional and national centre Stockholm has a large, diversified labour market which can be expected to attract people living in the county of Södermanland. The same good prerequisites, however, do not exist west of Eskilstuna due to the fact that travelling times are longer, services are less frequent and, consequently, accessibility is not as good. For this reason, the research project has concentrated on the effects in the municipalities of Eskilstuna, Strängnäs and Nykvarn. Nyköping, where no equivalent improvement in supply has taken place during the period, has been used as the reference centre of population.

The effects on social structure, however, are generally speaking very long-term and require a broad, comprehensive analysis to be imputed to the improvement in supply, and have therefore not been able to be accommodated in the research project.

1.2 Aim

1.2.1 Objectives

The aim of the research project was to identify general market effects arising from the improved market supply, i.e. the connection between a radically improved supply of train services on the one hand and travel demand and accessibility on the other. The general market effects that can be expected to occur can be used as indicators that changes in the social structure will materialise in the long term. The knowledge gained will be able to be used to improve and further develop various models for transportation and social structure, may be used in drawing up the decision-making bases for other infrastructure investments that may be considered in the future, and to identify areas where further research would improve the basic information underlying social planning, and contribute to a better understanding of the problem.

The research project took the form of a case study of the Svealand line, which for a number of reasons is well suited for studying the ef-

fects. The main thrust of the project has been to analyse and describe the linkage between supply and demand, and between accessibility and new journeys. The emphasis is on different aspects of the market effects of changes in supply on several levels with varying aggregation of individuals, from general effects on travelling to differences in influence between different socioeconomic groups.

The linkage to regional development and social structure also needs to be studied, but is not included in the project because of the project's limited resources and the prolonged time that such a study would require. Nor are environmental issues, the train services' economy or the Svealand line's social economic return touched upon in the project. Within these necessary limitations, the research project can be expected to contribute to further knowledge of the market effects of high speed train services.

1.2.2 Subobjectives

To fulfil the aim of the research project (the overarching goals) a number of subgoals were drawn up for the surveys regarding the Svealand line. The first of these was to describe the expectations prior to the opening of the Svealand line and to examine how far these were met once it was open. A second subgoal was to study the introduction of the new services with the market's response to the improved supply.

Other subgoals were to study how residents along the line were influenced in their choices between different modes of transport by the radically improved supply, to study differences in valuations and behaviour between different socioeconomic groups, and between motorists and public transport passengers, and to describe how the improved supply and the increase in demand can be linked to the change in accessibility. The intention was to use this knowledge to draw general conclusions about the market effects of a radically improved regional train service supply and to try to relate the effects identified to different factors in the world around that can be assumed to influence development.

1.2.3 Target groups

The research project's primary target groups are:

- Officers in public transport and the railways, i.e. rail administration (Banverket), transportation companies, transportation clients and consultants
- Municipal and regional planners and politicians
- Politicians and government ministries
- Universities, research institutes and international research bodies

1.3 Arrangement of the thesis

In chapter 2 of the thesis the reader will find examples of present knowledge, theories and models related to travel and accessibility in a literature review. A summary and discussion in section 2.6 is followed by a description of the research project's theoretical framework in section 2.7.

Chapter 3 deals with the methods used in the surveys. The description is quite detailed in places, but the intention is to allow the reader to assess the results according to the methods and, should the surveys be repeated in other contexts, to be able to compare the results with the present research project.

The Svealand line's inception and the development of the region are described in chapter 4. The purpose here is to give a background to the surveys themselves and to see the effects in their context in society.

Supply and demand along the Svealand line are described in chapter 5. The chapter provides a summary of the journeys in the form of travel statistics, but with a clear linkage to the supply that has been available during the period studied.

Chapters 6-8 present the results of the special surveys that were carried out in the research project. Chapters 6 and 7 deal with the results of the field surveys. Changes in knowledge and valuation of the supply are described in chapter 6, while chapter 7 describes travel behaviour. The results of analyses of the differences in accessibility before and after the high speed train services on the Svealand line are presented in chapter 8.

Chapter 9 contains a general discussion and conclusions, together with conclusions about the survey methodology and proposals for future research. Certain conclusions that concern the Svealand line explicitly can instead be found at the end of each of chapters 5-8.

The list of references, chapter 10, and the appendices constitute necessary supporting documents for the thesis.

2. Theoretical framework and literature review

The intention of the literature review that follows is to give the reader a clear picture of current knowledge in the areas of transportation, accessibility and economy. Traffic is the result of transportation, or the production of transportation and travel. In this context, it is the direct impact of transportation on economic development that is of primary interest, even though the environmental consequences, accident hazards, and effects on health, for example, of traffic must not be underrated. The main focus of the literature review is on passenger transport, and especially on a regional level. Many linkages, however, are general irrespective of geographical level.

2.1 Transportation and economy

2.1.1 The importance of transportation to the economy

In market economies demand for transportation can be expected to increase with economic development as a consequence of households' and companies' maximisation of benefits or profits. The consumption of transport services tends to be complementary to the consumption of other goods and services. The demand for transport services is normally regarded as a derived demand, in the sense that transportation is not needed for its own sake, but to satisfy other needs (with a few exceptions such as pleasure trips and cruises).

Transportation, the movement of people or goods in space, creates a value, an increase in prosperity.[5] Among objections that can be raised to this, however, are that we do not know the distribution between the proportion of transportation that results from derived demand, and the proportion that takes place for its own sake.[6] [7] The latter category must here also include destination choices that are influenced by the opportunity to make a – in some respects – stimulating journey, and people's need for variation and change.[8] There are researchers who argue that no direct link will be needed in future between economic growth and in-

[5] Meyer (1971)
[6] Preston (2001)
[7] Mokhtarian and Salomon (2001)
[8] Eliasson and Mattsson (2000)

creased traffic, among other things through the study of the concepts of accessibility, proximity and the development of modern logistics.[9]

Economic growth is a complex process. Transportation economists prefer nowadays to say that infrastructure and transportation allow natural resources and human capital (knowledge and manpower) to be exploited, thereby bringing about economic development. Another important factor for economic development is the availability of private capital. Transportation can free capital from one area to be used in another to give a higher yield. Transportation is thereby a necessary prerequisite, but not in itself sufficient, for economic development.[10]

2.1.2 The importance of the infrastructure

From an economic point of view, infrastructure can be regarded as one of a number of production factors. Infrastructure represents invested capital tied to, and available to, a particular region or a country. One difficulty of regarding it as a production factor is that infrastructure has network characteristics, which means that it is hardly possible to break individual parts out of their context.[11] This is primarily the case with regard to road networks and rail networks. Taken together, the most typical characteristics (all infrastructure systems do not have all these characteristics) are that they are networks, they are a necessary part of the total production of transport services, they have many of the features of natural monopolies, they have high capital costs in relation to their operating costs, and the start-up cost and the time it takes to establish the infrastructure are both considerable.[12]

Infrastructure can be expanded partly by means of a passive strategy, which means that society invests in infrastructure when the economy (the private sector) has expanded so much that the existing infrastructure shows a distinct capacity shortage, or by means of an active strategy, which means that society uses the infrastructure as a motor to drive national or regional development. The latter entails a degree of risk-taking by society, since it presupposes a response from the private sector in the form of increased investment to succeed. The notion that a structural balanced development between infrastructure and regional development is possible can also be regarded as illusory. The inertia and the long-term nature of infrastructure changes mean that there will be long periods of either excess supply or excess demand.[13]

[9] Banister och Berechman (2001)
[10] Button (1993), p. 224
[11] Rienstra, Rietveld, Hilferink and Bruinsma (1998)
[12] Adapted from Banister and Berechman (2000), p. 59
[13] Hirshman (1958), in Rietveld and Nijkamp (2000)

The effects of an improved infrastructure are generally speaking small in developed countries. The areas that are influenced most by improvements in infrastructure are those directly connected by the link in questions. The effects on other regions not directly connected by the link in question are negligible, but tend to be slightly negative.[14]

The marginal return for regional economic development, or the marginal improvement in productivity engendered by more infrastructure, gradually diminishes as the transportation network becomes increasingly complete. There is a linkage between the marginal return and the size of the investment relative to the existing system.[15] The reduction in marginal return has been proven in several empirical studies, for example of motorway network expansion. The importance of expanding the road network for choice of location thereby diminishes over time. The expansion of infrastructure to accommodate new means of transportation that increase accessibility can, on the other hand, produce substantial effects. Large, radical changes are of much greater importance than stepwise changes. One example is the introduction of high speed trains, that operate in a market that is partly new – very fast passenger transport over medium to long distances. A conclusion that may be drawn from this is that infrastructure systems display distinct life cycles.[16]

Banister and Berechman find that when investments are made in railway lines for passenger transport, the benefits of only the transport improvement are often insufficient on their own to justify the high costs of the new infrastructure. Consequently, other, indirect effects need then to be included to be able to justify the investment.[17]

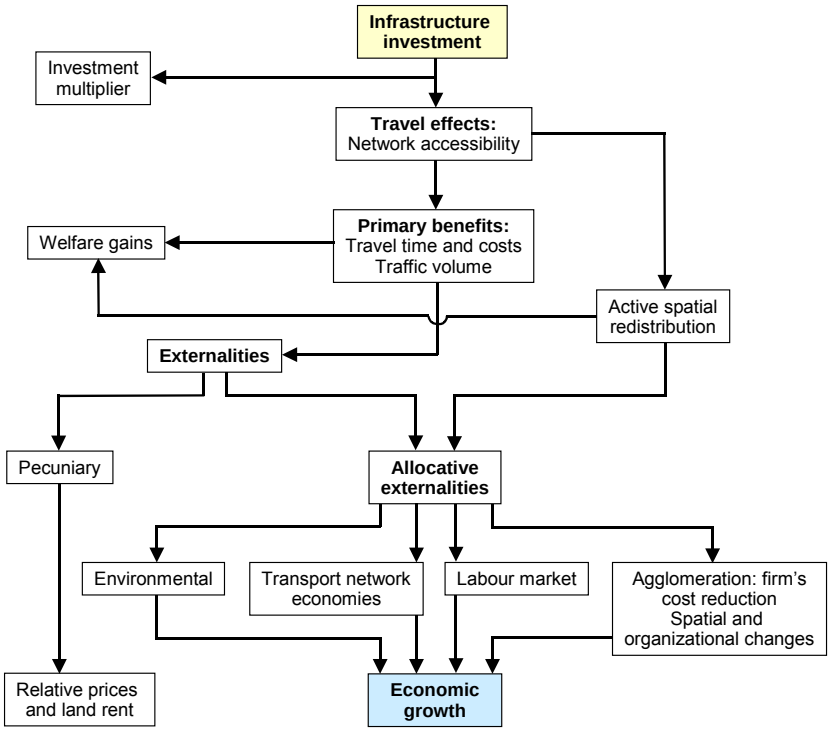
2.1.3 Regional economic development

The differences in economic activity between different regions and provinces, such as differences in unemployment, incomes, relocations and industrial structure, are important because they both result in spatial differences in prosperity and often also reduce the country's general economic growth. However, no general case exists where investments in transport infrastructure will automatically improve economic growth in underdeveloped regions. According to a number of research findings, it would appear that an improved infrastructure influences regional development principally in those regions where economic development is

[14] Rietveld and Nijkamp (2000), p. 227
[15] Giuliano (1995)
[16] Rietveld and Nijkamp (2000), p. 227
[17] Banister and Berechman (2000), p. 285

slow and where infrastructure is a constraining factor for faster development.

Model of the influence of infrastructure on economic growth



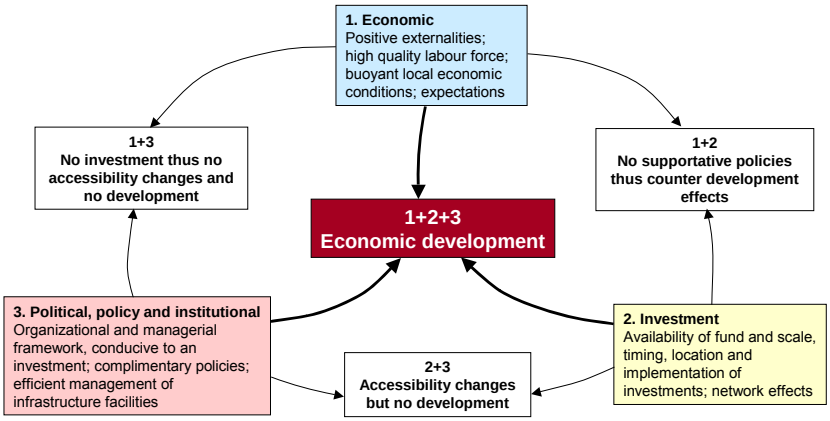
Model for evaluating economic growth resulting from an investment in transport infrastructure. Source: Banister and Berechman (2000), p. 173, and Banister and Berechman (2001)

In regions that already have strong, dynamic economic development, an expanded infrastructure is less important. If the transport system is overloaded, however, economic growth may be slowed.[18] [19]

In weak regions, factors other than just new infrastructure may be important for increasing growth. Capital to invest in new activities or improvement of higher education, for example, might have the greatest effects. Some of the effects will often mean a loss of markets due to increased competition from the world around. An improved infrastructure can then have a negative effect in weak regions when the local industry that exists is forced out of business by increasing competition and the investment thereby has a counter-productive effect.[20] [21]

[18] Biehl (1991)
[19] Vickerman (1996)
[20] Button (1993), pp. 234-235
[21] Banister and Berechman (2000), pp. 14-15

Prerequisites for the contribution of infrastructure to economic growth



Source: Banister and Berechman (2000) p. 319, Banister and Berechman (2001)

Three prerequisites need to be fulfilled for a new infrastructure to be able to contribute to a region's economic development. First, the economy must function properly and have growth potential, which is possible with a well-educated workforce and dynamic regional development. Second, the investment must be made and in the correct manner. Third, society's institutions need to support the development, also on planes other than just the infrastructure in itself, with both political and administrative decisions about other measures that promote the region's economic growth.

There are several examples of how society's institutions can promote development. In many cases, a city centre has been revitalised by high speed trains that stop at a centrally located railway station, if it has been located in the developed area where contact-intensive activities take place. This has in turn gone hand in hand with a faster introduction of expansive companies in such areas as business services and knowledge-based production. A new high speed link must be integrated into other existing traffic systems and be joined to the built-up environment and regional trade and industry so that potential synergy effects can be fully exploited.[22] Four examples are given below of supportive strategies from studies of local and regional track-bound traffic in North America where the urban structure is as a rule different to that in Europe; [23]

- Regional coordination of land use and expansion of track-bound traffic
- Preferential traffic and parking policies (for park-and-ride systems)

[22] Johansson (1996)
[23] After Giuliano (1995), p. 338

- Make available a public infrastructure to support development around the track-bound traffic's stations
- Use economic incentives to induce development around the track-bound traffic's stations

In Sweden, with its long tradition of strong physical planning, the importance is emphasised of society planning so as to support public transport. This applies both to the location of the traffic systems and land development, and regional interaction to enable optimum utilisation of the resources.[24]

If any of the economic or institutional prerequisites are missing, or if the investment is not made, society risks being deprived of the development potential of the new infrastructure. If the factors interact, the infrastructure leads to an economic development that is to the region's advantage.[25]

Improvement of the infrastructure gives rise partly to distributive (redistributing), and partly generative (creative) effects. The distributive effects resulting from an infrastructure investment arise through the accessibility to a region having been improved relative to other regions. The economic development in this region can therefore take place at the expense of the economic development in or more other regions. Rietveld and Nijkamp point out, however, that the effects are negligible if improvements of infrastructure take place in all the areas at the same time (and gradually).[26]

The negative distributive effect, however, can be compensated by a generative effect, which means that the sum of economic activity in all regions at one time may increase. This results in a net profit for the economy as a whole. Economic growth takes place especially if there is significant international trade.[27]

Generative effects of improvements of infrastructure can easily be overestimated if the area studied is too narrow. What might really be happening is an unseen redistribution at a higher level, for example in the country instead of in the region.[28]

2.1.4 Redistribution of improvements of infrastructure

Investments in infrastructure reduce transport costs, or the generalised cost of travelling or transporting goods both for households and companies. The profits may accrue to different groups; they may go to en-

[24] Sverige 2009, *Sweden in 2009* (1996)
[25] Banister and Berechman (2001)
[26] Rietveld and Nijkamp (2000), p. 228
[27] Giuliano (1995)
[28] Banister and Berechman (2000), p. 28

trepreneurs or land owners in the form of higher profits or higher rents; they may also go to employees in the form of higher wages and salaries. Another possibility is that the profits will be passed on to consumers in the form of lower prices. Improvements of infrastructure will not, however, have the same effects for all households and all individuals. The increased accessibility can be assumed to influence households differently depending on whether the household has no, one or two gainfully employed members, access to a car, the size of the household's income, and other social, socioeconomic and demographic factors.[29] [30]

Giuliano states that shorter travelling times tend to influence higher income groups more than low-income earners, since the value of time is a function of income. Higher income groups can afford to pay the higher transportation costs for travelling quickly, unlike low-income earners who can not compensate higher transportation costs with time savings to the same extent. The question is also related to wages and salaries – greater mobility for individuals enables them to seek more qualified jobs, which in most cases will give them higher incomes.[31]

2.1.5 Social structure

The effects of infrastructure on regional development can be divided into transient and permanent effects. The permanent, structural effects are often difficult to identify since they do not become sufficiently clear until after a long period of time, and can only with difficulty be disentangled from other factors that affect regional development. One example of inertia in the social structure is that companies that expand do not relocate as a result of direct changes in the infrastructure, but when they need more space. Another example is that an increase in the demand for business premises and dwellings can not be met with an increase in supply (new construction) other than in the relatively long term. In areas that are already built up the inertia is even greater. Social structure changes slowly.[32] [33]

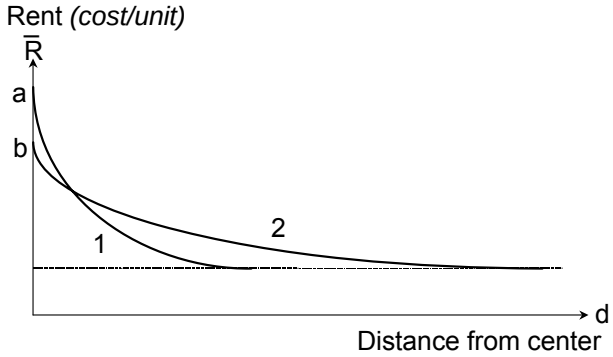
The linkage between generalised transportation costs (accessibility) and the costs for housing and premises is reflected in prices. The closer to the centre of a town or city (or region), the higher the rents. This means that only businesses that can afford the high rents for central premises establish themselves there – businesses that are more often than not dependent on large customer potential, or qualified staff, in

[29] Rietveld and Nijkamp (2000), p. 228
[30] Preston (2001)
[31] Giuliano (1995)
[32] Rietveld and Nijkamp (2000), p. 210
[33] Giuliano (1995)

order to be profitable. People and businesses that can not afford the high rents in the centre are located further from the centre. A levelling between the costs for dwellings (and premises) and transportation implies that demand varies with the distance to the centre.[34]

Improved travel opportunities, i.e. a reduction of the generalised transportation cost, means that the costs for premises in the centre decrease at the same time as the demand in peripheral areas increases, given that the demand has a certain degree of elasticity.[35]

Fundamental relation between rent and location (business premises, dwellings)



The dotted line represents the rent levels in rural areas. Curve 1 shows the rent levels before an infrastructure investment as a function of the distance to the centre of a town or city, while curve 2 shows the levels after. The prerequisite for curve 2 is that the population centre grows at the same time, i.e. that there is an elasticity of demand. Otherwise the whole of curve 2 would lie below curve 1.[36] Source: Giuliano (1995)

Improved accessibility causes economic activity to be spread over a larger area, and the infrastructure investments thereby have a decentralising effect on the town or city.[37] In so far as track-bound traffic is important for general accessibility a centrally located station can, however, have the opposite effect inside the town or city, but a decentralising effect in broader contexts (the region or the country). Newman and Kenworthy point out several examples where towns and city centres have been vitalised by local and regional track-bound traffic, which counteracts the impoverishment of inner cities that widespread car usage can cause.[38]

Several empirical studies of both motorways and track-bound traffic systems in North America, however, show that the effects on social

[34] Button (1993)
[35] Button (1993), p. 32
[36] Mills and Hamilton (1994), p. 125
[37] Giuliano (1995)
[38] Newman and Kenworthy (1996)

structure of investments in infrastructure are neither consistent nor predictable. Many of the studies, however, were marred by shortcomings in either data or methodology.[39] Giuliano states that the studies of the local and regional track-bound traffic indicate that it has had no systematic impact on social structure since the second world war.[40] On the other hand, the urban structure and the density of the conurbations are a factor that also influences the choice of travel mode[41], which means that the prerequisites for public transport are generally speaking not as good in North America as they are in Europe.

2.1.6 The transport markets

The transport market consists in actual fact of several submarkets. The markets, however, are interlinked both on the supply side and the demand side. A few examples of this are that prices vary in correlation between different products on the supply side, and on the demand side there are possibilities for substitution, for example by choosing different transport modes. On the whole, transportation and travel take place in a market system that differs significantly from the ideal market model, where a well-defined good (product or service) has a price determined according to an equilibrium (optimum) between supply and demand. In the transport markets, prices for example are far from being isolated and transparent. The operators also use price discrimination and several other means to compete, especially different timetables and quality factors. External effects are also difficult to take into consideration when choosing a mode of transport as long as they are not fully internalised. Customers thus do not have access to, or can not utilise, complete information for choosing alternatives.[42]

One of the most typical characteristics of the demand for transportation is its variation over time. Demand varies over the day, over the week, over the season and over other cyclical periods such as economic upswings and declines. It is difficult to balance supply with demand. Transportation systems are often dimensioned according to what is as good as the total loading at peak periods, which means that the systems have an overcapacity that burdens the operating results during normal or off-peak periods. Where monopolies exist in the transport markets, fares and rates are normally set using factors other than optimising supply and demand. One example is that the fares and rates can be the

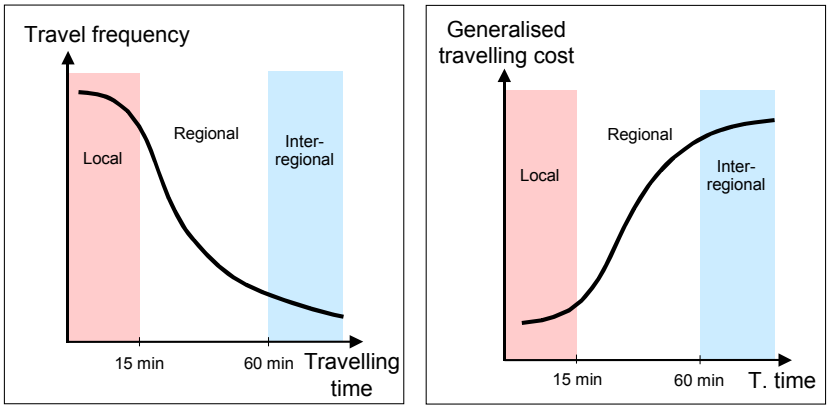
[39] Badoe and Miller (2000)
[40] Giuliano (1995)
[41] Cervero (2002)
[42] Quinet (2000), p. 126

same throughout a region irrespective of the production costs at other times and in other places.[43]

2.1.7 Generation of travel

For a certain combination of reduced travelling cost and critical travelling time, i.e. generalised travelling or transportation costs, travelling starts to increase dramatically. There is therefore good reason to assume that the influence on the travel markets (and social structure) is non-linear, that there are threshold effects.[44] When the conditions for travel are changed drastically, for example radically shortened travelling times and new patterns of location, it is difficult for established forecasting models to calculate the new travel generated, because they assume an equilibrium and can not take into consideration the dynamic effects that arise out of the improved supply, i.e. fast economic development and rapid changes in the housing and labour markets and perhaps also car ownership (for more details, see appendix 7).

Travelling frequency and generalised cost as functions of travelling time



Disposition to travel (travel frequency) as a function of travelling time (left), and generalised travelling cost as a function of travelling time (right). The times are approximate. The linkages are general for daily (frequent) travel irrespective of the purpose of the journey. Source: Johansson and Karlsson (2001)

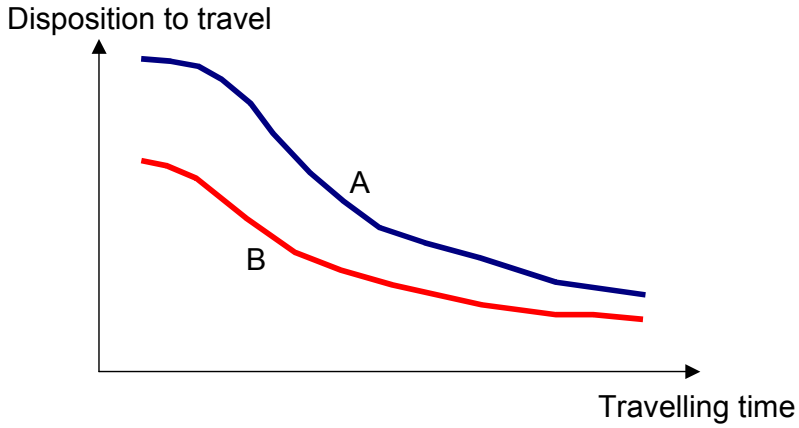
The most travelling (disposition to travel) with regard to daily journeys is done when travelling times are short, and falls dramatically up to 50-60 minutes. The generalised travelling cost (travelling time and cost) is low up to a certain travelling time. The breakpoint might be the length of a walk, or a bicycle ride, with low cost. After that point the generalised travelling cost starts to increase drastically when the traveller needs a motorised means of transport (car or public transport with distance-

[43] Quinet (2000), p. 132
[44] Blum, Haynes and Karlsson (1997)

or time-dependent fares). For longer distances, the increase declines with the travelling time, which means that a longer journey has a lower marginal cost for the additional length of the journey.

Different groups' valuations of time differ. Groups who value time highly may react more strongly to longer travelling times than the average traveller does. Individuals' time sensitivity also varies between different times of the day and different days of the week as soon as shortage of time differs between the days of week. This also means that the value of time varies for different journey purposes, for example between business trips, commuting to work and pleasure trips. One group may also be less sensitive than the average traveller to costs other than time, i.e. a group that is willing to pay more to travel quickly. [45]

Different groups' disposition to travel as a function of travelling time



Disposition to travel as a function of travelling time for two different groups of people. Group A is more sensitive to time and is more disposed to travel (high frequency of travel), while group B is less sensitive to time and less disposed to travel (low frequency of travel). Source: Johansson and Karlsson (2001)

Travel decisions affect each other, since each journey reduces the amount of money and time available for other journeys, and the benefit of one journey is dependent upon the other trips the individual makes. People can also be expected to want to make variations over time. Different destinations can therefore be assumed to be not fully, but to some extent equivalent, and the value will vary depending on the purpose of the journey.[46] Consequently, possibilities exist to substitute between different destinations. A calculation using a model shows that if the generalised transportation costs decrease specifically for a certain route, a small portion of the additional journeys are newly generated.

[45] Johansson and Karlsson (2001)
[46] Eliasson and Mattsson (2000)

The remainder are redistributed journeys from other destinations, and other modes of transport. This seems to indicate that a transportation system is extremely important to both private and business relations.[47]

2.2 Accessibility

2.2.1 What is accessibility?

The word "accessibility" is used among other things to describe one of society's overarching objectives with the transportation system. There are obviously several objectives, but accessibility can really be said to be the final product of the transportation system. The effects of accessibility on the other hand are many-faceted and varying, and can be described in many different ways (effects on the economy, regional development etc.).

It is difficult to define accessibility unambiguously and make it a usable concept, and researchers have presented several different approaches since the 1930s.[48] There are consequently a number of measures, each with its own advantages and disadvantages. For example, access to information and mental accessibility are important factors with regard to spatial accessibility.[49] [50] In the following, however, the primary focus is on spatial accessibility measures with the emphasis on social structure as they are used to describe the effects of the transportation system, i.e. in those cases where mobility is the means of achieving accessibility.

A brief definition of accessibility is "the ease with which supply and activities in society can be reached, in the sense of the needs of individuals, trade and industry and public organisations".[51] The most important supplies are partly the supply of places of work for private individuals and of manpower for companies, and partly the supply of service for individuals and companies. Greater accessibility can consequently be attained by developing the transportation system, but there are also other ways of increasing accessibility. Examples are new companies setting up and companies relocating, establishing a university where

[47] Sonesson (1998)
[48] Pooler (1995)
[49] Hanson (2001)
[50] Schilling (1999)
[51] Vägverkets nationella plan för vägtransportsystemet 1998-2007, *The Swedish National Road Administration's national plan for the road transportation system 1998-2007*. (The same definition is used in, for example, Strategisk analys, *Strategic analysis* (1999) and Infrastruktur och regional utveckling, *Infrastructure and regional development* (2001))

none existed previously, or building a shopping centre where large numbers of people live.

In order to increase accessibility using the transportation system, the sacrifices for transporting people and goods need to be reduced. Possible means include:[52]

- Shorter travelling and transportation times
- Lower prices
- Greater reliability (quality)
- Greater comfort while travelling

Susan Handy and Debbie Niemeier have defined accessibility in somewhat more detail; Accessibility is the spatial distribution of potential destinations, the ease of reaching each destination, and the magnitude, quality, and character of the activities found there. The cost, or sacrifice, for travelling is central to the accessibility; the less time and money that is spent on travelling, the more places that can be reached within a certain budget and the greater the accessibility. The choice of destination is also critical; the more destinations, and the greater the variety, the higher the accessibility. The choice of travel mode is equally important; the greater the supply of different modes, the greater the accessibility. Accessibility is thus a product of both social structure and the nature of the transportation system. People however value supply – and thus accessibility – differently, since intentions, wants and tastes vary from individual to individual.[53]

Different circumstances and situations need different approaches for measuring accessibility. Irrespective of approach there are a number of mutually dependent issues that need to be resolved;[54] [55]

- the degree and type of disaggregation
- the definition of origins and destinations
- the measurement of travel impedance
- the measurement of (an opportunity's) attractiveness

There are three clear types of disaggregation (division); spatial, socio-economic and trip purpose. The last can also be described as the type of opportunity or supply that the individual wants to use. In an analysis of accessibility one or several of these groups can be used.

Regarding the definition of origins and destinations, one question is whether only journeys to and from home are to be analysed, or whether also chaining with other destinations may be included.

[52] Infrastruktur och regional utveckling, *Infrastructure and regional development* (2001), p. 17
[53] Handy and Niemeier (1997)
[54] Handy and Niemeier (1997)
[55] Makrí and Folkesson (1999)

Travel impedance is most easily measured as either distance or time. One developed measure is generalised cost, which includes both travelling time and the cost of the journey, i.e. the total sacrifice.

Finally, attractiveness is the appeal or benefit a specific supply or opportunity has for the individual. The opportunity may be both the individual's source of livelihood, a service, social interaction and pleasure. It is the subjective appeal that drives or attracts an individual to make a journey. From this it also follows that the journey is not a need in itself, but is made to satisfy other needs. In order for the journey to take place, the benefit to the individual must be greater than the generalised cost of the journey.

2.2.2 Accessibility measures

There are several different approaches and measures for measuring accessibility, but a common characteristic is that accessibility must be interpreted in its own context. Observed accessibility in a special analytical context, for example a case study, is dependent upon the accessibility measure used. Different measures are sensitive to the prevailing circumstances to varying degrees, or show the effects that arise with different levels of clarity. It is therefore difficult to point to any one accessibility measure as being generally speaking better than another.[56] [57]

There are also several circumstances at both micro- and macro-level that are not immediately clear from a brief exposition, or even in the accessibility measure. One example is the cumulative measures of accessibility to places of work, i.e. the number of places of work that can be reached within a given time. The effect of competition in the labour market is not clear from a simple quantitative measure. Nor is it clear that the labour market in actual fact is made up of several different markets, depending on the sector, the workforce's qualifications etc., and which partially overlap.[58] [59]

The most common accessibility measures partly comprise individual accessibility measures, that try to capture opportunities and space-time limitations, and partly integral measures of accessibility to or from a certain place, i.e. place accessibility measures.

Individual accessibility measures

Individual accessibility measures focus on an individual's accessibility given certain prerequisites (need, mobility, supply, and resources in the

[56] Handy and Niemeier (1997)
[57] Kwan (1998)
[58] Mattsson and Weibull (1981)
[59] Wee, Hagoort and Annema (2001)

form of money and time). They describe accessibility on the basis, for example, of one day's activities in time and space. Activity-based accessibility from the individual's point of view can consequently capture causal relationships within different socioeconomic groups, which traditional spatial accessibility measures with a relatively high degree of aggregation are not able to do.[60]

In time geography the fundamental idea is to try to describe the constraints, or restrictions, that govern an individual's actions in time and space. By compiling all the opportunities to do things that an individual has, the ultimate result is the segment in which the individual can be assumed to have a free choice. the individual's real behaviour will lie somewhere between these constraints. The constraints will change over time and are changed through the individual's own actions, through actions that take place in the individual's environment, through collective decisions and through processes of nature beyond human control.[61]

Aggregated statistics can quantify events, but couplings between different events are not generally clear. One advantage of the time-geography approach is that it is possible to describe actions that are related to each other in time and space. In that context the criterion of indivisibility is important. This means that an individual is not divisible. One and the same individual must follow a chain of actions, an individual path.

The constraints surrounding an individual's actions can be described in a three-dimensional space-time diagram. Time constraints for various actions can be illustrated, and the individual's path is then a continuous line in time and space. If all the constraints are drawn in, they describe a volume in a space-time diagram, a space-time prism, and the individual may be somewhere inside the volume of the prism at a given time. The surface of a section of the prism at a certain point in time projected onto a map is called the activity area or potential individual path area.[62] [63]

Place accessibility measures

A common feature of place accessibility measures is that they are aggregated from a number of individuals (or individual opportunities) that belong to a certain geographical area, a zone. All together, the measures thereby focus more on geographical differences than individual differences. Accessibility is inversely proportional to travel impedance, and a

[60] Kwan (1998)
[61] Hägerstrand (1970)
[62] Hägerstrand and Lenntorp (1974)
[63] Lenntorp (1976)

high travel impedance (measured for example as generalised cost, see below) thereby results in low accessibility. The measures can be divided into a number of subgroups;[64] [65]

- Distance measures
- Cumulative-opportunity measures
- Gravity measures (attractiveness measures)
- Utility-based measures

Distance measures are the simplest, and describe the distance from one location to another or several other places, or different opportunities. The distance can be measured both in time and geographical distance, the latter on condition that the assumed average travelling speed is constant. Travel impedance is consequently described with only one factor.

Cumulative-opportunity measures may for example be the number of places of work that it is possible to reach within a certain time. It is consequently the number of opportunities given a certain constraint that are described using this measure.

Gravity measures are based on the same theory as the gravity models for trip generation. Accessibility is a result of attractiveness and travel impedance, where the distance is critical. Gravity models are static models that are primarily used to calculate total travel demand (and accessibility) between different localities.[66] Gravity measures are sometimes very similar to utility-based measures, but the latter kind have theoretical and empirical advantages.

Utility-based measures are based on theories of benefit to the individual. The most common measure is logsum, which is described in more detail below.

2.2.3 Modelled accessibility

The most commonly used measures when modelling accessibility are partly those that measure potential accessibility, and partly actual accessibility.[67] Potential accessibility, or the possibility to be reached, can be expressed as the number of places of work or the number of residents (manpower) that can be reached within a certain time or by using a certain means of transport, or travelling times to a certain destination by a certain means of transport. It is therefore a cumulative-opportunity measure.

[64] Handy and Niemeier (1997)
[65] Makrí and Folkesson (1999)
[66] Sonesson (1998)
[67] See for example Sampers, version 643. Technical documentation (2001)

Actual accessibility reflects how people do in fact travel, while potential accessibility does not take into account how people choose to travel but instead measures the possibility of reaching the supply. In so far as the calculations of actual accessibility are based on a travel forecast, the expression forecast accessibility is also used.

Generalised cost

The concept of generalised cost is fundamental to a mathematical description of accessibility. The generalised cost describes the travel impedance and includes both the fare, the travelling time and other sacrifices that the person who is travelling or transporting has to make for the journey or the transportation to take place. Generalised cost can be represented mathematically as

$$G = p + vt + qs$$

where G is the generalised cost, p is the price of the journey, v is the value of the travelling time, t is the travelling time, q is a quality index, and s is the uniform value of quality.

Logsums

A good comprehensive measure of travel impedance weighted according to the importance of accessibility at each individual point (or tour) is the logsum. Logsums are a kind of utility index of actual accessibility that can also be converted into monetary units, for example Swedish crowns (Skr) and can thus be used as a measure of prosperity.[68]

If we suppose that the individual assigns a value to each of the destinations and opportunities in a limited choice set, and then maximises his benefit, accessibility can be defined as the denominator of the multinomial logit model, also known as logsum.[69] Accessibility, A_n, for individual n can thus be expressed as

$$A_n = \ln \left[\sum_{\forall \in C_n} \exp\left(V_{n(c)}\right) \right]$$

where $V_{n(c)}$ is the observable utility of the temporal and spatial transportation for choice c for individual n, and C_n is the choice set for individual n.

Logsum functions as a general measure of the attractiveness, or desirability, of the whole choice set. The specified utility function includes variables that represent the attributes of every possible choice, which include both the attractiveness of the destination, travel impedance, and

[68] Att mäta tillgänglighet med logsummor, *Measuring accessibility with logsums* (2002)
[69] Ben-Akiva and Lerman (1985)

socioeconomic characteristics and individual preferences for each choice.[70]

2.2.4 Studies of accessibility

Since there are several alternative approaches and accessibility measures dealing with accessibility to transportation, there is a wide spectrum of literature dealing with theory and methodology and case studies. These range from simple graphically or mathematically calculated measures to large complex models and computer programs. Only accessibility calculations using geographical information systems (GIS), a powerful tool for analysing traffic and social structure, are discussed here. GIS can handle large quantities of place data, providing good possibilities for calculating general accessibility at a relatively disaggregated level. However, it is normally geographical zones that are treated, often with a heterogeneous composition of different socioeconomic groups, which is a weakness of the studies of the distribution of accessibility. In some respects, therefore, it would be desirable to move towards studies of individual accessibility, which could be performed using GIS.[71] [72] [73]

2.3 Previous studies of the effects of the Svealand line

2.3.1 Traffic and land development in the Mälaren valley

The effects of the Svealand line have been calculated using IMREL (Integrated Model of Residential and Employment Location). IMREL is one of a number of similar models in use around the world[74] and is used to analyse and evaluate general changes in land use and the transportation system, for example to assess the consequences of investment packages in passenger transport infrastructure.[75] The model is however too simple to be able to forecast future patterns of location. Another limitation is that besides trend projection only redistributions within the region studied are calculated.[76] [77]

The result of a model calculation describes both rapid courses of events, such as effects on travel mode choice, travelling times and dis-

[70] Handy and Niemeier (1997)
[71] Kwan (1998)
[72] Makrí and Folkesson (1999)
[73] Miller (1999)
[74] Wegener (1998)
[75] Anderstig and Mattsson (1992)
[76] Anderstig and Mattsson (1991)
[77] Anderstig and Mattsson (1998)

tances, as gradual effects on the location of residences and places of work. Accessibility to manpower is a strategic location factor for companies, and the cost of commuting is critical to where people choose to live. The location of places of work therefore shows in practice a similar pattern to the distribution of the population.

When applying IMREL on the Mälaren valley, different strategic supplies of the transportation opportunities of an extended road system and regional trains were evaluated. The effects of the Svealand line are most noticeable in Strängnäs, where both the population and the number of places of work were expected to increase by approximately 10% by the year 2020. For Strängnäs, the regional train services, i.e. train services with short travelling times, relatively low fares and high frequency of service, led to considerably greater effects than the assumed investments in roads (here the E20 converted to motorway), and a railway without regional trains. An increase in population and the number of places of work was also predicted for the western districts of the municipality of Södertälje (now the municipality of Nykvarn). The municipality of Eskilstuna, on the other hand, would not see any change over the years up to 2020. Other municipalities where the number of places of work and population increased due to an improved supply of regional trains included areas of Uppsala, Bålsta, Enköping, Gnesta and Arboga.[78]

2.3.2 Model and reality on the Svealand line

A research project around travel forecasts and the real result for travel on the Svealand line has been carried out by the consulting firm of Transek AB. The forecasting models that were then in use for investment planning, the InterCity (IC) and the intra-regional (IR) model (now superseded by the Sampers system), were used to reflect the situation before and after the Svealand line, with the prerequisites that applied in 1997 and 1998 with regard to supply, fares, and economic development.[79]

The increase in travelling in the forecasting project, calculated using the model, amounted to 230% more journeys by train in 1998 than by bus the year before. Transek's own passenger census on a Thursday in May both years, indicated 480% more passengers in 1998 than in 1997. By way of comparison, the local transport authority, Trafik i Mälardalen (TiM), counted the number of train journeys over a somewhat longer period, and in TiM's passenger census the increase was 330% when

[78] Anderstig (1996)
[79] Modell och verklighet, *Models and reality* (1998)

comparing SJ's bus service to the high speed trains on the Svealand line in February 1998.[80]

The forecasting models above all underestimated travel in the borderline zone between regional and interregional journeys, i.e. distances of around 100 km (see appendix 7 for more details). It is here that high speed trains on the Svealand line and similar regional railways can enable daily commuting. If the forecasting models are not in sync with the real world, the result will be that future travel will estimated incorrectly in the analyses of similar investments.

The forecasts from the 1980s and the early 1990s that preceded the decision to build the Svealand line were also analysed. The forecasts generally indicated greater increases in travel on the Svealand line for 2000 (and later) than had previously been estimated. The main reason, however, is that the forecasts assumed a more positive economic development during the 1990s than proved to be the case. In reality, incomes have been lower, as has employment, but fares on the Svealand line on the other hand are higher than the input data used in the forecasts. With the right prerequisites, the models would probably have indicated less travel than proved to actually be the case.

2.3.3 Travel habits on the new Svealand line

Lars Segerman wrote his master's thesis on the subject of travel by bus between Eskilstuna and Stockholm in autumn 1996. His aim was to test different ways of interviewing travellers and potential travellers about their travel habits and their knowledge of the supply on the new Svealand line that was then under construction. The thesis can be seen as a before-study to the studies carried out in the present research project. The field surveys were carried out in December 1996, 6 months before the train services started. Among the conclusions drawn in the thesis can be mentioned; [81]

- People had good knowledge of travelling time and frequency of service for the (soon to begin) train services on the Svealand line. They expect, however, that it will be expensive to travel on the trains.
- People's willingness to pay is somewhat higher for the new trains than for the old SJ trains (locomotive and carriages).
- The expected customer base for the bus services is probably based on travellers who would prefer to travel by some other means if they could.

[80] En undersökning av TiM, *A survey of TiM* (1998)
[81] Segerman (1997)

- Some people would prefer the old trains, others the current bus services.
- Most people have a positive attitude to the Svealand line. Factors such as income, place of residence and experience of modern trains do, however, have some significance for people's attitudes.

Data from Segerman's survey, together with some conclusions as to which methods are appropriate for interviews, have been taken into account in the present research project.

2.4 Examples of train service supply and demand in Sweden

2.4.1 A study of long-distance parallel bus and train services

Interviews with train and bus passengers in 1996 are of for the Svealand line research project because they have a number of issues in common (cf section 6.2.5). The interviews were carried out on trains and buses on the Stockholm–Linköping, Stockholm–Karlstad, Göteborg–Karlstad and Göteborg–Malmö routes (distance by rail between 209 and 329 km).[82] [83] The routes are therefore longer than the Svealand line. Before the Svealand line was completed, however, the travelling times between Stockholm and Eskilstuna with the old train or bus were so long that journeys were mostly long-distance trips with a small number of commuter trips, which all the routes listed above have in common.

Two questions that are discussed here deal with alternative modes of travel for an ongoing journey by train or bus, and passengers' main suggestions for improving the supply.

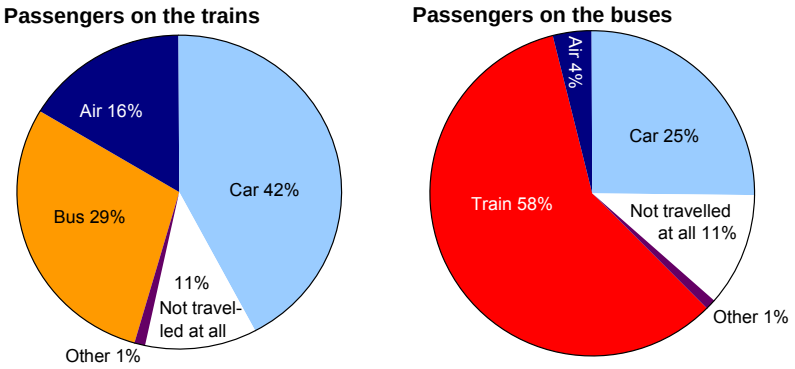
Answers to the question "If you had not chosen the train/bus for this particular journey, how would you have chosen to travel?" are different for the train and the bus passengers. About 40% of the train passengers would choose to go by car, barely 30% would have chosen the bus, and 16% would have travelled by air. 11% would not have made the journey at all. The relatively high proportion of passengers who would have chosen to fly were mainly passengers on the Stockholm–Karlstad route, where there is a relatively good supply of flights.

Of the bus passengers almost 60% would choose the train as their main alternative, 25% car and 4% air. 11% would not travel at all.

[82] Tidsvärden för tåg och buss – en studie av parallell buss- och tågtrafik, *Time values for train and bus – a study of parallel bus and train services* (1996)

[83] Utvärdering av en ändrad reglering beträffande prövning av tillstånd till busslinjetrafik, *Evaluation of changes in the regulations governing the issuing of licences to operate scheduled bus services* (1997)

Alternative modes of travel



Alternative modes of travel for passengers on the trains (left) and passengers on the buses (right) on the Stockholm–Linköping, Stockholm–Karlstad, Göteborg–Karlstad and Göteborg–Malmö routes, 1996.

Almost 90% of the bus passengers consider lower prices to be the most important improvement factor on the route they themselves travelled by bus. Other supply factors in the train services were of only secondary importance for the bus passengers. 60% of the train passengers also mainly want lower prices, while shorter travelling times are the next most important factor with 20%. About 10% of the train passengers want higher frequency of service.

Train and bus passengers have similar ideas about what is most important to change in the bus service supply. First, both groups want lower fares (about 35% of the passengers), followed by shorter travelling times (about 30%) and higher frequency of service (20-25%).

One of the conclusions of the study is that most bus passengers have the train as their first alternative on the routes studied. They take the bus because they think the train is too expensive. The passengers have a tendency to be stratified between the different modes of transport in so far as the supply, and especially the fare, is different. Travellers with a low time valuation, for example students and pensioners, choose the bus to a greater degree than passengers who value time highly, for example people travelling on business or long-distance travellers in general, for whom speed is the first priority.[84]

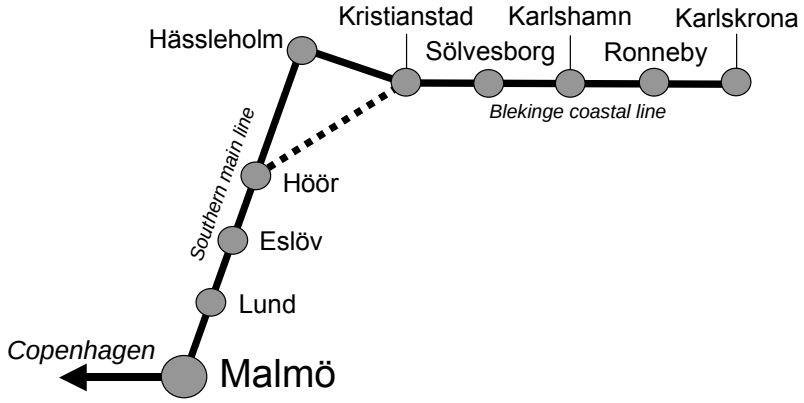
2.4.2 The Kustpilen train

The effect of the changes in supply when the new Kustpilen train system was introduced can be compared in part to the Svealand line. In

[84] Utvärdering av en ändrad reglering beträffande prövning av tillstånd till busslinjetrafik, *Evaluation of changes in the regulations governing the issuing of licences to operate sceheduled bus services*, (1997)

January 1992 SJ introduced a new train system between Karlskrona and Malmö (a distance of 243 km) acting as contractor with a net revenue agreement[85] with the county public transport companies in Blekinge and what was then the county of Kristianstad, replacing the simple diesel rail-cars (Y1) on the Blekinge coastal line with comfortable diesel-driven multiple unit trains (Y2) named Kustpilen. The introduction of Kustpilen together with an improved time table, i.e. 10-20 minutes' shorter travelling time, the elimination of 1-2 changes, more departures and a price-reduction for single journey tickets, led to a dramatic increase in the number of journeys.[86]

Kustpilen and the Blekinge coastal line



Kustpilen operates between Karlskrona and Malmö (and Copenhagen after the opening of the Öresund link in 2000). A proposed short-cut between Kristianstad and Höör is shown as a dashed line.

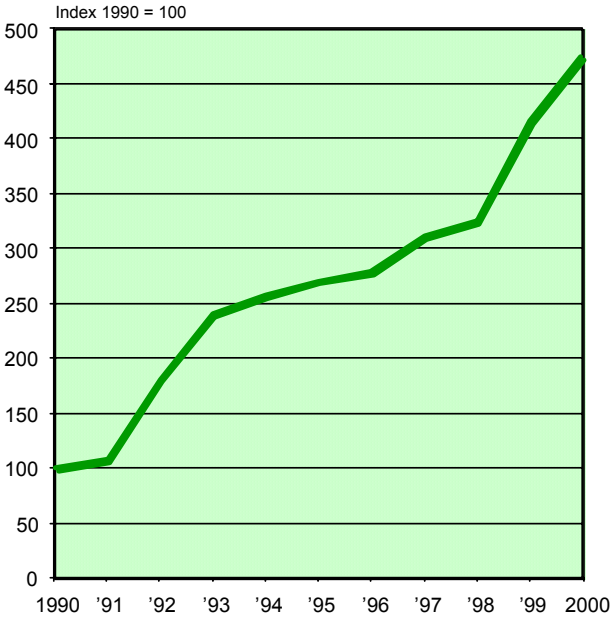
The supply also includes subsidised monthly passes, which make it cheap to commute with Kustpilen in comparison to SJ's own monthly passes on equivalent routes. For journeys inside Blekinge, a monthly pass cost 370 Skr in 1994 and 430 Skr in 1999. A monthly pass for commuting over the county border on the Karlskrona–Kristianstad route (130 km) cost 500 Skr in 1999. The price for a monthly pass is thus only about 1/4 of the price of, for example, a monthly pass between Eskilstuna and Stockholm (115 km) on the Svealand line.[87]

Further improvements have been made since Kustpilen began operating, mainly even higher frequency of service. Travelling times, on the other hand, have not been shortened very much since the line has only been modernised to a limited extent. The fastest train covered the dis-

[85] SJ receive the revenues from selling single journey tickets, while the principals sell monthly passes and pay the operator for running the train services (*SJ nytt* no. 2, 2002)
[86] Lindh (1994)
[87] Infrastruktur och regional utveckling, *Infrastructure and regional development* (2001)

tance from Karlskrona to Malmö in 3 hrs 16 mins in 1990, while the journey took 2 hrs 54 mins in 1999. In July 2000 the service was extended to Copenhagen via the newly opened Öresund bridge. Future plans include electrification of the Blekinge coastal line and a number of improvements to the line. If a proposed short-cut between Kristianstad and Höör were built, travelling time between Karlskrona and Malmö would be cut to about 2 hrs 10 mins.[88]

Journeys made with Kustpilen, 1990-2000, index



Development of journeys made with the Kustpilen trains. Source: SJ (Figure: G. Troche)

Before the Kustpilen train was introduced 0.6 million journeys were made in 1991, of which a small percentage were made by bus. Over 1992 the number of journeys increased to 0.9 million, and up to the third quarter of 1993 to 1.2 million, an increase of 100% between 1991 and 1993. The increase in travelling has continued, and in 1995 journeys totalled 1.5 million annually.[89] 2.7 million journeys were made on Kustpilen in 2000, a total increase of 450% between 1991 and 2000.

There is a difference between the travel forecasts and actual development. Low fares, higher frequency of service and the elimination of the need to change trains are probably behind most of the increase in the number of journeys. A traditional forecasting model, however, lacks

[88] Infrastruktur och regional utveckling, *Infrastructure and regional development* (2001)
[89] Nelldal, Kottenhoff, Lind, Rosenlind and Troche (1996)

certain factors that influence demand, for example the value of new train systems with a high standard of design, comfort and service (concept trains). The effect of concept trains appears to be strongest over the first two years following their introduction, and then diminishes before finally almost disappearing over the next 10 years. One explanation is that the Kustpilen trains were perceived as so different compared to the railbuses (the older diesel rail-cars) and the bus that they can almost be regarded as a totally new travel mode, with a successful design, good service and the support of enormous mass media coverage. Under these circumstances, the forecasting models underestimated the effects of total changes in supply.[90]

Passengers' valuation of the supply, investigated with Stated Preferences (SP), was considerably higher with Kustpilen than with the same supply described before it began operating. This shows that neither train passengers nor motorists could imagine the high level of comfort they perceived once they had practical experience of they new trains. The SP method is sensitive to how the alternatives are presented to the interviewee, and also gives different results in before and after situations.[91]

Passengers' valuation of train (Kustpilen) or bus (Kustbussen) along the Blekinge coastal line has also been studied. Passengers value the train more highly than the bus, at least if the train in question is Kustpilen. There appears to be a difference between bus and train that can not be explained by traditional standard factors such as travelling time, frequency of service etc. The difference in valuation between train and bus can be reduced by using roomy high standard buses – "buses with train interiors". People value bus and train very differently; the people who travel by bus, or who have tried the bus, are less negative to the bus than people who routinely travel by train. Motorists are more negative to the bus alternatives, except for the bus with extra large legroom. Pensioners prefer the bus at times.[92]

Commuting on the Blekinge coastal line

Total commuting between the municipalities along the Blekinge coastal line (Karlskrona, Ronneby, Karlshamn, Sölvesborg and Kristianstad) increased by 14% between 1992 and 1998, and especially commuting by train increased markedly. The largest increases, between 20% and 35%, were in commuting to the municipalities of Sölvesborg, Ronneby and Karlskrona. Commuting to Karlshamn and Kristianstad, on the other hand, was unchanged or slightly less between 1992 and 1998. Outward

[90] Kottenhoff and Lindh (1996)
[91] Kottenhoff and Lindh (1996)
[92] Kottenhoff (1994)

commuting increased most from Kristianstad, Karlshamn and Karlskrona, by between 25% and 40%.[93]

The pattern of change in commuting is an indication that trade and industry in Karlshamn were doing less well during this period, while companies were expanding and creating more jobs in Ronneby, Karlskrona and Sölvesborg.

There are other important factors besides the public transport supply that decide the degree of commuting: the local labour markets are as decisive as any other factor for inward and outward commuting. It is possible that the Kustpilen service has contributed to the increase in commuting through the greater accessibility the train system has made possible, thus alleviating the consequences of the fluctuations in trade and industry in the municipalities.

2.4.3 Commuter trains in Stockholm

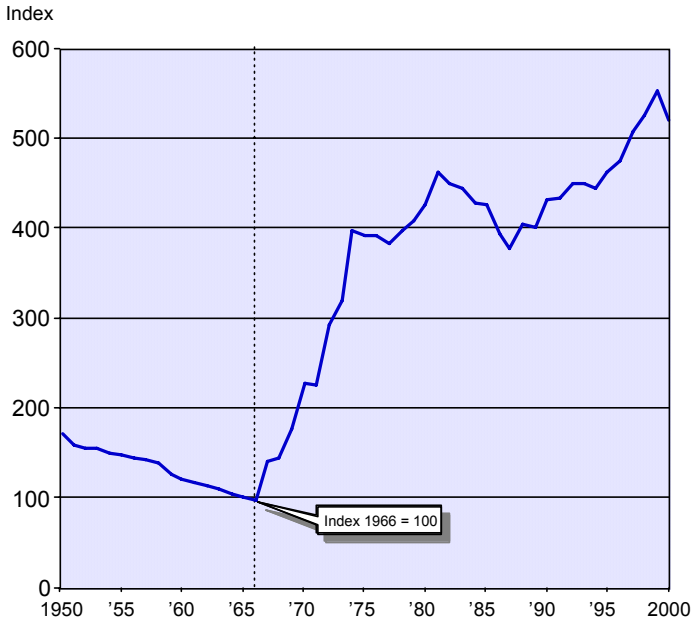
Commuter trains began operating in Greater Stockholm in 1968 following the negotiation of an agreement on the distribution of responsibility for the services in 1964.[94] The agreement meant that county council of Greater Stockholm (through the Greater Stockholm Public Transport Company) took over responsibility for the commuter services from SJ, and a new solution for operating the commuter trains was created with modernised stations, new carriages and a better timetable. Together with the reformed fare system, which meant that the same fare system applied on all public transport in the county, and a cheap season ticket, the so-called 50-pass, the prerequisites were created for increasing travel by public transport. Similar initiatives in regional train services in other parts of the country did not materialise until after the national transport policy decisions of 1979.

The population in the Stockholm area grew dramatically during the 50s and 60s, and the amount of land available for new housing in the city of Stockholm was limited: much of the new housing was built in the suburbs and in the neighbouring municipalities during this period. In 1950 some 2/3 of the county's 1.1 million inhabitants still lived in the city of Stockholm; in 2000 the figure was 41% of 1.8 million. Places of work have been concentrated to the central areas for a long time. The increasing number of places of work in the Stockholm region during the post-war years, however, have mainly been located outside the central

[93] Statistics Sweden, Infrastruktur och regional utveckling, *Infrastructure and regional development*, extract, (2001)
[94] Sannel and Svallhammar (1997)

areas, which means that the number of places of work in the central areas had fallen to 34% of 0.95 million by 1990.[95]

Journeys made with local and commuter trains in Greater Stockholm, 1950-2000, index



The development of commuter train services in the Stockholm region, 1950-2000 (state owned tracks only). Sources: SJ and SL, Nelldal and Troche (2001a)

The commuter train system was built up at a time when the need to travel was increasing. The low-point for local trains came in 1966, at which time the number of journeys to central Stockholm had been halved in 15 years, while trips by car to the same destination had almost tripled over the same period.[96]

Commuting increased dramatically during the first few years, up until the oil crisis in 1974, at which time it had grown to four times what it had been at the outset in 1968. The increase was due to a higher, regular frequency of service, and the co-ordination of fares and timetables with the rest of public transport throughout the county. The rate of increase subsequently began to fall off, but in the 1990s (1990-1999) travel increased by 40% thanks to the investment in an expanded system and higher frequency of service. 66 million trips a year were being made on commuter trains in 1999 [97], which is more than half of all the train journeys in the whole country, and about 20% of all passenger transporta-

[95] Hårsman and Quigley (1998)
[96] Nelldal, Kottenhoff, Lind, Rosenlind and Troche (1996)
[97] SL årsredovisning, *The Greater Stockholm Public Transport Company's Annual Report* 1999

tion (number of journeys multiplied by distance travelled) by rail. The temporary dip in 2000 in the figure is due to quality problems in connection with switching service supplier. The services are operated using multiple unit railcars designed for local and short-distance regional trips with a low level of comfort.

2.4.4 X 2000

The high speed X 2000 train was put into service in autumn 1990 between Stockholm and Göteborg. Following modernisation of the line the high speed trains with tilting capabilities and a maximum permitted speed of 200 km/h could run faster than ordinary trains. Travelling times were cut by 25%, from about four hours to just under three with the fastest train. Promotion of the X 2000 has been very successful and the trains are perceived as being very modern and comfortable. The X 2000 had gradually been introduced on more lines and it has been the backbone of SJ's long-distance services since the timetables were reformed in January 1996 and the X 2000 replaced most InterCity trains on the western and southern main lines.

The total travel market for journeys between the Stockholm and Göteborg regions was approximately 4 million journeys a year in 1996, of which private car, air and train had roughly equal shares, and travel by bus was negligible. In the competition between rail and air on this particular route rail travel fell from a predominating 67% share in 1980 (33% for travel by air) to 42% in 1990. When the X 2000 was introduced travel by train began to increase, and reached 57% in 1996. The new rail passengers have mainly been taken from the airlines; six of ten business travellers had previously flown.[98]

The reduction in travelling time between Stockholm and Göteborg to three hours on the X 2000 meant that many business travellers who could now make the round trip in a single day began using the train. By ordinary train travelling time was four hours at best, which meant that working time at the destination was short for same-day round trips. Moreover, both ordinary and high speed trains give passengers the chance to work while travelling. Almost 30% of the high speed train passengers gave the possibility to work as an important reason for choosing the X 2000 instead of flying between Stockholm and Göteborg in 1994.[99]

At the same time as travelling on the X 2000 between Stockholm and Göteborg was increasing, long-distance train journeys were decreas-

[98] Nelldal (1998)
[99] Engström, Eriksson and Wenninger (1997)

ing over the country as a whole. The main reason was the introduction of VAT on travel, which meant a substantial increase in the price of tickets. Taking the general decline in travelling into consideration, the increase in travelling by train between Stockholm and Göteborg was approximately 40%, which can only be explained by the introduction of the X 2000. The short travelling times, proximity to the railway station, the possibility to work and the high level of comfort were important factors among the passengers who chose the X 2000 in 1994.[100] Since then the number of non-business passengers on the X 2000 has increased markedly due to timetable and fare changes, which most assuredly affected valuations.

In summary, the success of the X 2000 between Stockholm and Göteborg is due to:

- Shorter travelling times
- Higher frequency of service
- Better comfort, service and quality
- Better image; X 2000 a totally new product.[101]

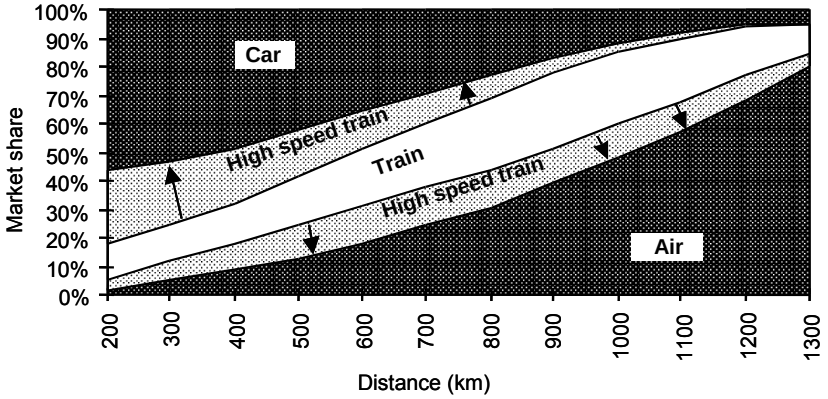
2.5 High speed trains

2.5.1 The travel markets for high speed trains

The markets for high speed trains differ depending on how the train system is planned. On the one hand, the high speed trains can replace air travel between two end-points. A typical example is France's TGV, where the new lines mainly link major regional centres with Paris. On the other hand, the high speed services can link several different places along a line, building a region of high accessibility within the corridor. The best examples can perhaps be found in Germany, where several corridors also build a network – though partly at the expense of travelling speed between the end-points. A high speed line can also have both functions on condition that it has been planned as such, for example that the line has sufficient capacity and stations are strategically located. Japan's Shinkansen train is an example of such a combination. Several new high speed lines have also been built to international airports, further increasing accessibility in an international perspective since the trains provide fast feeder trips to flights.

[100] Engström, Eriksson and Wenninger (1997)
[101] Nelldal, Kottenhoff, Lind, Rosenlind and Troche (1996)

The effect of high speed trains on market share, long-distance journeys



Source: ECMT, in Nelldal and Troche (2001b)

The increase in travel for the high speed trains can be explained by the fact that they are trains that operate on long-distance services that can compete time-wise with medium- and long-distance air services, and compete with the car even when slower connections to the high speed trains are necessary. The train services can in most cases also offer very short travelling times in submarkets, trips between small towns and between regional centres, that do not have access to air services. The train's market is thus a wide one. The high speed train initiatives have meant that the trains have become the market-leaders in fast passenger transport on many tours, which has led to more train journeys by train in a growing total market.

The most comprehensive high speed train systems on new lines can be found in Japan (Shinkansen) and France (TGV). The Shinkansen train can in part be likened to a regional train system in Europe as far as frequency of service and passenger volume are concerned. The new train systems have come to be the most important part of the railway company in both countries from an economic viewpoint, and high speed train travel accounts for a large part of all travel by rail. Some of the effects that the French TGV has had on the travel markets is presented below, together with the Spanish AVE train that has had enormous impact for a number of interjacent medium-sized towns.

2.5.2 TGV in France

The second largest high speed train network after Japan is the new TGV network in France. The first line, TGV Paris–Sud-Est (the south-east corridor), was opened in two stages (1981 and 1983) between Paris and Lyon. It was followed by TGV Atlantique to the Atlantic coast in the south-west in 1989 and TGV Nord-Europe to Lille and the Channel

Tunnel and Brussels in 1993. More links have been added, but Paris is still the hub of the system.[102]

Distance and travelling time, Paris–Lyon

	TGV	Normal train	Car	Air (incl. connection)
Distance	427 km	512 km	481 km	
Travelling time	2:00	3:46*	4:50	3:10

* before 1981

The distance between the capital, Paris, and Lyon, the centre of France's second most important region, Rhone-Alpes, is approximately the same as the distance between Stockholm and Göteborg. Travelling time with TGV is two hours. At the end of the new line, many trains continue out onto the old railway network, shortening the travelling time to Paris from other places that are not located directly on the new line.

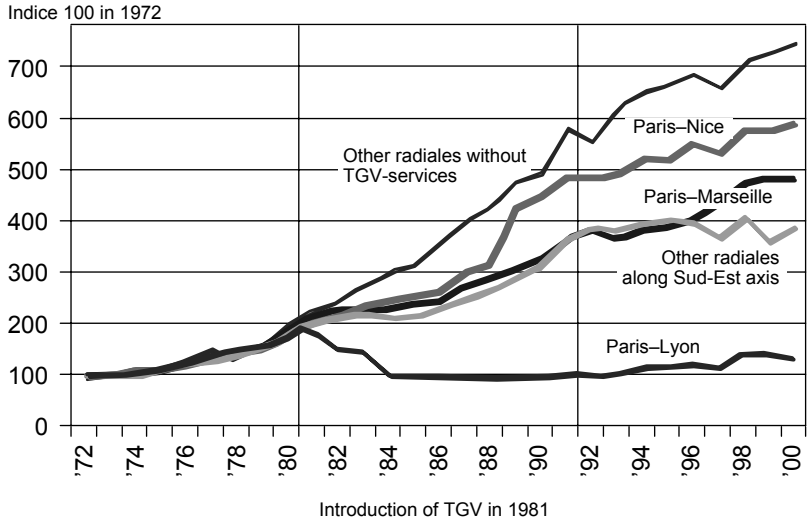
When the TGV trains began operating between Paris and Lyon the total number of journeys by train in the south-east corridor, i.e. including journeys to destinations beyond Paris and Lyon, increased from 12 million in 1980 to 19 million in 1985 and 22 million in 1991, of which 18 million were made on the TGV trains. The increase in train journeys in the south-east corridor is equivalent to almost 60% between 1980 and 1985. Train journeys just between the cities of Paris and Lyon increased even more dramatically and in 1984 was 2.5 times greater than before the high speed services began in 1980. Between Paris and the interjacent station at Le Creusot-Montchanin, with a travelling time by TGV of 1 hr 25 mins, travel increased 7.2 times over the same period.[103]

Some changes in mobility have also been observed, and journeys to Paris from the smaller towns especially show an overall increase. On the other hand, the better accessibility to Paris with the TGV trains has also meant that the supply of train services and consequently accessibility on other tours has deteriorated, in particular Dijon, situated as it is on the old line between Paris and Lyon.[104]

The railway has increased its market share from about half in 1980, to about 3/4 of all journeys by train, air and car. Of the other modes, air has lost most. An estimate is that of the new train passengers 33% switched from travelling by air, 18% from travelling by road, and 49% are new journeys.[105]

[102] Huot (2001)
[103] Bonnafous (1987)
[104] Mannone (1995)
[105] Bonnafous (1987)

Domestic air travel (index) in France, 1972-2000



Development of French domestic air services (Index 1972 = 100). Source: DGAC, in Huot (2001)

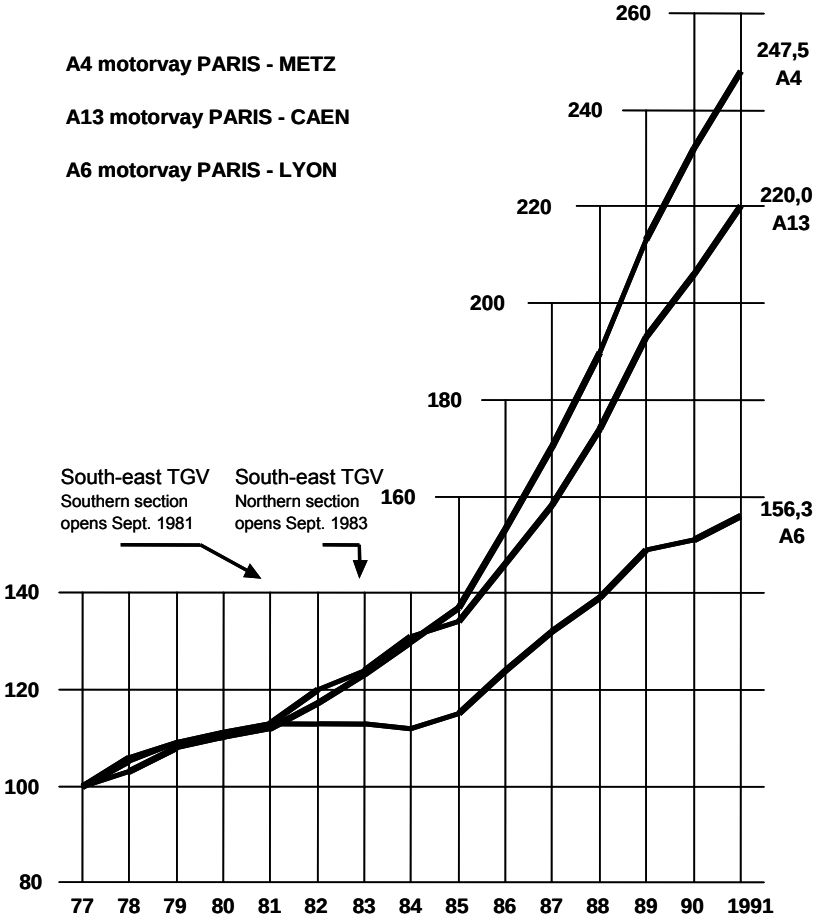
With the south-east Paris–Lyon TGV and the new supply of fast train connections from 1981 on, car traffic stagnated on the parallel motorway for many years, and is less than on other comparable stretches of motorway. Air services on the same route have been marginalised to just a small percentage of the total travel market, and are important mainly for transfers starting and ending outside Paris or Lyon and surrounding areas.[106]

In addition to the increased number of journeys and the change in market share for different travel modes, a new pattern of travel behaviour has emerged since the TGV trains began operating on the route. Many passengers have markedly increased their frequency of travel at the same time as visits at the destinations have become shorter and the number of trips over the day has increased. Journeys are also planned an increasingly shorter time in advance.[107]

During the first years of the TGV services the number of business contacts within service from companies in Rhone-Alpes to Paris increased more than contacts in the opposite direction. This indicates an asymmetry in the effects of the fast train services, an asymmetry that can contribute to expanding companies' also running their operations from places other than the region around the capital.[108]

[106] Huot (2001)
[107] Engström, Eriksson and Wenninger (1997)
[108] Bonnafous (1987)

Development of motorway traffic (index) in France, 1977-1991



Development of motorway traffic in France. Index 1977 = 100. The growth of traffic on the A6 stopped when the TGV services began in 1981. From 1984 on traffic has again increased, but more slowly than on other comparable motorways. Source: SNCF, in Nelldal and Troche (2001b)

The only significant urban growth that has been seen around the three new stations on the TGV Paris–Sud-Est line (Le Creusot, Mâcon and Lyon Part-Dieu) over the first decade was the office development that took place around the Lyon Part-Dieu station. Part-Dieu is easy to get to locally in Lyon and has good connections with two hours' travelling time to Paris. Moreover, there were few vacant offices in central Lyon.[109]

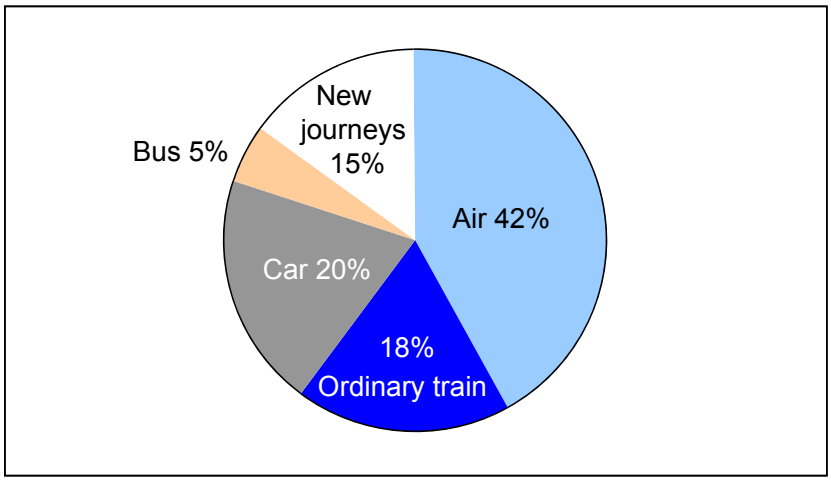
[109] Banister and Berechman (2000), p. 280

2.5.3 AVE in Spain

The first high speed line in Spain, from Madrid to Seville, opened in March 1992. The route is 471 km long, compared to 574 km on the old line, and travelling time is 2 hrs 15 mins (6 hrs 30 mins by ordinary train on the old line).

Between 1991 and 1995 the total number of journeys between Madrid and Seville increased by 20%, from 2.2 million a year to 2.6 million. Journeys by train quadrupled during the first years and totalled 1.4 million, while air travel was more than halved over the same period.[110] Before the new high speed line opened in March 1992 the train had about 1/3 and the airlines 2/3 of the market. The train has since then increased to about 80% and the airlines have fallen to 20%. The total number of journeys, however, has increased during the 1990s.[111] Journeys by air, though, are still fewer than before the new high speed line. Travel by bus and car has also declined.

AVE passengers' main alternatives in 1995

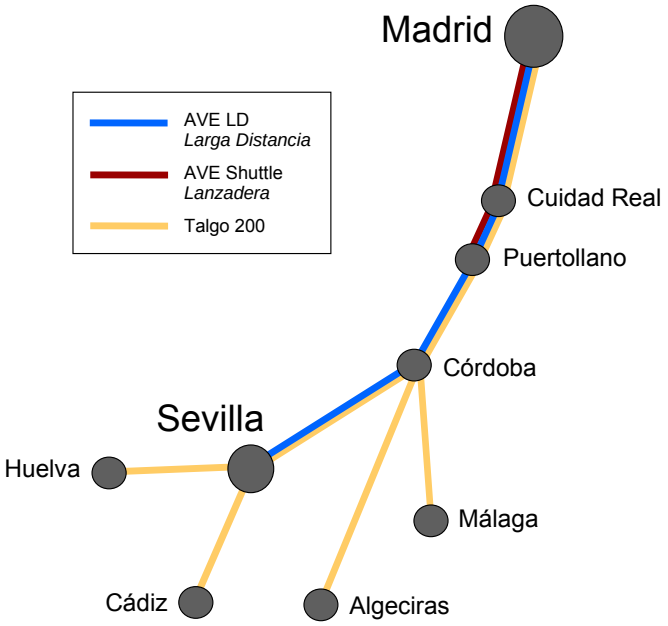


Mode of transport that passengers on the AVE high speed train between Madrid and Seville in 1995 would choose if the AVE did not exist, and the proportion of new journeys. Source: Engström, Eriksson and Wenninger (1997), p. 88 [112]

In the beginning the AVE train services mainly attracted those who had previously travelled by air between Madrid and Seville. A transfer of some 40% has taken place from air travel, calculated on travel in 1995. The new journeys are a result of the improved accessibility and also of a growing total market.

[110] Engström, Eriksson and Wenninger (1997)
[111] Renfe High-speed Marketing Department (2002)
[112] BB&J Consult S.A., Renfe and Spanish transport ministry

The traffic system between Madrid and Andalusia



The traffic system with three different train products between Madrid and Andalusia. The Madrid-Seville high speed line that opened in 1992 is the backbone of the system. Travelling time was shortened from 6 hrs 30 mins with the old train to 2 hrs 15 mins with the AVE LD.

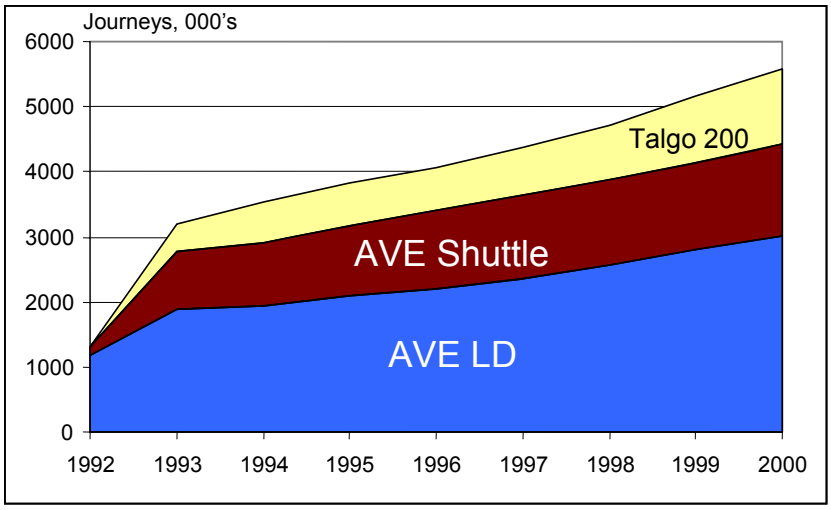
The Spanish State Railways (Renfe) operate services on the new high speed line with three different train products. AVE Larga Distancia (LD) operate between Madrid and Seville, long-distance trains that stop at a varying number of stations along the route. This service is complemented by the AVE Lanzadera, or shuttle, between Madrid and Puertollano. Talgo 200 trains also use the new line. Talgo 200 are locomotive hauled trains with passive tilting and the ability to switch gauge between the high speed line's standard gauge (1 435 mm) and the rest of the Spanish broad gauge network (1 668 mm). This means that the trains can run all the way between Madrid and Huelva, Cadiz, Algeciras and Malaga in Andalusia, for example, at fairly high average speeds. All types of train stop at the interjacent stations on the route, but have somewhat different travelling times because they have different maximum permitted speeds.[113]

Journeys on the shorter routes from Madrid to Cuidad Real (171 km) and to Puertollano (210 km) can be made with any of the three train products, but fares and travelling times vary somewhat. Travelling time from Madrid Atocha to Cuidad Real is 50 minutes by high speed train,

[113] Talgo 200; 200 kph, AVE; 300 kph

with 19 departures a day, of which half are by Lanzadera.[114] Travelling time to Puertollano is 15 minutes longer. The previous supply of train services consisted in 1991 of slow trains that went a long way round compared to the new line, with a travelling time from Madrid Atocha to Cuidad Real of between 2 hrs 30 mins and 3 hrs 15 mins, (40 minutes longer to Puertollano), and an irregular timetable with 8 departures a day.[115] The AVE trains have thus considerably improved the supply.

Travel by train between Madrid and Andalusia, 1992-2000



Train journeys between Madrid and Andalusia, in 000s per year, divided over different products. Train journeys totalled 5.6 million a year in 2000, of which AVE LD (long distance) accounted for roughly half. Source: Renfe High-speed Marketing Department (2002)

The effects of the improved accessibility have been studied in a research project.[116] The stations in Cuidad Real and Puertollano have come to be important interchanges for passengers changing from other travel modes (car, taxi, bus) to the high speed train on journeys to Madrid. There is a clear linkage between an increase in the amount of traffic on the roads leading to the railway stations in these towns, and the introduction of AVE. The difference between Cuidad Real and Puertollano (each with a population of about 60 000) is that in the former the station is located on the outskirts of the existing built-up area, while the station in Puertollano is in the town centre. This means that a considerably greater number of passengers in Puertollano, about 60%, walk to and from the station, while motorised travel modes dominate in Cuidad

[114] Menéndez, Coronado and Rivas (2002)
[115] Cook´s European Timetable, June 2-30 1991
[116] Menéndez, Coronado and Rivas (2002)

Real (20% on foot). In the stations' regional area of influence, that stretches 30-100 km around the stations, the car is the predominant travel mode (80%) for getting to the stations.

On the other hand, there has been extensive new development close to the station in Cuidad Real, but not in Puertollano. The inhabitants of Cuidad Real have also been made more aware of AVE through the material changes that took place in the town when the new line with its new station replaced the old line.

The number of commuters to Madrid is four times greater from Cuidad Real than from Puertollano. The shorter travelling times and cheap fares (monthly passes) might explain some of the difference, but the frequency of service is the same in both places. By far the major commuting route, however, is the Puertollano–Cuidad Real route, with many students travelling to the university in Cuidad Real.

The people who live in Madrid and commute to Cuidad Real are in general senior clerical and administrative employees, of whom most say that they would work in Madrid if AVE did not exist. Commuters in the other direction are greater in number and have a more variegated background, but in general they say that they are more dependent on their work in Madrid and would move there if it were not possible to commute on the AVE. The long-distance commuters living in Cuidad Real often consider accessibility to the railway station when choosing where to live.[117]

A second high speed line is now under construction in Spain: the Madrid–Barcelona route which will be completed by 2004. Travelling times by train will be cut from 6 hrs 30 mins to 2 hrs 30 mins between the end-points. The greatest improvement in accessibility, however, can be expected in Zaragoza, at the mid-point of the line, whose residents and trade and industry will be able to reach both the capital and Barcelona with very short travelling times.[118]

2.5.4 Conclusions from empirical studies

Earlier empirical studies of high speed trains provide a lot of information, but so far little consensus or theories around the subject have resulted from these studies. It has proved difficult to generalise the results because the case studies have often been focused at the micro-level. The studies carried out at the macro-level have not gone undisputed.[119]

The conclusions drawn in studies of the effects of high speed trains on economic development in Japan (Shinkansen) and France (TGV) are

[117] Menéndez, Coronado and Rivas (2002)
[118] Gutiérrez (2001)
[119] Banister and Berechman (2000), p. 28

that effects can be seen both at network level and at local level. The network effects can be attributed to the considerable improvements in accessibility to the most important national and international markets. The local effects vary more and are also dependent on a robust local economy that can utilize the new possibilities that come about as a result of the improvements in accessibility. The effects are most tangible in high-tech businesses and service industries, but also more generally in all business sectors where meetings between people are important. In this context image and access to support activities and service are important for location effects to materialise. Local connections inside the town or city are also important, especially if the new station for high speed trains is located on the outskirts. Finally, the need for other, supportive public strategies at all levels must be emphasised if the investment in high speed transportation is to be successful.[120]

A combination of a motorway and a high speed railway gives better total accessibility than just one of the modes. A corridor economy arises when travelling times are short, and integration takes place between the various localities, forming a functional region. A functional region is defined as a geographical area with a common labour market and common household and service sector, where the labour market is of primary interest. In a large region a higher degree of specialisation can be achieved than in each locality separately before accessibility was improved. Improved accessibility lowers the transportation costs, primarily for passengers and high-value goods. On the other hand, there can hardly be any advantages for low-value goods, but a substitution of passengers for heavy goods may take place as a result of economic development.[121]

There are also studies that show that new high speed systems have not had the desired effects as regards regional economic development. One observation is that economic activity has in several cases been concentrated to the major conurbations instead of helping the peripheral regions. Another is that careful planning and good accessibility to the stations are necessary for effects to materialise. The transportation system may be seen as a network, where the links must be joined together in order to stimulate economic development in the region.[122] [123] [124]

[120] Banister and Berechman (2000), p. 282
[121] Blum, Haynes and Karlsson (1997)
[122] Vickerman (1997)
[123] Hugosson and Pettersson (1995)
[124] Karlsson (1995)

2.6 Discussion and conclusions

2.6.1 Regional development

Most researchers appear to agree that a linkage exists between economic development and improved infrastructure. With regard to railways, it is probably better to speak about improved train services rather than the infrastructure in itself, even if the infrastructure is often a key issue for improving the services. The supply factors of the services are important, and short travelling times, high frequency of service, high comfort and service in combination with low fares can produce large increases in travel.

The effects of improved infrastructure are generally speaking small. The greatest effects and the best results are found in areas where economic development is restricted by insufficient accessibility, which in turn can be remedied by investment in transport infrastructure. The effects mainly materialise in the area immediately adjacent to the link in question. New, fast rail connections provide the prerequisites for labour markets to function better. Companies find it easier to recruit competent personnel. Contacts within trade and industry become simpler and more frequent in the areas where accessibility to the railway stations is good, thereby promoting economic growth and creating the prerequisites for greater volumes of travel. Improvement of accessibility is thus reflected in the generation of new trips.

To achieve maximum benefit from the investment and stimulate economic development, several public measures must interact with supportive strategies, and the private sector must find the new prerequisites attractive for economic development to take off on the local or regional plane. The improved infrastructure gives better accessibility, which may constitute a contributory yet not necessary measure, or a necessary yet not sufficient measure, for vitalising the economy. The time for different effects to materialise, however, varies considerably, and the effects on the transport markets materialise much faster than the effects on the social structure. Moreover, time will introduce dynamics into the development.

A couple of Swedish ex ante studies state that the effects of improved accessibility resulting from new regional train services should be able to be traced in the productivity of trade and industry, in the consequences for the different localities' labour markets, in the different localities' housing markets, and in municipal and governmental planning.[125] Future population figures and people's employment and income

[125] Snickars (1994)

levels and the number of companies may also be affected by increased integration.[126]

The regional effects depend partly on synergy effects between different sectors, and partly on the distribution of resources. Redistribution may take place between different areas at the local, regional, national and international level, and also between different groups of people. Both dynamics, synergy effects and distribution effects require a relatively large amount of work to be able to be analysed, as compared to simply studying direct, average effects. The results of the analyses can then fail to take into account important dimensions of infrastructure and economic development. It is therefore important to develop models and increase knowledge of the benefit that different groups gain from improved infrastructure, and to try to emulate the dynamics in economic development and social structure that can result from an investment in transportation infrastructure.

2.6.2 The introduction of new train systems in Sweden

A summary of the examples in the literature study of new train systems which have had a great effect on demand in Sweden shows not only that the increase factors vary in size, but also that the supply factors differ between the systems.

The effects of the introduction of the X 2000 trains were not as great, relatively speaking, as the other train systems in Sweden. The increase for X 2000 has been estimated to be 40%. The most important reason is that the supply was relatively good before the new train systems were introduced, which meant that the trains had a larger market share to begin with than in the other examples. Another reason is that the railway companies can adjust the fares to maximise their profits. This means that that the train service operator sets a price such that passengers must pay more when the supply improves, and as a result there are no great increases in travel volumes.

In all the cases where the increase in travelling is several hundred per cent, the supply of train journeys was deficient in one or more respects before the new train system was introduced. The train services' market share was consequently considerably smaller before the supply was changed. Following the introduction of the new train systems, the train services' market share has grown substantially. The Kustpilen train and the Svealand line are both new train systems that have seen increases of 400-600% during the first few years, but where regional travel is still predominantly by car.

[126] Tegnér and Holmberg (1995)

New train systems in Sweden with major market impacts

Traffic system	*Market*	*Main construction period*	*Increase factor*	*Supply factors*
Commuter trains Greater Stockholm	Local, regional	1968-1974	4	New system, new trains *Lower price* *Higher frequency of service* *Co-ordinated system*
Kustpilen train Karlskrona–Malmö	Regional, interreg.	1991-1995	3	Old line, new trains *No changes* *Lower price* *Higher frequency of service*
The Svealand line Stockholm–Eskilstuna	Regional, interreg.	1993-1998	6	New line, new trains *Shorter travelling times* *Higher frequency of service* *Normal price*
X 2000 Stockholm–Göteborg	Inter-regional	1990-1996	1.4	Upgraded line, new trains *Shorter travelling times* *New service concept* *High price*

The markets that the train system is intended to serve are strategically important, and they grow over time through the generation of new journeys, which is a sign of changes taking place in the social structure due to the improved accessibility. In the long term, the market share of established, attractive train services can therefore be expected to increase, provided that the supply develops in a positive manner.

2.6.3 The research project

Experience from other projects

One example of a research programme where experience from a number of similar earlier studies was collected deals with the extension of one of the lines on the London Underground, the Jubilee Line extension, stretching from central London via Docklands to Stratford. The effects on both traffic and social structure were studied. It was found that it is important to take current land use into consideration, to consider economic, planning and political conditions and background factors, bear in mind that effects materialise over different lengths of time, and that quantitative and qualitative methods should be used in the

studies in order to better understand the development process and the dynamics.[127] [128]

About as comprehensive as the research around the London Underground extension is the before and after study of the effects of the Öresund bridge. The study was made in four steps and deals with four different aspects of the effects; on traffic, social structure, the economy and the environment.[129]

Where appropriate, these findings can also be used in the Svealand line research project.

Expected effects of the Svealand line

The Svealand line can be expected to have effects on the social structure, even though the process is a slow one. The effects of the improved accessibility will mainly be seen in an increase in the number of journeys made by public transport. This might in turn result in a reduction in car usage. In this perspective the areas where accessibility improves significantly, i.e. the areas close to the stations, are the ones where changes in travel behaviour should be most evident.

The research project on the effects of the Svealand line on travel demand and social structure covers only a limited period of time, from 1996 to 2002. The new service began operating during this period. The before and after study is however too limited as regards time to be able to follow the more long-term effects, especially with regard to regional effects and social structure. The effects on social structure of the Svealand line's train services, if any can be shown, will probably be difficult to see in comparison to other, more important background factors. The background factors include, for example, economic trends; an upswing at the end of the 1990s coincided with the introduction of the new train services.

There is some doubt as to whether a new public transport system contributes so much to increased accessibility as to affect the social structure. The reason is that in total the car dominates all travel in the western world. Consequently, accessibility by car is the single most important factor for the transportation of passengers and goods. And accessibility by car is already very good. On the other hand, there are unquestionably certain market niches where the effects of public transport investments can be substantial. Fast regional travel might constitute one such niche, where the Svealand line is of interest when the trains become the fastest means of transport between regional and local centres

[127] Jubilee Line Extension (1997)
[128] Lane and Eyers (2001)
[129] Lundqvist and Snickars (2001)

in Södermanland, and Stockholm, which is also a national centre. The train services have become the market leaders as regards travelling time on these tours, and travelling time is an important parameter in the sacrifice made in terms of time and money for a certain journey. The dynamic effects that may be critical to (large) structural changes may then appear as a result.

In a regional perspective the train services may lead to decentralisation, i.e. that growth is spread from the Stockholm region to places along the Svealand line in so far as the train services improve accessibility. There may also be some redistribution within a community, as the concentration of people around the railway stations gives rise to increased activity in these areas. In a society dominated by the car, it is at the intersections of major roads that most activity occurs, as can be seen from the external relocation of businesses and service outside the real city centres that has taken place – and is continuing to take place. Typical for the car-dominated society is also that all human activity, and consequently property prices, exhibit a greater surface spread and evenness than a society dominated by public transport. In the case of the Svealand line it might therefore be profitable to study whether the increased accessibility to the proximity of the railway stations is reflected in increased activity, especially in comparison with other areas in the same community, or perhaps a different community with an equivalent change in supply – a reference population centre. The comparison will in the latter case naturally suffer from the weakness that there will be differences in a number of location-specific circumstances, both known and unknown.

Hypotheses about regional development and social structure would then be difficult to prove or refute. Perhaps a follow-up project is needed in a decade or so to determine further aspects of the long-term effects – which according to the model will continue for several decades before a new system equilibrium has been attained.

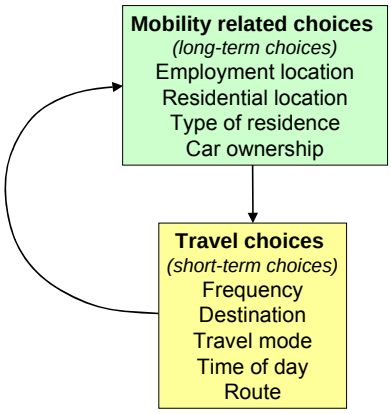
To begin with it is therefore of interest to study the effects both on travelling as a whole and at the disaggregated level, i.e. for individuals who are affected by the train services to a greater or a lesser extent. This will also make it possible to study expectations with regard to the Svealand line before its opening, knowledge of the supply at various stages, and actual behaviour.

2.7 Theory, model and hypotheses

2.7.1 Theory

Theory states that there is a mutual influence between traffic and social structure. Traffic is a result of social structure, and changes in social structure also cause changes in the flows of travel and the transportation of goods as people's activities change. Conversely, new prerequisites for traffic, for example investments in infrastructure, affect social structure. At the centre of the changes are the choices individuals make on the basis of given prerequisites. The individuals choose partly where they are going to live and work, whether they need a car and other similar long-term choices, and partly short-term choices such as how and when journeys will be made. The former are called mobility-related choices and the latter trip choices. Both groups are travel-related choices, and are also intimately connected to the social structure.

Individual travel-related choices



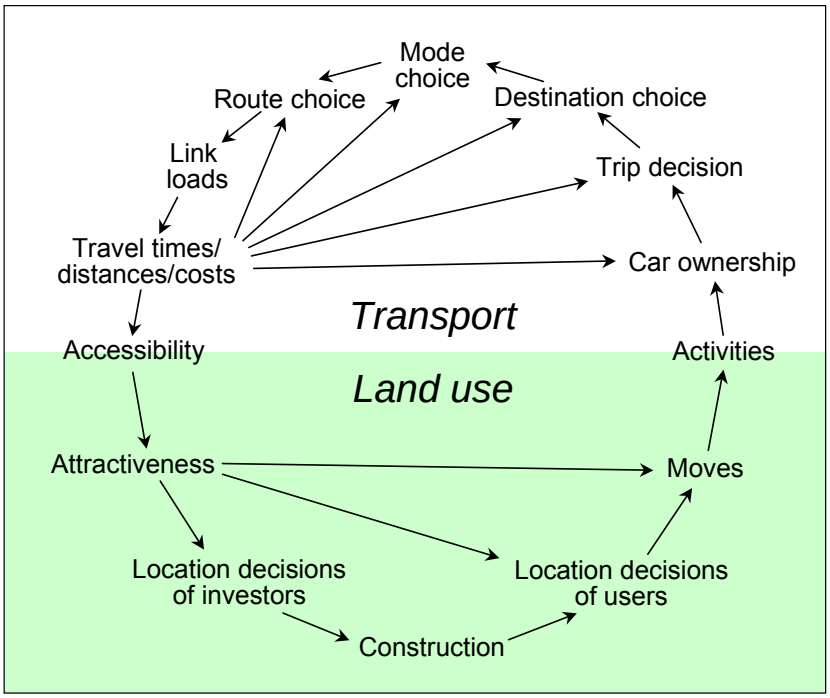
Source: Adapted from Ben-Akiva and Lerman (1979), and Fisher (2000)

Changes in supply take place with a certain delay.[130]

- *Adaptation of regional structure within and between town and city regions.* Takes place in the long term and comprises location of work sites, places of work and residences.
- *Structural mobility decisions* are medium-term. Comprise individual choice of residence, place of work and car access.
- *Travel decisions*, rapid changes in supply and new conditions. Concern frequency of travel, destination, travel mode, time and route.

[130] Ben-Akiva and Lerman (1985), pp. 328-329

The land use transport feedback cycle



Source: Wegener (1996)

There are also other ways to classify effects and describe how quickly the effects materialise. A division into four different time horizons (very slow, slow, fast and immediate changes) makes the differences in time clearer.[131]

- *Very slow changes*; changes in the physical networks (the infrastructure) and social structure.
- *Slow changes*; mainly changes in the building stock for businesses and dwellings. The buildings as a rule have a longer life than the time individual households and companies use them for.
- *Fast changes*; changes in trade and industry, and thus employment, and population and housing.
- *Immediate changes*; demand for transportation and travel.

All these human activities, however, affect their surroundings, which leads to environmental changes, and they may thus change the prerequisites for the activities.[132]

If changes in transport services (supply and demand) are linked to changes in social structure it is possible to derive a theory. One of the theories, but one which does not contain any information about how

[131] Wegener (1998)
[132] Wegener (1998)

long the linkage lasts, is the land-use transport feedback cycle. The land-use transport feedback cycle shows that traffic (transport) and social structure (land use) are intimately interrelated. In the borderline area between transport and land use are found the central concepts of accessibility and activities. Increased accessibility through improved travel opportunities creates greater attractiveness in a locality, which is converted into location of residences and businesses. This in turn creates activities, which generates a need for more journeys, and consequently new travel patterns and traffic conditions. Changes in social structure, however, are generally slower to materialise and more long-term than changes in traffic.

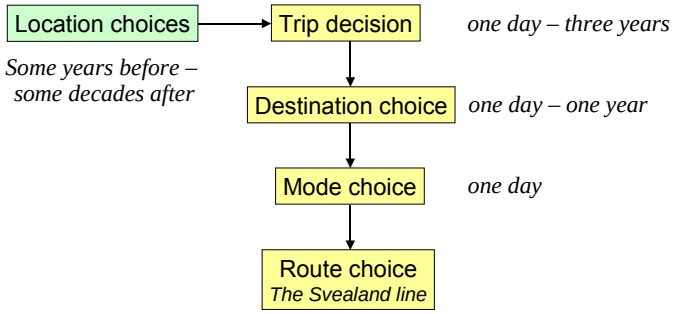
2.7.2 Model

In conventional forecasting models, for example Sampers, changes in services are normally calculated according to given external prerequisites in four steps, the so-called four step model. Detailed descriptions of the four step model can be found for example in Ortúzar and Willumsen (1994) or McNally (2000a). Only a brief description is given here.

The four step model says that changes in traffic supply affect demand momentarily, and in reality that the effects materialise at different times. The four steps can also be found in the land-use transport feedback cycle, i.e. trip generation, trip distribution, mode choice and route choice. By estimating demand with the future requisites (the supply) at equilibrium, a forecasting model based on the four step model can calculate the amount of future travel, i.e. a demand forecast. The research project studied only the Svealand line corridor, so only route choice is given. Instead it is of greater interest to include how location affects travelling. A new first step, location choice, has therefore been added and route choice does not need to be considered. This then creates a theoretical linkage to the long-term trip-generating effects of the social structure.

The changes in demand begin immediately the supply is changed, in some cases even before the supply has changed (for example expectations of the new supply that affect location). Some typical periods for the changes to materialise are from one day to the next for mode choice, up to a year for trip distribution, over a year for trip generation, and a change in location can affect demand for several decades after the change in supply. In general, it takes at least two to three years to attain a new theoretical equilibrium in the traffic system, and several decades before an equilibrium is attained in the location system.

The four step model examples of periods of change



The four step model (the column from trip generation to route choice) as a theory for changes in demand caused by changes in supply, and some typical periods before a new equilibrium is attained in the various steps. The periods may be subject to considerable variation.

However, the four step model can not in practice handle dynamic changes, long-term trends in travel behaviour or interaction with the social structure, which is typical when major supply changes are made and new background factors appear. The assumed equilibrium will not materialise in practice. This argument is developed further in appendix 7.

2.7.3 Hypotheses

The hypotheses concern the Svealand line with the constraints imposed by the research project. With the results obtained, the intention is that the hypotheses will be proved or rejected in favour of the alternative hypotheses, i.e. that no effect can be traced. How far the hypotheses can be accepted is described in the summary of chapters 5-8.

Supply and demand

1. The improved train service supply increases demand for journeys on public transport where the supply of train services is attractive.

2. The Svealand line involves a system change in the supply of travel opportunities, which should mean the start of a dynamic process in the demand. The introduction phase will therefore be followed by further increases in travelling over a relatively long time before a new equilibrium is attained.

Knowledge

3. Knowledge of the train service supply is essential to high demand. The radical system change that construction of the line and the start of services entailed will probably contribute to widespread knowledge of the supply.

Valuation

4. The valuation of the public transport supply with regard to travelling times, frequency of service and fares ("hard" supply factors) can explain most of the demand, regardless of travel mode. The shorter travelling times by train on the Svealand line consequently give a high value added per journey.

5. The travel mode in itself influences the travel mode choice for the whole journey. The high speed trains on the Svealand line have contributed to the increase in demand for journeys on public transport through the high level of comfort, service and design ("soft" supply factors).

Behaviour

6. The radically improved supply of train services on the Svealand line leads to increased accessibility, which causes people to travel more and choose other travel modes and destinations than before the improvement in supply.

7. The increased attractiveness of public transport means that people's dependence on the car for regional journeys is reduced, leading to a reduction in car ownership.

8. Connecting trips to and from the railway stations reduces the accessibility to and the attractiveness of public transport compared to the car.

Accessibility

9. The increase in demand can be explained by the improvement in regional accessibility to places along the Svealand line brought about by the high speed train services.

10. Inside the communities the greatest relative improvement in accessibility has taken place closest to the railway stations, which results in greater effects close to the stations.

3. Methods

The research project took the form of a case study of the effects of the new train services on the Svealand line. The methods were chosen to allow the situation before and after their introduction to be compared. The areas studied were supply, demand and accessibility, and efforts were concentrated on describing travel behaviour as a consequence of the changes. A summary of the methods used in the research project is shown in the table below.

Methods used in the Svealand line research project

Subject	*Methods, reference material*
The Svealand line's inception and development in the region	Printed and non-printed sources, statistics (SCB, Statistics Sweden) Compilation
Supply and demand	Timetables, passenger censuses, traffic censuses Processing and analysis
Knowledge, valuations and travel behaviour	Field surveys, SP and RP questions Processing and analysis
Accessibility	Modelling with Sampers Time geography Processing and analysis

Some of the conclusions are based on results from several different approaches and methods. In some cases, a need to develop the method(s) was identified (see chapter 9).

3.1 Supply and demand

The description of the supply has been made by compiling available data, primarily bus and train timetables and fares.

The demand has been described by compiling passenger and traffic censuses. In certain cases, no information is available on the precise demand, for example divided into different trip purposes and lengths.

3.1.1 Regional travel

The definition of regional travel needs to be clarified. One definition is that travel inside a municipality is local travel, within a county regional travel, and over a county border interregional travel. Another definition is by the length of the journey; up to 10 km is local travel, 10-100 km regional travel and trips longer than 100 km interregional travel. The latter definition is generally used in Banverket's economic calculations.

In Sampers the definition has been supplemented with a criteria that to some degree divides travelling by trip purpose. Commuting to work, even over greater distances than 100 km, is calculated by the regional models.[133] The definition thus means that journeys that can be made daily are called regional (or local) travel, while long-distance journeys that are made more seldom are interregional travel.

For daily travel to be possible travelling time must not be too long. The average speed of the journey is therefore an important factor. The distance travelled per time unit, however, varies considerably between various modes. Here a definition specific to this thesis is used; journeys between Eskilstuna and Stockholm (115 km) or parts of this particular route are called regional travel, irrespective of the purpose of the journey. Journeys beyond (west of) Eskilstuna are defined as interregional. Journeys beyond Stockholm should therefore in the name of consistency also be classified as interregional, but no such differentiation can be made due to the shortage of data. The definition means that the expression regional journeys in this thesis refers to comparable journeys from the time of the old train services, both journeys by bus and with the new train services on the Svealand line between Eskilstuna and Stockholm. In fact, it is only with the regional high speed trains on the Svealand line that travel has come to be predominantly regional.

3.1.2 Traffic measurement on roads

Traffic measurements in the road network were carried out by the Swedish National Road Administration (SNRA). The measurements are made by counters, and the equipment registers the number of wheel axles that pass the counter. The data is then used to compute the total number of vehicles, and the number of trucks. Trucks are defined here as vehicles with a wheel base longer than 3.3 m and which consequently also include buses. However, the number of buses is marginal compared to the number of trucks.

Since 1988, average annual daily traffic volume (AADT) in the road network is calculated by measuring the traffic flow at a randomly chosen point on a section of road for 4-12 days, spread over weekdays and weekends, on 2 or 4 occasions at different times during the year. A section is here defined as a section of road with homogenous traffic. In practice a section of road between the intersections of two county or national roads is chosen. The flow is allowed to vary, however, within a certain interval. The AADT at the point of measurement can thus differ

[133] Sampers version 643. Technical documentation (2001)

from the average flow for the section, since junctions with minor roads along the section can add traffic.[134]

Measurements are thus made over a varying number of days for each section. However, the number of measurements (n) is not given by the SNRA, nor is the standard deviation. The number of vehicles (AADT) is given with a confidence interval of 95%. The size of the confidence interval is dependent on whether the measurements were made on 4 or fewer occasions, seasonal and incidental variations in motor traffic, and the number of approved measurements.[135]

In this context it is the number of private cars that is most interesting. The figure is not, however, stated directly in the material, but since the total consists partly of trucks and partly of cars, the number of cars is easy to calculate.

Assume that the confidence interval for all the traffic is greater than the confidence interval for trucks and that the observations are in pairs. The confidence interval for the number of cars can then be calculated approximatively;

$ki_{pb} = ((ki_{tot})^2 - (ki_{lb})^2)^{1/2}$

where ki_{pb} is a 95% confidence interval for the number of cars, ki_{tot} for the total traffic and ki_{lb} for the number of trucks.

The SNRA also has a fixed measurement point on the E20 road west of Eskilstuna and west of the exit to road 53, at the Gröndal intersection. The fixed measurement point continuously records the number of vehicles that pass. There is a certain degree of dropout, however. In 2000 about 80 days had an hour or hours that contained some dropout. One of the reasons for the dropout is that the equipment is operated by tubes placed across the roadway on the 13 m wide road, and the snow ploughs used to keep the road clear cause problems, mainly during the winter season. There is therefore no simple way to calculate the confidence interval for the data reported in the thesis, but it is assumed that $\alpha \approx 0$.[136]

3.2 The field surveys

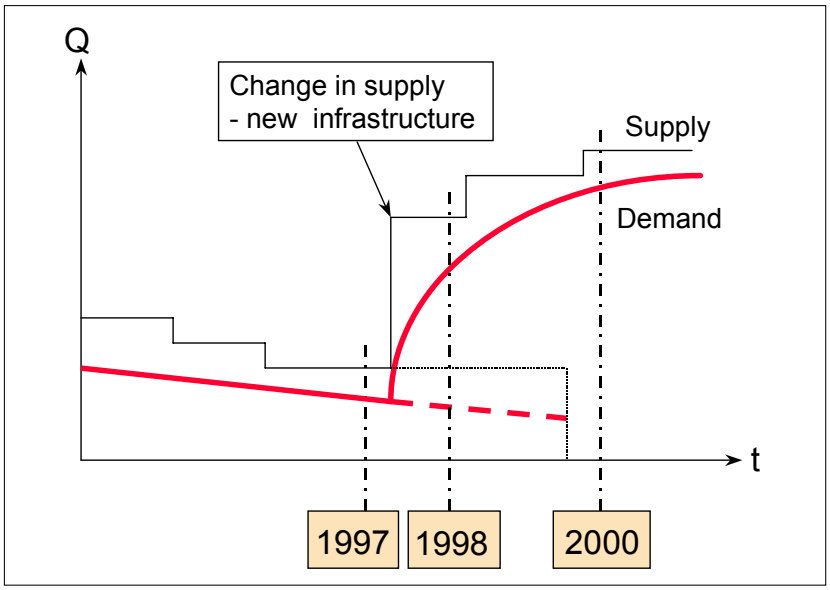
3.2.1 The survey period

Three rounds of surveys were made in the course of the research project: in spring 1997, spring 1998 and spring 2000. The times represent the situation shortly before, shortly after, and a few years after services

[134] Measurements before 1988 were made along the whole section of road
[135] Årsmedeldygnstrafik, *Average annual daily traffic volume* (1999)
[136] Mats Hagström, SNRA. E-mail, 27 June 2002

began operating on the Svealand line. The purpose was to create a time series of survey data from the introduction period.

Survey times



Outline description of the survey times' linkage to the change in supply on the Svealand line.

3.2.2 Survey methodology

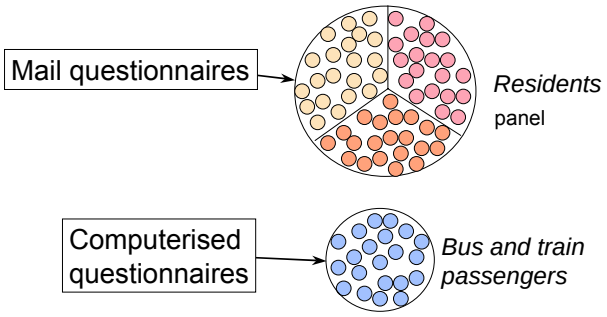
The research project has been carried out with a quantitative approach, i.e. a study that primarily measures (quantifies) the total effects according to a theory based on a rationalistic approach.[137] Data on travel habits, knowledge and valuation of the supply has been collected in three rounds of surveys. Two groups of people were chosen for the surveys: residents and public transport passengers. The two groups can be assumed to have different average valuations, even if certain individuals are the same in both groups. Analogous to the public transport passenger group, it would be interesting to interview a group of motorists, but the aim here was instead to capture the motorists from the areas along the Svealand line in the residents group.

Residents were interviewed by means of mail questionnaires, while the public transport passengers were interviewed using portable computers on board buses and trains. The contents of the questionnaires were in principle the same for both groups, except that the residents were asked questions about their most recent trip by public transport and car journey outside of the place where they lived, while the bus and

[137] See for example Bryman (1997)

train passengers were asked questions about the particular journey they were on.

Interview methods



The method of interviewing by mail questionnaire was chosen in order to be able to cover a demographic section of the population in the selected areas at a reasonable cost. Telephone interviews were also considered but after enquiries were made of a number of consultants was judged to be more expensive per interview. Mail questionnaires were judged to be able to give acceptable results even considering the large dropout expected. More detailed descriptions of the advantages and disadvantages of the different methods can be found in other literature on the subject, for example Wärneryd (1993) or Aaker, Kumar and Day (1998).

Interviews using portable computers on board buses and trains have been made before at the department in several different contexts since the beginning of the 1990s.[138] Experience gained in the previous field surveys has also been used in this project. One great advantage is that the respondents themselves enter their responses, obviating the need for that element in the post-processing of the data.

Analysis

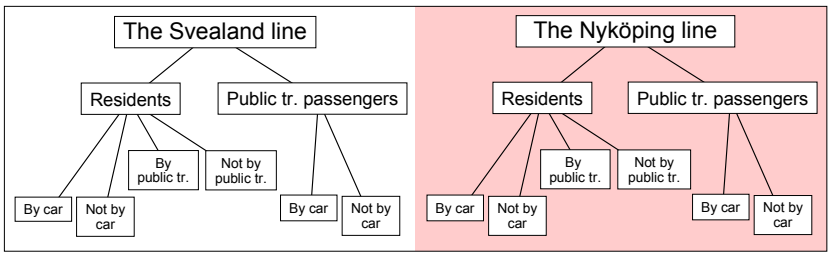
The field surveys have mainly been analysed using statistical tools (SPSS). The surveys were stratified for the analysis. The first level divides the results from the Svealand line and from the Nyköping line, the second level whether the data is from residents or public transport passengers, the third level whether the residents have travelled by car, by public transport, or not travelled at all.

The figure showing the stratification is also found in the descriptions of the analyses in chapters 6 and 7. The levels in question are clearly shown, while the levels that are not relevant to the analysis are shaded.

[138] See for example Kottenhoff (1999)

Some analyses have more levels, for example socioeconomic conditions, but this is made clear where the results concerned are presented.

Stratification in the analysis



3.2.3 Mail questionnaires

Residents for the surveys were selected by choosing a number of people at random in the postal code areas in question from a commercial address register. The respondents are assumed to constitute a representative sample of the population between the ages of 16 and 74. The age group roughly corresponds to 72% of the population of the whole country,[139] and was chosen to capture the people who travel most in the most effective manner.

The panel interview is one of the methods used to study a group's preferences before and after a certain event.[140] In this case the panel interviews were so designed that in each of the surveys (1997, 1998, and 2000) the residents were divided into three groups, with 1/3 being replaced each time. 1/3 of the respondents therefore receive all three questionnaires, while the other 2/3 receive one or two. The advantage of this method is that a specific group's changes in knowledge, valuations, and behaviour over a period can be clearly seen, at the same time as changes caused by changes in the composition of the population can be taken into account. The latter would not be possible if the members of the panel were the same for the whole period.

The questionnaires were then sent to all the respondents at the same time, 2 400 questionnaires in 1997 and 1998, and 3 000 in 2000. Most of the questionnaires were filled in and returned by the respondents quite quickly. A reminder was sent after about two weeks, and a few more questionnaires were received. After yet another week, a new reminder was sent, this time with a new questionnaire and the promise of a reward if the questionnaire was filled in and returned in a few days. Respondents who sent in a completed questionnaire after the second reminder received a reward in the form of a lottery ticket or a cinema

[139] Statistisk årsbok 2001, *Statistical Yearbook for Sweden 2001*. SCB
[140] See for example Aaker, Kumar and Day (1998)

voucher. The final reminder was by postcard the first year but by telephone in 1998 and 2000.

Total frequency of response for mail questionnaires

	1997	*1998*	*2000*
Survey period	*9 April-10 June*	*24 April-30 June*	*3 April-27 June*
Planned sample	2 395	2 395	3 000
Actual gross sample	2 395	2 395	2 981
Moved/staying abroad or at sea	*7*	*23*	*15*
Sick	*6*	*16*	*40*
Does not speak Swedish	*2*	*22*	*8*
Wrong address, moved	*31*	*61*	*305*
Total excluded from target group	46	122	368
Net sample	2 349	2 273	2 613
No response	*744*	*693*	*710*
Does not want to participate/no time	*42*	*40*	*65*
No. of dropouts	786	733	775
Questionnaires received	1 563	1 540	1 838
Frequency of response, net	67%	68%	70%
Frequency of response, gross	65%	64%	62%

The target of at least 60% reply frequency based on the gross sample was met in total for all three years. In individual areas, however, the gross frequency of response is between 53% and 75%. The areas that did not come up to 60% are rural areas with few respondents, and Eskilstuna in 2000 where the dropout from the gross sample on the panel was large with a sample that was three years old. In the surveys in 2000, more telephone reminders were ordered than in 1998 to try to raise the gross reply frequency to the target level in all individual areas in the survey. This was not fully successful. Net frequency of response, on the other hand was high in these areas (65-85%) thanks to the telephone reminders. Among the reasons people gave for not responding were that they did not want to participate, that they did not have time, had language difficulties, had moved, were away on a trip, or something else. No analysis has been made of non-respondents, except for the figures reported in the table. The survey period including reminders was from April to June in all three surveys.

The content of the questionnaires and the design of the survey are the work of the author with the help of experience gained in a master's thesis, his supervisors' knowledge, and available literature on the subject. A few dry runs were also made before the first survey proper. In all

three main surveys, a firm of consultants, Sifo Research & Consulting AB (now Research International AB), was engaged to handle the selection of the samples, mail the questionnaires, send or phone reminders, and code and register the responses.

3.2.4 Computerised questionnaires

The surveys on board buses and trains were made by the author. In 1997 interviews were carried out on board the buses between Eskilstuna and Stockholm, a small number on board the trains between Eskilstuna and Flen, and on the trains between Nyköping and Stockholm. In 1998 interviews were carried out on the trains on the Svealand line between Eskilstuna and Stockholm, on the trains between Nyköping and Stockholm, and on the buses on this last route. In 2000 interviews were carried out on the trains on the Svealand line and between Nyköping and Stockholm. In all cases the interviewers drew up programmes with trips in both directions spread over the days of the week and the hours of the day.

Total frequency of response for computerised questionnaires

	1997	*1998*	*2000*
Survey period	*24 April-16 May*	*24 April-8 May*	*7-18 April*
Net sample	680	836	990
Number of interviews	491	490	502
Frequency of response, net	72%	59%	51%
Interviews made by	Oskar Fröidh, Lars Segerman, Ingmar Sörhammar	Ingmar Sörhammar, Karin Törnström	Ludvig Andersson

An interview typically began by the interviewers asking the intended respondent where he or she was travelling to. If it was a journey that began and ended in places other than in the survey areas, the person was not in general allowed to proceed to the questionnaire. The interviewers then handed the respondent a portable computer with a self-instructing questionnaire program, and the respondent ran the program unaided. The time this took depended on the respondent's familiarity with computers, but an average interview lasted between 20 and 30 minutes.

The advantage of computerised questionnaires is that the results can be processed directly. For most of the 1997 interviews a two-page questionnaire was also handed to the respondent. The intention was to be able to compare the valuations of different alternatives with the answers in the mail questionnaires.

A passenger on the Svealand line in 2000 being shown how to fill in the questionnaire on a portable computer.

The response percentage on board buses and trains was between 50% and 70%, but was generally speaking higher for the buses than for the trains. The proportions are calculated by dividing the number of usable interviews by the number of intended respondents. The dropout then includes interrupted interviews, people who did not want to or did not have time to do the interview, people who were asleep when the interviewers came past, and people who had already done the interview. People who were asked but who travel longer distances than to Eskilstuna and Nyköping have been excluded from the net sample. The high frequency of response on the buses in 1997 resulted from the fact that the journey took longer, giving the respondent time to do the interview, and that a greater number of passengers on parts of the journey had time to do the interview.

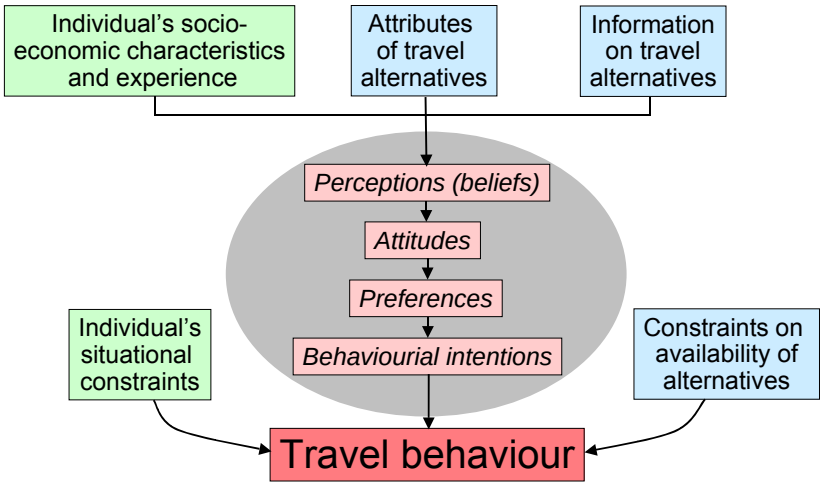
One observation is that a relatively large number of older people, mainly pensioners, declined to do the interview, stating that they had too little knowledge of computers, or too little time or interest. Young people on the contrary often wanted to do the interview. The shorter travelling times by train on the Svealand line also mean that passengers who only travelled only part of the way are underrepresented in the data, in the same way that the number of interviews at peak periods are fewer than in the actual distribution. The dropout is also too great with the method used in certain cases. All together, this means that it is not known how representative of the average train passenger the sample in the data is.

The author has for the most part been responsible for designing and carrying out the computerised interviews. The interview program was further developed from the ground laid by Lars Segerman's thesis with the interviews on the Svealand line in 1996.[141] That thesis may be regarded as a trial survey for this project's main surveys.

3.2.5 Theoretical background to the SP and RP methods

Stated Preferences (SP) and Revealed Preferences (RP) are two investigative methods that can describe a studied group's preferences, their valuations. Both methods have been used in the research project to study residents' and public transport passengers' valuation of different supply factors among the travel opportunities. The valuations are assumed to reflect the individuals' benefits of different choices, and this theoretical basis is found in behavioural science. For example, Ben-Akiva and Lerman (1985), Hensher and Button (2000), Gärling, Laitila and Westin (1998), Lindh (1998) and Nerhagen (2001) discuss the behaviour and selection processes concerning travelling.

The individual's choice process for travelling



A model of the way people choose to travel or not to travel. Note that the perceptions are strongly controlled by the individual's convictions. Source: Pearmain, Swanson, Kroes and Bradley (1991)

SP attempts to clarify the values by means of hypothetical choices, while RP is based on real choices. SP measures what people say that they will do, while RP measures what they do or have done, for example in a study of travel habits. The results of the methods can differ if the individual takes a further step in a selection process leading to a type of

[141] Segerman (1997)

travel behaviour in RP, a step that is not part of SP (see the illustration).[142] Among other things, the result is influenced by the individual's socioeconomic factors.[143] In SP it is often difficult to ensure that all the respondents understand the description and can see the relevant factors in a hypothetical alternative, while in RP it may be difficult to gather data from the most important factors that controlled the individual's choice. Findings in British studies, for example, indicate that the values for frequency of service and changes are different in SP and RP.[144]

McFadden (1998) states that it is rare for an SP study of a hypothetical market to agree with real preferences. For an SP study to produce good results, consumers must be well-informed and practised at making choices in similar situations, and that the change is closely connected to a possible real change. Otherwise, the model will need to be calibrated, which can for example be done by combining SP data and RP data.[145]

Some of the possible sources of error that affect the models' usability and results are shown in the table below.

Sources of error in SP and RP

	SP	*RP*
Sample errors	•	•
Dropouts	•	•
Reported data	•	•
Absence of constraints	•	
Confirmation	•	
Rationalisation	•	
Policy responses	•	

Some possible sources of error in Stated Preferences (SP) and Revealed Preferences (RP). From Widlert (1992)

Sample errors and dropouts have to do with the fact that the group of respondents is relevant, and that the response frequency is (sufficiently) high. When the data is processed, errors can occur and they can be wrongly stated. In SP an absence of constraints in the study can also be a source of error. Absence of restrictions means that each individual in reality has limitations in the travel opportunities that may perhaps not be clear from the actual design of the study. Budgetary constraints and fixed working hours, for example, can mean that the choice does not agree with the individual's valuations.

[142] Pearmain, Swanson, Kroes and Bradley (1991)
[143] Ortuzar and Iacobelli (1998)
[144] Wardman (2001)
[145] McFadden (1998), p. 361

The respondents can also give answers that do not reflect their real valuation of the factors for several reasons. One is the desire for confirmation that he or she has done something well, i.e. the respondent gives the answers in the way that he or she thinks the interviewer wants. Rationalising the questions and answering them with just one or a few factors in mind if the first factor can not differentiate the alternatives are called lexicographic responses. Finally, the respondent can give policy responses, i.e. answer how he or she things should be, not how he or she values a particular alternative.

Methods studies have shown that rating and paired choices to value different hypothetical travel alternatives in SP studies give better results than for example ranking different alternatives. The number of lexicographic answers is as a rule small in the former methods. It is especially important to adapt the SP study to the respondent's current situation to ensure good results.[146] [147] [148]

A few examples of response distribution in connection with rating are that some respondents try to distribute their scores around a mean value which is the ideal value for their evaluation. Others have consistently used the score 1 for anything they do not like, and 10 for what they like. All methods must ideally be able to handle different strategies on the part of the respondents without causing systematic errors in the results.

The approach in this research project was to use existing case study methods. For this reason, the reader is referred to other literature for further details about the methods, for example Widlert (1992) or Lindqvist Dillén (1995), Widlert (1994), Louviere, Hensher and Swait (2000), Louviere and Street (2000) or Sanko, Daly and Kroes (2002).

3.2.6 Using SP in the surveys

Both rating and paired choices have been used as SP methods in this research project. Rating was used in the mail questionnaires, because rating was considered to be the simplest and cheapest method for the respondents in their home environment. Bus and train passengers were given the same SP survey as in the mail questionnaire in 1997 in order to be able to compare public transport passengers' responses with those of residents. In the following two surveys on board trains in 1998 and 2000, however, the studies were made using paired choices on portable computers, since this was more practical for a small number of interviews and meant less subsequent work.

[146] Widlert (1994)
[147] Lindqvist Dillén (1995), p. 52
[148] Ortúzar and Garrido (2000)

The most interesting differences between the different years are of course those that concern the population's actual change in their valuation of the travel suggestions. There is, however, some bias in the sample population's valuations, which may partly depend on somewhat altered geographical areas and changes in the study method. For this reason it is more interesting to look for trends than to fix exact values.

SP rating

The mail questionnaire contains a number of questions about how the respondent values a journey between his home and the centre of Stockholm (see appendix 10). The questions have different levels for the factors travel mode, fare, frequency and travelling time (see appendix 2). Rating is relative, i.e. the score is dependent on the factors and levels in the questions. The levels are also adapted to the place of residence. It is therefore not possible to combine the responses from different survey areas, or to extrapolate the result to questions outside the area studied. Valuation is done in the form of a score on a scale from 1 to 10, where 1 is very bad and 10 is very good.

In the first survey, in 1997, levels were chosen for the factor travelling time that made it difficult to evaluate the result, mainly because the questions were supposed to be realistic. In the surveys of 1998 and 2000 the levels have been corrected in three of the four rating questions and the question design was more orthogonal than it had been before. The new question construction improved the result but makes statements about the magnitude of the changes before and after the Svealand line began operating less reliable. The control area (Eskilstuna 6) with the old question design also in 1998 and 2000 has confirmed suspicions that the 1997 question design gives a worse result. The problems with the 1997 survey arose because the results of the trial surveys were not analysed in sufficient depth due to a shortage of time in the before-study before the train services on the Svealand line began.

The rating questions were divided into two question packages, comprising six questions 4.1A-4.1F and four questions 4.2A-4.2D respectively. This division was made after a trial survey, where several respondents thought that ten rating questions in the same valuation were too many to take all factors into account. A car question was also added, question 4.2E in the 1997 survey and question 4.2.G in the two that followed.

In the first package (4.1A-4.1F) the factor correlates travel mode with travelling time to get realistic questions. The factor frequency of service is the same in all the questions in order to define frequency of service more exactly for the respondents, but can consequently not be

analysed. In the second package (4.2A-4.2D) the design is orthogonal with regard to travelling time, fare and frequency of service with two factors each, given the high speed train travel mode. The question construction, in other words, is not ideal for the analysis, but the intention was to simplify and adapt the questions to the interview situation.

In the 1997 survey one question in the two packages is the same. The intention was to calibrate the scores given between the questions since some of the respondents have given the same supply factors different scores (which is plausible in a relative valuation). In order to calibrate the analysis using packages 4.1 and 4.2 together, a scaling factor was introduced to try to take the difference into account. However, the scaling factor proved to have little importance, and the difference was a slightly worse result as regards the degree of explanation (R^2) and t-values. Analysis of the question packages separately has also been tried, but it did not give the desired significance. In the end, the analysis was made with the questions together without a scaling factor.

The car question was analysed using a generic approach, i.e. the travelling time and the cost of a car journey were equated to an equivalent journey by public transport. However, the results of the analysis were not satisfactory, with large, apparently random, variations between years and places. The number of observations is probably too small, which gives large variations in the sample, and there may also be other, hidden factors that the respondents have taken into account. The analysis of the values of the factors therefore included only the ten public transport alternatives.

Regression analysis

The rating has been evaluated using multiple linear regression analysis to determine the parameter values of the factors. The method is based on estimating the survey population's valuation of the relation between one variable, the dependent variable, and a number of other variables, explanatory variables.[149] The scores are assumed to be a relative measure of the benefit to an individual of an alternative with certain attributes, or supply factors. In a regression analysis it is important that a causality exists between the dependent variable and the explanatory variables, and to determine how strong the relation, the correlation, is between the variables.

In this case the score is the dependent variable, and the valuation of the travel mode, travelling time, frequency of service and fare are explanatory variables. The relation is expressed in coefficients of regres-

[149] Gujarati (1995)

sion, or parameter values. Using the least square method the regression analysis fits the data to a line. Multiple linear analysis is expressed mathematically as fitting functions of the type

$$y = a + b_1x_1 + b_2x_2 + ... + b_kx_k$$

where y is the dependent variable (score), a is a constant, and $b_1, b_2, ... b_k$ parameter values for $x_1, x_2, ... x_k$, which are the explanatory variables (travel mode, travelling time, frequency of service, and fare). However, the estimation also includes sources of error, and the survey population's (the sample's) valuations will in practice therefore deviate from the real value in a random manner. This random variation is normally designated ε.[150]

When the parameter values were determined the scores were transformed into to Swedish crowns for all factors by dividing by the score for price (Skr).[151] The method is simple and in general gives plausible results compared to earlier similar studies using different methods.

SP with paired choices

On board buses and trains surveys were conducted using portable computers and the MINT interview software.[152] Paired choices with a fractional factorial design were used in the SP part.[153] [154] The factors that were studied were travel mode, travelling time, frequency of service, and fare (see appendix 5). Every respondent made a total of eight paired choices between different combinations of levels of the supply factors. The passenger had previously given a cost and travelling time for the ongoing journey in the questionnaire. The levels in the SP studies were thereby adapted to the real levels.

The results of the public transport passengers' paired choices on portable computers were analysed using a program called ALOGIT. The program is based on theories of consumer choice on the basis of a logit model, and calculates parameter values.[155] The results were then converted into monetary units (Swedish crowns or a percentage of the fare).

3.2.7 Travelling time elasticity

Demand elasticities are a relatively simple way of calculating the sensitivity of the demand to changes in supply. However, they are rather rough,

[150] Andersson, Jorner and Ågren (1994)
[151] Kottenhoff (1999), p. 182
[152] User´s manual for the MINT … (1994)
[153] Pearmain, Swanson, Kroes and Bradley (1991)
[154] Lindqvist Dillén (1995)
[155] ALOGIT (1992)

approximate measures, and accuracy is not as good as results generated by a reliable forecasting model.[156] A formula that takes the current market share into consideration when calculating demand elasticities can be written

$$E_{ik} = (1-P(i)) \times a_k \times X_{ik}$$

where E_{ik} is the elasticity for component k for alternative i, $P(i)$ the probability, or market share for alternative I, a_k the parameter value for component k, and X_{ik} the variable value of factor X for component k for alternative i.[157] [158]

On the basis of the estimated parameter values, in this case travelling time elasticities can be calculated. An elasticity of -1 means that 1% shorter travelling gives 1% more passengers, while -2 means that the increase in the number of passengers is double the proportional reduction in travelling time. The demand elasticities vary for example between different travel modes, trip choices and survey populations. There is also a difference between elasticities in the short term and in the long term.[159] [160]

3.2.8 Journeys outside the home community

The field survey included a question about how many times the respondent had travelled outside his or her home community during the last seven days, by car and by public transport, divided into all journeys and journeys on the E20/the Svealand line. The responses were used to calculate the mean value of the population's journeys outside their home community. The difference between the situation in 1997 (before the Svealand line) and in 1998 and 2000 (with train services) was then tested using hypotheses to see if it was significant.

The zero hypothesis, H_0, says that no change in travelling took place between 1997 and 1998 and 2000. The alternative hypothesis, H_1, says that a change took place.

There is a risk (a probability) that the zero hypothesis will be rejected although it is true. The risk is called the significance level and is denoted α.

A high significance (a low value of α) means that the risk of rejecting the zero hypothesis although it is true is small. As can be seen from the table above α=0.001 is denoted with three asterisks, which means that the zero hypothesis is true with a probability of 99,9%. According to

[156] Goodwin (1992)
[157] Systemeffekter av kollektivtrafik, *System effects of public transport* (1989), p. 42
[158] Kottenhoff (1999), p. 182
[159] Goodwin (1992)
[160] Oum and Waters II (2000)

praxis α>0.05 is not reported since it is regarded as insufficient significance.

Significance levels

Confidence interval	*Significance level* α	*Symbol*
95%	0.05	*
99%	0.01	**
99.9%	0.001	***

The decision to reject the zero hypothesis, i.e. those cases where significance is denoted with asterisks, means that the sample supports the converse hypothesis. However, there is also a risk of accepting the hypothesis despite the fact that the zero hypothesis is in fact true.

The conclusion is that the statistical test proves that the changes are significant or that they are not. This does not mean however that reality and the sample are in agreement, but it is very probable that that is the case. All results can therefore be regarded as reliable, but not absolute.

In a pre-analysis of residents' travel outside their home community two different methods were used to test whether the changes were significant. In both methods it was assumed that the mean values of the samples show a normal frequency distribution around the real values.

- Random samples of the difference between the panel's journeys before and after
- Independent random samples

The method with independent random sampling gave the clearest result. The reasons for this are that the sample is bigger and the standard deviation is therefore smaller, and that changes in the composition of the population are reflected, in contrast to the respondents who participate in the panel for one or two of the survey years.[161] The hypothesis test is then consequently done in the form of independent random samples.

Survey data about residents' travel outside their home community shows a broad spread and a relatively large standard deviation and skew. A large number of the observations have the value 0, while a small number have high values. The mean value of the change between the years is to be assessed from these values. One supposition is that the people who registered the values from the questionnaires had different assessment criteria the different years, since the maximum values differ. Another is that a number of respondents misunderstood the questions and gave too high values. This second supposition is based on the fact

[161] Fröidh (2000; unpublished)

that the value 10 has a definite peak which could be either interpreted as that somewhat more respondents made ten return trips from their home community (which was what was intended with the question), or that they had made ten single trips, i.e. five return trips over the previous seven days, for example commuted to work. It may also be so the respondents rounded an approximate value to ten.

To reduce the degree of uncertainty in the assessment, the 99th percentile of the observations is used. The 99th percentile means that the results greater than the value of the largest of the 99% smallest values have been excluded. The occurrence of extreme values noticeably affects the mean value and the standard deviation. For the purposes of the study, they are of little importance, however, and exclusing some extreme values means that principally the standard deviation diminishes. The 95th percentile can also be used, but according to one analysis this would mean that some daily commuting would then fall outside the study, which is not desirable.

3.2.9 Geographical delimitation of the studies

The main area of the study is the area around the Svealand line between Södertälje and Eskilstuna. The conurbations of Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna are the places where the greatest effects can be expected. In addition to the conurbations, the study also includes the rural areas of the municipalities of Södertälje and Nykvarn (the municipality of Nykvarn was formed from one of Södertälje's municipal districts in 1999), Strängnäs and Eskilstuna. Residents in the conurbations can be expected to have other travel habits than residents in the rural areas including places further from the railway stations.

Nyköping is the survey's reference centre of population. In order to compare the effects of the improved supply on the Svealand line it was necessary to have a place of suitable size and at a comparable distance from Stockholm, but which does not get the improved supply. Other places were also discussed, but Nyköping had the desired properties and the possibility of regional commuting to Stockholm.

The conurbations of Stockholm, Södertälje and Örebro were included in the 1997 and 1998 studies, but were dropped from the 2000 survey in favour of a larger sample from the other areas. The three last are also served by the trains on the Svealand line, but the effects can be expected to be smaller and more difficult to identify there than between Södertälje and Eskilstuna. Only in a very small number of cases have the responses from residents in Stockholm, Södertälje and Örebro been analysed in this project.

Survey areas in the surveys of residents

	Area	No. of house-holds[1]	Size of house-hold[2]	Planned gr. sample[3] 1997 / 1998 / 2000
1	Stockholm			215 / 215 / 0
2	Södertälje			215 / 215 / 0
3	Örebro			215 / 215 / 0
4	Nyköping	14 503	2.5	250 / 250 / 500
5	Nykvarn	2 101	2.9	250 / 250 / 500
6	Eskilstuna, centre	4 451	2.0	250 / 250 / 250
7	Eskilstuna (conurbation except centre)	23 875	2.5	250 / 250 / 250
8	Strängnäs	5 925	2.4	250 / 250 / 500
9	Mariefred conurb., Åkers styckebruk incl.rural area	2 837	2.8	250 / 250 / 500
15	Nykvarn rural area	672	3.1	
16 17	Eskilstuna rural area incl. Torshälla, Skogstorp, Kjula and other conurba-tions	10 282	2.8	
18	Strängnäs rural area incl. Stallarholmen	2 775	2.8	
19	Läggesta, Mariefred rural area	690	2.9	*Total 15-19* 250 / 250 / 500
	Total			2 395 / 2 395 / 3 000

[1] in the survey area delimited by postal code areas according to appendix 1. Figures from the Swedish Post Office's postal code register, October 2001

[2] Average no. of people in the respondent's household in the 2000 survey of residents between the ages of 16 and 74

[3] Real gross sample is shown in appendix 1

In 1997 and 1998 a total of 13 survey areas were used. The number was reduced to 10 in 2000 when Stockholm, Södertälje and Örebro were dropped. For practical reasons, the addresses in the survey were chosen by postal code area. The limits of the postal codes follow the postmen's rounds, but do not agree exactly with the delimitation of the conurbation.

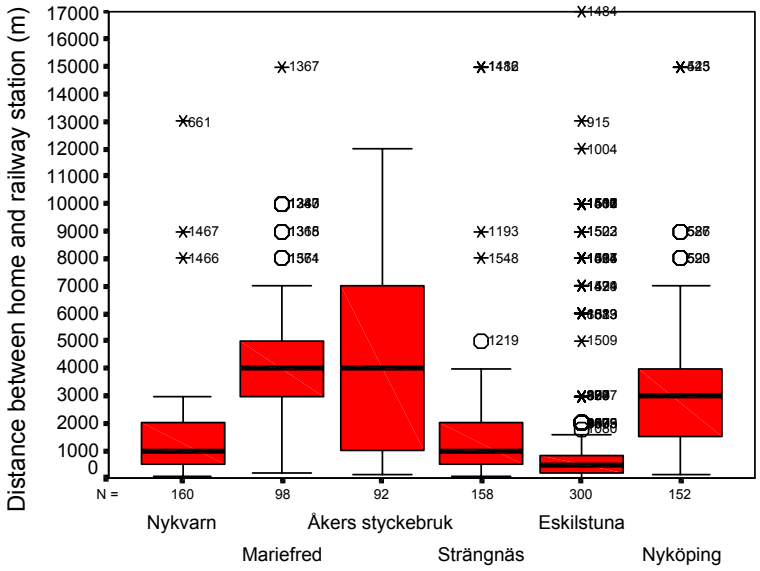
The borders of the areas differ in certain cases between 1997 and the surveys made in later years. This is because the consultant on the first year's survey chose postal code areas that were not fully in line with the agreed geographical delimitation, due to a misunderstanding between the consultant and the Swedish Post Office. This primarily affects the sample of respondents in Eskilstuna. The sample has been gradually corrected in the subsequent surveys as new respondents have replaced

old ones, but the error in the before-study of 1997 and a number of other changes in the sample mean that some desirable analyses of the situation before and after can not be carried out, while others are affected in one or the other direction.

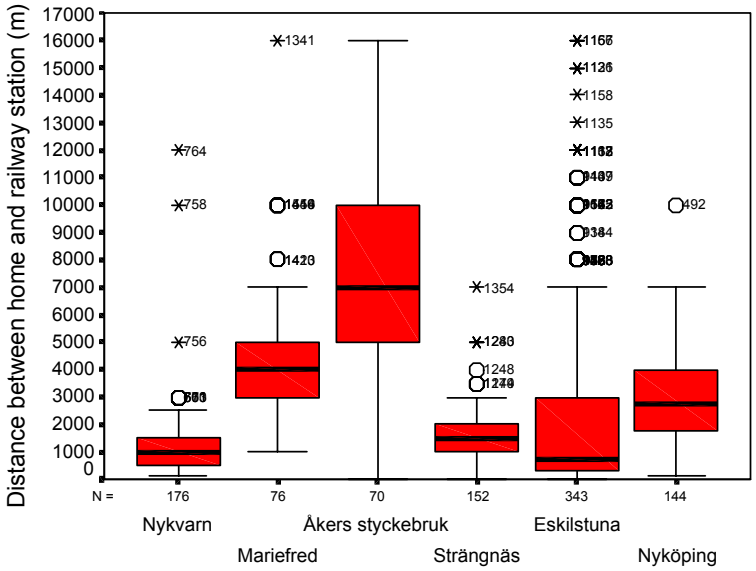
The surveys, however, contain a control question about where the respondent lives, which allows comparisons between the different years to nonetheless be made. The respondents' spread with regard to distance from home to the railway station are shown in box plots. The coloured box represents 50% of the values, with the lower end at the first quartile and the upper end at the third quartile. The bold cross-line indicates the median value. The crosslines on the outliers correspond to the 5th and the 95th percentiles, and extremes are shown by dots and crosses.

The box plots show graphically how the selection of respondents functioned, by interpreting the distance from home to the railway station. Residents in (and outside the conurbation) Åkers styckebruk were selected from a wider geographical area in the 1997 and 1998 surveys than in 2000.

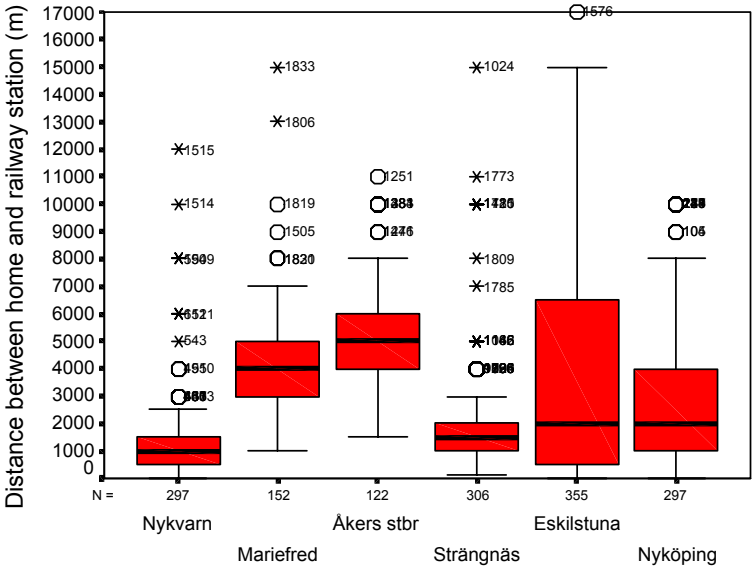
Distance between home and railway station, residents, 1997



Distance between home and railway station, residents, 1998



Distance between home and railway station, residents, 2000



An analysis of the spread of values shows two pronounced peaks as regards the residents, especially in 1997 but also to some degree in 1998. This is probably an effect of the difficulty of deciding which is the clos-

est railway station those two years, Åkers styckebruk or Läggesta. In 2000, it is more clearly Läggesta, which is confirmed by the smaller spread. Åkers styckebruk still exists, however, as a goods station.

Residents in Strängnäs show a slightly larger spread in 1997 than the following years. In this case, too, the probable reason is the relocation of Strängnäs station within the conurbation.

In Eskilstuna, the selection in 1997 was chiefly made from residents in the centre of Eskilstuna, up to 1 km from the railway station. On the other hand, almost no respondents were selected from outside the city centre (area 7) as a result of the earlier misunderstanding about the postal codes. The skewed sample has subsequently continued to be included over the years, but has successively been corrected, and in 2000 it shows an acceptable spread of residents at different distances within the conurbation. In studies of the situation before the Svealand line, there are in practice only residents in the centre of Eskilstuna to compare with.

The public transport passengers

The geographical delimitation of the interviews on board buses and trains are passengers on the Eskilstuna–Stockholm and Nyköping–Stockholm routes. Passengers who travel beyond Nyköping or Eskilstuna have not been asked to do an interview, but passengers who travel beyond Stockholm participated in the study.

3.2.10 Grouping of areas

During the course of the interview the respondent must personally estimate the distance from home to the nearest railway station. Residents of the conurbation whose homes lie within a certain distance from the railway station are here delimited into three zones. The innermost, first, zone comprises respondents who live at most 1 km from the railway station. A delimitation has also been made in that a respondent's home must be a minimum of 50 m from the railway station, in order to eliminate possible errors since the responses were registered in kilometres instead of in metres. The second zone comprises residents living within 1.1-3.0 km of the railway station. The third zone comprises residents living 3.1-10.0 km from the railway station. The conurbations of Nykvarn and Strängnäs thereby comprise residents in the first and second zones, while the conurbations of Mariefred, Åkers styckebruk, Eskilstuna and Nyköping here also include the third zones, i.e. up to 10 km from the nearest railway station.

Based on other empirical studies the first distance zones can be characterised as walking distance up to 1 km, and cycling distance up to

3 km, since walking and travelling by bicycle constitute a large part of the trips within each distance. The distances vary of course between this part of the trip where the respondent lives ("the home end") and where the activities take place ("the away end"), especially in the sense that walking distance is longer at the away end and bicycles are not used to the same extent, but it is primarily the home community that has been studied here.[162] [163] [164]

In the analysis the conurbations along the Svealand line are called Svea conurbations AB+D, i.e. the conurbations in the counties of Stockholm (AB) and Södermanland (D). To be able to compare data in a time series a definition has been introduced that by means of weighting compensates for certain sample errors and changes in the sample between the surveys. This delimitation is called Svea conurbations AB+D' (prime).

Delimitations and weights, Svea conurbations AB+D'

Conurbation	*Delimitation*[1]	*Pop*[2]	*No. of responses*			*Weight*		
			n 1997	*n 1998*	*n 2000*	*1997*	*1998*	*2000*
Nykvarn	50 m-3 km	6	157	173	287	0.8	0.7	0.6
Mariefred	50 m-10 km	4	96	75	150	0.9	1.0	0.8
Åkers styckebruk	50 m-10 km	3	86	65	120	0.7	0.9	0.7
Strängnäs	50 m-3 km	12	140	145	284	1.8	1.6	1.2
Eskilstuna	50 m-1 km	10	252	208	157	0.8	0.9	1.8
Svea conurbations			*731*	*666*	*998*	*1.0*	*1.0*	*1.0*

[1] Distance from home to railway station. For residents of Mariefred and Åkers styckebruk the nearest railway station is Läggesta.

[2] Approximate population within the delimitation, 000's

The weights are calculated by dividing the population in the delimited survey areas by the number of responses for each survey year. The value is then multiplied by a factor so that the mean value of the factors is 1. This last operation is done to be able to make calculations of statistical significance for the mean values without affecting the number of observations (n).

Despite the weighting there is still some imbalance in the selection of respondents. Primarily, there are many people who live around Eskilstuna (more than 1 km from the railway station) who are not covered in the survey because of the sample error in 1997. The measures

[162] Rystam (1998)
[163] Reneland (2001)
[164] Rietveld (2000)

described were introduced as a necessary compensation for the changes in the sample, but there are a number of minor differences that remain uncompensated, and which may to some degree affect the results.

3.3 The accessibility analysis

3.3.1 The components of the accessibility analysis

The research project has analysed accessibility before and after services began operating on the Svealand line. The intention was to study the linkage between supply on the one hand and modelled demand and accessibility on the other in the form of a before and after study.

Most of the analyses in the accessibility study were made using a modelling system for making demand forecasts, Sampers. A consult was engaged for the analyses since Sampers is a relatively complicated system. The modelling calculations were made by project leader Jonas Eliasson and traffic analyst Carl-Henrik Johansson at Transek AB in Stockholm and Göteborg, between November 2001 and April 2002. The other components in the accessibility study are comparisons of travelling times and time-geographical studies. These were made by the author.

3.3.2 The Sampers modelling system

In the accessibility study, Sampers version 1.2.643 was used as the tool to calculate a number of different measures of relatively altered accessibility. A number of known shortcomings and problems that may possibly affect the results of demand and accessibility modelled with Sampers in general are described in appendix 7. Special attention should be paid to the travel demand forecasts for regional train services in the regional models in particular.

The accessibility module in Sampers is relatively new and was not of practical use until 2001. The accessibility calculations are based on a coded supply and demand forecast. The regional submodule for the Mälaren valley (SAMM) was used, and its division into forecasting areas (about 6 000 areas) sets the limit for the geographical resolution. The analyses were concentrated to the area along the Svealand line in the municipalities of Eskilstuna, Strängnäs and Nykvarn.

In Sampers the realised accessibility can be calculated as travelling time, generalised cost or transportation using a specific travel mode or as a composite of modes weighted after the true modal distribution. As a utility-based measure the realised accessibility can be described as a logsum (see section 2.2).

The logsum is defined at the trip purpose level in Sampers. It is therefore important to choose one of the trip purposes since the logsum can not be summed for different purposes.[165] In this case journeys to work were chosen, because the effect on journeys to work is one of the most important indicators of the effects of the Svealand line, and because it is also easy to separate journeys to work from other types of journey. At the same time, this means that the logsum can not be divided up over different travel modes in the graphical map representation. A logsum calculation was nonetheless performed in the accessibility study to separate accessibility be car and by public transport, but this calculation applies to a selection of some important areas, individually, and not all Sampers areas in the Mälaren valley model together.

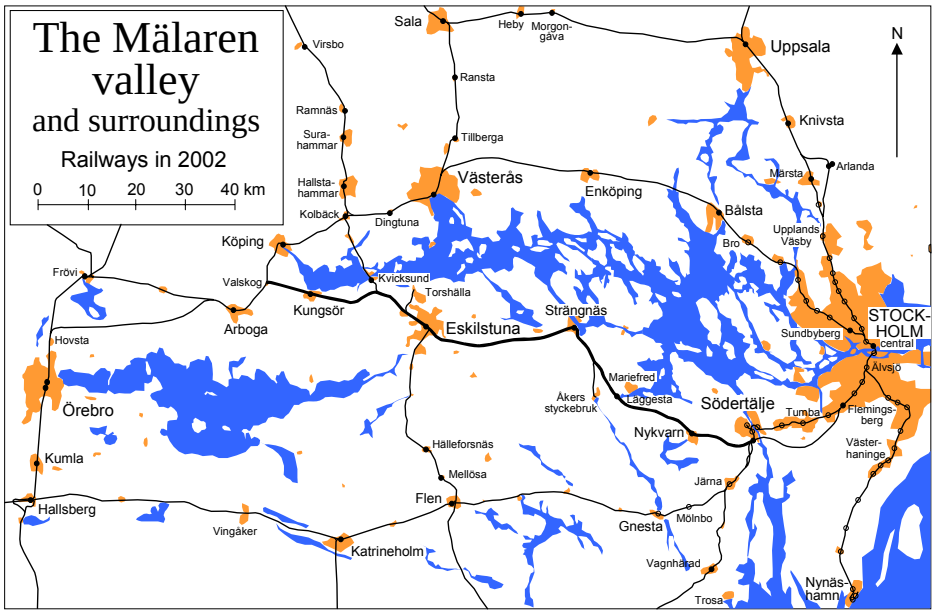
The results are presented as the difference between before and after train services began operating on the Svealand line, with a bus supply equivalent to the supply in 1997 and the supple of train services in 2000 (Uppsala–Stockholm–Eskilstuna–Hallsberg through trains). Connecting regional bus services have also been adjusted according to actual conditions before and after the Svealand line. The base year, i.e. all other factors such as population, economy, car ownership, other aspects of networks (links, nodes, and lines in EMME/2), however, is 1998 in both cases. This means that the result describes only the difference made by a new public transport supply before and after the Svealand line where everything else is the same in the different scenarios. Periodic changes in socioeconomics and demographics are thus eliminated.

Modelled traffic flows

The Sampers modelling system was not calibrated with the real trip flows in Södermanland in the accessibility calculation, which means that the modelled traffic flows do not reflect the real flows, and they are not reported for this reason. A technical explanation of the inadequate calibration as regards road traffic in Södermanland is that the difference matrix, used in the vehicle distribution was developed and calibrated for the Stockholm region, but not for adjacent areas in the Mälaren valley.

No calculation was made of rail trip flows or the train passengers' routes. The vehicle distribution for road traffic was performed in the study but no corresponding network assignment for public transport was done.

[165] Sampers version 643. Technical documentation (2001)



The Svealand line (shown as a semi-bold line) is a new railway between Södertälje and Eskilstuna (79 km), and an upgraded section from Eskilstuna to Valskog (35 km).

4. The Svealand line's inception and the development of the region

4.1 The Svealand line

4.1.1 Inception and construction

The Svealand line opened on 9 June 1997 between Södertälje and Eskilstuna. Its opening marked the first stage of a new era for trains in the Mälaren valley. The old line had by then definitely had its day and parts had been demolished to make place for the new Svealand line and new roads in the area.

The then private railway Norra Södermanlands Järnväg, with a main line from Södertälje to Eskilstuna and the Läggesta–Mariefred and Åkers styckebruk–Strängnäs branch lines had opened in 1895 (the Eskilstuna to Mälarbadens hamn (Mälarbaden Port) line was added a few years later), while the Eskilstuna–Valskog section opened in 1877.[166] Passenger transport had never had a high standard, because the main route was the western main line via Katrineholm, and the area in the north of Södermanland ended up in the backwaters of the railway net-

[166] Järnvägsdata 1999, *Railway data 1999*

work. In later decades it became increasingly apparent that the supply was not especially attractive. The passenger trains were slow, services between Stockholm and Södertälje and Stockholm and Eskilstuna were infrequent, and passenger services had as good as ceased between Eskilstuna and Valskog.

The decision to build the new line was made by the government in September 1991 after agreement on financing had been reached with Svealandsbanan AB, a company jointly owned by the municipalities of Kungsör, Eskilstuna, Strängnäs and Södertälje, Södermanland county council and the county public transport authority in Södermanland, Södermanlands läns Trafik AB.[167] Svealandsbanan AB would contribute a total of 360 million Skr to the construction of the line. The government would pay the greater part, just under 1.7 billion Skr, partly through the National Rail Administration's (Banverket) ordinary allocation, and partly though Delfin, the delegation for infrastructure investments. The total cost was estimated in 1991 at 2.1 billion Skr.[168] The figures do not include the regional grant to Södertälje syd (Södertälje South) station, or the cost of converting Eskilstuna station. It must also be pointed out that at the time of the decision the findings of the studies were none too detailed as regards the construction costs.

The decision was preceded by a number of studies and work to build public opinion. The idea for the Svealand line took shape in the middle of the 1980s, and the planned line was given its name in 1986. The prime movers in the early stages were the municipalities of Eskilstuna and Strängnäs and the county administrative board of Södermanland. One of the major factors was that there was already a group working for the Mälar line on the north side of Lake Mälaren. According to these plans Eskilstuna would be connected with Västerås by an improved line, while no solution was presented to resolve the railway issue on the south side. The south side stakeholders therefore decided to push for a rail link between Örebro and Stockholm via Eskilstuna and Strängnäs, a solution that had better prerequisites to satisfy the needs those areas had. Through studies, opinion building, a dialogue with the government, SJ (Swedish Rail) and, from 1988, Banverket, and not least their own financial commitment, the group's efforts eventually led to the decision to build the Svealand line.[169]

The consultant Stellan Lundberg was engaged for the study and in 1985 he presented a systematised overview of the different alternatives,

[167] Svealandsbaneavtalet, *The Svealand line agreement* (1991)
[168] Carlsson (2001), p. 132
[169] Carlsson (2001)

drafts.[170] These drafts were then developed further. It was estimated that the Svealand line would have a relatively high, positive value for the economy in general, as well as for corporate profitability, especially if both the Mälar line (north of Lake Mälaren) and the Svealand line (south of Lake Mälaren) could be built within the so-called coordinated arrangement. The reasons were that advantages of scale were expected to materialise for the train services and it was considered that the resultant regional development in the Mälaren valley would be substantial and balanced.[171]

The studies pointed to the Svealand line's possibilities, above all the alternatives with a completely new line for high speeds and short travelling times. In 1987 Lundberg estimated that travel by train in 2000 would be six times greater with the Svealand line compared to without, with a future market share of 29%. The single track alternative was estimated to have somewhat higher profitability from a social economic viewpoint, even if the double track alternative was also profitable.[172]

Since the positive effects of the coordinated arrangement were estimated to be so great, the government commissioned a final study in January 1989. When the ministry of transport and communications presented the study of future railway expansion in the Mälaren region, it constituted a proposal for the extension of both the Mälar line and the Svealand line.[173] In contrast to the budgetary constraints that had characterised the coordinated arrangement proposal in Banverket's main line plan, the new study included a proposal for full expansion and an agreement to implement to go ahead was reached in 1991.

Planning and construction of the Svealand line were done by Banverket. Construction began in 1992 and the total cost was 2.3 billion Skr (1997), not including the conversion of Eskilstuna central station, which was somewhat cheaper than had been estimated taking the monetary value into consideration.

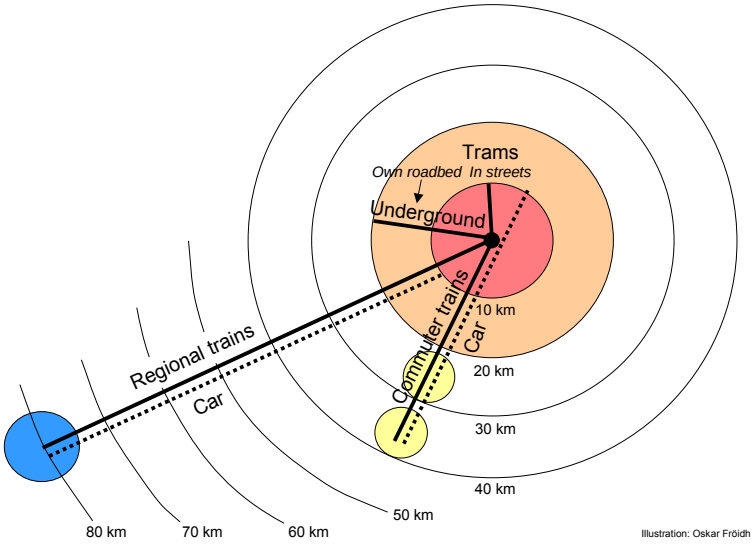
4.1.2 The expected effects of the Svealand line

By investing in infrastructure in general the intention of the government was to create the prerequisites for increasing economic growth and improving the environmental situation, mainly in the big cities. The gov-

[170] Utvecklad tågtrafik söder om Mälaren – idéskisser, *Developed train services south of Lake Mälaren – drafts* (1985)
[171] Svealandsbanan, *The Svealand line* (1987)
[172] Svealandsbanan (1987), kompletterande lönsamhetsberäkningar, *The Svealand line, complementary profitability calculations* p. 4
[173] Framtida järnvägsutbyggnad i Mälardalsregionen, *Future expansion of the railways in the Mälaren valley region* Ds 1991:13

ernment therefore increased the levels of investment in roads and railways at the beginning of the 1990's from a level that had been rather low since the 1970's.[174]

Range of daily commuting – one hour's journey



Approximate commuting range with a one hour door-to-door journey by public track-bound transport (tram, underground railway, commuter trains and regional trains) and by car to a regional centre.

The Svealand line can be seen as a means of developing the southern part of the Mälaren valley into a well functioning region. Good communications create the long-term prerequisites for competitive trade and industry, efficient labour markets, access to higher education and research both inside and outside the region, a broad offering of leisure activities and a good environment. The high speed train services constitute an important complement to other forms of transport.[175]

Accessibility by public transport to several other localities was improved as a result of the short travelling times by train. The fast transportation makes commuting feasible over greater distances than were possible by the old trains, by bus or even by car. Differences within the region as regards the housing and labour markets can thereby be equalised, and fluctuations in the local labour markets can be alleviated. It becomes easier for companies to recruit personnel, to secure their competence supply. The railways in the Mälaren valley, for example the Svealand line, hoped to strengthen the economies of the municipalities along the line through regional integration and contribute to spread the

[174] Regeringen proposition, *Swedish government bill* 1990/91:87, p. 73
[175] Svealandsbanan, *The Svealand line* (1991)

Stockholm region's economic growth to neighbouring areas in the Mälaren valley.[176]

The direct effects of building the Mälar and Svealand lines were primarily the gains in travelling time, and the accompanying improvement in accessibility. Moreover, the extensions to the line were estimated to provide employment amounting to 5 500 years' work during the construction period.[177] In the longer term the train services may also lead to positive structural effects on economic growth in the region.

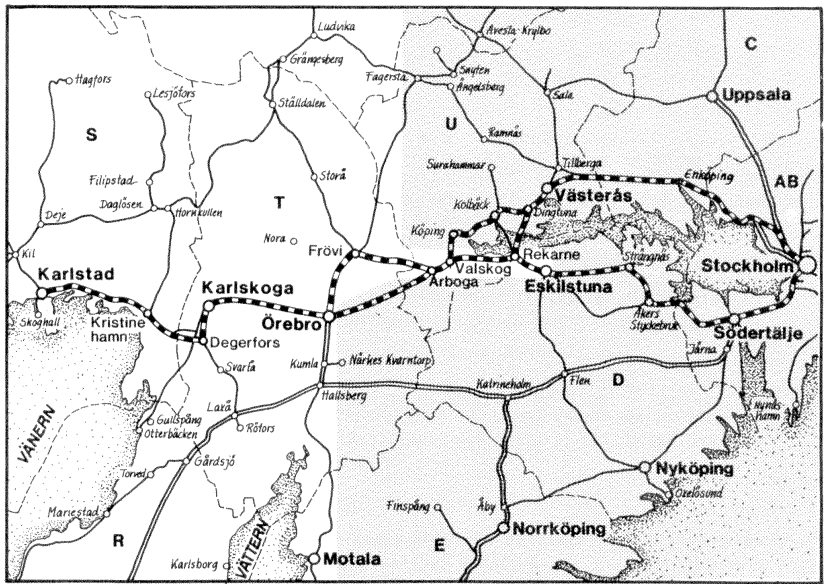
The aims and expectations of the decision to build the Svealand line can be summarised by a newspaper extract from the period.[178]

- Greater Stockholm is becoming increasingly overheated as a region, and by improving communications the population can be dispersed around the Mälaren valley, which also offers a good housing environment.
- Örebro, Västerås and Eskilstuna can together constitute a strong future region, provided they cooperate instead of practising local patriotism, and the high speed train services will facilitate communication.
- High speed train services create the prerequisites for a more flexible labour market, and an exchange of recreation opportunities and culture between Stockholm and the Mälaren valley.
- Greater Stockholm is threatened with traffic infarction, and the high speed train services will offer an alternative to commuting by car.
- The pressure of public opinion for a better environment has created an awareness that track-bound public transport is cheaper, more energy-saving, cleaner and safer than private motoring. Any effort to relieve the load on the roads is to the good of the environment.

4.1.3 The Nobel line

The Svealand line was so named because in the early stages of planning it also included an extension of the line from Örebro via Karlskoga to Degerfors or Kristinehamn, i.e. through a substantial part of the region of Sweden known as Svealand. When the Mälar line and the Svealand line were built, however, they terminated in Örebro. The original idea of the Svealand line in its entirety, to create a fast rail service in the densely populated band stretching from Stockholm via the Mälaren valley, Örebro and Karlstad westwards towards Norway, has therefore been only partially realised. The Svealand line's originally planned extension to the west is nowadays called the Nobel line.

[176] Järnvägsprojekt utanför Storstockholmsområdet, *Railway projects outside the Greater Stockholm area* (1987)
[177] Carlsson (2002), p. 146
[178] *Dagens Nyheter,* 1 September 1991



The Svealand line's planned extension from Örebro via Karlskoga to Degerfors/Kristinehamn and Karlstad is now called the Nobel line. Source: Järnvägsprojekt utanför Storstockholmsområdet, Railway projects outside the Greater Stockholm area*, (1987).*

The groups who would gain most from the Nobel line are people who travel between the Mälaren valley (Västerås, Eskilstuna and Örebro) and Värmland (Karlstad), and Karlskoga, who no longer have any passenger train services. On long-distance services between Stockholm and Karlstad travelling times would on the other hand be only marginally shortened compared to travelling on the western main line via Hallsberg. In their report the Transport Council therefore pointed out that the Svealand line with high speed trains would provide opportunities for regional interaction between the conurbations along the line, compared to an alternative solution where they were linked to a future high speed train network within the existing infrastructure.[179]

4.1.4 The technology of the Svealand line

The Svealand line consists of a completely new railway between Södertälje and Eskilstuna, a distance of 79 km, and an upgraded old line between Eskilstuna and Valskog, a distance of 35 km.

The Svealand line was dimensioned for regular hourly services, with the capability of operating extra trains at peak periods. The planned travelling time between Eskilstuna and Stockholm was one hour.

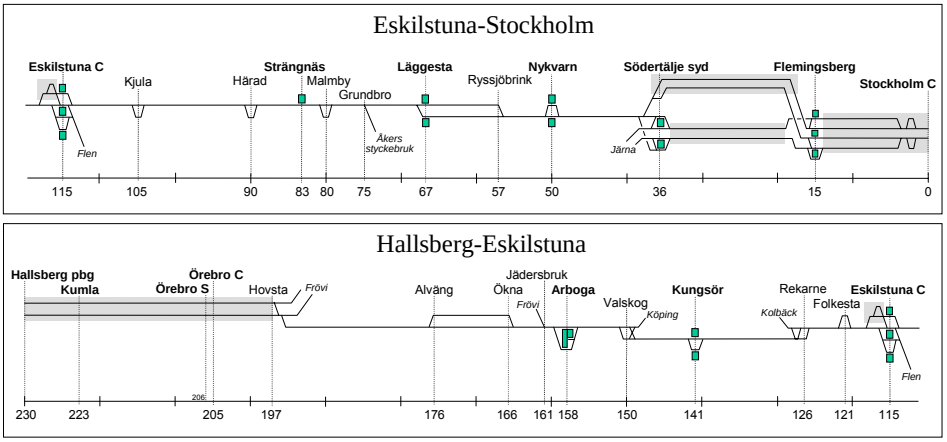
[179] Järnvägsprojekt utanför Storstockholmsområdet, *Railway projects outside the Greater Stockholm area* (1987)

A 10 km stretch of double track starts at Ryssjöbrink. This allows trains to pass without needing to slow down, but requires the trains to be on time to work without any problems.

The line was consequently built as a single track line with passing points, except for a 10 km section east of Läggesta which was built as a double track to allow trains to pass each other without stopping. In the agreement on the extension of the Svealand line there were two double track sections for passing without stopping; 10 km between Kjula and Härad on the Eskilstuna–Strängnäs section and about 10 km between Ryssjön and Nykvarn. During the course of the planning process, the double track sections became one section, between Läggesta and Ryssjöbrink, and Kjula and Härad became ordinary passing stations. It was felt that this particular configuration was better aligned to the train services as planned. Another change was that the planned passing loop in

Strängnäs was moved 3.5 km south to Malmby. Consequently, the lay-out of Strängnäs station means that all trains stop on the same platform, and passengers can change trains without the need to go up or down staircases, but trains can not pass each other

System outline, Stockholm–Eskilstuna–Hallsberg, 1997-2002



Only tracks and platforms for passengers are shown. The shaded areas are not fully described.

The new stretches of line were built to a standard that permits a speed of 200 kph for locomotive-hauled trains. With some minor adjustments (certain changes to the signal system) the maximum permitted speed could be raised to 250 kph for tilting multiple-unit trains, and at least 220 kph for modern multiple-unit trains without tilting capabilities. Together with the Mälar line that was decided at the same time, traffic services in the Mälaren valley were thereby given the prerequisites to become an attractive option with high standard of new or upgraded railway.

4.1.5 The planning of station locations on the Svealand line

The municipalities and Banverket planned and analysed the location of the stations on the Svealand line in collaboration. The municipalities had a decisive influence on the decisions through their so-called monopoly on planning, and also carried out the early planning work. Banverket then did the formal planning and built the line. However, the municipalities were responsible for a good deal of work of building the stations and other facilities at the travel centres.

A high speed train from Stockholm arriving in Eskilstuna in 2002. The station building has retained its function in the new travel centre which was completed in time for the opening of the Svealand line in 1997.

Eskilstuna central station

Eskilstuna central station was converted to a travel centre where it stood, as a separate project within the Svealand line project. The location of the main station in Eskilstuna was given since the existing station was already in the centre of the city. The travel centre project included rearrangement of the connecting bus services, and the bus station was moved and extended next to Eskilstuna central station. A new subway was built under the tracks with stairs and lifts up to the platforms. The car park on Nyforstorget next to the travel centre has 274 spaces, of which 236 are reserved for commuters with monthly parking passes. The municipality reports that there are normally vacant spaces.[180]

A new stop at the Mälar hospital 2 km east of Eskilstuna central was also discussed. It would be possible to arrange for a further 270 parking spaces for park-and-ride, which would not be able to be accommodated at Eskilstuna central. Many homes and places of work would also be closer to the new stop than to the central station.[181] However, the stop, Eskilstuna east, was not built.

[180] Monica Eberfors, Eskilstuna Municipality. Telephone conversation, 15 April 2002
[181] SJ Projekt Mälartåg, *Notes from PRG meeting* no. 2/91

The new station at Långberget in Strängnäs has no passing loop. A high speed train to Stockholm is seen arriving at the station in 1999.

Strängnäs

There are two stations in the municipality of Strängnäs, Strängnäs and Läggesta. The old station location in Strängnäs, which was a terminus close to the centre on a branch line from Åkers styckebruk, was unsuitable for the Svealand line. To allow a new through line to Eskilstuna a new station was therefore needed. Early in the planning process, a suitable location was proposed at Långberget in central Strängnäs, approximately 700 m south of the conurbation's central point, Tingshuset (the law courts). The other location that was of primary interest was in an area known as the Fårhus area on the outskirts of the conurbation, more than 2 km from the centre.

The balanced mean distance from different parts of the city to the location at Långberget would be about 920 m, but was estimated to be 1 570 m to the Fårhus alternative. In addition to there being no possibilities for development in the peripheral areas, access would thus not be as good.[182] In 1990 the municipality therefore decided to recommend the alternative at Långberget. After Banverket's study of this alternative,

[182] Strängnäs centralort – läge för resecentrum, *Strängnäs central conurbation – location for travel centre* (1990)

a public debate ensued. The Långberg park in Strängnäs is a recreational area, and some people protested against the environmental impact of a railway in the urban environment, despite the fact that the environmental consequences were considered to be relatively small. An alternative with the station within a tunnel at Långberget was therefore also included, but was estimated both to be more expensive and to entail disadvantages for the operation of the trains and for the passengers.

A study carried out by Stellan Lundberg estimated that for the residents of Strängnäs the Fårhus alternative would give 15% fewer journeys to Stockholm and 20-30% fewer to Eskilstuna and Södertälje, and even greater losses of trips to Strängnäs by people who were not residents.[183] Transek estimated that a central station in Strängnäs would give approximately 0.6 million journeys to or from Strängnäs station, while the Fårhus alternative would give 3-7% fewer.[184] For their part, SJ mistrusted Transek's estimates and recommended a central location in no uncertain terms.[185]

After further consideration the municipal council therefore decided in September 1992 to choose the location at Långberget. This location means that the whole of the conurbation, with the exception of the more peripheral districts of Finninge, Tingstuhöjden and Abborrberget, are within a radius of one kilometre from the station.

The new station was finally built with a single track line, no passing loop and with a new stations building containing service amenities and a waiting room. The bus station on Västervikstorget was moved to the new station.[186] A park-and-ride car park was also accommodated. This was built first with about 125 spaces, but has been extended in stages to take more cars and the number of spaces had grown to 178 by 2002.[187] The municipality planned a minor extension in 2002, but it will be difficult to find more room for further extension of the car park after that.

[183] Strängnäs centralort – läge för resecentrum, *Strängnäs central conurbation – location for travel centre* (1990)

[184] The figure is from a field survey on the question of a central or non-central railway station in Falkenberg. Ur Översiktlig bedömning av olika stationslägen i Strängnäs, *in Overall assessment of different station locations in Strängnäs* (1992)

[185] SJ Projekt Mälartåg, *Notes from steering group meeting* no. 7/92

[186] Centralstation eller hållplats utanför staden? *A central station or a stop outside the town?* (1995)

[187] Including 5 parking spaces for disabled people. Erik Strand, Municipality of Strängnäs

Läggesta railway station has parking spaces and bus stops, with connecting services to Mariefred and Åkers styckebruk (2002).

Läggesta

Läggesta station primarily serves the conurbations of Mariefred and Åkers styckebruk, 3-5 km away, but there are only a few residents in the immediate proximity of the station. The old line had a station in Läggesta, with a bus connection to Mariefred, and in Åkers styckebruk. In the early stages of planning, the municipality of Strängnäs had a study made of possible stations in the area, and this study recommended Läggesta as the best alternative for a new shared station for Åker and Mariefred. Another possible alternative was a new station at Åkers krutbruk, which would entail a more westerly line location, while the alternative with the Svealand line going via Mariefred was considered unrealistic bearing in mind the costs and the environmental effects.[188] A location at Ärja, about 3 km north of Läggesta, was also discussed. The municipal authorities, however, decided on Läggesta. Banverket's study was made first with a station in Läggesta, with the subsequent addition of Ärja. In 1992 Banverket decided on Läggesta and could begin the planning.[189]

At Läggesta there are stops for buses to Mariefred (and Stallarholmen) and to Åkers styckebruk, which connect with most of the trains on the Svealand line. A park-and-ride car park allows local residents to travel to

[188] Åker/Mariefred. Alternativa bansträckningar och stationslägen, *Alternative railway routes and station locations* (1989)

[189] Centralstation eller hållplats utanför staden? *A central station or a stop outside the town?* (1995)

8 minutes late, a morning train to Stockholm brakes hard in Nykvarn in 2002 to pick up 21 new passengers. Locomotive-hauled trains with a locomotive at either end and 6 carriages between replaced the X2-type trains on the Svealand line.

the station by car. The car park has 259 marked spaces and a section with a gravel surface where more cars can park, but the car park does not ever seem to be full.[190] One reason for this might be that there are many car burglaries at the car park, which is unguarded. The car park also has capacity to accommodate a future increase in travel.

The museum railway to Mariefred (ÖSlJ) has been allowed to take over the old Läggesta station. There are no service amenities at Läggesta, but a kiosk and a petrol station are in the planning stages.

Nykvarn

At Nykvarn it was possible to us the old central station location. The community has grown up around the railway since it was built in 1895, and the Svealand line's location and the environmental consequences (mainly noise and barrier effects) were able to be accepted after a number of grade-separated connections had been built and noise-preventive measures taken. The station has a park-and-ride car park with room for 36 cars, which is normally full during the daytime. There is another park-and-ride car park with 30 spaces about 250 m from the station, and there are usually empty spaces at that one.[191]

[190] Erik Strand, Municipality of Strängnäs. Telephone conversation, 2 May 2002
[191] Rolf Nilsson, Municipality of Nykvarn. Telephone conversation, 16 April 2002

Södertälje syd (Södertälje South) station is situated 4 km south of the town centre, but there are plenty of parking spaces for passengers. (2002)

Södertälje syd (Södertälje South) station

In Södertälje the Svealand line was linked up to the Grödinge line, that had opened in 1995, at Södertälje syd (Södertälje South) station outside the city centre. Södertälje syd and the Grödinge line were built a few years before the Svealand line. The Grödinge line, though, is also an important prerequisite for short travelling times to Stockholm for passengers on the Svealand line. At the planning stage, the projects were in practice connected, among other things through their common stakeholders.

The Grödinge line was originally planned to pass outside Södertälje completely, without a station in the conurbation. This plan was changed in 1988 when it was decided that the line would go through Södertälje. The location chosen for a new main line station that was to become Södertälje syd lies between the Scania industrial estate and district of Pershagen, 4 km south of the city centre. The municipalities of Eskilstuna, Strängnäs and Nyköping and Södermanland county council contributed a total of 70 million Skr to the station's financing in order to enable the Svealand line to be connected up to the Grödinge line. Travelling times to and from Stockholm were thus 6-7 minutes shorter than with a connection to the old line, which was otherwise Banverket's basic

alternative in an agreement from 1988 on the financing of the Grödinge line.[192] [193]

To take advantage of the non-central location with good possibilities for commuting by train, the area around Södertälje syd needs to be developed for activities such as higher education, research and development, other service companies and a conference centre.[194] This development has not yet been realised.

4.1.6 Traffic operators

According to an agreement with the government, SJ has the right to operate services on the Svealand line and the other long distance lines in the Mälaren valley until at least 2025, with an option to terminate the agreement in 2005. A condition is that the prerequisites for the transport service policy do not change during the period of the agreement,[195] but the deregulation of long-distance bus traffic in 1997 has in practice already changed these prerequisites. SJ has in turn entered into an agreement with Mälardalstrafik AB (Mälab)[196] and the county public transport clients in the Mälaren valley about how services are to be operated and the forms of cooperation. This agreement is effective until mid-2005, with an automatic prolongation in five-year periods unless notice of termination is given two years in advance at the latest.[197]

Through the marketing company Trafik i Mälardalen AB (TiM), SJ cooperates with the other public transport authorities in the Mälaren valley. The cooperation covers fares and timetables among other things, to allow passengers to use one authority's tickets and passes in another authority's area, and the county public transport companies have pledged to adjust bus services that operate parallel to train services so that they do not compete with SJ's train services. The intention is instead to build up a joint public transport system for regional journeys, where the buses act as feeders to the railway stations.

[192] Avtalsförslag (BV 88-0134/40) från Banverkets huvudkontor, *Proposed agreement from the National Rail Administration's Head Office* (1989)

[193] Carlsson (2001), pp. 109-110

[194] Södertälje syd, *Södertälje South station* (1990)

[195] Protokoll från förhandlingar 1995-10-12 mellan Statens Järnvägar (SJ) och Tåg i Mälardalen AB (TIM) angående samarbetsavtal för persontrafiken i Mälardalen (ramavtal), *Minutes of negotiations between the Swedish State Railways (SJ) and Tåg i Mälardalen AB (TIM) on 12 October 1995 about the cooperation agreement for passenger transport in the Mälaren valley (framework agreement)*

[196] Mälardalstrafik AB (Mälab) was previously called Tåg i Mälardalen AB (TIM). The company is not to be confused with TiM, Trafik i Mälardalen AB, which is a marketing company (see the text)

[197] Samarbetsavtal (1995) mellan Statens Järnvägar (SJ) och Tåg i Mälardalen AB (TIM), *Cooperation agreement (1995) between the Swedish Rail (SJ) and Tåg i Mälardalen AB*

The Svealand line at Åker in 1999 with a high speed train (X2-type) on its way to Eskilstuna.

The agreement also contains clauses to the effect that the county public transport companies undertake to work to promote national planning that promotes railway traffic and to build park-and-ride car parks at the regional train stations.[198]

SJ's old train services were subsidised by the government's purchasing of a certain traffic supply. The new train services are operated on a commercial basis, which means that SJ can in principle decide the fares (see also section 5.1.3).

[198] Samarbetsavtal (1996) mellan SJ Persontrafikdivision (SJP) och Länstrafiken i Sörmland AB (LT-S), *Cooperation agreement between SJ's passenger transport division and the county public transport authority LT-S*

4.1.7 The trains

The procurement of new rolling stock for the Mälaren valley services has not taken place at the rate that would have been desirable from several points of view. In 1990 SJ began procurement of new electric multiple unit trains designed for 200 kph, with the working name of EMU90.[199] In 1992, 7 multiple units[200] with 190±10 seats were considered sufficient for the train services on the Svealand line.[201]

The procurement stopped, however, when uncertainties arose about future service operation rights in the Mälaren valley and the government's intention that the Arlanda line should be built and operated by a private consortium, which would mean that new trains would entail a great degree of financial risk on SJ's part. SJ instead put high speed trains into operation on the Svealand line as soon as it opened in 1997. These high speed trains, designated X2, had really been ordered with other services in mind but with the aid of government labour market support the order was able to be made earlier than SJ needed for its own services. The high speed trains were therefore able to be used on the Svealand line for a few years and the last one was transferred to other duties in June 2002. At the same time, a few Regina trains, modern high speed electric multiple units began operating on the Svealand line at off-peak times.

The high speed trains have a high level of comfort and at this time were the only trains in the country that could reach 200 kph. During the first few years the X2 trains had just under 240 seats (4 coaches[202]) in first and second class, but they were gradually lengthened to 360 seats (6 coaches[203]) to accommodate more passengers.

Later, locomotive-hauled trains were put in operation on the Svealand line. First, locomotive-hauled trains were put in as extra trains in the afternoons, and later in many of the ordinary services as well, as the need for rolling stock grew with the extension from Stockholm to Uppsala via Arlanda in 2000, and some of the high speed trains were switched to other services. The locomotive-hauled trains have a locomotive at either end with coaches between them. A train of this type with 6 coaches from the 1980s has 400 seats,[204] and can be extended

[199] EMU: Electric Multiple Unit. The name M90 is also used in parallel with EMU90.
[200] Several trains can be coupled together to make a longer train requiring only one driver.
[201] SJ Projekt Mälartåg, *Project management group meeting* no. 7/92
[202] Calculated in the combination X2+UB2F+UB2+UBS2+UA2X. Nilsson (1999)
[203] Calculated in the combination X2+UA2G+UB2F+UB2F+UBS2FK+UB2+UB2X. Nilsson (1999)
[204] Calculated in the combination Rc6+B7+B7+B2+BF4+B7+A7+Rc6. Nilsson (1999)

easily with more coaches. The maximum permitted speed for the trains, however, is only 160 kph, which means that the locomotive-hauled trains have somewhat longer running times compared to the high speed trains on the new line. Over short distances between stops, however, the lower top speed is compensated by better acceleration.

In January 2001 SJ ordered new trains for the Mälaren valley, double-decker electric multiple units designated X40, to be delivered between 2004 and 2005. The X40 can accommodate approximately 50% more passengers for the same train length compared to the EMU90 that was never ordered nine years before. A three-coach train will have approximately 300 seats, and several multiple units can be combined into trains.

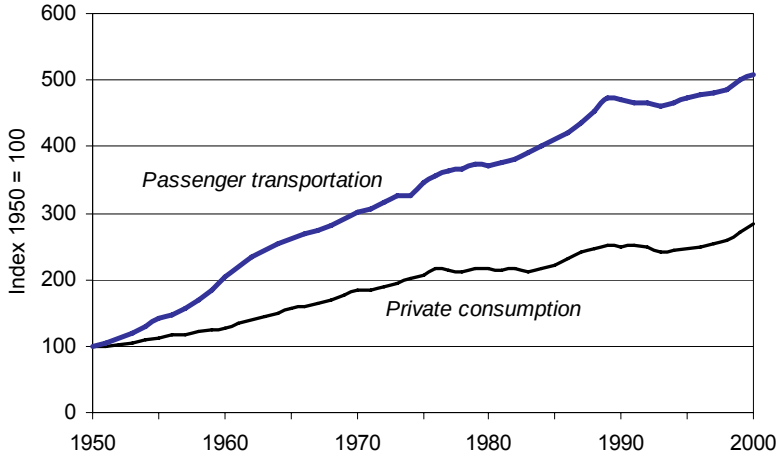
4.2 Economic development during the 1990s

4.2.1 Private consumption

A look back over the last century shows that both passenger transportation and private consumption have both increased substantially in Sweden during the latter half of the 1900s.

Private consumption per capita in the 1990s fell between 1991 and 1993, before stabilising and increasing markedly from 1996.[205] This development has fallen off in 2001.

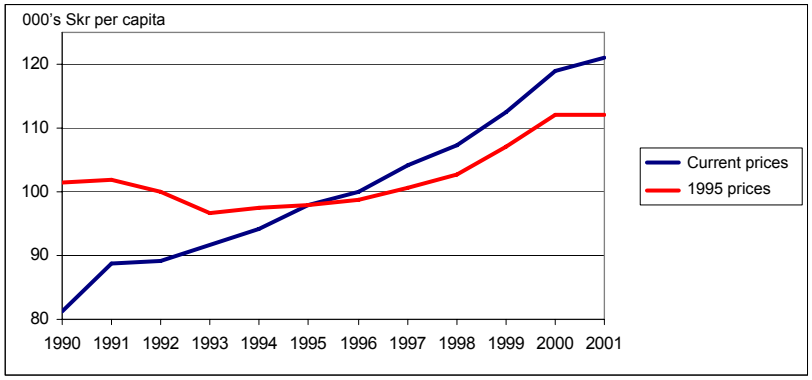
Private consumption and passenger transportation, index, 1950-2000



Domestic travel and private consumption in Sweden. Source: Nelldal (2002)

[205] Statistisk årsbok för Sverige, *Statistical Yearbook of Sweden* (2002)

Private consumption per capita in Sweden, 1990-2001



Source: SCB

Households increased their consumption of transportation in real terms between 1996 and 1999. It is vehicle costs that have increased, while the operating costs of vehicles have remained constant, and the purchase of transportation services has seen a slow but steady increase totalling 15% over the period from 1994 to 2000. During the same period transportation's share of total private consumption has increased from 11.8% to 12.3%.[206] Purchases of vehicles (mainly cars) consequently accounted for part of the increase in households' consumption in the late 1990s.

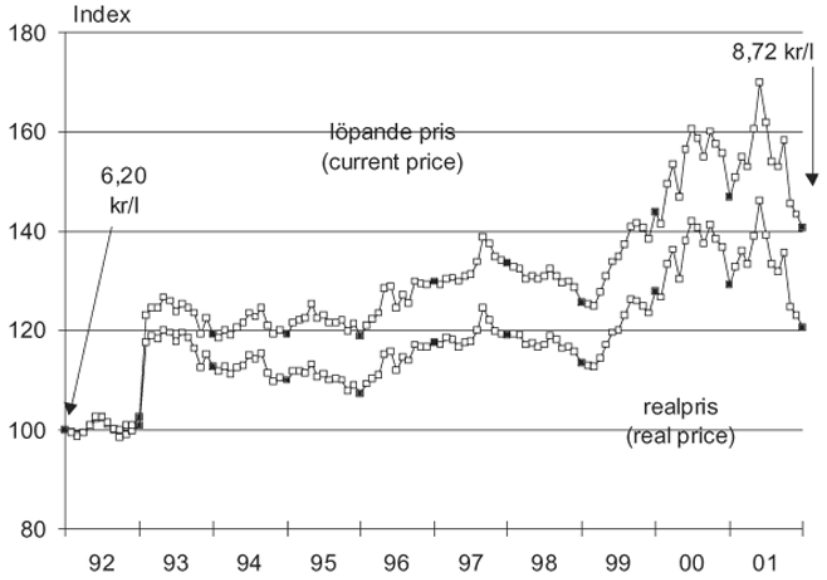
4.2.2 Price index

Petrol price index

The price of petrol has varied somewhat during the survey period. A few general trends are that the price of petrol was unusually low in 1992, but rose dramatically up until 1993. Following a stable development from 1993 to 1998 the price increased again during 1999 and 2000. After peaking in May 2001 the price of petrol fell by 17% over the period up to December 2001, from 10.54 to 8.72 Skr a litre.

In the spring of both 1997 and 1998 the price of 95 octane lead-free petrol was around index 118 in real price terms. On the other hand it was higher, between 130 and 142, in spring 2000 (April - June), the final survey period. In real price terms the rise in the price of petrol was consequently 10-20% from the 1997 and 1998 surveys up until the survey in 2000. [207]

[206] SCB, Table "Household consumption expenditures by purpose", items 071-073
[207] SIKA Kommunikationer, *Bulletins*, no. 1, 2002



Development of petrol prices (lead-free, 95 octane) in the middle of every month between 1992 and 2001 in current and real prices. Index 100 = December 1991. Source: SCB (Statistics Sweden)[208]

Consumer price index

Consumer price index 1995-2001

1980 = index 100	*CPI, total (shadow index)*	*CPI, transportation*
1995	255	298
1996	256	303
1997	258	306
1998	257	305
1999	258	310
2000	261	324
2001	267	324

Source: SCB

During the second half of the 1990s the consumer price index has changed very little. Consumer prices for transportation are at present higher than for the total consumer prices. The index rose between 1999 and 2000 primarily as a result of the increases in the price of petrol. The total difference in the consumer price index between the three surveys in 1997, 1998 and 2000 is only about 1%. For this reason no conversions of monetary values or monetary results are made in the report.

[208] SCB, extract from *SIKA Kommunikationer,* Bulletins no. 1, 2002

4.3 Population, migration and commuting

4.3.1 The Mälaren valley as a region

The name Mälaren valley, or the Stockholm-Mälaren region, is often used to refer to a region in eastern central Sweden, in principle embracing the counties of Stockholm, Uppsala, Västmanland, Södermanland and Örebro. Regions of this size are traditionally not found in the Swedish administrative system, and the most common concept for region has so far been the county. The Mälaren valley is consequently not a clearly defined administrative region. It can instead be referred to as a functional region, meaning an area that is held together by a relatively large number of everyday contacts in patterns of travel and moving, housing and labour markets, traffic and goods transportation and examples of geographical structures in trade and industry.[209] In this region, however, this everyday interaction has historically speaking been of limited scope in some respects.[210]

Relations are being strengthened all the time, however. The city of Stockholm has been expanding for a long time and its sphere of influence is enlarging to form an increasingly larger region with its focus in the eastern part of the Mälaren valley. In a comparison, Stockholm and Uppsala together were considered one of approximately 500 urban regions in Europe with more than 100 000 inhabitants. In 1995 for example, Stockholm–Uppsala was one of the 20 largest regions when it comes to gross regional product, and in fifth place with regard to research measured as the number of scientific papers published.[211] Another study concluded that the Mälaren valley is a leading region in Scandinavia on the basis of the structure of trade and industry.[212] Distribution in the Mälaren valley is uneven, however.

The functional region called the Mälaren valley has become especially useful as a concept when planning the infrastructure. The definition of a region is primarily linked here to a definite phenomenon: the infrastructure and primarily the Svealand line.[213] Labour market regions are another measure (see below), which can serve as examples of the focus that Stockholm constitutes in the eastern part of the region, and the traditionally less cohesive "region" in the western part of the Mälaren valley.

[209] Mälardalen – en region? *The Mälaren valley – a region?* (2002)
[210] Regioner kring Mälaren, *Regions around Lake Mälaren* (1994)
[211] Matthiessen (2001)
[212] Forslund and Johansson (1994)
[213] Carlsson (2001), p. 14

4.3.2 The labour markets in recent years

Labour market regions

Local labour market regions (LA regions) are a national statistical definition of a type of region, intended to enable comparison of how the labour markets function between different regions. An LA region is defined at municipality level as a coherent area consisting of one or more municipalities on the basis of the amount of commuting over the borders of the municipalities in relation to the total number of gainfully employed people in the municipality. For a more detailed definition, the reader is referred to SCB.[214]

Number of LA regions in Sweden

Year	No. of LA regions
1970	187
1980	139
1990	112
1993	*109*
1998	*100*
2000	90

Source: SCB

The number of LA regions fell from 187 in the country as a whole in 1970 to 90 in 2000. The decrease in number is a sign that the regions are becoming larger as a consequence of increased commuting over the municipalities' borders, and an increase in commuting distances in general. Settlement structure in Sweden resembles some 20 separate islands in an archipelago with a relatively poor links between neighbouring regional agglomerations, even if interaction has increased over time.[215] However, changes do not take place uniformly distributed over the country or over socioeconomic groups. The local labour markets have changed most in the south of Sweden. The willingness to commute differs considerably between different occupations, age groups and levels of education, and also between men and women. This means that that there are more areas that can be defined as LA regions for women than there are for men, and more for people with a lower level of education than there are for those with a high level.[216]

[214] See for example SCB's Lokala arbetsmarknader och förvärvsregioner, information om arbetsmarknaden 1991:7, *Local labour markets and employment regions, information about the labour market 1991:7,* or later editions.
[215] Sverige 2009, *Sweden in 2009* (1996)
[216] Kullenberg and Persson (1997)

In the area along the Svealand line the municipalities of Södertälje, Nykvarn and Strängnäs all belonged to Stockholm's LA region in 1998. The municipalities of Eskilstuna and Flen, on the other hand, constitute an LA region in their own right. In general, more people consequently commute from the municipality of Strängnäs to the county of Stockholm than to the regional centre, Eskilstuna. The municipalities of Nyköping and Oxelösund also form an LA region in their own right.

Structure and commuting

The labour markets have undergone considerable changes over the last decades through structural transformation and the recession of the early 1990s. In the country as whole, the number of gainfully employed people fell by 15% between 1991 and 1993. During the period from 1993 to 1997 there was first a slight recovery, followed by a few years' slow decline. From 1998 the number of gainfully employed increased more strongly, beginning a new economic upswing that began to slow again in 2001. The number of gainfully employed is still, however, showing a downward trend from its peak in 1989. Young people (16-24) are a group where the fall is especially noticeable, while the 45-64 age group has not been affected at all.[217]

A study of migration and commuting for 1970-1994 shows that the pattern of moving across county and municipality borders has changed over the last decades. Generally speaking, a reduction in long-distance moves can be observed. Possible reasons might include the geographically well spread growth of the public sector and the expansion of the regional universities, enabling people to work and study within the region. Another reason might be that there are better possibilities for commuting over longer distances, and that the necessity for longer commuter journeys is becoming accepted.

One clear trend is towards longer commuter journeys over the outer limit of an established labour market, which contributes to enlarge the region. Young people and people with a higher level of education choose to enlarge their labour market by travelling further than do other socioeconomic groups. This trend is strongest in regional centres and the smaller communities. Along the Svealand line both Eskilstuna and Strängnäs municipalities fall into these categories.[218]

Commuting is generally mainly by car, but the potential for more short-distance commuting is probably limited. Faster modes of travel

[217] Statistiska meddelanden, *Statistical bulletins* (2000)
[218] Kullenberg and Persson (1997)

than the car (and the bus) can enlarge the region still further and promote interaction between different regions.[219]

4.3.3 The communities along the Svealand line

The character of the communities

The conurbations along the Svealand line and the reference population centre of Nyköping have different prerequisites as regards size, structure, location and historical background. Läggesta, however, has never been more than a minor junction in the road and railway networks (and even earlier for shipping) with few residents in its vicinity.[220]

The character of the communities

Size	*Character*	*Attractiveness*	*Service*	*Stations*	*Demand*
Urban district pop. 1 000-5 000 **Nykvarn Mariefred Åkers stbr.**	Commuting community	Social security and possibility to telecommute	Work for more public and commercial service	Station, stop	Build close to the station. Fewer two-car households
Provincial town pop. 10 000-20 000 **Strängnäs**	Both commuting community and own labour market	Charm and social security. Accessibility to education, large labour market and telecommuting	Upper secondary school and centre for town and surrounding area	Transport service node -parking spaces -bus stops -bicycle parking -taxis	Good housing, high standard. The train has the greatest effect
City pop. 50 000-100 000 **Eskilstuna Södertälje (Nyköping)**	Regional centre	Cultural and commercial centre. Access to large labour market	Hospital University Administrative county seat	Travel centre Feeder buses	Public services and other places of work close to the station. The train has a symbolic value, start of something new

An attempt to characterise the communities (by size) along the Svealand line and a few of the expected effects of the train services along the Svealand line. Source: Några stationssamhällen i Mälarregionen, Towns with railway stations in the Mälaren region *(1997), modified*

Trade and industry in Södertälje, Åkers styckebruk, Eskilstuna and Nyköping have been dominated for centuries by manufacturing industries, mainly metal and engineering. During the latter half of the 1900s the traditional trades and industries saw a reduction in both number and importance. There is, though, a noticeable regional imbalance in the

[219] Sverige 2009, *Sweden in 2009* (1996), p. 16
[220] Welander (1998)

Stockholm-Mälaren valley region though the concentration of knowledge-intensive activities to Stockholm and Uppsala, while Södertälje and Södermanland have a greater share of traditional industries. This also has consequences for the possibility to find qualified jobs both for men and for women. Industry is male-dominated, and women may as a result find it difficult to find qualified jobs in the industry-dominated communities.

There are still some relatively important engineering industries in Eskilstuna and Södertälje. The mill in Åker now produces rollers for the steel industry, and a steel works still exists in Nyköping's youngish port of Oxelösund. But it is in services and public administration that the greatest growth has taken place during the post-war period, and the municipalities are now as a rule the single largest employers within health, care and schools in their own areas. Higher education has also grown.

The Mälar hospital in Eskilstuna is one of three county hospitals in Södermanland. About 2 500 employees serve the inhabitants in the northern part of the county (Eskilstuna and Strängnäs municipalities), with some specialised care for the whole county. Some 70% of the patients come from Eskilstuna, 20% from Strängnäs and 10% from the other municipalities in the county.[221]

Nykvarn has relatively few places of work and over the last decades it has expanded mainly as a suburb of Södertälje. Södertälje has many places of work and much inward commuting from the neighbouring municipalities of Nykvarn, Strängnäs, Gnesta and Trosa. The biggest companies in Södertälje are AstraZeneca (pharmaceuticals) with almost 7 000 employees and Scania (trucks) with almost 6 000 (2001).[222]

Structure

Eskilstuna is a relatively compact city as regards residents, with 30% of the population in the built-up areas living within a walking distance of 1 km from the centre in 1995. The number of low-income households is relatively high in the centre, which indicates small households on average with a large number of pensioners and students. 55% of the population in the built-up areas lived in the 1-3 km from the centre zone, within cycling distance, which means that 85% in all lived at most 3 km from the centre. Places of work, on the other hand, are more spread out in Eskilstuna than in other conurbations of similar size in the country as a whole. 40% of places of work were within a 1 km radius of the centre

[221] Eva Blom, Södermanland county council/Mälar hospital. Telephone conversation, 10 January 2002

[222] *Dagens Nyheter*, 24 October 2001, p. C 3

in 1995, and 90% within 3 km. One important reason for the smaller number of places of work at walking distance from the centre is the location of Mälar hospital, in the 1-3 km from the centre zone.[223]

In Strängnäs and Nyköping most of the town is within a radius of 3 km from the centre of the conurbation and can thus be reached on foot and by bicycle for local journeys. Åkers styckebruk and Mariefred are small conurbations, but the shared railway station at Läggesta can only be reached by connecting journey.

4.3.4 Population

The populations of the municipalities along the Svealand line in 2002 are shown in the table below.

Population of the municipalities on 31 December 2002

Municipality	*Population*	*Change since 31 December 2000*
Eskilstuna	90 089	+1.9%
Strängnäs	30 015	+1.4%
Nykvarn	8 204	+1.9%
Södertälje	79 613	+2.2%
Nyköping	49 310	+0.5%

Source: SCB

The population has increased in all the municipalities over the past year. In Eskilstuna several years' downward trend has been reversed.

The population of the municipalities is followed up every six months by SCB (Statistics Sweden), and the conurbations are delimited and a census taken every five years.

In several of the municipalities, there are some suburbs close to the conurbations, but since there is more than 200 m of undeveloped land between the suburb and the conurbation, SCB classes the suburb as a second conurbation, which consequently is not included in the population of the central conurbation. Examples of where this happens are Skogstorp (2 757 inhabitants on 31 December 2000), Hällbybrunn (3 413) and Torshälla (7 453) outside Eskilstuna, Abborrberget (1 569) outside Strängnäs and Arnö (3 826 inhabitants) outside Nyköping.

In several cases the municipalities delimit the conurbation differently to how SCB does in its national comparisons. The municipality of Strängnäs includes Strängnäs cathedral parish and Abborrberget in the conurbation of Strängnäs, which are areas that SCB classifies as, respectively, countryside and a different conurbation (suburb). Consequently,

[223] Reneland (2001)

according to the municipality, the population of the conurbation was 14 144 on 31 December 2000, while SCB's definition gives a figure of 12 010.

Population of municipalities and conurbations on 31 December

Municipality *Conurbation*	*1990*	*1995*	*2000*	*Change 1990-2000*
Eskilstuna municipality	89 765	89 425	88 408	-1.5%
Eskilstuna	*59 815*	*58 984*	*57 867*	*-3.3%*
Strängnäs municipality	26 835	28 669	29 610	+10.3%
Strängnäs	*11 420*	*11 617*	*12 010*	*+5.2%*
Mariefred	*3 488*	*3 728*	*3 702*	*+6.1%*
Åkers styckebruk	*2 769*	*2 824*	*2 792*	*+0.8%*
Nykvarn municipality [1]	6 897	7 438	8 052	+16.7%
Nykvarn	*5 640*	*5 867*	*5 969*	*+5.8%*
Södertälje municipality	74 889	74 917	77 882	+4.0%
Södertälje	*58 097*	*57 327*	*59 342*	*+2.1%*
Stockholm, conurb.[2]	*1 040 907*	*1 148 953*	*1 212 196*	*+16.5%*
Nyköping municipality [3]	47 481	48 737	49 063	+3.3%
Nyköping	*26 384*	*26 869*	*27 164*	*+3.0%*

Source: SCB. Delimitation of conurbations follows SCB's praxis; at least 200 people and at most 200 m between the buildings in a continuous built-up area

[1] For 1990 and 1995 Nykvarn municipal district in Södertälje municipality; for 2000, Nykvarn municipality

[2] The Stockholm conurbation includes continuous built-up areas in all or parts of the municipalities of Stockholm, Botkyrka, Danderyd, Haninge, Huddinge, Järfälla, Nacka, Sollentuna, Solna, Sundbyberg and Tyresö

[3] Nyköping municipality's present area, i.e. without Gnesta and Trosa municipalities

The population changes over the period from 1991 to 2000 depend largely on people moving. In some municipalities in growth areas, for example Södertälje in the county of Stockholm, the nativity surplus (excess of births over deaths) is greater than the net migration some years. The municipalities studied in the county of Södermanland, however, generally have small positive or often negative nativity surpluses, i.e. more people die than babies are born. Net migration is often larger and fluctuates more, and is thus critical for the size of the population.[224] Here, therefore, migration to and from the municipalities is studied and nativity surpluses are disregarded.

[224] Statistics Sweden, Population statistics 1991-2000

4.3.5 Migration

Annual net migration in the municipalities, 1991-2001

Year	*Eskilstuna*	*Strängnäs*	*Nykvarn*[1]	*Södertälje*[2]	*Nyköping*[3]
1991	-5.8‰	24.1‰		-8.7‰	
1992	-0.9‰	11.9‰		-6.6‰	6.0‰
1993	1.6‰	14.7‰		-9.7‰	4.7‰
1994	-1.0‰	4.3‰		-2.0‰	6.5‰
1995	-4.0‰	0.4‰		-0.2‰	0.7‰
1996	-7.4‰	3.8‰	-2.8‰	-0.9‰	1.9‰
1997	-3.2‰	7.7‰	12.7‰	-0.2‰	6.7‰
1998	-0.3‰	6.8‰	12.0‰	3.8‰	3.9‰
1999	3.6‰	6.4‰	16.1‰	7.5‰	3.6‰
2000	4.4‰	11.3‰	13.8‰	13.0‰	1.6‰
2001	10.2‰	6.3‰	1.2‰	9.2‰	7.1‰
Mean					
1991-1995	-2.0‰	11.0‰		-5.4‰	3.6‰
1996-2000	-0.6‰	7.2‰	10.4‰	4.7‰	3.5‰
1998-2001	4.5‰	7.7‰	10.8‰	8.4‰	4.0‰

Source: SCB. Net migration is the difference between the number of people moving in and away per mil of the average population for the period

[1] For 1996-1998 Nykvarn municipal district in Södertälje municipality. Nykvarn became a municipality in its own right on 1 January 1999, but has its own statistics since 1996

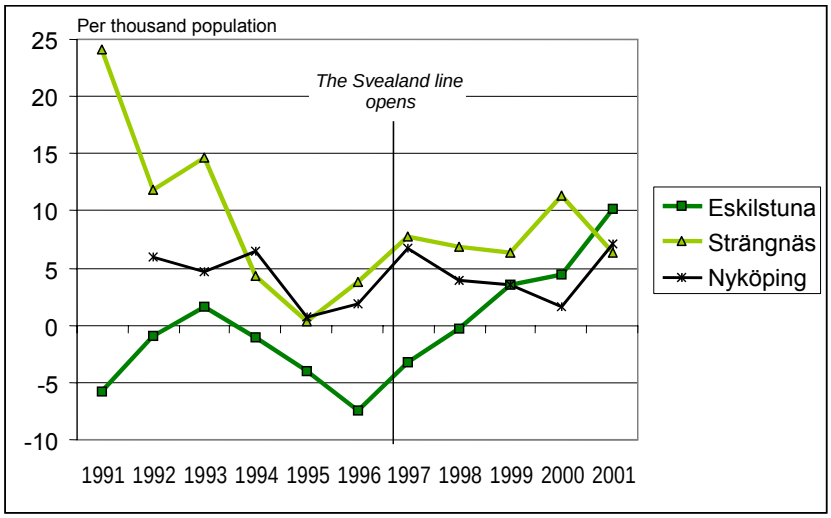
[2] For 1991-1995 including Nykvarn municipal district

[3] The statistics refer to Nyköping municipality after Gnesta and Trosa were detached on 1 January 1992

In 1998 net migration in Eskilstuna municipality changed from negative to positive (more people moved in than out), which resulted in an increase in population. A closer study of the statistics shows that the increase is really in the number of people moving in, from 2 300 in 1996 to 3 800 in 2001. The number moving out, on the other hand, has remained constant, about 3 000 people a year from 1996 to 2001. Over the previous five years, 1991-1995, the number of people moving in and out of the municipality varied by between 2 200 and 2 900 a year.

The number of people moving into Södertälje municipality has increased every year over the period from 1995 to 2000, but the number of people moving out has also increased. The numbers moving in and out of the other municipalities in the study have fluctuated.

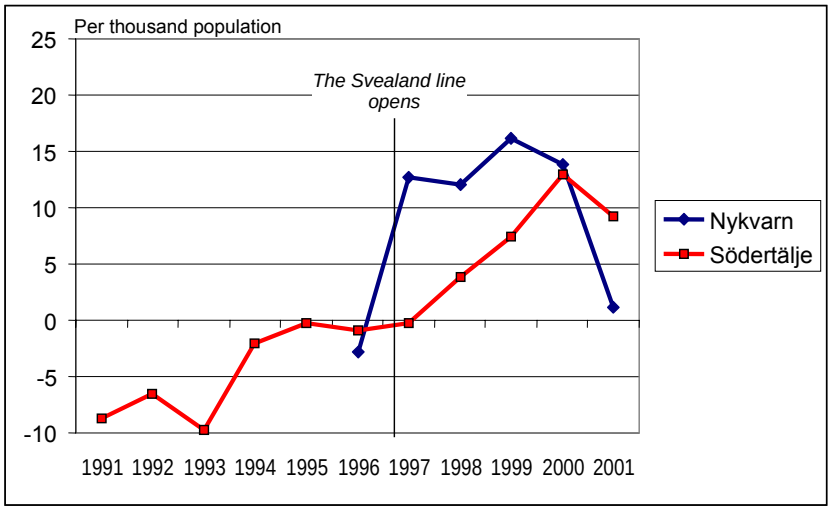
Net migration in Eskilstuna, Strängnäs and Nyköping, 1991-2001



Net migration (number moving in minus the number moving out) in the municipalities, per thousand population for each year. Source: SCB

Between 1991 and 2000 net migration reached a minimum around 1995-1996 in Eskilstuna, Strängnäs and Nyköping, after which it began to increase in Eskilstuna and Strängnäs, where net migration has been positive since. In Nyköping met migration has been smaller but relatively stable during the whole of the 1990s.

Net migration in Södertälje and Nykvarn municipalities, 1991-2001



Net migration (number moving in minus the number moving out) in the municipalities, per thousand population for each year. Source: SCB

Significant trends are the large migration surpluses in Södertälje (and Nykvarn) at the end of the period, following deficits of roughly the same size at the beginning of the 1990s.

In 2001 Strängnäs, Södertälje and Nykvarn municipalities all show a smaller yet still positive net migration, while Eskilstuna and Nyköping increase their positive net migration. In 2001 Eskilstuna had a net migration of 1%, which is its largest positive net migration for the period. This means that the population of Eskilstuna municipality increased by about 700 during 2001.

4.3.6 Gainful employment

Gainfully employed night population is the number of gainfully employed people living in a municipality. The available statistics on gainfully employed night population are normally grouped by municipality. The border of Nyköping municipality have changed over the period, and no comparison is possible between 1990 and 1998 since the municipality has no statistics for comparable areas for the first-mentioned year. Nykvarn municipality is equivalent to Nykvarn municipal district in Södertälje municipality in 1990 and 1998, which allows a comparison to be made.

Population and gainful employment in the municipalities, 1990

	Pop.	Gainfully employed night population			
Municipality		No. of people	work in home municipal.	work in other municipality	Level of employment
Eskilstuna	89 765	45 865	92%	8%	51%
Strängnäs	2 835	13 811	69%	31%	51%
Nykvarn [1]	6 897	4 049	19%	81%	59%

Source: SCB. Figures for 31 December 1990

[1] Nykvarn municipal district in Södertälje municipality

Population and gainful employment in the municipalities, 1998

	Pop.	Gainfully employed night population			
Municipality		No. of people	work in home municipal.	work in other municipality	Level of employment
Eskilstuna	88 027	36 309	89%	11%	41%
Strängnäs	29 161	12 883	64%	36%	44%
Nykvarn [1]	7 724	4 042	23%	77%	52%
Nyköping	49 000	21 693	78%	22%	44%

Source: SCB. Figures for 31 December 1998

[1] Nykvarn municipal district in Södertälje municipality

Population and gainful employment in the municipalities, 2000

Municipality	Pop.	Gainfully employed night population			
		No. of people	work in home municipal.	work in other municipality	Level of employment
Eskilstuna	88 408	37 268	86%	14%	42%
Strängnäs	29 610	13 652	63%	37%	46%
Nykvarn	8 052	4 274	25%	75%	53%
Nyköping	49 063	22 111	77%	23%	45%

Source: SCB. Figures for 31 December 2000

The night population is divided into the number of people who work in the municipality and the number who commute to another municipality.

The gainfully employed night population decreased in Eskilstuna and Strängnäs between 1990 and 1998, but was unchanged in Nykvarn. One reason for the sharp reduction in Eskilstuna is the structural transformation and the recession between 1991 and 1993 (see day population below). Outward commuting increased in all the areas studied except Nykvarn. Common to all three municipalities is that the level of gainful employment fell by 7-10 percentage points over the period from 1990 to 1998. In Eskilstuna municipality it fell from 51% in 1990 to 41% in 1998. The reduction was smaller in Strängnäs conurbation, 2 percentage points. After 1998 the degree of employment rose in the municipalities along the Svealand line, but only 1-2 percentage points up to the year 2000. One clear trend is that outward commuting is slowly increasing in Eskilstuna municipality, but is decreasing in Nykvarn.

Changes in gainfully employed night population in the municipalities

Municipality	No. of people		Work in other municipality, percentage points		Level of employment, percentage points	
	1990-1998	1998-2000	1990-1998	1998-2000	1990-1998	1998-2000
Eskilstuna	-21%	+3%	+3	+3	-10	+1
Strängnäs	-7%	+6%	+5	+1	-7	+2
Nykvarn [1]	0%	+6%	-4	-2	-7	+1
Nyköping	-	+2%	-	+1	-	+1

Source: SCB

[1] For 1990 and 1998 Nykvarn municipal district in Södertälje municipality

Gainfully employed day population in the municipalities

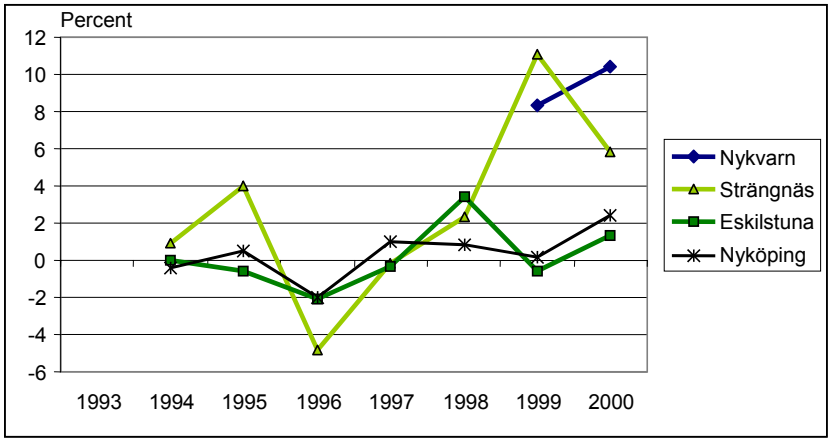
Municipality	Gainfully employed day population 1990	1998	2000	Change 1990-1998	1998-2000
Eskilstuna	46 312	36 340	36 579	-22%	+1%
Strängnäs	10 839	9 647	11 344	-11%	+18%
Nykvarn [1]	1 291	1 470	1 758	+14%	+20%
Nyköping	-	19 711	20 221	-	+3%

Source: SCB. Figures for 31 December

[1] For 1990 and 1998 Nykvarn municipal district in Södertälje municipality

Gainfully employed day population is another way of describing the number of jobs in a municipality. In the country as a whole there was a substantial decrease in the number of gainfully employed people between 1991 and 1993. Eskilstuna municipality was one of the municipalities hardest hit by the ongoing structural transformation and the recession. In the country as a whole the number of jobs fell by about 12% between 1991 and 1993.[225] The number of jobs in Eskilstuna municipality fell by about 10 000 over the same period, which can be seen in the table in the difference between 1990 and 1998. The reduction is equivalent to 20% of the number of jobs in 1990.

Change in number of jobs, 1994-2000



Change since previous year in the number of jobs in the municipalities. Source: SCB

In Strängnäs municipality the number of jobs fell by 11% between 1990 and 1998. In Mariefred conurbation the number of jobs has risen sharply by 28% over the same period. The number of jobs has also increased in Nykvarn municipality.

At the end of the 1990s the economy recovered and the number of jobs increased in the area along the Svealand line. Strong growth is es-

[225] SCB, Arbetskraftsundersökningarna (AKU), *Manpower surveys*

pecially noticeable in the municipalities of Strängnäs and Nykvarn, while the increase was only marginal in Eskilstuna in 2000.

The job to population ratio, also called the degree of self-sufficiency, is the ratio between the gainfully employed day population and night population, or, in other terms, the ratio between the number of jobs and the number of gainfully employed people in a municipality. A high ratio shows that there are many jobs in relation to the number of residents, which is often an indication of inward commuting to the municipality. In large towns the job to population ratios are in general high, often greater than 1, while smaller communities with much outward commuting have small job to population ratios.

Job to population ratios in the municipalities

	Job to population ratio		
Municipality	*1990*	*1998*	*2000*
Eskilstuna	101%	100%	98%
Strängnäs	78%	75%	83%
Nykvarn [1]	32%	36%	41%
Nyköping	-	91%	91%

Source: SCB. Figures for 31 December

[1] Nykvarn municipal district in Södertälje municipality

Some observable trends regarding the job to population ratio is that it falls slowly in Eskilstuna, but increases drastically in Nykvarn and parts of Strängnäs municipality. Eskilstuna's falling ratio is a sign that outward commuting is increasing in relation to the number of jobs. The increase in Nykvarn and (parts of) Strängnäs is mainly explained by the local labour markets' strong growth. The degree of self-support of these traditional commuter communities is increasing with regard to jobs for their population.

4.3.7 The Mälardalen University example

During the first five years the Svealand line has existed Mälardalen University has expanded greatly. The university has approximately 40 course programmes and a total of 13 000 students (2002), with most of its activities concentrated to Västerås and Eskilstuna.[226] The campus at Eskilstuna is located in the centre of the town, close to the railway station.

The university's expansion has meant the recruitment of a relatively large number of new staff. The availability of qualified people is limited in smallish communities, but it can be assumed that, especially in the

[226] Mälardalen University's homepage, 3 July 2002

Stockholm region, there is a relatively plentiful supply of academics who can apply for new jobs. The effects of the improved accessibility that the Svealand line has led to should therefore be able to be seen at a relatively early stage where these people live. It is consequently of interest to study the campus at Eskilstuna as an example of the effects of the Svealand line on Eskilstuna's labour market as a complement to the study of the effects among residents of the area along the Svealand line.

Data on the registered domiciles of university staff working in Eskilstuna between 1997 and 2001 was obtained from Mälardalen University.[227] No corresponding data for students is available.

Students and staff at Mälardalen University in Eskilstuna 1997-2001

	1997	*1998*	*1999*	*2000*	*2001*
Full-time students	2 241	2 777	3 132	3 301	3 329
Full-time staff	113	139	180	227	271
of which professors, lecturers and junior lecturers	*73*	*85*	*114*	*142*	*163*

Source: Mälardalen University

People with qualified academic education are generally speaking more mobile than other groups, partly as a consequence of a more specialised competence. One hypothesis is that relatively rapid changes should be observable in this group. The material was therefore divided into two groups, one consisting of professors, university lecturers and junior lecturers, and the other of full-time staff in Eskilstuna. The total material comprised 113 full-time employees in 1997, of whom 73 were professors, lecturers or junior lecturers. By 2001 the number of staff hade risen to 272, of whom 163 were professors, lecturers or junior lecturers.

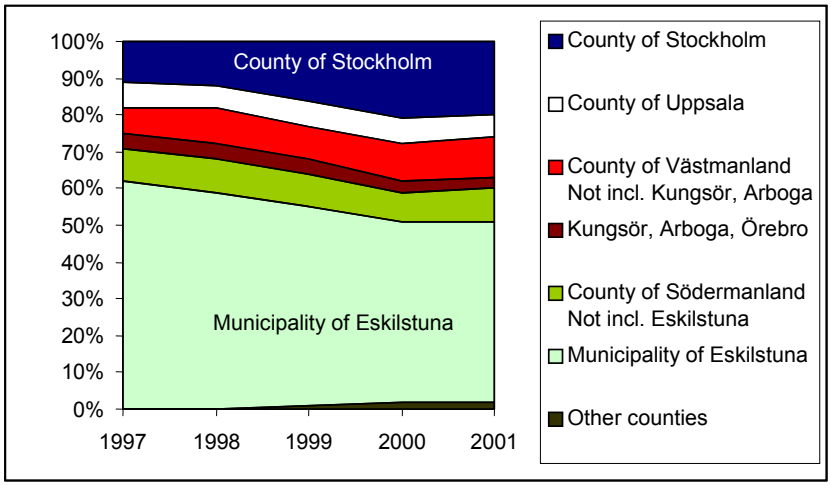
One clear difference between the professors, lecturers and junior lecturers, and other full-time staff in Eskilstuna is the distribution by registered domicile even before the Svealand line. The former group are registered as living in places other than Eskilstuna to a considerably greater degree. The proportion with Eskilstuna as their registered domicile decreased from 62% in 1997 to 49% in 2000 and 2001. The corresponding figure for other full-time staff remained steady at 80% between 1997 and 2000, but decreased in 2001 to 73%.

Residents in the county of Stockholm accounted for the greatest increase in the number of professors, lecturers or junior lecturers. Here the proportion increased from 11% to 20% at the same time as the number of employees living in Eskilstuna fell. The increased proportion

[227] Kerstin Malmgren, Mälardalen University. E-mail, 2 July 2002

with their registered domicile in the county of Stockholm is significant with a confidence interval of 95% (*). Among the 20% with their registered domicile in the county of Stockholm in 2001, the city of Stockholm (14%) is by far the largest, followed by the northern suburbs (4%) and the southern suburbs including Södertälje (2%). The corresponding figures for 1997 were for the city 8%, the northern suburbs 3% and no staff at all registered in the southern suburbs.

Registered domicile of professors, lecturers and junior lecturers in Eskilstuna



Of the professors, lecturers and junior lecturers employed at Mälardalen University in Eskilstuna, the number with their registered domicile in the county of Stockholm increased from 11% in 1997 to 20% in 2001.

No major differences can be observed in the other areas. Accessibility, for example, also improved between Eskilstuna and Arboga and Örebro, but in this case there is no significant change in the number of people with their registered domicile there. Recruitment to Eskilstuna from other municipalities in the county of Södermanland is relatively small, and is greater from Västerås, where the university's other campus is located. The greatest changes in registered domicile took place between 1998 and 2000, and the situation was more stable in 2001.

The development described here has established a regional position in the Mälaren valley for Mälardalen University's campus at Eskilstuna, partly at the expense of its local position. New competence has been able to recruited, especially from the Stockholm area. Even if there is no data to prove it, there is reason to assume that a substantial number of people with their registered domicile in the county of Stockholm commute by train on the Svealand line.

4.3.8 Commuting

In the country as a whole, there is a clear trend towards increased commuting over municipality borders. In 2000 almost 30% of all gainfully employed people in Sweden commuted to work, more in the large city counties. However, commuting is not evenly distributed over the population, and certain differences are significant between different socio-economic groups. Generally speaking, men commute more than women, but the differences are small in the 20-30 age group. After the age of 55, the willingness to commute decreases sharply. People with a high level of education commute considerably more than those with lower levels. People in financial services, trade and communications, and public administration are the ones who commute most.[228]

Commuting along the Svealand line

Most commuting is in to Stockholm in the morning and back to Södermanland in the afternoon. During the first few years the line has existed commuting in the "opposite direction", from Stockholm to Eskilstuna and Strängnäs, has also increased.

One reason that has contributed to commuting in the opposite direction to the traditional flow is the relocation of a number of businesses from Stockholm till Eskilstuna. Part of the National Postal Giro's computer unit and the newly formed Energy authority (the part that previously belonged to Nutek) have moved to Eskilstuna since services began operating on the Svealand line. Employees at the latter were offered generous terms to continue working for the authority at its new location over an introductory period of three years from autumn 1998, which meant that they could count part of the travelling time as working time and were also compensated financially for having to commute. Mälardalen University has also expanded during this period.

In Södermanland there is a relatively large flow of commuters between Strängnäs and Eskilstuna. Upper secondary school pupils in both places also account for a considerable proportion of the daily travel, as a consequence of the public transport authority (PTA), Länstrafiken, switching school transport from the bus to the train when the Svealand line opened.

Total number of commuters

The figures for commuting in the statistics refer to the number of people with their registered domicile in one place, but who work in another. This number includes both people who commute to work every day and

[228] Statistiska meddelanden, *Statistical bulletins* (2000)

people who commute on a weekly basis. There may also be a certain bias in the statistics caused by people who in practice do not commute at all since they both live and work in the same place, but have their registered domicile elsewhere.

Total commuting in the municipalities in 1996 and 2000

No. of commuters	*Outward*			*Inward*		
	1996	*2000*	*change*	*1996*	*2000*	*change*
Eskilstuna	3 665	5 109	+39%	3 661	4 420	+21%
Strängnäs	4 317	5 100	+18%	1 426	2 792	+96%
Nyköping	4 437	5 012	+13%	2 845	3 122	+10%

Source: SCB (AMPAK)

Total commuting in to and out from the municipalities increased generally speaking between 1996 and 2000. The increases in Eskilstuna and Strängnäs, however, were greater than in Nyköping. The most noticeable changes are in inward commuting to the municipality of Strängnäs, which doubled, and in outward commuting to the municipality of Eskilstuna, with a 40% increase. In the reference centre of population of Nyköping the increases are around 10%. One observation is that the number of outward commuters is the same, about 5 000, from each of the three municipalities. Inward commuting, on the other hand, varies with the size of the conurbation and regional attractiveness between the municipalities.

The increase in inward commuting to Strängnäs and Nyköping municipalities largely took place in 1999 and 2000. The increase in Eskilstuna took place in 1998 and 2000 (a number of businesses and activities relocated from Stockholm in 1998). Outward commuting has increased most during the later part of the period.

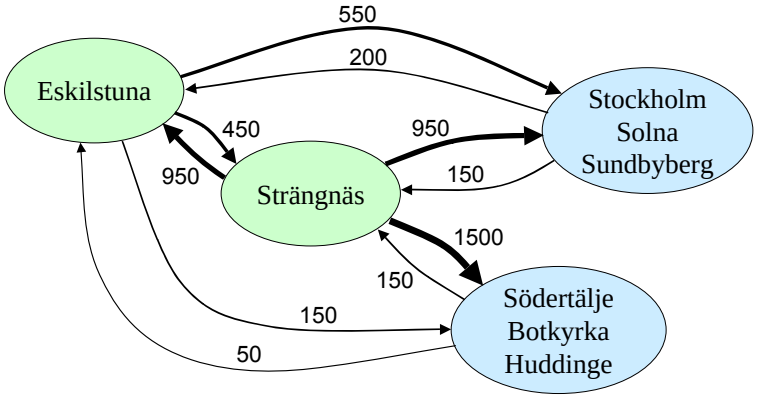
Commuting along the Svealand line

Of all the commuter routes to and from Eskilstuna municipality to neighbouring counties, commuting to and from the county of Stockholm (county AB) has doubled since the Svealand line opened in 1997. Commuting has also increased generally to and from neighbouring municipalities in the county of Södermanland, as it has to and from the county of Västmanland. However, there is a marked contrast to commuting towards the county of Stockholm, where the increase has been dramatic.

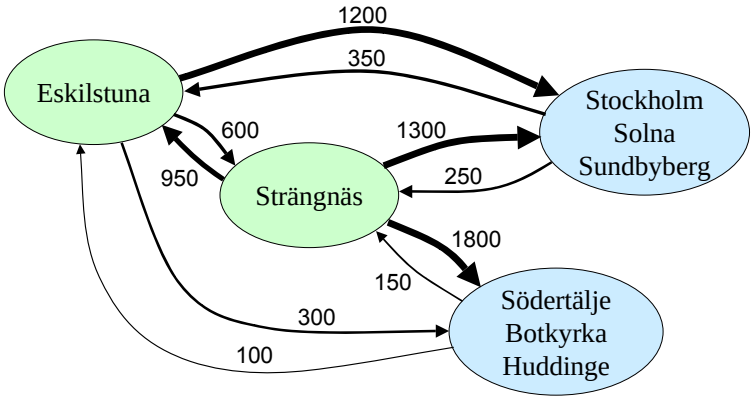
The biggest commuter flows along the Svealand line are from Strängnäs municipality to Södertälje and from Strängnäs to Stockholm. Commuting from Eskilstuna to Stockholm has greatly increased since

the Svealand line opened and in 2000 almost the same number of people were commuting on that route as from Strängnäs. Commuting from Strängnäs to Eskilstuna is also substantial.

Number of people commuting between the municipalities along the Svealand line in 1996



Number of people commuting between the municipalities along the Svealand line in 2000

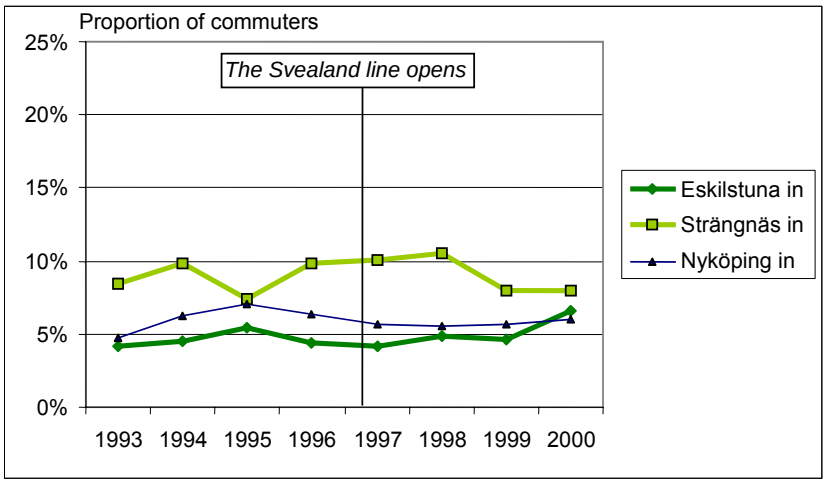


Source: SCB (AMPAK)

Proportion commuting to the municipality of Stockholm

Of the total commuting to and from the municipalities, it is interesting to study the proportion of inward and outward commuting from and to the municipality of Stockholm. The shorter travelling times that the Svealand line gave from 1997 on can be assumed to influence accessibility most in those tours where travelling times by car were too long for any considerable commuting, but the travelling times by train are shorter, and there is a large labour market that gains greater accessibility.

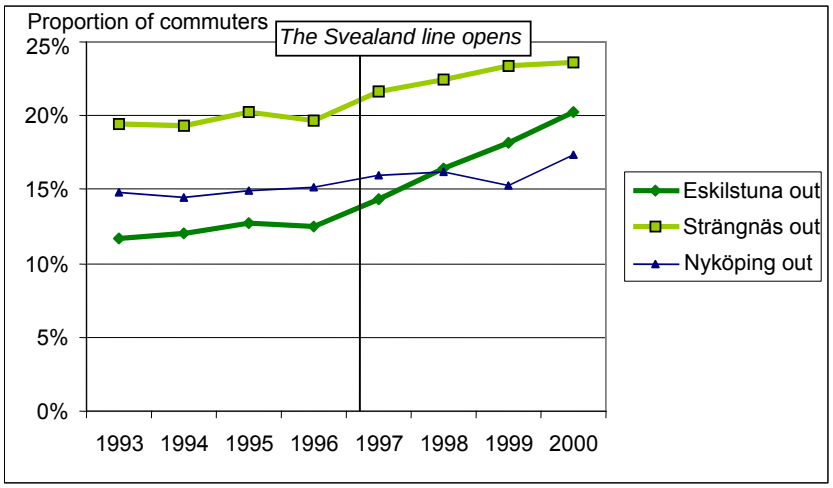
Proportion of inward commuters from the municipality of Stockholm of total inward commuters



Source: SCB (AMPAK)

In Eskilstuna municipality the proportion of commuting from Stockholm increased from 4% in 1996 to 7% in 2000. No great change can be seen for Nyköping. In Strängnäs the proportion of commuting from Stockholm even seems to have diminished, but this must be seen in the light of the drastic increase in the statistics for total commuting in 1999 and 2000. Inward commuting from the county of Stockholm to Eskilstuna increased by 5 percentage points over the same period, but was unchanged to Strängnäs and Nyköping.

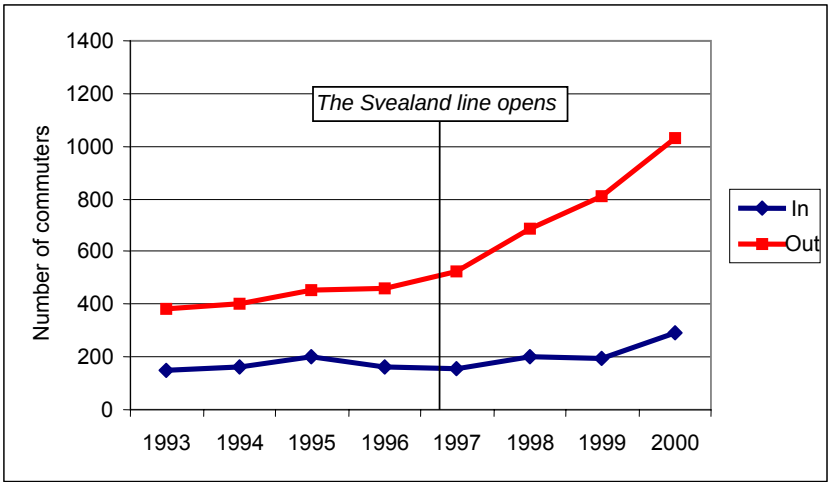
Proportion of outward commuters to the municipality of Stockholm of total outward commuters



Source: SCB (AMPAK)

There was an increase of 7 percentage points in the proportion of outward commuting to Stockholm municipality from Eskilstuna, from 13% in 1996 to 20% in 2000. From Strängnäs the increase is 4 percentage points, from 20% to 24%, and from Nyköping 2 percentage points to 17%. The improvement in accessibility to Stockholm's labour market is consequently most noticeable in Eskilstuna, and the increase is significantly greater than the general trend for the area.

Inward and outward commuting to Stockholm from Eskilstuna municipality



Commuting to and from Eskilstuna municipality to/from Stockholm municipality, 1993-2000. Source: SCB

Commuting between Eskilstuna and Stockholm municipalities increased markedly between 1996 and 2000. In absolute terms, the number increased from 460 outward commuters from Eskilstuna to 1 030 (125%), and from 160 to 290 (80%) commuting in to Eskilstuna.

The relative change in the proportion of women commuting between Eskilstuna and Stockholm compared to total commuting is equivalent to an increase of 2-3 percentage points between 1996 and 2000.

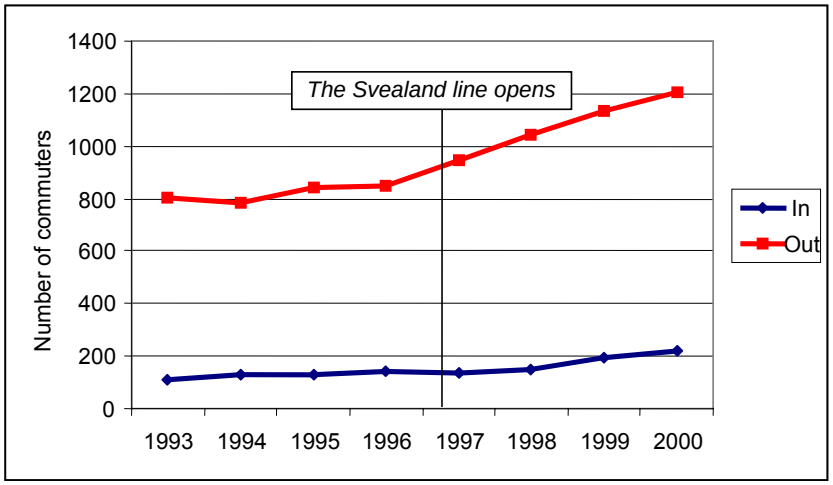
Inward and outward commuting have also increased in Strängnäs municipality since 1996. The number of inward commuters has increased by almost 60% to 220 and outward commuters by approximately 40% to 1 200 during the period from 1996 to 2000. The number of outward commuters to Södertälje municipality, however, has only increased by 15% over the same period, and to the county of Stockholm by about 30%.

Recorded inward commuting to Strängnäs municipality from the whole of the county of Stockholm increased dramatically over 1999 and

2000, the increase amounting to almost a doubling of the number of people commuting.

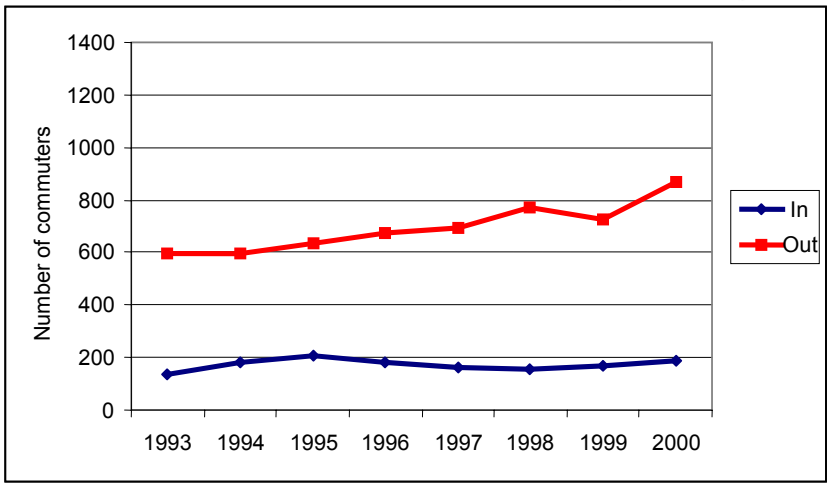
The proportion of women commuters of the total number of commuters changed very little between 1996 and 2000, while the proportion of women commuting to or from Stockholm increased by 2-4 percentage points more.

Inward and outward commuting to Stockholm from Strängnäs municipality



Commuting to and from Strängnäs municipality to/from Stockholm municipality, 1993-2000. Source: SCB

Inward and outward commuting to Stockholm from Nyköping municipality



Commuting to and from Nyköping municipality to/from Stockholm municipality, 1993-2000. Source: SCB

In the reference centre of Nyköping the changes in commuting look somewhat different to Eskilstuna and Strängnäs. The number of inward

commuters from the city of Stockholm remained largely unchanged at 180 between 1996 and 2000, while the number commuting out to Stockholm increased by 30% to 870 during the same period. Outward commuting to Södertälje municipality, however, has increased by almost 40% since 1996, as has outward commuting to the whole of the county of Stockholm.

The proportion of women commuting over the municipality border has generally speaking decreased in Nyköping. The proportion of women commuting to Stockholm has decreased by 2 percentage points more than the proportion of women commuting of total outward commuting, while their inward commuting has increased by 2 percentage points more.

4.4 Discussion and summary

The expected effects of the Svealand line were primarily economic growth and regional development, based on the possibilities made available by the improved accessibility, mainly to the labour markets. The expectations must be seen in the light of the enormous structural transformation that above all trade and industry in Eskilstuna underwent in the 1980s, during the course of which 20% of the existing jobs disappeared in the ensuing deep recession of 1991-1993. The municipalities and the region pushed strongly in the process preceding the decision to build the line in 1991, and also participated in its construction. One conclusion that can be drawn is that the region's stakeholders assumed that a great many of the effects of the improved train service would be to their advantage.

The statistics also show that the municipalities have seen a positive development both in people moving in and new jobs during the Svealand line's first few years of existence. In Nykvarn and Strängnäs, however, this is a trend that has continued over several decades, while in Eskilstuna it is a break in the trend from a downward development. The development must be seen against the background of a very progressive economic development over these years.

The studies of commuting show that the proportion of people commuting out from Eskilstuna has increased drastically, above all those commuting to Stockholm. Commuting inward has also increased, but from a lower level. Commuting from Strängnäs to Stockholm has also increased relative to the reference centre of population, Nyköping. The relocation of some jobs to Eskilstuna and Mälardalen University's expansion have assuredly had a considerable impact on inward commuting. The changes in the labour markets and the fluctuations in economic

trends would thus appear to be critical factors for how commuting develops. The differences between Eskilstuna and Strängnäs on the Svealand line and the reference centre of population, Nyköping, are on the other hand considerable. One conclusion is that the improved possibilities for commuting offered by the regional high speed trains have contributed to an equalisation of the differences between the local labour markets in the region.

The Svealand line has thus contributed to increased commuting between Stockholm and Eskilstuna, and probably also to a number of location decisions. The latter conclusion, however, has not been studied in any great detail in this project, and so must remain a hypothesis for future research.

5. Supply and demand along the Svealand line

5.1 Supply

The public transport supply between Eskilstuna and Stockholm changed substantially on two occasions during the 1990s. The first time, in 1993, Swedish Rail (SJ) went from a supply of train services to bus services, with a higher frequency of service than previously. The second time was in 1997, when the Svealand line opened. All SJ's bus services were then replaced by trains. In addition to the supply of train and bus services operated by SJ the county public transport authority (PTA), Länstrafiken i Södermanland (LT), also offered a bus supply between the communities in the north of Södermanland, at the time partly in competition with SJ but today more as a complementary supply. The Greater Stockholm Public Transport Company Ltd (SL) also operates bus services between Nykvarn and Södertälje.

5.1.1 SJ's supply before the Svealand line

During the last few years of the old line between Stockholm and Eskilstuna the train services were operated with ordinary locomotives and carriages (Rc-class locomotives and carriages from the 1960s or 1980s). The trains stopped at the stations in-between at Ärla, Åkers styckebruk, Läggesta, Nykvarn, Södertälje södra station (the old Södertälje South), renamed Södertälje hamn (Port of Södertälje) in 1994, and Flemingsberg (also called Stockholm syd from its opening in 1990 until 2001). Public transport authority buses to Mariefred connected at Läggesta, and to Strängnäs at Åkers styckebruk. The travelling time from Eskilstuna to Stockholm was about 1 hr 40 mins, and 1 hr 35 mins, including a connecting bus service, from Strängnäs to Stockholm. Thee complementary bus services between Eskilstuna and Stockholm stopped at a few places along the way until spring 1993, but gave Strängnäs a direct bus service to Eskilstuna, Södertälje and Stockholm. Travelling time by bus was between 1 hr 20 mins and 1 hour 30 mins between Strängnäs and Stockholm (City terminus).

From 1993 on, the bus services were SJ's basic supply. The buses stopped more irregularly and especially the services that stopped in Åkers styckebruk and Nykvarn had longer travelling times since the buses had to leave the E20 and drive into town to the stops at the railway stations. The bus services were operated with modern long-distance

The old line between Södertälje and Eskilstuna had a low standard and wound its way through the countryside. The top speed was 90 kph, but speed was restricted through these bends at Taxinge-Näsby. (1993)

During the construction of the Svealand line the buses stopped at the old bus station at the port in Strängnäs. Here is a bus on its way to Stockholm in 1996.

buses. The train services were limited, with two trains in the direction of Stockholm in the morning rush hour, and two to Eskilstuna in the afternoon Monday to Friday.

From 8 January 1994 there were only bus services after all passenger train services between Eskilstuna and Södertälje had been cancelled. The supply then consisted of about 18 bus services in each direction Monday to Friday between Eskilstuna and Stockholm, and a few more services on parts of the route (Strängnäs–Stockholm). Frequency of service was one departure an hour, except late in the evening and on Saturday afternoons and Sunday mornings when departures were less frequent.

5.1.2 SJ's supply with the Svealand line

The Svealand line was opened on 9 June 1997, and SJ's bus services were then replaced by trains. At the same time, the county public transport authority (LT) adjusted its bus services in alignment with a cooperation agreement within Trafik i Mälardalen (TiM) in order to avoid operating a parallel, and thus competing, bus service to the Svealand line. The supply of train services was roughly equivalent to the bus supply, with the difference that travelling times had been roughly halved, that the trains stopped at all stations along the way, thus offering a higher frequency of service than the buses had, especially to Nykvarn, and that the trains were more comfortable.

Travelling time between Eskilstuna and Stockholm is one hour, with stops at Strängnäs, Läggesta, Nykvarn, Södertälje syd and Flemingsberg. The frequency of service is one departure an hour, the same number of minutes past the hour, (a so-called basic interval timetable), with a couple of extra trains to increase frequency to half-hourly during the rush hour from Monday to Friday. Late in the evening and on Sunday mornings there is a train every two hours. The unexpectedly high demand for train journeys also on Saturdays and Sundays led SJ to very quickly extend the hourly services to include Saturday afternoon and early Sunday morning. From summer 2002, however, the supply at weekends has once again been curtailed.

When services began, SJ used the same type of train (X2) as the main line X 2000 trains, which meant that the trains are fast and have a high level of comfort. However, the X2 trains have gradually been replaced by older locomotive-hauled trains, entailing a reduction in comfort and somewhat longer travelling times. With the current timetable (autumn 2002) the travelling time between Eskilstuna and Stockholm is 1:05, except for a morning express to Stockholm which covers the distance in 54 minutes.

From 6 October 1997 services on the Svealand line were extended from Eskilstuna to Örebro and Hallsberg, with approximately every second train continuing westward. Since 10 January 2000 the trains also run between Stockholm and Uppsala via Arlanda airport.

SJ's supply between Eskilstuna and Stockholm, 1990-2002

Year	No. of services		Travelling time (hrs:mins)		Fares (2001 price levels) 2nd class		
	Total	Of which bus	Shortest	Average	basic	Lowest	Highest
1990	8	4	1:35	1:43	131 Skr	40 Skr	209 Skr
1991	8	3	1:41	1:48	162 Skr	49 Skr	259 Skr
1992	8	3	1:39	1:47	132 Skr	67 Skr	231 Skr
1993	8	3	1:38	1:46	119 Skr	42 Skr	209 Skr
1994	18[1]	18	1:50	2:06	123 Skr	41 Skr	123 Skr
1995	19[1]	19	1:40	2:04	120 Skr	40 Skr	120 Skr
1996	19[1]	19	1:44	2:04	125 Skr	44 Skr	125 Skr
1997	19[1]	19	1:49	2:04	135 Skr	47 Skr	135 Skr
1998	18	-	1:00	1:00	130 Skr	88 Skr	228 Skr
1999	18	-	1:00	1:00	129 Skr	88 Skr	232 Skr
2000	18	-	1:02	1:02	128 Skr	92 Skr	225 Skr
2001	18	-	1:02	1:02	125 Skr	90 Skr	250 Skr
2002	18	-	1:02	1:03	125 Skr	90 Skr	250 Skr

Compiled by G. Troche, KTH

Data is for March each year

[1] Not including scheduled trains from Eskilstuna to Stockholm. 1 upward train ran via Västerås, 2-7 trains entailed changing at Flen. The main supply during this period was bus services

Note that the supply to the stations in-between is not the same as between Eskilstuna and Stockholm. The bus services have always run via Strängnäs. The old line ran via Åkers styckebruk with a connecting bus to Strängnäs. However, only some of the buses between Eskilstuna and Stockholm drove in to Åkers styckebruk. The new railway runs through Strängnäs, with bus connections from the stations in both Läggesta and Strängnäs to Åkers styckebruk.

The fares in the table below are the second class fares. The trains also have first class seats, which are mainly used by passengers on business trips. The buses did not offer this possibility (see the "highest fare" column above).

SJ's supply between Eskilstuna and Stockholm, spring 1997

to Stockholm C from	*Eskilstuna*	*Strängnäs*	*Läggesta*	*Nykvarn*
Frequency				
Monday-Thursday (in each direction)	*Bus* 18-19, *Train*[1] 8-9	*Bus* 21-23	*Bus* 19-21	*Bus* 9
Trav. time (hrs:mins)				
Bus	1:45-2:25	1:15-2:00	1:00-1:30	0:50-1:05
Ordinary train	1:50-2:20	-	-	-
Fare (Skr)				
student, single	75	65	50	35
adult, single	110	90	70	50
Monthly pass	2 000	1 885	1 580	1 275

[1] Express via Västerås or change at Flen

SJ's supply on the Svealand line, spring 1998

to Stockholm C from	*Eskilstuna*	*Strängnäs*	*Läggesta*	*Nykvarn*
Frequency				
Monday-Thursday (in each direction)	*High speed train* 18	*High speed train* 18-19	*High speed train* 18-19	*High speed train* 18-19
Trav. time (hrs:mins)				
High speed train	1:00	0:47	0:39	0:30
Fare (Skr)				
student, single	85	65	55	40
adult, single	125	95	75	60
Monthly pass	2 200	2 075	1 740	1 000[1]

[1] Includes monthly pass for local services in the county of Stockholm (on SL)

SJ's supply on the Svealand line, spring 2000

to Stockholm C from	*Eskilstuna*	*Strängnäs*	*Läggesta*	*Nykvarn*
Frequency				
Monday-Thursday (in each direction)	*High speed train*[1] 18	*High speed train*[1] 18	*High speed train*[1] 18	*High speed train*[1] 18
Trav. time (hrs:mins)				
High speed train [1]	1:02	0:48	0:39	0:30
Fare (Skr) [2]	*With TiM-pass from machine / over the counter ticket*			
student, single	77 / 95	63 / 80	50 / 65	36 / 50
adult, single	113 / 135	86 / 105	68 / 85	54 / 70
Monthly pass	2 200	2 075	1 740	
Monthly pass incl. SL	2 465	2 350	2 035	1 125[3]

[1] Certain services with locomotive and carriages ("ordinary train"), but with same timetable as for the high speed trains

[2] Fares from 3 April 2000

[3] TiM pass Stockholm

Ticket machines in Eskilstuna (2002).

5.1.3 SJ's fares

The fares on the Svealand line are set by SJ according to market principles. The start of services on the Svealand line meant that TiM also began their operations. Ticket sales are therefore divided between SJ's ticket system (Petra) for long-distance journeys, and TiM who sell most of their tickets from machines for journeys within the Mälaren valley. Discounts are available for children, young people and students. There is also a monthly pass for commuters. SJ previously sold multi-trip tickets (booklets) at a 10% discount for several journeys in the Mälaren valley, but these have been superseded by the TiM pass. During the period studied fares have been the same the whole day.

In summer 1997 SJ offered train journeys at half price from the start of services on 9 June until 31 August, as an introductory offer. An ordinary ticket between Eskilstuna and Stockholm then cost 55 Skr, and monthly passes were also sold at half price during the same period.

The cooperation within TiM means that passengers can buy discounted county passes for local and regional public transport within the counties if they buy a monthly pass for the SJ service in the Mälaren valley. Some municipalities also subsidise SJ's monthly passes, in addition to the already subsidised public transport in each county. The county passes are also valid on the train for journeys in the county of Södermanland.

Up until April 2000 the ordinary fare applied for tickets bought before departure, but there was an additional charge for tickets bought on

the train. The new ticket system introduced on the Svealand line in April 2000, as the first route in the TiM area, uses a so-called smart card, the TiM pass.[229] The card has a memory contained in a microchip. It is filled with money (between 300 and 3 000 Skr) from a bank card in a special machine, and assumes that tickets are bought from machines. Single tickets are then 10%+10 Skr cheaper than when bought at the station or on the train.

It is also possible to fill the TiM pass with a period, but so far only as a non-personal monthly pass for a maximum of 48 single journeys on a predetermined route over a 30-day period. Passengers pay for a journey by inserting the pass into a special reader. On average such a non-personal TiM pass is used on the Svealand line for 35 single journeys over a 30-day period. In the TiM area this figure varies somewhat.[230]

5.1.4 Quality problems

Shortage of seats

On certain services, passengers have had difficulty in finding a seat due to the great demand. It has mainly been on some of the morning trains in to Stockholm that a large number of passengers have had to stand, but the trains have also been full during the afternoon rush hour. SJ has tried to meet the demand by lengthening the trains with extra carriages but this may in turn affect the travelling times because of the trains' slower acceleration. The locomotive-hauled trains that have successively replaced the high speed trains have more seats.

Delays

Train services on the Svealand line have suffered from frequent delays.[231] The delays cause inconvenience for passengers and unnecessary extra costs for the operator, SJ, in addition to having a negative effect on the train services' attractiveness. Earlier research has shown that reliability is important in the decision process, and that passengers value punctuality highly.[232] [233] Not having to suffer a deterioration, for example a delay, in an existing supply is valued more highly than a possible improvement by the same amount of time. A study of the time values for car journeys showed approximately double values for a delay (Willingness To Accept, WTA) compared to an equally long shortening of

[229] SJ Press release, 3 April 2000
[230] Heinz and Lundberg (2002; unpublished)
[231] Lindfeldt (2001)
[232] König and Axhausen (2002)
[233] Bates, Polak, Jones and Cook (2001)

travelling time (Willingness To Pay, WTP). Passengers could, however, accept minor delays of a few minutes without this affecting their valuation negatively, at least in the short term.[234] [235] Banverket's calculation guide also shows approximately double values for length of delay compared to in-vehicle time.[236]

The extent of the delays has varied between different timetable periods, but a general observation is that the services did not have the desired quality during any period on the Svealand line. SJ's delays statistics for the period from 1 November 2001 to 30 April are shown below. The delays refer to the trains' arrival time at their destination.

Delayed trains

No. of trains run on the Svealand line 1 November 2001 - 30 April 2002	*6 900*	*100%*
On time (0 minutes)	3 295	48%
1-5 minutes late	1 953	28%
6-15 minutes late	974	14%
More than 15 minutes late	678	10%

Note: During the period from 15 December 2001 until 30 April 2002 a total of 93 trains were cancelled, which is equivalent to almost 2% of the scheduled trains

Source: Riksdagens utredningstjänst, *Swedish Parliament Research Service* (2002a), (2002b)

With the delay measure that trains that are at most 5 minutes late are counted as being on time, 76% of the trains arrived on time at their destination, i.e. 1 in 4 trains were more than 5 minutes late. A reasonable interim target might be to achieve 95% (at most 1 in 20 trains more than 5 minutes late), and aim for 99% (1 in 100 trains) in the long term. The latter can be regarded as very good.

There are many reasons for the delays. One general observation is that the traffic system is sensitive in the Mälaren valley due to the high utilisation of capacity in the infrastructure. Other reasons are planning errors and changing prerequisites, including everything from the dimensioning of the infrastructure and the design of the timetables to preparedness for adverse weather conditions, faults on the track or faulty rolling stock. One problem that is easy to understand is that the system of high frequency services on a single track line is sensitive to disruptions, which means that delays are quickly propagated throughout the whole

[234] Gunn (2000), p. 443
[235] Hultkrantz and Mortazavi (2001)
[236] Beräkningshandledning, *Calculation guide* (2001), section 2.3

traffic system.[237] There are several places along the route that have limited capacity and can easily cause delays, but if Banverket's plans are carried out in full, several bottlenecks will largely be eliminated through new investments over the coming years.[238]

From the passengers' point of view, fewer delays would not only mean less irritation and inconvenience from the delays were less, but also that much of the time that passengers at present have to keep in reserve could be used for other things. The risk of a delay has as a rule a greater influence on the attractiveness of the train services than a real delay de facto has.[239]

5.1.5 Express buses

The Swebus Express bus company began operating a long-distance bus service along the Svealand line on 8 January 2001, service no. 842 on the Örebro–Eskilstuna–Stockholm route. The supply consists of 5-6 buses in each direction Monday to Friday, 3-4 on Saturdays and 2 on Sundays. Between Eskilstuna and Stockholm the buses stop at Strängnäs and Läggesta, but local journeys within the county are not permitted. The travelling time between Eskilstuna and Stockholm is 1 hr 45 minutes, and the fare for a single journey, is 75 Skr for adults. The number of journeys is estimated at less than 100 000 a year.[240]

5.1.6 County public transport in Södermanland

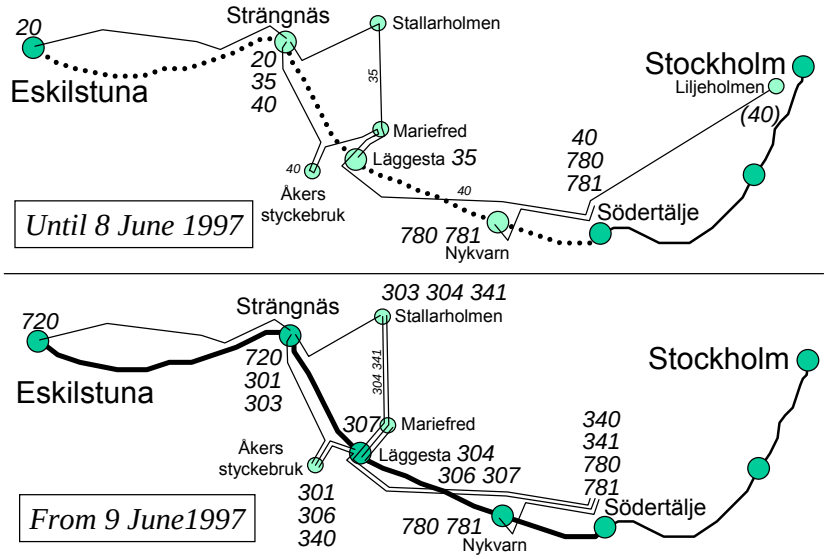
In the county of Södermanland, the public transport authority (Länstrafiken) had several routes that ran completely or partly parallel to the railway up until the opening of the Svealand line. Bus no. 20 from Eskilstuna to Strängnäs accounted for a large part of the regional travel between the two towns, in addition to local travel, and connected with bus no. 40 in Strängnäs. Bus no. 40 ran between Strängnäs and Södertälje, and on certain journeys all the way to Liljeholmen in Stockholm. However, the travelling times were longer than with SJ because bus no. 40 stopped at both Mariefred and Åkers styckebruk on the way.

When train services began on the Svealand line on 9 June 1997 some changes were made to the route network and the bus routes were given new numbers. No. 20 became no. 720, and nos. 35 and 40 were discontinued and were replaced by five feeder buses and two peak period buses. The peak period buses gave Åkers styckebruk (no. 340) and Stallarholmen and Mariefred (no. 341) a few non-stop connections, without

[237] Lindfeldt (2001)
[238] Framtidsplan för järnvägen, *Plan for the future for the railways* 2004-2015 (2003)
[239] König and Axhausen (2002)
[240] Stefan Carlén, Swebus Express, by e-mail, 20 June 2002

the need to change at Läggesta, to places of work in Södertälje Monday to Friday.

The county public transport authority's route network along the Svealand line



The route network of the county of Södermanland public transport authority (Länstrafiken) and SL (buses 780 and 781) along the Svealand line before and after the line opened.

5.1.7 SL's buses

The buses operated by SL that concern the area studied are nos. 780 and 781 between Nykvarn and Södertälje. In Södertälje they connect with the commuter trains to and from Stockholm. A journey from Nykvarn to Stockholm Central station by bus and commuter train takes about 1 hr 15 mins. Bus no. 780 runs once every half an hour during the day Monday to Friday, with in principle every second bus travelling via the motorway. At other times it runs every hour. The travelling time is approximately half an hour. Bus no. 781 runs a few times at peak periods via the motorway and Södertälje hamn (Port of Södertälje) station.

The normal price of a single ticket from Nykvarn to Stockholm was 35 Skr in 2000, and a monthly pass cost 400 Skr between 1997 and 1999, 450 Skr in 2000 and 500 Skr from 1 September 2001.

SL's monthly passes were valid for train journeys between Nykvarn and Södertälje hamn[241] until the line was closed for conversion, and also on the buses that replaced the trains until the train services reopened in

[241] Until 1994 the name of the station was Södertälje södra (Södertälje South)

June 1997. A supplementary pass was also available for continuing a journey with SJ from Södertälje hamn to Stockholm C.

5.1.8 The Nyköping line

A comparison with the supply on the Nyköping line (between Nyköping and Stockholm) for the years in the study shows that single tickets are slightly more expensive than on the Eskilstuna–Stockholm route, while monthly passes were cheaper in 1998 and 2000 thanks to a subsidy from Nyköping municipality.

SJ's supply to Nyköping

to Stockholm Central	*Spring 1997*	*Spring 1998*	*Spring 2000*
Frequency Monday - Thursday (in each direction)	*Train* 9-10	*Train* 10 *bus* 2-3	*Train* 11
Travelling time (hrs:mins)			
Bus		1:20-1:25	
Ordinary train	1:05	1:05	1:05
Fare (Skr)			*Single/10-trip ticket*
student, single	85	95	100 / 780
adult, single	120	135	145 / 1 100
monthly pass	2 000	1 700	1 975

A monthly pass for journeys between Nyköping and Stockholm together with a monthly pass for the county of Stockholm (on SL) cost 2 255 Skr in spring 2000.

More than anything else, the supply's frequency of service was lower than on the Svealand line, with some concentration around good commuting times. The travelling time between Nyköping and Stockholm Central was 1 hr 5 minutes for the 104 km journey. The difference between travelling times by bus and by train (20 minutes) in 1998 is relatively modest because the train services are not especially fast, the E4 is motorway for all of the route, the buses did not stop very often, and the buses mainly ran at off-peak times with little risk of getting caught in traffic jams in the Stockholm area.

5.1.9 Roads

The main road, and the fastest, between Eskilstuna and Stockholm is the E20. The E20 has been motorway between (Stockholm) Södertälje and Nykvarn, expressway (clearway) between Nykvarn and Läggesta, and two-lane highway of varying standard between Läggesta and Eskilstuna since the 1970s. At the same time as the government built the Svealand line in the 1990s, the expressway between Nykvarn and Läg-

gesta was converted to motorway. The first stage of the rerouted motorway, between Arphus and Härad (west of Strängnäs), was completed in 1994. The Järsta–Läggesta section was opened in 1996 and the Eskilstuna–Arphus section in autumn 1999. The remainder of the E20 between Eskilstuna and Stockholm that is still highway, the Strängnäs bypass, is currently being converted to motorway over the period from spring 2002 to spring 2005 (the Härad–Järsta stage, 13 km long).[242]

Travelling times are now shorter thanks to the motorway extension, and the distance by road between Eskilstuna and the centre of Stockholm is also shorter. In the Swedish National Road Administration's (Vägverket) database (1999),[243] the distance is given as 114 km, but it will in actual fact be a few kilometres shorter again. The journey by car takes between 1 hr 15 mins and 1 hr 30 mins. The travelling time is to a great extent dependent on the congestion situation in Stockholm, and at peak periods travelling times will be longer to the central parts of the city.

The distance by road between Nyköping and the centre of Stockholm is 106 km, and travelling time by car is approximately 1 hr 15 mins. The E4 has been converted to motorway along its length, giving shorter travelling times as long as travelling in dense city traffic can be avoided.

5.2 Demand

5.2.1 Travelling by SJ on the old line

SJ made a travel behaviour study, counting the number of passengers on the trains between Eskilstuna and Stockholm in both directions over a period of one week in October 1989 (week 41). The supply at that time comprised 5 trains and 3 buses in each direction. Up until two weeks before the census, passengers had to change at Södertälje for some trains and this may have had some effect on the results.

During week 41, 3 300 journeys were counted on the route. The largest single markets were Eskilstuna–Stockholm (and vice versa) with 64% of the journeys made, Åkers Styckebruk–Stockholm with 12% and Eskilstuna–Södertälje södra with 7%.

On the basis of the number of tickets sold, the number of journeys over the whole of 1989 was estimated to be 263 000. Of these, 7% were made using SJ's monthly pass and 4% with a 12-month season ticket. A further 8% travelled part of the route on a county public transport au-

[242] Vägverket (SNRA), the Mälardalen region homepage, 16 January 2002
[243] Vägverket (SNRA): Vägavstånd i Sverige 99, *Road distances in Sweden 1999*

thority monthly pass (the county public transport authority, LT, and SL). These groups contain commuters and frequent business travellers. The vast majority (80%) were thus passengers who travelled more seldom on single, return or multi-trip tickets.[244]

In 1993 travelling by train or bus with SJ was estimated to have fallen to an estimated 230 000 journeys a year before the supply was improved in the autumn.

5.2.2 Travelling by bus with SJ

In autumn 1993 frequency of service was increased significantly when more buses were added, and about 440 000 journeys a year were being made up until the start of services on the Svealand line, almost double the number made previously. There is, though, some uncertainty as to how many journeys were made on sections of the routes since bus travel was counted by means of random sampling on the route between Södertälje and Eskilstuna. There were probably fewer journeys on the sections of the route than with the Svealand line, both with the old train services and SJ's bus services, since the county public transport authority offered cheaper journeys with a rather good supply. It is therefore assumed here that these values are the same both for journeys over the borders of counties and including sections of the route.

5.2.3 Regional travel on the Svealand line

The extension of the Svealand line services to Hallsberg in October 1997 meant many new passengers. TiM estimates that a total of 2.2 million journeys were made on the Svealand line between Stockholm and Hallsberg in 1998, including all journeys made on sections of the route and with an average length of journey of 95 km. In the travel census of February 1998 the average length of a journey was estimated at 80-83 km depending on the direction of travel, but this estimate then also includes a relatively large amount of short-distance commuting in the county of Örebro.[245] In the research project, on the other hand, regional travel is defined as the Eskilstuna–Stockholm route or parts of it, which is a subset of all the journeys that are made on the Svealand line.

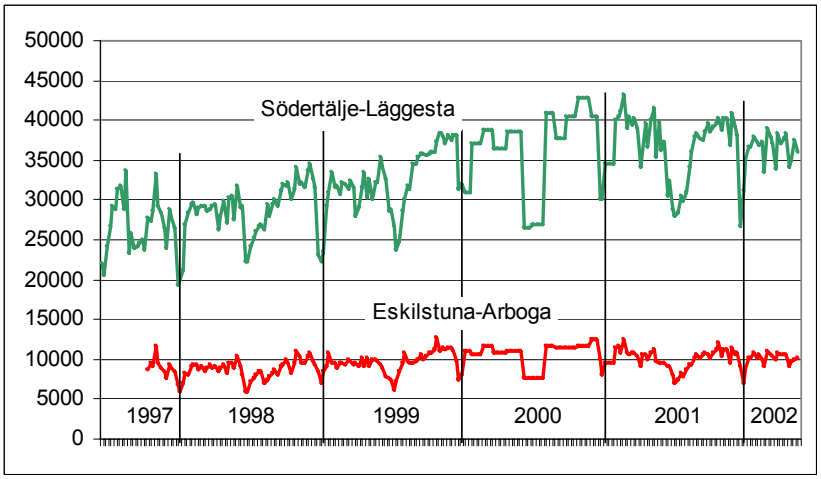
The number of passengers is estimated by means of random sampling, but continuously according to a schedule, by railway staff on board the Svealand line trains. It should be pointed out that there are uncertainties and a disturbance term (error term) in the censuses, but

[244] SJ passenger transport division (Per Höij), extract from a letter to the Municipality of Eskilstuna dated 22 May 1990

[245] En undersökning av TiM, *A survey of TiM* (1998)

the confidence interval is unknown. The compiled results based on SJ's figures give a picture of the load on certain routes, and travel between Södertälje and Läggesta and between Eskilstuna and Arboga over the Svealand line's first five years are shown as examples.

SJ's passenger census on the Svealand line, passengers per week



Total travel by train per week including regional travel, counted by train staff on board between Södertälje and Läggesta and between Eskilstuna and Arboga from week 24, 1997 to week 21, 2002. Only some sampling weeks were counted during the period from week 1, 2000 to week 5, 2001. Source: SJ.

One clear trend is the large number of passengers in July 1997, when services had just begun and tickets were sold at half price. During this period of introductory discounts on the Svealand line, an average of 27 700 passengers a week were counted between weeks 24 and 33. Converted into annual passengers, this is equivalent to 1.4 million regional journeys over the county border, and 1.9 million journeys including sections of the route.

There are no passengers to Örebro and Hallsberg on the Södertälje–Läggesta section in the figures up to and including week 40, 1997. They are, however, included from week 41 (6 October) when the services were extended west towards Hallsberg.

Up until the beginning of 2001 travel increased dramatically, with an approximate annual increase of 10% on the most loaded section between Läggesta (in reality Nykvarn) and Södertälje syd. There has subsequently been a decline in travelling. Possible explanations include the slowdown in economic development from 2001 and falling petrol prices, but also the deterioration that has taken place with regard to the supply. Travelling times have become a few minutes longer and the level of comfort has fallen as the X2 trains have gradually been replaced by

locomotive-hauled trains. Some passengers may also have switched to travelling by express bus, even if the number is relatively small (see section 5.1.5; cf also section 2.4.1).

Estimated regional travel between the counties of Stockholm and Södermanland

Journeys, 000's Year	*SJ passenger censuses*		*Estimated regional travel*	
	Södertälje–Läggesta	*Eskilstuna–Arboga*	*Over county border*	*Including route sections*
1997	780[1]	110[2]		
1998	1 500	460	1 200	1 600
1999	1 690	500	1 370	1 820
2000[3]	1 870	560	1 540	2 040
2001	1 910	520	1 590	2 110

[1] 29 weeks of services 1997

[2] 12 weeks of services 1997

[3] Random sampling weeks converted to whole year

Source: SJ

The estimated regional travel over the county border between the counties of Södermanland and Stockholm has increased from 1.2 million in 1998 to 1.6 million in 2001. Including shorter journeys, on sections of the route between Eskilstuna and Stockholm, regional travel on the Svealand line has increased from 1.6 million to 2.1 million a year.

The week with most passengers so far is week 9 in 2001, with 43 200 journeys counted between Södertälje and Läggesta. In 2000, however, passengers were counted only every third to sixth week, which means that fluctuations can not be shown. The average number of journeys counted on this route has increased from 28 900 a week in 1998 to 36 800 in 2001, an increase of 27% over three years. The number of journeys counted between Eskilstuna and Arboga rose from 8 800 a week in 1998 to 10 000 in 2001, i.e. about 15%.

The journeys counted by SJ every week have been added to give annual figures. In a travel census in February 1998 they amounted to 18-21%, depending on the direction of travel, of the passengers between Södertälje and Nykvarn who continued on west of Eskilstuna.[246] Travel has subsequently increased more between Södertälje and Läggesta between 1998 and 2001 than between Eskilstuna and Arboga. One of the reasons is that the travelling times for the services on the Mälar line between Stockholm and Örebro were shorter after 1998 and more passengers have been enticed over from the Svealand line, and another that

[246] En undersökning av TiM, *A survey of TiM* (1998)

commuting to work has developed in different ways. There is therefore reason to assume that 20% of the passengers between Södertälje and Läggesta continued west to Eskilstuna in 1998, but that this proportion fell by 3 percentage points to 17% in 2001.

The proportion of journeys on sections of the route within the counties of Södermanland and Stockholm respectively is estimated to be 33% of the total number of journeys across the county border (the Södertälje–Läggesta censuses) by comparing the number of passengers boarding between Nykvarn and Stockholm Central and between Läggesta Eskilstuna in the 1998 census.[247] This method gives a rough estimate of journeys on sections of the route between Eskilstuna and Stockholm.

5.2.4 Travelling with the county public transport authority in Södermanland

Travel by county public transport authority bus services before (1996) and after (1998 and 1999) the start of services on the Svealand line is shown in the table. Figures for 2000 are not available.

Travel by bus with the Södermanland county public transport authority along the Svealand line

Journeys/year, 000's				
No.	*1996*	*No.*	*1998*	*1999*
20	310	*301*	122	110
35	169	*303*	100	88
40	447	*304*	87	108
Total	927	*306*	28	24
		307	46	27
		340	28	24
		341	15	18
		720	135	121
		Total	561	519

Source: Länstrafiken i Södermanland, *Södermanland PTA*

If the journeys made on the county public transport authority's three bus services, nos. 20, 35 and 40 are added together and compared with the total number made on the eight corresponding services in 1998, it can be seen that travel volume with the county authority has fallen from about 930 000 journeys annually to 560 000, i.e. 370 000 fewer journeys after the start of services on the Svealand line. There was a further re-

[247] En undersökning av TiM, *A survey of TiM* (1998)

duction up to 1999, which runs contrary to how journeys by train on the Svealand line have developed.

5.2.5 Travelling on SL's buses between Södertälje and Nykvarn

The possibility to travel by SJ's trains and buses on an SL pass up until the start of services on the Svealand line led to imbalance in the load between the directions travelled on routes 780 and 781 some years, since SJ's train or bus service suited passengers better in the one direction but not in the other.[248]

The calculations of travel by bus per mean weekday have here been recalculated to annual values. SL normally multiplies the number of journeys a winter weekday by 275 to reflect the annual number of journeys. In the table journeys are given in thousands per year during the validity of the winter timetable, which means for example that the winter timetable for 1997/98 applies to journeys in spring 1998.

Journeys on SL buses nos. 780 and 781

Winter timetable	*Journeys/year 000's*
1992/93	569
:	
1995/96	592
1996/97	595
1997/98	564
1998/99	579
1999/2000	512
2000/01	500

Source: SL/TrafikKompetens

Travel on SL's buses peaked during the period that SJ operated bus services instead of train services, i.e. until spring 1997. Almost 600 000 journeys a year were made in 1996 and 1997 on buses 780 and 781. When train services began on the Svealand line, the number of bus journeys fell somewhat, but the greatest reduction can be seen in 1999. In the 2000/01 season journeys amounted to 500 000 a year, i.e. a reduction of 16% since 1996/97.

5.2.6 Load along the Svealand line

A comparison of the total number of regional journeys by public transport in 1996, 1998 and 2000 gives a picture of how the changes in pub-

[248] Melker Larsson, TrafikKompetens. By letter dated 20 February 2001

lic transport have taken place. It shows how the distribution over different sections of the route has changed between the years. The table and diagrams contain some uncertainties since the available travelling statistics from LT, SL and SJ have different forms and degrees of accuracy, in so far as any statistics are available at all. There are no figures for purely local bus travel. SJ's interregional services are included (here defined as travel on the Svealand line with point of origin and destination west of Eskilstuna), but are not shown separately for 1996 because the amount of interregional travel was probably negligible during the bus service period.

Estimated load on public transport in 1996, 1998 and 2000

Journeys/ year, 000's	*beyond Eskilst.*[3]	*Eskilst.– Strängnäs*	*Strängn.– Läggesta*	*Läggesta– Nykvarn*	*Nykvarn– Södertälje*	*Södert.– Flemingsb.*	*Flemingsb.– Stockholm*
1996							
SJ bus		350	400	430	450		420
LT bus[2]		260	190	170	170		50[1]
SL bus					590		
1998							
SJ train							
regional		1 030	1 090	1 200	1 310	1 250	1 190
interregion.[3]	460	300	300	300	300	280	260
LT bus[2]		45	45	40	40		
SL bus					570		
2000							
SJ train							
regional		1 300	1 370	1 540	1 680	1 600	1 520
interregion.[3]	560	330	330	330	330	310	290
LT bus[2]		40	40	40	40		
SL bus					510		

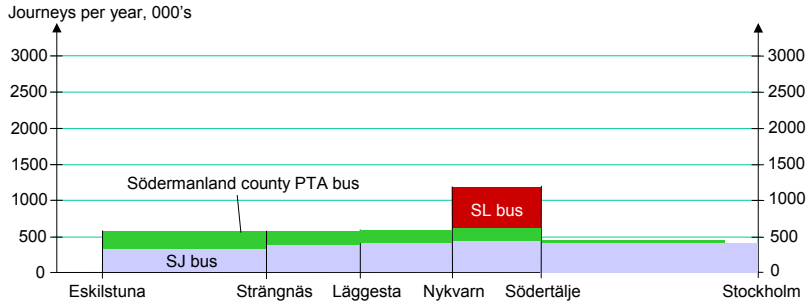
[1] Journeys on bus no. 40 Södertälje–Liljeholmen

[2] With regard to the bus services, there are also some purely local journeys (shorter than the routes given), but these are not shown in the table. Figures for 2000 refer to 1999

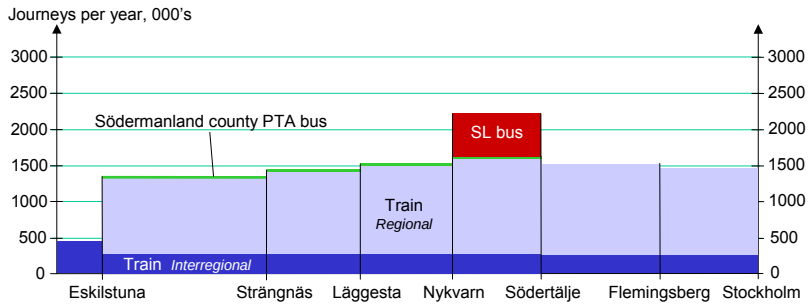
[3] Interregional travel beyond Eskilstuna comprises journeys starting or finishing west of Eskilstuna, for example journeys from Stockholm to Örebro.

The values for sections of the route are estimates in some cases. Sources: SLT-resor våren 1991 (SLT travel spring 1991), LT travel statistics 1996, 1998, 1999. SL travel censuses on buses no. 780 and 781. SJ travel censuses for buses 1996-97 and trains 1998, 2000. *A survey of TiM* (1998)

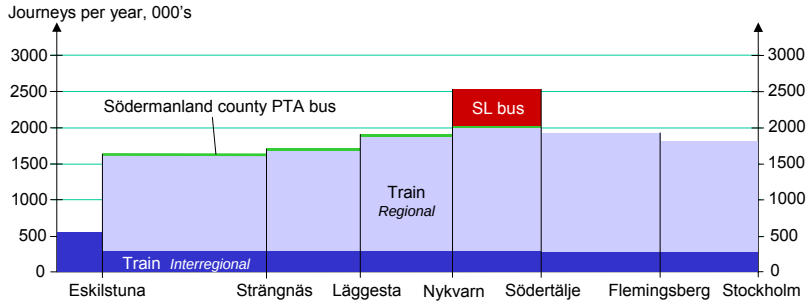
Load on regional public transport services along the Svealand line, 1996



Load on regional public transport services along the Svealand line, 1998



Load on regional public transport services along the Svealand line, 2000



Local travel on county public transport authority (LT) buses is not shown in the diagrams.

In 1998 TiM made censuses of passengers on trains in the Mälaren valley, including travel on the Svealand line.[249] The censuses were taken Tuesday to Thursday for the month of February. If the mean weekday figure is multiplied by 320, which is the general conversion factor from mean weekday to annual value for railway passenger traffic[250], TiM's censuses show 15-25% less travel than equivalent routes in SJ's. In TiM's censuses the total amount of travel by train is very similar to the

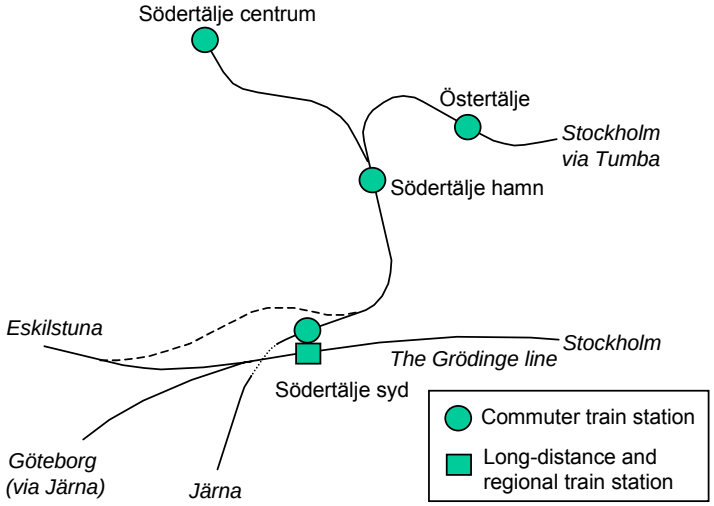
[249] En undersökning av TiM, *A survey of TiM* (1998)
[250] Beräkningshandledning, *Calculation guide* (2001), section 2.6.2.2

figures for "SJ train, regional" in the table. The differences may be due to the fact that the methods differ between the two censuses. TiM had their staff count the number of passengers alighting and boarding at each station, while SJ had the bus driver and train staff respectively count the number of passengers on board. However, SJ's travel censuses for the train services have been used here, partly because they were taken continuously and spread over the whole year, and partly to be able to compare them to the bus service censuses.

A marked reduction in travel between places served by LT bus services from 1996 to 1998 is quite noticeable, coinciding with the new train services on the Svealand line. Total travel by public transport has increased. On board the trains between Eskilstuna and Stockholm 17-20% of the passengers started or ended their journey west of Eskilstuna, for example journeys from Stockholm to Örebro. These journeys are counted as interregional journeys.

5.2.7 Travel on public transport along the Svealand line to Södertälje

The railways in Södertälje



The railways and stations in Södertälje. The distance between Södertälje syd and Södertälje centrum is 4 km. There is a connecting railway between the Svealand line (Eskilstuna) and Södertälje hamn, at present without passenger services.

The first buses that replaced the trains between Eskilstuna and Stockholm stopped at the Södertälje hamn railway station, and connected with the commuter trains to Södertälje centrum station (2 km) and Stockholm Central. Some buses also stopped at the newly opened Södertälje syd station, 4 km from Södertälje centrum station, starting in

1995. Trains on the Svealand line stop at Södertälje syd and Flemingsberg, but not at Södertälje hamn.

The Södermanland county public transport authority carried many passengers to and from Södertälje up until 1997. Bus no. 40 had stops on Saltsjögatan at the Södertälje centrum commuter train station, and at Södertälje hamn. In 1998 LT operated peak period bus services to Södertälje from Åkers styckebruk and Mariefred. In Södertälje, in addition to Södertälje hamn and Saltsjögatan, the buses also stop at Astra-Zeneca's main facility, where many people work (see section 4.3.3).

Travel on public transport between north Södermanland and Södertälje

journeys/year, 000's	*1996*	*1998*
LT bus	120	40
SJ bus	50	
SJ train		120
Total	170	160

Sources: SLT-resor våren 1991 (SLT travel spring 1991), LT travel statistics 1992-1998. SL travel censuses on buses 1996-97. *A survey of TiM* (1998).

The large increase in regional travel that the train services on the Svealand led to has not materialised for journeys to and from Södertälje. The location of the Södertälje syd station requires making a connection by bus or in exceptional cases by commuter train, to almost all destinations in the town. Travellers to places of work in Södertälje's supply of jobs and service probably largely choose to go by car.

5.2.8 Car travel

Survey of travel habits

The E20 European road, that runs parallel to the railway, is also one of the roads between the Stockholm region and Göteborg and Värmland, while rail traffic on that tour does not use the Svealand line but the western main line via Katrineholm. The last survey of travel habits on the E20[251] with regard to the proportions of local, regional and long-distance journeys was made in 1986. At that time, the Swedish National Road Administration carried out a survey of travel habits east of Malmbyhus, about 6 km south-west of Strängnäs. The annual average daily mean traffic volume (AADT) totalled 12 000 vehicles, of which 14% were heavy vehicles. This gives an AADT of about 10 300 cars. A ran-

[251] The E20 was previously called the E3

dom sample was taken of these and the drivers of 470 cars interviewed over the course of two weekdays.[252]

In the table, local travel has been defined as travel within the municipality of Strängnäs, regional travel as journeys along the E20/the Svealand line for all or part of the way between Eskilstuna and Stockholm, and interregional travel as longer journeys or outside the Svealand line corridor.

Survey of travel habits at Malmbyhus, 1986

Proportion of car journeys	
Local	33%
Inside Strängnäs	*6%*
Strängnäs–Åkers styckebruk/Mariefred	*27%*
Regional	31%
Eskilstuna–Södertälje/Stockholm	*12%*
Strängnäs–Södertälje/Stockholm	*19%*
Interregional	36%
Road 55 (Enköping)–Södertälje/Stockholm	*8%*
E20 (Örebro, Göteborg, Värmland)–Södertälje/Stockholm	*28%*

Source: The E3 road. Field survey at Malmbyhus (1987)

The results show that about 1/3 of the car traffic on the E20 southeast of Strängnäs was local, 1/3 regional and the remaining third interregional, according to the classification assumed here. The proportions, however, differ from the proportions of cars because the number of people in a car will normally vary depending on the purpose of the journey. There is no estimate of the number of journeys in the survey of travel habits and other sources might be able to fill out the picture.

In the survey of travel habits, RES 2000, the number of passengers in a car is given by total distance travelled in kilometres, but not the number of journeys. RES 2000 shows the driver is often alone in the car on journeys to work, to school or on business for 84% of the distance. There are often more people in the car when a journey has some other purpose. On leisure time trips, for example, the driver is alone for only 24% of the total distance travelled, and there are two or three people in the car for the remaining distance. In total, the driver is alone for half the total distance travelled.[253]

[252] Väg E3. Intervjuundersökning vid Malmbyhus, *The E3 road. A field survey at Malmbyhus* (1987)
[253] RES 2000. National survey of travel habits, (2001), p. 17

The conclusion is that the more the proportion of commuters on the roads increases and the more the proportion of business trips increases, the fewer the number of people in each car.

According to Banverket, the number of people in each car for a regional journey is 1.3 when it is a business trip and 1.7 when it is a private trip; for national journeys, 1.17 for business trips and 1.88 for private ones.[254] Banverket's "private trips" category in this context contains the widely varying trip purposes 'journeys to work' and 'leisure-time trips', and the average can easily be misleading. One estimate is that when the proportion of journeys to work and business trips is relatively high, as is assumed to be the case on the E20 in Södermanland, there is on average 1.5-1.6 people in each car.

The proportions of local, regional or interregional travel on the E20 can not at the present time be determined from the data available. One way of estimating them might be to assume, on the basis of the data from the 1986 survey, that a longer average distance has primarily increased the number of regional journeys at the expense of local journeys. The estimated proportions for 2000 could then be 30% local, 35% regional and 35% interregional journeys on the E20 east of Strängnäs.

Traffic measurement on the E20

The Swedish National Road Administration (SNRA) has carried out nation-wide traffic counts, of which the latest in the county of Södermanland were in 1993 and 1998 (the next is planned for 2002). Other, more local, traffic counts also exist. There is one from 1986 from Malmbyhus (Malmby, on the link between roads 977 and 900), with no confidence interval given. Some of the difference between the 1986 count and later ones may possibly be explained on new measurement definitions (see section 3.1.2).

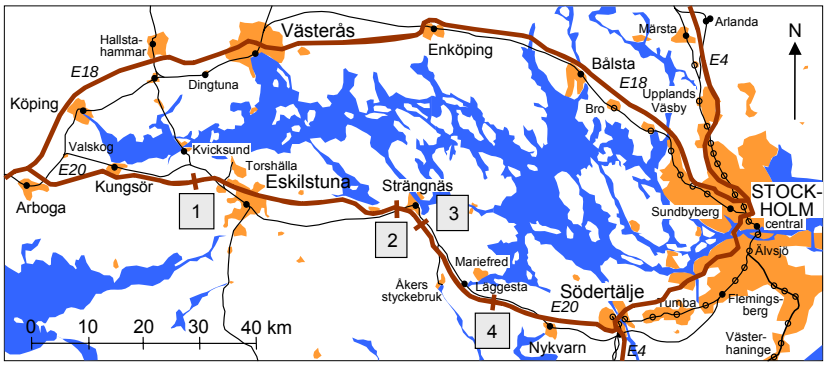
During 2000 the SNRA carried out a number of complementary traffic counts on the E20 and the E4 in Södermanland. However, it was not possible to measure the traffic on the section between Eskilstuna and Strängnäs due to road works. The counts in 1993, 1998 and 2000 should be fully comparable for each link.

The following tables, from the SNRA's traffic counts in 1993 [255] [256], 1998 [257] and 2000 [258] show the annual average daily mean traffic volume (AADT), i.e. the average number of vehicles in both directions over a

[254] Beräkningshandledning, *Calculation guide* (2001), section 2.13.3.6
[255] Trafikflödeskarta, *Traffic flow map* (1995a)
[256] Trafikflödeskarta, *Traffic flow map* (1995b)
[257] Årsmedeldygnstrafik, *Annual average daily mean traffic volume* (1999)
[258] Magnus Axelsson, *SNRA Mälardalen region. Results of traffic counts*, e-mail, 2 March 2001

twenty-four hour period. The stated accuracy is a confidence interval of 95%. "Trucks" are vehicles with a wheelbase longer than 3.3 m, i.e. the figure includes both buses and trucks. The number of trucks is in general significantly greater than the number of buses. The figure given for "Cars" is the total number of vehicles minus the number of trucks.

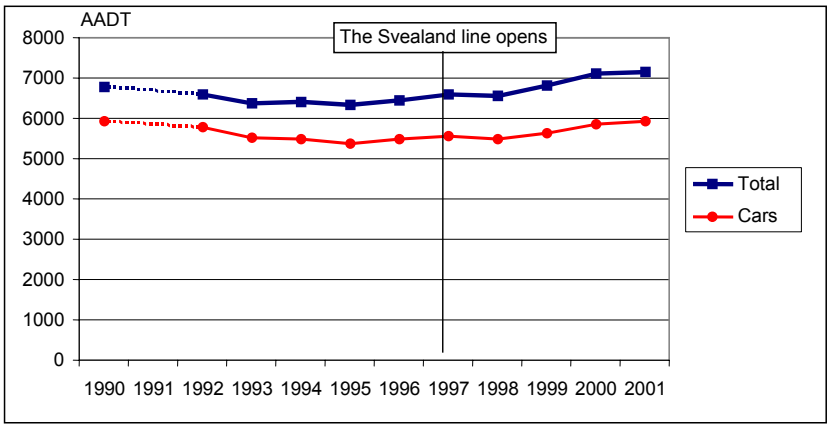
A selection of the Swedish National Road Administration's traffic measurement points on the E20



1. The Gröndal intersection (fixed measurement point), 2. Härad, 3. Malmby, 4. Läggesta.

Point 1, at the Gröndal intersection, has been measured partly by means of a fixed counter (a measurement series from 1990-2001 is shown in the diagram), and partly by means of measuring random samples (shown in the table). The values thus differ somewhat.

Continuous traffic counts at the Gröndal intersection, 1990-2001



Results of traffic counts at the fixed measurement point at the Gröndal intersection on the E20, west of road 53 west of Eskilstuna. Annual average daily mean traffic volume (AADT), in total (including heavy vehicles) and for cars alone.

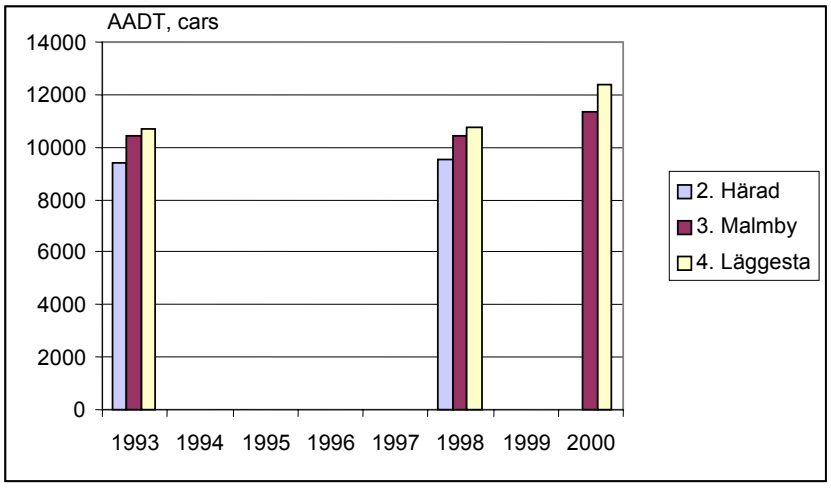
The fixed measurement point west of Eskilstuna shows a reduction in car traffic of about 10% over the period from 1990 to 1995. This was

followed by a slight increase, and car traffic in 2001 had reached the same volume as in 1990. A break in this upward trend can be seen between 1997 and 1998, coinciding with the start of services on the Svealand line. The deep trough during the 1990s coincides with the general economic development in the country as a whole.

The reduction in car traffic at the Gröndal intersection on the E20 between 1997 and 1998 was 0.8% (the train services to Örebro on the Svealand line began operating in October 1997). The reduction also occurred during a period when car traffic was increasing year by year, and traffic at the measurement point increased by 1% between 1996 and 1997 and 2.4% between 1998 and 1999. To get an idea of the immediate effects of the Svealand line in comparison to the SNRA's annual traffic counts, the estimated increase in traffic at the measurement point for 1997-1998 must be added. This increase can be assumed to be 1-2%. In addition, train services were operating during the last quarter of 1997, and it is then reasonable to adjust the reduction in car traffic to a value for the whole year. The real reduction in car traffic would then be close to 3% as a consequence of the train services to Örebro on the Svealand line.

As regards journeys east of Eskilstuna, a great number of transferred journeys can be assumed through the improved supply and the results of studies of travel behaviour that are presented in chapter 7, where the field surveys indicate a decrease of about 10% in regional car travel.

Random sample measurements on the E20



Results of the traffic counts outside Härad (only 1993 and 1998), Malmby and outside Läggesta on the E20 (1993, 1998 and 2000). Annual average daily mean traffic volume (AADT), only cars.

The SNRA's traffic counts on the E20

Section	1993	Change	1998	Change	2000
1. Kungsör–Eskilstuna (county border, road 53)	6 620±8%		7 010±12%		
of which, trucks	830±14%		1 130±10%		
Cars	5 790±9%	+2%	5 880±14%		
2. Eskilstuna–Strängnäs (Härad, 971-55)	10 340±8%		10 610±6%		
of which, trucks	950±14%		1 100±8%		
Cars	9 390±9%	+1%	9 510±7%		
3. Strängnäs–Läggesta (Malmby, 977-900)	11 300±11%		11 680±6%		12 800±10%
of which, trucks	890±14%		1 230±8%		1 430±10%
Cars	10 410±12%	+0%	10 450±7%	+9%	11 370±11%
4. Läggesta–Nykvarn (county border, road 223)	11 600±11%		11 910±6%		13 670±7%
of which, trucks	890±14%		1 130±7%		1 310±10%
Cars	10 710±12%	+1%	10 780±7%	+15%	12 360±8%

On the E20 through Södermanland car traffic at the measurement points was unchanged between 1993 and 1998. However, the two points that were also measured in 2000, at Malmby and at Läggesta, indicate that there was a marked increase since 1998. The individual changes are not, however, significant.

The Grundbro–Nykvarn section (the measurement point at Läggesta) has been converted from highway and expressway to motorway during the period between the counts of 1993 and 1998. Between 1998 and 2000 a long section between Eskilstuna and Strängnäs was also converted to motorway. At the measurement point west of road 55 (Härad), the road has been a normal highway on all three occasions.

Traffic counts on the E4

Trafik counts on the E4 north of Nyköping

Section	1993	Change	1998	Change	2000
Nyköping-Tystberga (809-771)	14 140±10%		16 580±4%		17 250±11%
of which, trucks	1 480±20%		2 100±6%		2 800±11%
Cars	12 660±11%	+14%	14 480±5%	-0%	14 450±13%

An increase in car traffic of about 14% between 1993 and 1998 can be seen on the motorway north of Nyköping. The change at an individual measurement point, however, is not significant, but the trend is confirmed at several measurement points. Between 1998 and 2000 car traffic was unchanged. On the other hand, truck traffic has increased substantially and has doubled between 1993 and 2000.

Redistribution of traffic

A comparison between the E20 and the E4 shows that car traffic was unchanged between 1993 and 1998 on the E20, but increased by almost 15% on the E4. Between 1998 and 2000, however, the situation was the opposite, with car traffic on the E20 increasing by 15%, but remaining unchanged on the E4.

A few possible explanations for this opposite trend might be:

- Redistribution of traffic between Göteborg and Stockholm
- Redistribution of traffic between Värmland, Örebro, Arboga and Stockholm
- New traffic engendered by the new stretches of motorway
- Regional differences in economic development, commuting etc.
- Random or systematic errors

The first point, the redistribution of traffic between Göteborg and Stockholm, might mean that some traffic has transferred from the E4 and road 40 via Jönköping, or the E20 via Örebro. In the SNRA's 1986 survey of travel habits, only 1% of the journeys on the E20 at Malmby were journeys between Göteborg and Stockholm.

The redistribution between the E18 north of Lake Mälaren and the E20 south of Lake Mälaren has not been able to be proven. Measurement points are lacking on the E18 since 1998, which means that possible transfers of long-distance traffic to the E20 due the completion of the new stretches of motorway can not be studied. One hypothesis, however, is that the transfer of traffic between north of and south of Lake Mälaren can be seen in the traffic counts, and is more significant than traffic between Göteborg and Stockholm.

The shorter travelling times by motorway compared to by ordinary highway also generate new traffic.[259] It is possible that the last stretch of the E4 between Nyköping and Norrköping that was converted to motorway in 1996, without any corresponding improvement in the public transport supply, increased long-distance car travel. It is also probable that the stretch of motorway between Eskilstuna and Strängnäs that opened in 1999 has led to an increase in car travel. On the other hand,

[259] Goodwin (1996)

the increase in traffic on the E20 due to the stretches of motorway that opened in 1996 can have been counteracted by the high speed train services that began operating on the Svealand line the following year.

5.2.9 Total travel

Most journeys to and from Stockholm originate in Eskilstuna. Many journeys from Strängnäs are made on sections of the E20/Svealand line, of which journeys to Eskilstuna are the most common. Commuting from Mariefred to Södertälje, and also to the Stockholm area, contributes to the traffic volumes, while commuting from Åkers styckebruk is to a greater extent concentrated to Strängnäs. Nykvarn generates a great number of journeys, primarily to Södertälje, but also to the Stockholm area.

Market shares of the travel modes – traffic counts

An estimation of the number of journeys by car on the E20 at different measurement points on the section between Eskilstuna and Nykvarn indicates a total of 5.2-7.2 million journeys in 2000 (annual average daily mean traffic volume 9 500-12 400 cars × 1.5-1.6 people in each car × 365 days).

Assume that 35% of journeys on the E20 east of Strängnäs are regional (Eskilstuna/Strängnäs–Södertälje/Stockholm) and thus comparable to regional train journeys on the Svealand line. Regional journeys by car would then amount to 2.2-2.3 million journeys in 2000 (annual average daily mean traffic volume 11 400 cars × 1.5-1.6 people in each car × 365 days × 0.35). This figure can be compared to about 1.4 million regional train passengers. This indicates that the total market for regional travel on the section at the measurement point is 3.6-3.7 million journeys a year, of which car journeys account for 60% and train journeys almost 40%.

The same calculation for 1993 indicates that 2.0-2.1 million regional car journeys were made at that time, 0.2 million regional train journeys and about 0.05 million regional bus journeys[260] to Södertälje/Stockholm in a section east of Strängnäs. The total market would then be 2.3-2.4 million regional journeys, of which car journeys account for almost 90%, train journeys about 9% and buses about 2%.

The estimated market shares for regional travel between Nyköping and Södertälje/Stockholm are subject to greater uncertainty than along the Svealand line since the proportions of local, regional and interregional travel on the E4 are not known. It is assumed here that the pro-

[260] SLT-resor våren 1991, *SLT travel spring 1991*

portion of regional traffic on the E4 between Nyköping and Södertälje/Stockholm is about 15% at a point north of Nyköping.[261] This is because the E4 has a smaller regional traffic base in Södermanland and consequently a larger proportion of interregional travel than the E20. This would give approximately 1.2-1.3 million regional car journeys in 2000. The corresponding figure for the train journeys was about 0.4 million journeys.[262] Total regional travel on the section was then 1.6-1.7 million journeys, of which 75-80% were made by car and 20-25% by train.

Market shares of the travel modes – modelled

Another approach is to calculate total travel on the basis of a travel forecast produced using the IC and IR models for 1996. These models are the precursors of the Sampers modelling system. According to this model a total of 3.0 million journeys were made between Eskilstuna/Strängnäs and Södertälje/Stockholm in 1996.

The total travel market is assumed to have grown since 1993, principally due to an improved public transport supply on the section. Travel is assumed to have increased by 5% between 1993 and 1996, which while travel by car was largely unchanged according to the traffic count.

The train services in themselves have led to less regional travel by car, even if the size of the reduction is open to discussion. An offsetting increase in regional car travel may, however, have taken place at the same time due to increased economic activity and longer journeys. According to the survey of travel habits total transportation by car in Sweden increased by about 15% between 1996 and 2000. The average distance travelled per person has increased at the same time from 40 km to 45 km a day, which explains most (12 percentage points) of the increase in passenger transportation.[263]

[261] At the measuring point on the county border at Nyköping/Trosa (D 4 800-218) the AADT was 13 300 cars in 1998, and on the Nyköping–Norrköping section the lowest AADT (D 4 216-608) was 11 200 cars. The difference, AADT 2 100 cars, is here assumed to be approximately the same as the number of journeys between Nyköping and Södertälje/Stockholm, i.e. comparable to the journeys by train. In the example, journeys on the E4 southward from Nyköping are offset against car journeys northward from Nyköping to destinations other than Södertälje and Stockholm. The regional share immediately north of Nyköping is then 2 100/14 450 = 0.15. Source: Årsdygnstrafik, *Annual average daily mean traffic volume* (1999)

[262] 1 270 alighting and boarding passengers in Nyköping northward on weekdays in January-February 1998. Source: En undersökning av TiM, *A survey of TiM* (1998)

[263] Svenskarnas resor 1996, *Swedes' journeys in 1996* (1997) (117 billion pkm), and RES 2000. Den nationella resvaneundersökningen, *National survey of travel habits* (2001) (134 billion pkm)

There is, consequently, reason to assume that total regional travel along the E20 and the Svealand line increased more than the national average, but that the increase in regional travel by car has slowed.

During the period from 1996 to 2000 total travel by public transport increased by about 0.8 million journeys. If at the same time regional travel by car was constant, this is equivalent to a regional traffic growth of 20%. If regional travel by car instead increased by 10% over the period, the regional market grew by 30%. The latter is equivalent to 1.1 million new regional journeys.

The first table below shows the market shares for total regional travel, measured at a point east of Strängnäs.

Market shares for all regional travel at a point east of Strängnäs

Journeys per year, millions	*1993*	*1996*	*2000*
Total regional travel	3.7	**3.9**	4.7-5.0
Car	87%	82%	68-70%
Public transport	13%	18%	30-32%
of which LT buses	*8%*	*7%*	*2%*
SJ trains	*5%*		
SJ buses		*11%*	
SJ high speed trains			*28-30%*

Estimated market shares for regional travel at a measurement point east of Strängnäs, based on total regional travel in 1996 according to the IC and IR models (shown in semibold). For 1993 it is assumed that travel by public transport to and from Eskilstuna also goes via the measurement point outside Strängnäs to agree with the latter years.

The proportion of travel by train at the point east of Strängnäs has increased from about 5% to about 30% between 1993 and 2000. The county public transport authority's (LT) share of regional journeys has fallen from 8% to 2% over the same period. In total, regional travel by public transport has increased from about 13% to at least 30% of a growing total market.

The corresponding calculation as regards travel over the county border between Södermanland and the county of Stockholm (Läggesta–Nykvarn section) is shown in the following table and diagram.

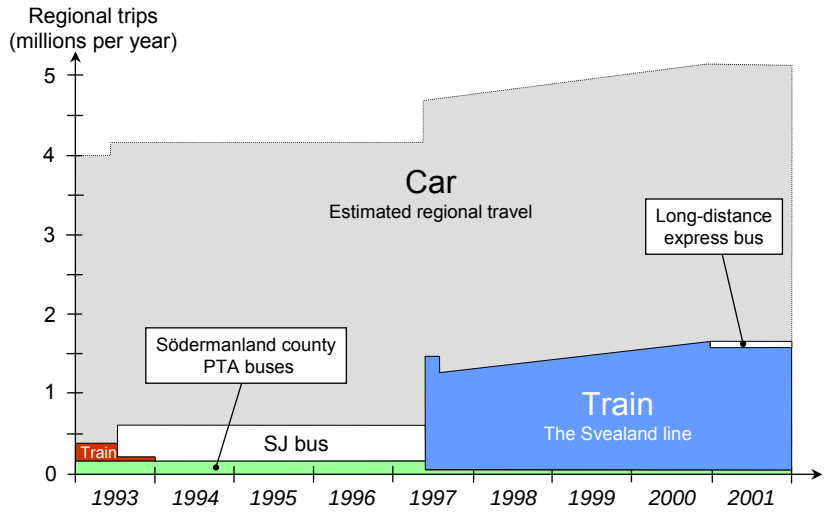
Steps in total regional travel can be seen in the diagram. This means that much of the new travel by public transport is assumed to comprise new journeys, and that they are assumed to occur at those times when the public transport supply changes in some substantial way.

Market shares for regional travel over the county border

Journeys per year, millions	*1993*	*1996*	*2000*
Total regional travel	4.0	**4.2**	5.0-5.4
Car	90%	86%	68-70%
Public transport	10%	14%	30-32%
of which LT buses	*4%*	*4%*	*1%*
SJ trains	*6%*		
SJ buses		*10%*	
SJ high speed trains			*29-31%*

Estimated market shares for regional travel at a measurement point on the county border (Läggesta–Nykvarn section), based on total regional travel in 1996 according to the IC and IR models (shown in semibold).

Total regional travel over the county border, 1993-2001



Estimated total regional travel over the county border between Södermanland and the county of Stockholm (Läggesta–Nykvarn section).

The market share for public transport (SJ and LT) was about 10% for journeys over the county border when train services were operated on the old Eskilstuna–Södertälje line until 1993. This increased to about 15% when SJ buses replaced the old train services between 1994 and 1997. The train services on the Svealand line increased the market share to about 30% by 2000. The train's market share has increased from 6% to 30% in a growing total market.

Regional travel between Eskilstuna/Strängnäs and Södertälje/Stockholm is a submarket of total regional travel. Train services can be assumed to have the largest share of this market, and the competitive supply of train services may have led to a real reduction in car travel

between 1996 and 2000. A wider interval is therefore assumed for regional travel by car, from a reduction of 10% along the route to an increase of 10%. This latter assumption is motivated by the fact that economic development in itself can generate an increased number of journeys by car that is greater than the reduction brought about by the transfer of journeys to high speed trains.

Market shares for regional travel between Eskilstuna/Strängnäs and Södertälje/Stockholm

Journeys per year, millions	*1993*	*1996*	*2000*
Total regional travel	2.8	**3.0**	3.7-4.2
Car	91%	85%	62-67%
Public transport	9%	15%	33-38%
of which LT buses	*2%*	*2%*	
SJ trains	*7%*		
SJ buses		*13%*	
SJ high speed trains			*33-38%*

Estimated market shares for regional travel between Eskilstuna/Strängnäs and Södertälje/Stockholm, based on total regional travel in 1996 from the IC and IR models (shown in semibold).

The number of journeys by train in the markets between Eskilstuna/Strängnäs and Södertälje/Stockholm has increased from 7% in 1993 to about 35% in 2000. The county public transport authority's small number of long-distance journeys have been taken over by the train (the feeder buses between Åkers styckebruk and Strängnäs in 1993 are counted here as SJ trains). The share for public transport is estimated to have increased from approximately 9% to approximately 35% between 1993 and 2000.

A comparison of the two approaches to calculating the market shares for journeys between Eskilstuna/Strängnäs and Södertälje/Stockholm shows that the two methods give similar results. The car's share has fallen from about 90% in 1993 to about 65-70% in 2000.

5.2.10 Where do the passengers come from?

A calculation of the journeys transferred between different modes of travel can give more information about the effects of the train services. In the comparison values that correspond to the immediate change between before and after the train services began operating on the Svealand line have been chosen, i.e. 1996/97 (before) and 1997/98 (after), or years close to these.

Regional travel by car has not been determined precisely, but according to previous calculations it should lie in the 2.1-2.6 million journeys a

year interval before services began on the Svealand line. The estimation of the reduction in regional car travel is uncertain. The author's own field surveys (see chapter 7) show a 10% reduction in car journeys on the E20 calculated for the conurbations along the Svealand line in 1998 compared to the 1997 survey. The total effect on regional car travel, however, is probably somewhat smaller since car travel is also generated in the countryside outside the conurbations, which is not taken into account in the evaluation of the field survey. It can, however, be assumed that travel generated in the conurbations dominates regional travel along the Svealand line.

The table shows two calculations; travel in a section on the county border between Södermanland and the county of Stockholm and regional travel including sections of the route along the Svealand line. The reduction in regional travel by car is here assumed to be 10% of the regional travel by car before the services began operating, and the number of completely new journeys is the remainder when the previous modes have been subtracted from journeys by train in 1998.

High speed train passengers' previous modes of travel (1998), regional travel

	Over county border		*Including sections*	
Journeys/year, 000's	*Journeys*	*Share*	*Journeys*	*Share*
Total regional travel by train (1998)	1 200	100%	1 600	100%
Car (10% reduction)	260	22%	260	16%
LT buses	130	11%	370	23%
SJ buses	430	36%	470	30%
New journeys	380	31%	500	31%

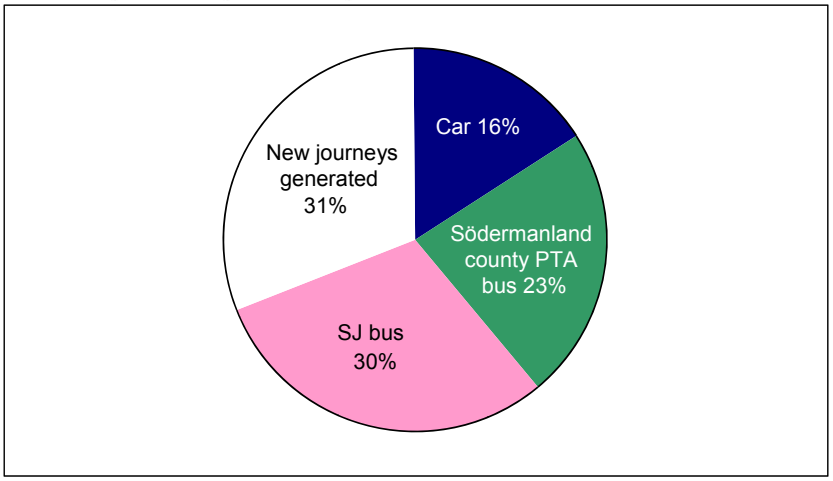
Estimated distribution by travel mode and new journeys generated that the regional passengers on the Svealand line in 1998 used immediately prior to the line's opening.

In the summary of where the passengers on the Svealand line's trains come from, a number of assumptions have been made. The distribution between earlier journeys by car and new journeys is especially uncertain. The conclusions are therefore based on the approximate shares for the previous modes.

About half the passengers on the Svealand line in 1998 came from the earlier bus services, and roughly half had transferred from the car or were making new journeys. In round figures, 25% are estimated to have come from the county authority's buses, 30% from SJ's bus services, 15% from the car, and 30% are new journeys. Note that "new journeys" refers to new journeys in the corridor along the E20/Svealand line. A large proportion of this category probably comprises journeys that were

made to other destinations, regardless of travel mode, before the train services on the Svealand line began.[264]

The high speed train passengers' previous modes of travel (1998)



Estimated shares for the passengers' previous mode of travel along the Svealand line, including sections of the route.

An estimation of the number of transferred journeys compared to 1993, when the train services were still operating on the old line, would give a larger share of travel transferred from the car and new journeys to trains on the Svealand line, and a correspondingly smaller share from earlier public transport services.

5.3 Discussion and summary

5.3.1 Supply and demand along the Svealand line

The public transport supply between Eskilstuna and Stockholm can be divided into three periods during the 1990s; the old train on the old line up until 1993, the bus period while the Svealand line was being built from autumn 1993 until spring 1997, and the train services on the Svealand line after summer 1997. The supply has primarily changed because the bus period meant a significantly higher frequency of service than with the old train supply. Travel on SJ doubled. When the Svealand line opened, this high frequency of service was maintained, fares were constant (except for the half price introductory offer the first summer) and travelling times were halved. Travel by train leapt overnight to three times what it had been by bus. In this demand survey it must also be taken into account that the county public transport authority in Söder-

[264] Sonesson (1998)

manland (LT) simultaneously rearranged its bus services to feed the railway stations rather than operate parallel bus services.

Travel by train between Eskilstuna and Stockholm subsequently increased to 1.6 million regional journeys over the county border in 2001, which is seven times as much as with the train services on the old line in 1993.

Supply and demand, regional travel on SJ between Eskilstuna and Stockholm

Period	*No. of services Mon-Fri, each dir.*	*Travelling time (hrs:mins)*	*Fare, single, 2nd class (Skr)*[1]	*No. of journeys (000's/yr)*[2]	*Incr. factor*
Up to spring 1993	8 trains	1:40	115	230	1
Autumn 1993-spring 1997	18 buses	1:55-2:20	105-120	440	2
Summer 1997	17 HS trains	1:00	55	1 400	6
Autumn 1997	17 HS trains	1:00	110	1 200	5
2001	18 HS trains	1:02	113-135	1 600	7

[1] Fares are shown in current prices

[2] Regional travel over the county border (Läggesta–Nykvarn section)

The quality problems that the Svealand line's train services were subject to during its first years of operation probably had a negative effect. A shortage of seats and repeated delays can be assumed to have deterred some potential travellers.

Travel on SL's buses between Nykvarn and Södertälje fell to 0.5 million journeys in 2000/01, since the record of almost 0.6 million journeys during the winter timetable 1996/97. There are, in fact, several plausible reasons; passengers transferring from SL's buses to the Svealand line's trains, and also the marked increase in the number of jobs in Nykvarn, especially since Nykvarn became a municipality in its own right in 1999. Some journeys may also have been transferred from the bus to the car. LT, too, saw a reduction in travel by bus between 1998 and 1999, probably for the same reasons as in SL's case.

An earlier report stated that travel by car on the E20 along the Svealand line fell between 1993 and 1998.[265] Some of the measurement points show a reduction, while others show the same traffic volume in principle in 1998 as in 1993. However, all individual changes are too small to be significant, but the general trend is that travel by car stagnated in the mid-1990s. There are several possible explanations. First, the start of the train services on the Svealand line in 1997 led to a reduc-

[265] Fröidh (1999)

tion in regional travel by car. This reduction is estimated to be about 10%, but is countered to some extent by a trend towards increasingly longer journeys. Second, a diversion of long-distance traffic from the E18 north of Lake Mälaren to the E20 south of Lake Mälaren for road works to be carried out, and differences in road standard may have had an effect on the results. Motorways that shorten travelling times and travelling time elasticities of -0,5 in the short term and -1.0 in the long term are reasonable estimates.[266] The conversion of the E20 to motorway consequently led to more journeys by car of which at least some would have been made by train if the standard of the road had been lower. Another important factor is the economic development in the region, and after the recession of the early 1990s it took until 1998-99 until the next upswing began to make itself felt. Traffic volumes increased dramatically during 1999 and 2000, and total car travel (interregional, regional and local) on the E20 increased by 10-15% between 1998 and 2000.

Total regional travel along the E20/Svealand line in Södermanland increased during the 1990s. Whereas regional travel by car has in principle remained unchanged, travel on public transport is judged to have accounted for the increase due to the improved supply. Public transport's (bus and train) market share of regional travel was 30% in 2000, as compared to 15% during the bus period from 1994 to 1997 and 10% with the old train services up until 1993. The train services alone had a market share of 6% of regional journeys in 1993, but this had increased to 30% by 2000.

On some tours, especially journeys to and from Stockholm, the train services have a higher market share. Regional travel between Eskilstuna/Strängnäs and Södertälje/Stockholm by train is estimated to be about 35%. This estimate takes into account the fact that travel by train to Södertälje has not increased as much as total regional travel.

Several studies show that passengers have definite preferences when it comes to central station locations, both for long-distance and regional journeys, and that the number of journeys increases drastically if they can walk from the station to their destination.[267] [268] The location of Södertälje syd station means making a connecting trip by bus or car to reach the town's supply of service and jobs. Despite the Svealand line Södertälje has thus hardly become easier to reach from the north of the county of Södermanland, while journeys to Stockholm have become

[266] Goodwin (1996)
[267] Prather Persson (1998)
[268] Rietveld (2000)

much easier relatively speaking. However, accessibility to Södertälje can be improved with complementary transport services, of which high speed commuter trains and/or express buses are discussed below.

In the study about 30% of the regional journeys by high speed train on the Svealand line can be categorised as new travel. A large number of these new journeys are probably journeys where the destination has been changed due to the improvement in supply, and the journey is made on the Svealand line instead of in another direction, irrespective of previous travel mode. About 15% of the new high speed train passengers are estimated to have transferred direct from having previously travelled by car, while the remainder had travelled by SJ's (30%) or LT's (25%) buses before the train services began.

5.3.2 High speed commuting

One idea that can give greater accessibility to the south-west part of the county of Stockholm and increase the number of journeys made by train to and from Södertälje is to integrate traffic in the Mälaren valley with the commuter train traffic in Greater Stockholm.[269] The new product could be called high speed commuting/commuter trains and be used first and foremost for travelling to work and leisure-time trips. Compared to today's services on the Svealand line, the supply would be differentiated and the train journey market broadened, which would give public transport a greater market share. High speed commuter trains can stop at all stations on the Svealand line, but only at the bigger commuter train stations in the Stockholm area with many places of work and residents in the vicinity, for example Södertälje hamn/Östertälje, Tumba, Flemingsberg, Älvsjö and at Södermalm before arriving at Stockholm Central station. Travelling times to central Stockholm would be longer than for the trains via Södertälje syd and the Grödinge line, but shorter door to door from north Södermanland to places of work in Södertälje and the southern parts of the Stockholm metropolitan conurbation.

5.3.3 Extended parallel bus services

Most of the parallel bus services along the Svealand line were discontinued when the train services began. Between Stallarholmen/Mariefred/Åkers styckebruk and Södertälje there remain only one or two bus services that run at peak periods. Södertälje has a large labour market and a few big multinational companies, many of whose employees live in the county of Södermanland. Accessibility for residents by public transport, however, is markedly poorer than by car because of the

[269] Effektiva tågsystem i Mälardalen, *Efficient train systems in the Mälaren valley* (1997)

changes between bus and train at both ends of the journey to reach most places of work, and public transport's share is small. Both Läggesta and Södertälje syd stations are a few kilometres outside the built up area and destinations in the nearest communities.

One idea would be to extend the bus services and run parallel to the Svealand line between Läggesta and Södertälje, at least more services for commuters than the present supply. Many people would then be able to travel non-stop between home and work without having to change. An alleviation of the load on the trains on this section during the rush hour is also positive, since the marginal costs for being able to offer these short-distance commuters on the most loaded section a seat on the train are probably higher than their willingness to pay.

The extended bus services would probably attract a new market for public transport, and some of the travellers who might prefer high speed commuter trains if they operated via Södertälje hamn.

5.3.4 Hypotheses

1. *The improved train service supply increases the demand for travel by public transport where the supply of train services is attractive.*

The increase in demand has been very dramatic, above all on the Eskilstuna–Stockholm section where travelling time is an hour at most. There were 7 times more regional train journeys over the county boundary between the counties of Södermanland and Stockholm in 2001 than with the old train in 1993. Train journeys have thus taken a considerably larger market share. Passengers on the trains can be divided into three groups; new travellers and passengers who have transferred from bus or car. The hypothesis is accepted.

2. *The Svealand line means a system change in the supply of travel opportunities, which should mean that a dynamic process will begin in the demand. The introduction phase will therefore be followed by further increases in travel over a relatively long period before a new equilibrium is attained.*

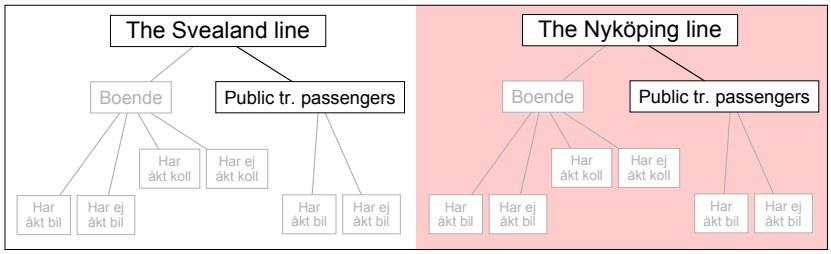
Travel increased markedly up until spring 2001, after which it began to slow. There are probably several reasons, some of the most important of which are the deterioration in supply (as regards comfort), the lower price of petrol and a general slowdown in the economic development. Previous experience shows that travel fluctuates in periods, but that initial growth is often strong. The Svealand line's introduction phase can thus be defined as the period from summer 1997 until winter 2001. Travel will probably continue to increase over a long period of time. The hypothesis can thus not be accepted at this stage, but nothing has so far been found that contradicts it.

6. Knowledge and valuation of the supply

This chapter describes the results of the analyses of the various studies conducted among residents and public transport passengers in 1997, 1998 and 2000 of their knowledge and valuation of the supply. For each analysis a diagram shows the level that the analysis comprises. The questions the respondents were asked can be found in the questionnaire in appendix 10.

6.1 Knowledge of the supply

6.1.1 Information about the journey



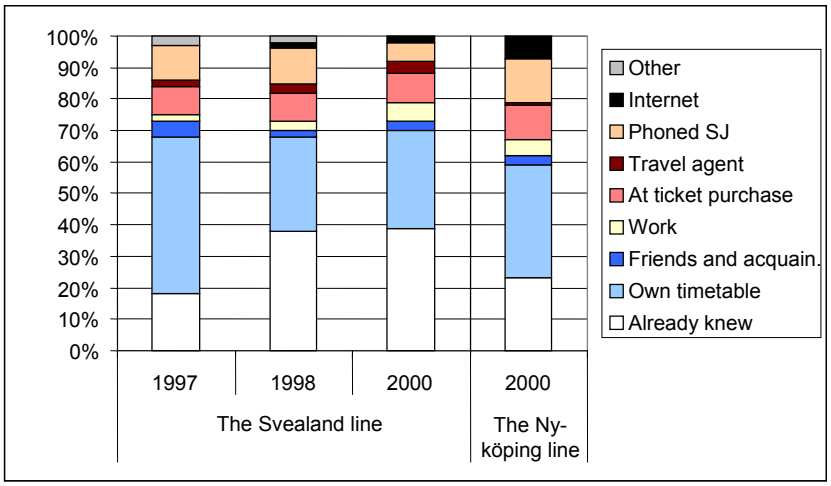
In the interviews with passengers on board the buses (1997) and on board the trains (1998 and 2000) the respondents were asked to answer how they obtained information about times and fares for their journey. Only one answer was allowed.

The number of passengers who say they already knew about times and fares for their current journey between Eskilstuna and Stockholm was roughly 1/5 in 1997. In the 1998 and 2000 surveys the proportion has doubled to 2/5. The remaining 3/5 needed to find the information for their journey. Especially noticeable is the reduction in the number of people who used an own timetable.

A comparison between passengers on the Svealand line and the Nyköping line in 2000 shows that the proportion of people who knew about times and fares since previously is almost double on the Svealand line. Train passengers on the Nyköping line seek their information to a greater extent before the journey. The proportions that had called SJ were 6% for the Svealand line and 14% for the Nyköping line. The proportion of passengers using the Internet to get information was 2% on the Svealand line and 7% on the Nyköping line.

That a relatively large proportion of passengers knew the times and fares on the Svealand line in 1998 and 2000 is probably a result of the

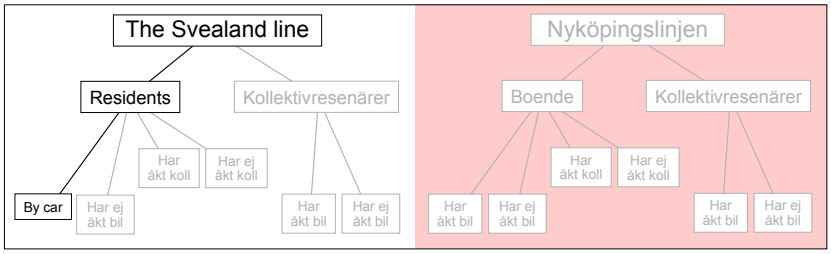
Information about the trip, bus/train passengers, the Svealand line



The proportion of passengers on the buses between Eskilstuna and Stockholm (1997) and the trains on the Svealand line (1998 and 2000), and the Nyköping line (2000), who got information in different ways.

basic interval timetable with regular hourly departures, which the Nyköping line did not have. The bus services along the Svealand line in 1997 also had more irregular departures than the train services. "Already knew" may also be an indication that several regular passengers began taking the train as a result of the improvement of the supply on the Svealand line.

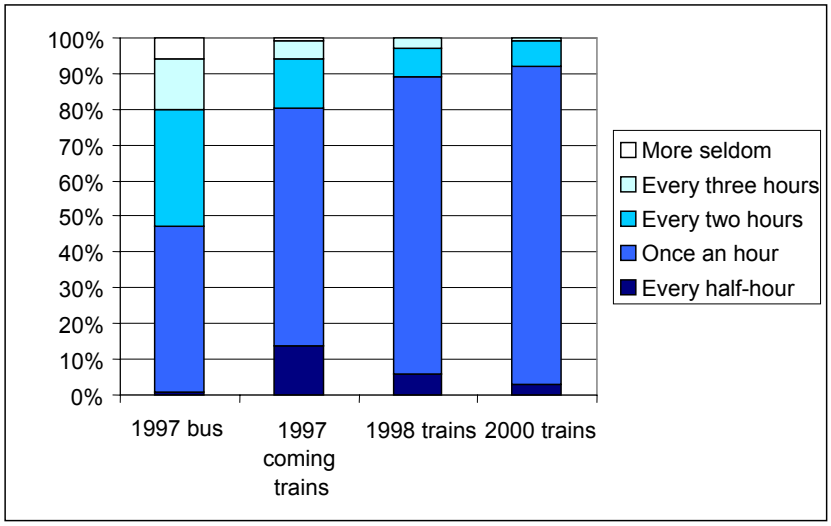
6.1.2 Knowledge about frequency of service



The questions about frequency of service for the buses between Eskilstuna and Stockholm in 1997 and the trains on the Svealand line in 1998 and 2000 were put to residents who had made (at least) one journey by car outside their home community over the last twelve months. This therefore does not exclude the fact that the respondents may have travelled by public transport.

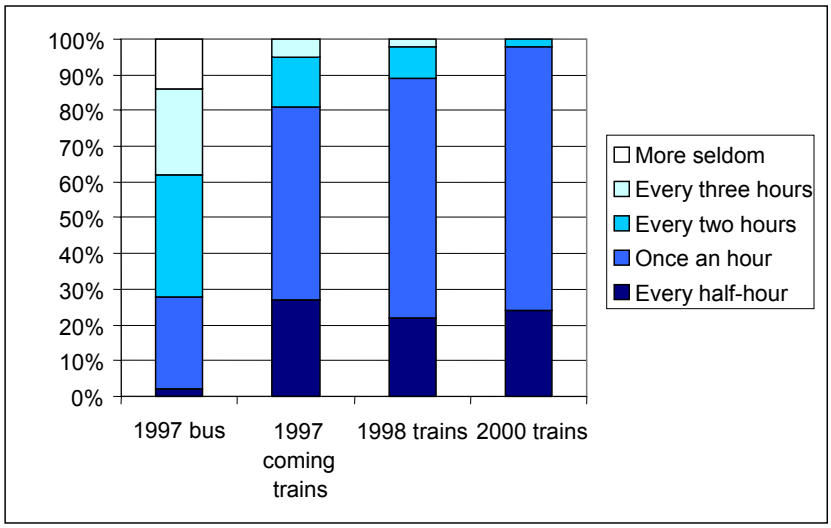
The real frequency of service varied, more for the buses than for the trains, so the results may be seen more as an indication than real knowledge. The buses ran in principle hourly between Eskilstuna and Stockholm in 1997, and half-hourly at peak periods, but more seldom at

Car-travelling Eskilstuna residents' knowledge of frequency of service between Eskilstuna and Stockholm



What car-travelling Eskilstuna residents assume about the trains' frequency of service on the Svealand line, and the earlier bus services.

Car-travelling Nykvarn residents' knowledge of frequency of service between Eskilstuna and Stockholm



What car-travelling Eskilstuna residents assume about the frequency of service. Real frequency of service for SJ's buses in 1997 varied more than for the trains.

weekends (hourly or two-hourly). However, not all buses stopped at Nykvarn and Åkers styckebruk. At Nykvarn frequency of service thus varied from hourly (peak periods, in the Stockholm direction, Monday to Friday), to six buses in all on Saturdays and Sundays. Frequency of service for the trains in the two later studies is in principle the same as it

was for the buses between Eskilstuna and Stockholm, but in contrast to the bus services all trains stop at Nykvarn. With few exceptions the trains also run to a basic interval timetable.

The message "once an hour" for the coming train services had reached 50-70% of the population along the Svealand line the month before they began in 1997, whereas there was greater uncertainty as regards the frequency of the existing bus services. In 1998, 70-90% of the residents answered that the frequency of service on the Svealand line during the day is once an hour. In 2000, knowledge about the frequency of service had further improved by a few percentage points. A general tendency is that many motorists living in Åkers styckebruk and Nykvarn assumed that the frequency of service on the Svealand line was half-hourly, while residents in Eskilstuna and Strängnäs were more certain that the trains ran hourly. Residents in Mariefred lie somewhere in between. This may be a consequence of poorer knowledge of the timetable, but since the frequency of service really is half-hourly in the direction of peak period traffic, the possibility that a larger proportion of motorists in these places are considering commuting by train can not be excluded.

One observation is that almost all the residents who travelled by car in 2000 gave an alternative that really exists, whereas a greater proportion thought that the buses' frequency of service in 1997 was poorer than it actually was. This shows that a large part of the population have detailed knowledge of the supply of good train services, and even have a tendency to overestimate the frequency, whereas expectations from the bus services were not particularly high.

Residents in Södertälje and Stockholm did not have the same knowledge, but about half of the respondents answered that trains go once an hour in 1998, while only 1/4 thought that the buses went once an hour in 1997.

6.1.3 Knowledge of travelling times and fares

The questionnaire sent to residents contained some questions where respondents describe their last journey by car or public transport. Among the questions about the journey and travelling time, there was one about how much the respondent estimated that it cost to travel by car.

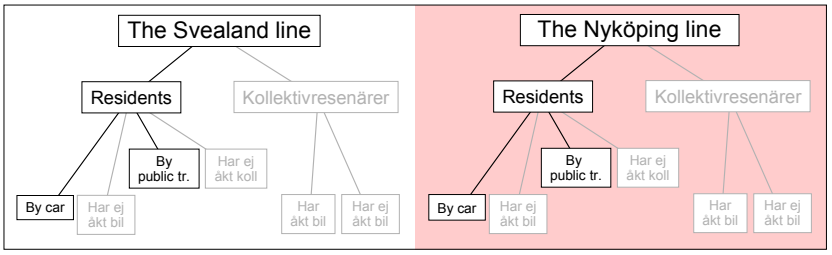
The average cost of a journey by car increased over the period in the whole of the field study of residents along the Svealand line and in Nyköping. In 1997 the cost was estimated to be 12.60 Skr/10 km, in 1998 13.80 Skr/10 km, and in 2000 the figure had risen to 15.10 Skr/10 km. The price of petrol (see section 4.2.2) was the same at

the time of the 1998 survey as it was in 1997 (approx. 8 Skr/l), but about 20% higher in 2000 (approx. 9.60 Skr/l). The estimated cost increase does not therefore fully coincide with the increase in the price of petrol.

Residents' estimated car costs

Car costs (Skr/km)	*1997*	*1998*	*2000*
Mean	1.26	1.38	1.51
Median	1.00	1.20	1.50

The question does not ask what the respondents include in the cost. The study contains values of between 0 and 50 Skr/10 km, which seems to indicate that some people count their car journeys as free, while others also count their fixed costs for owning a car. The difference between the mean and median value has diminished over the period, indicating that answers have become more symmetrically distributed. Skewness and kurtosis, however, have relatively high positive values in all three rounds of the study. The cost of travelling by car increased quite substantially towards the end of the 1990s, above all due to the increase in the price of petrol.



The journey and the alternative for residents along the Svealand line

Some questions about their last journey by car outside their home community were included in the residents' interviews. Those who travelled by car were asked to estimate the cost and travelling time for their journey, and estimate what the corresponding journey by public transport would have cost and how long it would have taken and vice versa.

In the evaluation two methods were tried; include all responses, or only those with full information about cost and travelling time for the latest journey. The result was not significantly affected when large groups were compared, such as all residents in Svea conurbations AB+D', whereas for individual communities the differences were somewhat larger. For individual communities, therefore, a condition was introduced to the effect that both cost and travelling time for the jour-

ney must be given in order for the cost and travelling time of the alternative to be included in the evaluation. Travelling time is for a door to door journey.

Last journey by car and estimation of public transport alternative, Svea conurbations AB+D'

	1997	*sign*	*1998*	*sign*	*2000*	*sign*	*1997*
Car journey							
Cost (Skr)	98	*	79		90		98
Travelling time (hrs:mins)	0:58		0:57		0:54		0:58
Publ. transp. alternative							
Cost (Skr)	105		115		113		105
Travelling time (hrs:mins)	1:47	***	1:25		1:23	***	1:47

Svea conurbations AB+D': Residents in Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna, weighted.
Asterisks denote significant differences between survey years.

The average cost and travelling time for the latest journey by car outside the respondent's home community fell somewhat for individual residents along the Svealand line over the period, but the changes are not significant except for the reduction in the cost of the car journey between 1997 and 1998. The travelling time for an alternative journey by public transport, on the other hand, has decreased significantly, by about 24 minutes, or about 1/5 between 1997 and 2000.

Last journey by public transport and estimation of car alternative, Svea conurbations AB+D'

	1997	*sign*	*1998*	*sign*	*2000*	*sign*	*1997*
Public transport							
Cost [1] (Skr)	77		76		86		77
Travelling time (hrs:mins)	1:50	***	1:20		1:19	***	1:50
Car alternative							
Cost (Skr)	132		114		123		132
Travelling time (hrs:mins)	1:09		1:10		1:09		1:09

Svea conurbations AB+D': Residents in Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna, weighted
Asterisks denote significant differences between survey years
[1] The cost is the fare for a single ticket on the bus or train, i.e. it does not include the cost for connections. Passengers with monthly passes are not included in the analysis

No passengers with monthly passes are included here in the study of residents' journeys by public transport along the Svealand line. The cost

stated for a journey by public transport is the cost of a single ticket using the bus or the train for the main part of the journey. Any costs involved in making a connection are not included because these vary within a very wide interval (from a walk to a trip abroad). It is not possible, therefore, to get a true picture of the average cost of the journey.

Travelling times are easier to compare and are for a journey from door to door. Between 1997 and 2000 the average travelling time was 31 minutes, or 28%, shorter for journeys by public transport outside the home community along the Svealand line. No other changes are significant.

Socioeconomic factors

An analysis of the journeys divided according to access to a car, i.e. the habitual motorist, frequent-infrequent motorist and non-motorist groups, shows that the non-motorists make considerably longer journeys than the habitual motorists when they travel outside their home community by car. The difference is significant both for travelling time by car (***) and for the cost (*) and travelling time for the public transport alternative (*). The non-motorists generally travel more cheaply per time unit by car than the other two groups. The explanation may be that many people travel in other people's cars at very low cost when they make a journey by car.

The frequent-infrequent motorists' travelling time by car is also longer (*) than the habitual motorists'. The frequent-infrequent motorists however give shorter travelling time (*) and lower cost (*) for the car alternative when they travelled by public transport compared to the habitual motorists.

A comparison between women and men shows no great differences in the estimated costs and travelling times. A significant (*) difference, though small, is that women who travel by public transport estimate lower costs for an alternative car journey than men do, while both have the same view as regards travelling times. It may, though, once again be a question of more women than men travelling as passengers and not needing to pay for the car journey.

Level of education correlates with the cost of the latest journey by car, where people with a university education have a significantly (*) higher cost for the car journey than residents with only elementary school as their highest level of education.

The differences as indices

The change between before (1997) and after (2000) train services began on the Svealand line can be described by means of an index. Index 100

is equivalent to the level of the costs and travelling times of the journey made. Note, however, that there are few observations for some individual communities, which means that random variations may affect the results. Svea conurbations AB+D', however, give significant values.

Resident motorists' knowledge about the public transport alternatives, index

Index	*Cost*		*Travelling time*	
100 = car journey	*1997*	*2000*	*1997*	*2000*
Nykvarn	106	115	257	235
Mariefred	63	143	198	191
Åkers styckebruk	97	144	196	174
Strängnäs	118	140	200	159
Eskilstuna	119	134	164	134
Svea conurbations AB+D'	*108*	*126*	*184*	*153*
Nyköping	112	165	172	178

Residents' latest car journey outside their home community and their knowledge about the public transport alternative before and after. Index 100 = the car journey's cost and travelling time.

Residents in the Svea conurbations AB+D' have on average estimated that the difference between the cost for the car journey and the public transport corresponded to index 108 in 1997. The difference had increased to 126 in 2000, i.e. an estimated relative cost increase for the journey by public transport of 17% compared to the car journey.

It is the residents in Mariefred and Åkers styckebruk who in 1997 could travel to Södertälje and Stockholm with the county public transport authority who show the largest relative price increase. That possibility ceased to exist when train services on the Svealand line began. Nykvarn residents, however, can still travel with the county public transport authority (SL), which is reflected in the price level relative to the car. The motorists in Nyköping assume that the cost of travelling by public transport has drastically increased between the years.

Motorists' estimations of travelling times show that the index has fallen most for residents of Strängnäs and Eskilstuna, and that the difference is smaller between travelling time by car and the estimated travelling time by public transport in 2000 than it was in 1997. In the Svea conurbations AB+D', the alternative public transport journey was on average estimated to have an index of 184, i.e. take 1.8 times as long as the journey by car in 1997, but 1.5 times (index 153) in 2000. The motorists thus thought that the difference in travelling times between the car and a public transport alternative had decreased by 17%.

Resident public transport passengers' knowledge about the car journey alternatives, index

Index	*Cost*		*Travelling time*	
100 = public transport	*1997*	*2000*	*1997*	*2000*
Nykvarn	221	136	48	79
Mariefred	146	143	53	86
Åkers styckebruk	118	116	65	63
Strängnäs	144	143	60	82
Eskilstuna	137	143	65	89
Svea conurbat. AB+D'	*172*	*143*	*63*	*87*
Nyköping	104	149	66	74

Residents' latest journey by public transport outside their home community and their knowledge about the car journey alternative. Index 100 = the public transport journey's cost (not including connections) and travelling time.

With regard to cost, the public transport passengers' knowledge about a car journey as an alternative has changed most among residents in Nykvarn between 1997 and 2000. A closer study shows that it is the average fare for the public transport journey that has primarily increased, which is an effect of the fact that more residents in Nykvarn paid SJ fares to travel on the Svealand line than SL fares on the bus and commuter train in the latter year.

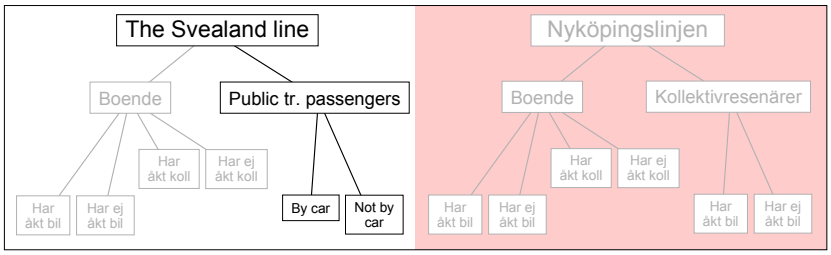
The situation has also changed for the Svea conurbations AB+D' as a whole. In 2000, residents in Svea conurbations AB+D' gave index 143 for the car journey alternative's cost in relation to a single ticket on the bus or the train, a decrease from index 172 before the Svealand line in 1997. This is equivalent to a relative reduction of the price difference of 17%.

For Nyköping residents the situation was the opposite in 2000 compared to 1997. The estimated costs for the car journey alternative have increased dramatically between the years, while the public transport fares are unchanged. The magnitude of the change, however, is uncertain.

The index for travelling times has changed between 1997 and 2000. All residents along the Svealand line except those in Åkers styckebruk estimated that the difference in favour of the car journey is smaller in 2000 than it was in 1997. It is primarily travelling time on public transport that is shorter. In 1997 residents in Svea conurbations AB+D' estimated that a car journey as an alternative to their last journey by public transport would take an average of 0.6 times as long as the journey by public transport (index 63), whereas the corresponding figure in 2000 was 0.9 times (index 87). The relative advantage of the car has

decreased by 65%. Expressed in another way, the public transport passengers estimated that the car alternative had lost much of the advantage of shorter travelling times due to the start of the train services on the Svealand line.

The public transport passengers' journey and alternatives



The corresponding question was put to the passengers on board the buses and trains on the Svealand line. This evaluation therefore includes people who live in places other than the communities along the Svealand line, but only passengers with single tickets. Compared with the interviews about the residents' last journey by public transport and the car alternative, the interviews on board the trains therefore predominantly concern journeys over longer distances. The residents on board think that the alternative journey by car, for example, is twice as expensive. The car alternative's cost and travelling time have also increased during the period, while the average travelling time by public transport has decreased by 44 minutes, or 25%. In addition to the fact that this may be a consequence of faster train journeys, some of the differences may be able to be explained by the selection of the respondents on board the buses and trains. On the buses the interviewer had time for more short journeys. On the trains, passengers over longer distances dominate, especially those who travel all the way between Eskilstuna and Stockholm. It is therefore risky to pay any great attention to the period's result. No significance check has therefore been made.

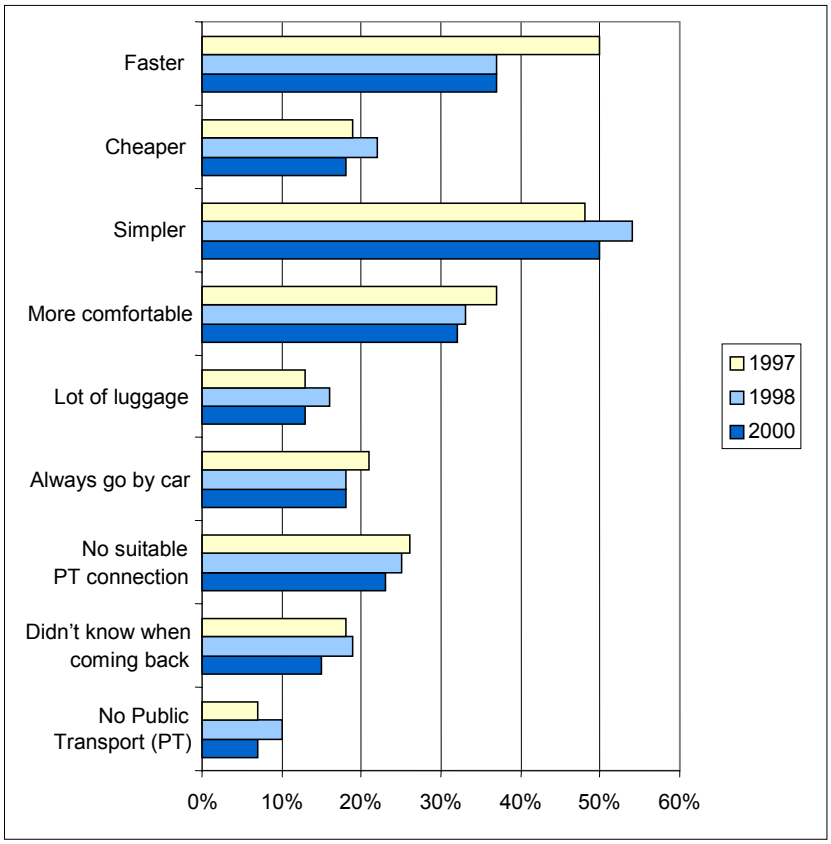
For individual years, on the other hand, comparisons between travel by public transport and the car alternative should be useful. In 2000 the train passengers thought that the car journey would take 10% longer than public transport, while the situation was the opposite in 1997 where the bus passengers estimated that the car would take 35% less time.

6.1.4 Residents' reasons for their choice of travel mode

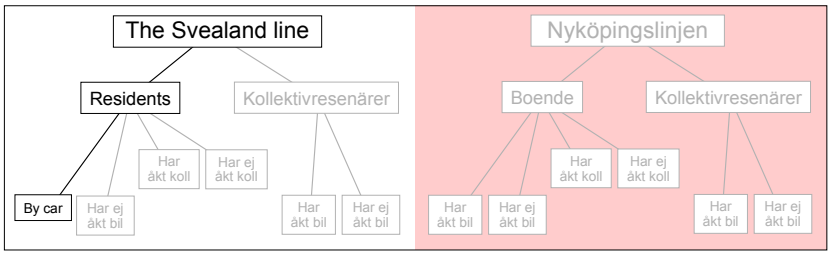
Reasons for choosing the car

The reasons why residents along the Svealand line chose the car instead of bus or train for their last car journey outside their home community between Eskilstuna and Södertälje, or further afield, were studied. The base is those residents in the Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna conurbations who had travelled by car outside their home communities over the previous twelve months. The respondents were allowed to choose more than one answer, so the total percentage is more than 100%. The relative length of the bars shows the reasons that were most important.

Residents' reasons for choosing the car, Svea conurbations AB+D'

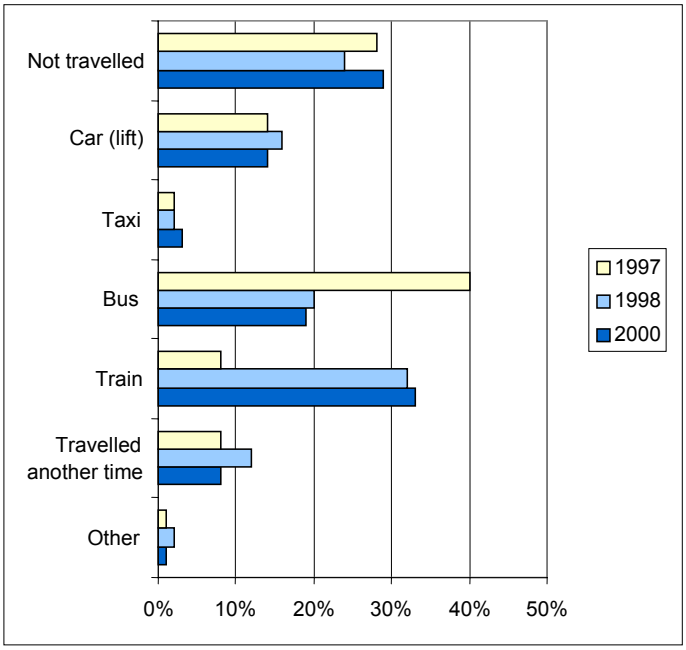


Proportions of the different reasons given by respondents among residents in Svea conurbations AB+D' for choosing the car instead of public transport for their last car journey during the previous 12 months along the E20/the Svealand line. Each respondent may give more than one reason, and the total for some years is therefore more than 100%.



The main reasons for choosing the car over the bus or train is that it is faster, cheaper, simpler and more comfortable to go by car. As can be seen, it is the car's advantages that are emphasised, while shares are smaller for public transport's disadvantages. From 1998 the argument that the car is faster is less common once the train services on the Svealand line had begun, compared to the bus services in the 1997 study. Half the motorists say that the car is simpler than the public transport alternatives.

Alternatives to latest car journey

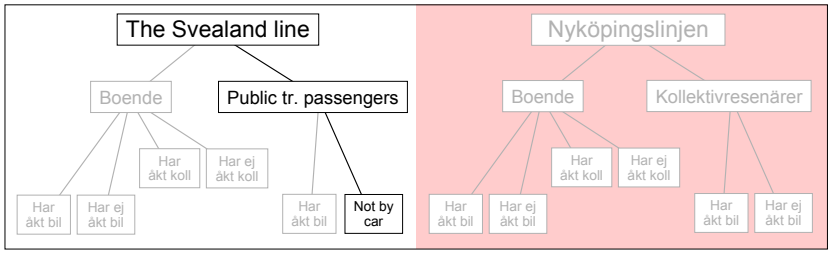


Residents' (Svea conurbations AB+D') alternatives to latest car journey outside home community along the E20/the Svealand line.

There are, however, often alternatives to the journey that was made. Respondents were asked to say what they would have done if they had not had access to a car for their journey. Their answers show that half would have taken the bus or the train instead of going by car. Many, about 1/4, would also have decided not to travel. The difference be-

tween the studies in 1997 (SJ bus) and 1998+2000 (trains on the Svealand line) is that trains have turned out to be a better alternative for more people at the expense of the bus. Note that in addition to SJ's, the county public transport authority's supply is also an alternative for the residents.

Reasons for choosing bus or train

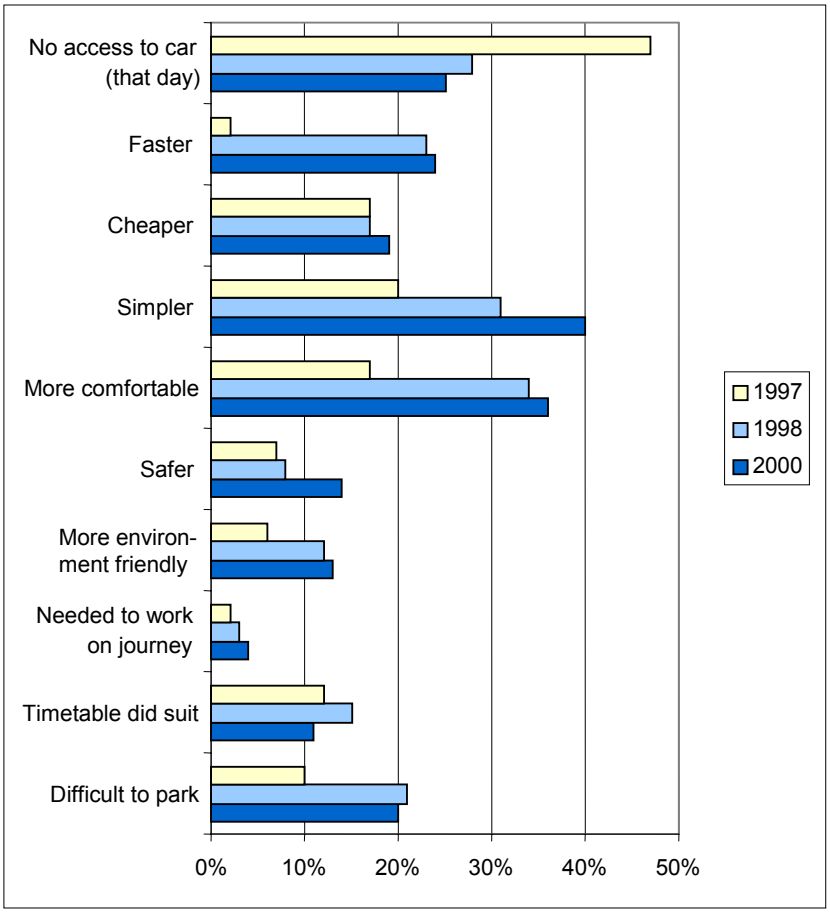


The question about residents' reasons for choosing the bus or the train for their latest journey between Eskilstuna and Södertälje, or further afield, was put to those who had made a journey by public transport during the previous twelve months along the Svealand line. Here too, respondents were allowed to give more than one reason and the percentages once again total more than 100%. Their main reasons are shown in the diagram on next page.

The most common reason in 1997, and given by almost half of the respondents, was that they did not have a car (that particular day), i.e. that they did not have access to a car at the time of the journey. A smaller group also emphasise the advantages of the bus over the car, that the bus was cheaper, simpler and more comfortable. The situation changed radically in the 1998 study. Not having access to a car was still an important reason for about 1/4 of the public transport passengers, but the simplicity and greater comfort of public transport (compared to the car) were together the most important factors behind their decision to take the bus or the train. The fact that the trains on the Svealand line are faster than the buses also makes speed a factor to consider, which it was not in the case of the bus services in 1997. The trend of emphasising the train services' advantages, primarily "simpler" and "more comfortable", was reinforced in the study in 2000 compared to the one in 1998. More people said that the train is safer and more environment-friendly, and more said that parking spaces were hard to find.

Respondents' alternatives for their last journey by public transport outside their home community have changed somewhat between the 1997 and 1998 studies.

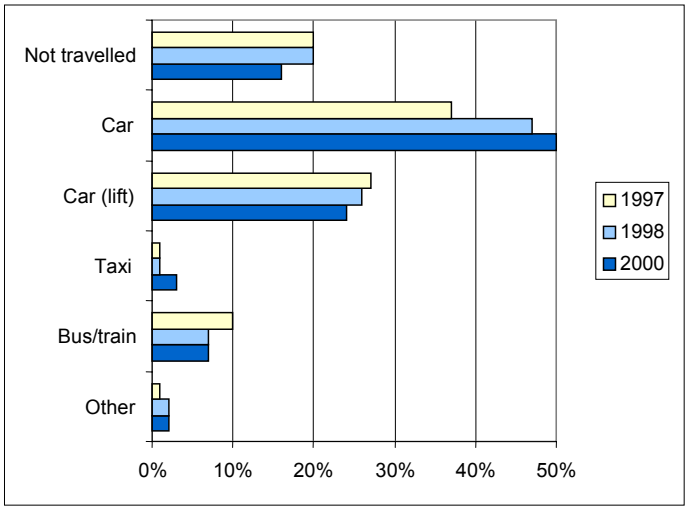
Residents' reasons for choosing bus or train, Svea conurbations AB+D'



Proportions of the different reasons given by respondents among residents in Svea conurbations AB+D' for choosing the bus or train instead of the car for their last car journey during the previous 12 months along the E20/the Svealand line. Each respondent may give more than one reason, and the total is therefore more than 100%.

Many passengers obviously have access to car as an alternative, since 2/3 would have chosen to drive or get a lift with someone else in 1997. The proportion who would have driven increased markedly when the train services began, and in the study in 2000 half the residents said that they would have driven as an alternative to their latest journey by public transport. The increase in the number of public transport passengers who would have driven shows that a larger proportion of them have the car as an alternative since the train services began on the Svealand line. Note, however, that the number of individuals is not proportional to the number of journeys, since the individuals make different numbers of journeys over the year.

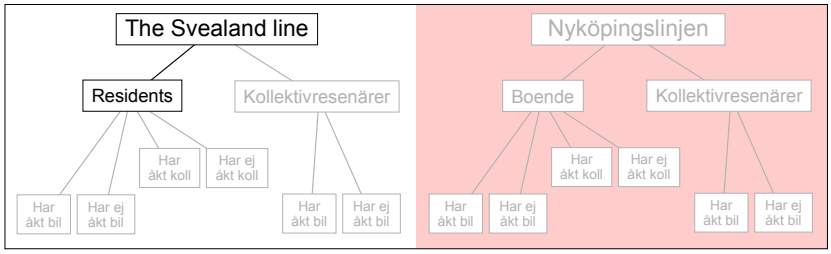
Alternatives to bus or car journey



Respondents' alternatives for their last journey by public transport outside their home community along the E20/the Svealand line. The "Bus/train" bar shows the proportion of respondents who would have chosen the train as an alternative if they had travelled by bus on their last journey, and vice versa.

6.2 Valuation of the supply

6.2.1 Rating



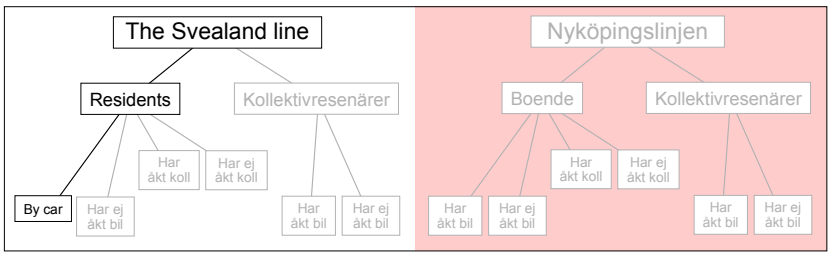
In an SP study respondents were asked to rate various suggestions for a journey from home to the centre of Stockholm on a scale from 1 to 10, where 10 is very good and 1 very bad. The median value of the scores was on average around 7 in the study. A tendency that can be seen over the studies, however, is that the price of the journey relatively speaking has fallen somewhat in importance in most of the areas in the study. The alternatives with a higher price level have therefore generally been given higher scores over the period. The high speed train travel mode has also been given a higher average score at the expense of the bus and ordinary trains, since services began on the Svealand line. The differences in the average scores between the study years, however, are small and are only significant in exceptional cases.

The results of the analysis can only be used in the context for which the questions were written for the respondents in question. The parameters calculated and the resulting values are presented with the knowledge that other studies have shown similar values for travelling time etc.[270] The parameters that are calculated by means of multiple linear regression analysis are in some cases not significantly different from zero with a 95% confidence interval, i.e. $|t| > 1.645$ in a one-sided significance test ($n \to \infty$) for $\alpha = 0.05$. These values are shown in brackets in the tables.

The first study year, 1997, there was greater correlation between modes and travelling times than in the subsequent studies in 1998 and 2000. Residents in the central areas of Eskilstuna, study area 6, however, were given the same questionnaire in all three rounds if the study. This can be compared to Eskilstuna without the central area (area 7), who were given modified rating questions in 1998 and 2000, as were all other areas in the study. Due to an error in selection, however, there were no respondents in Eskilstuna outside the centre in the 1997 study.

The mean scores from all study areas including a 95% confidence interval are shown in appendix 3.

Public transport compared to car journey

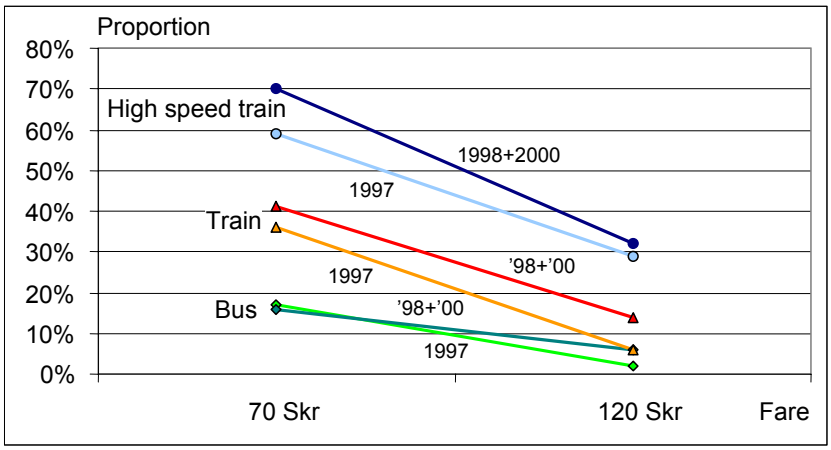


The proportion of residents who answered that they have a car as an alternative for an imagined trip between home and the centre of Stockholm is about 45-50% of all answers in the centre of Eskilstuna. Of these, some value high speed train, ordinary train or bus more highly than travelling by car for such a journey.

The travel mode contains a correlated travelling time, whereas the frequency of service is the same. Travelling time was given as 1 hr for high speed trains, 1 hr 30 mins for (ordinary) trains, and 2 hrs for the buses. The limited sample gave few observations, and residents in the centre in the studies in 1998 and 2000 were therefore analysed together in this case.

[270] Kottenhoff (1999)

Motorists resident in the centre of Eskilstuna who gave public transport the highest score

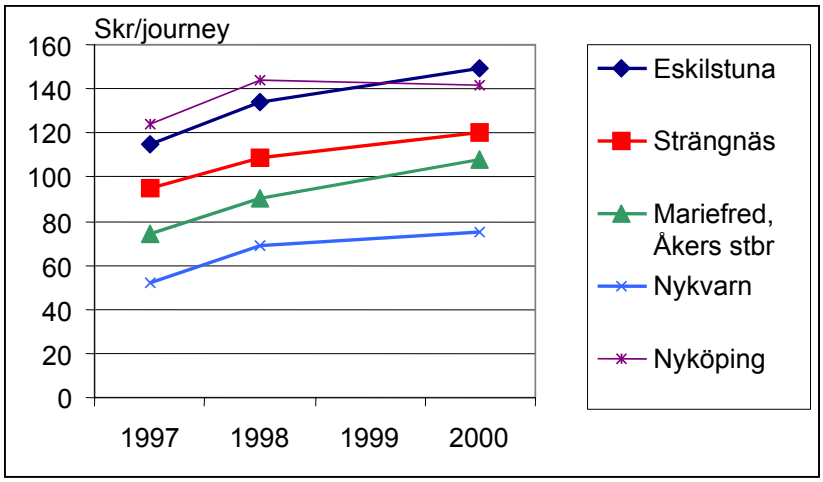


The proportion of motorists resident in the centre of Eskilstuna who rated both a journey by car and a journey by public transport between home and the centre of Stockholm, but gave the bus, train or high speed train a higher score than the car. The slope of the line between the 70 Skr and 120 Skr points gives an indication of the price elasticity, but since there are only two points, it is impossible to get any idea of the shape of the curve.

Of the residents in the centre of Eskilstuna who say they can travel by car to the centre of Stockholm as an alternative to the bus or the train, 60-70% prefer the high speed train to the car if the tickets are cheap (70 Skr). If the fare is higher (120 Skr) their proportion falls to half as many, around 30-35%. The train and bus modes attract fewer residents with the car alternative. Interest appears to be minimal especially with regard to an expensive bus journey, with 2-6% of the residents preferring the bus to their own car.

For residents in all the areas in the study the car alternative became more expensive between 1997 and 2000. The increase varies between 15% and 46% (compare this to the RP data in section 6.1). The cost of the public transport suggestions in the study has been constant, however, which means that there has been a change in the cost relation between car and public transport. The increase may explain some of the higher scores for public transport between 1997 and 1998+2000, compared to the car alternative. A trend can also be seen in that travelling time by car to Stockholm has increased between the years for residents of Nykvarn, Mariefred and Åkers styckebruk, while Strängnäs, Eskilstuna and Nyköping residents in general give the same travelling time over the period.

Cost of a car journey to the centre of Stockholm

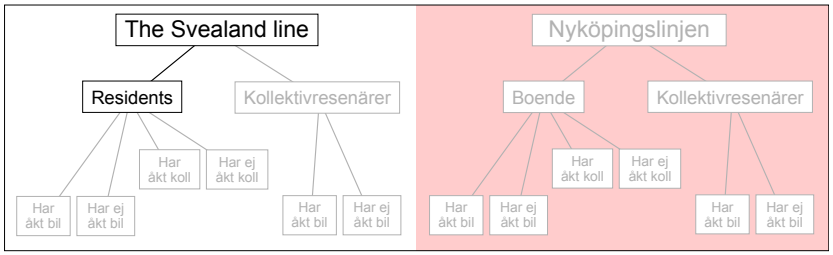


The cost of a car journey to the centre of Stockholm that motorists resident in the places above gave in questions 4.2E (1997) and 4.1G (1998 and 2000).

6.2.2 Residents' valuation of public transport

The regression analysis of the dependent variable scores for different travel suggestions gives the results in the form of parameters, expressed with the unit score per unit level. By dividing with the parameter value representing points per crown (Skr) for the fare, the other parameters can also be converted into crowns.

Residents' valuations in Skr, the Svealand line



A comparison between the communities the same study years can give different valuations of the factors due to actual real differences. Some of the difference between them can be explained by the fact that the passengers' trip purpose when they imagined the journey they scored may differ between the communities' populations. For the ones nearer Stockholm the proportion of people commuting to work is higher than in Eskilstuna for example, where many people mainly make leisure-time trips to Stockholm. Another possible explanation is that the different travel alternatives between the various places have varying levels of difference in the factors; the low price varies for example be-

tween 54% (70 Skr/130 Skr for Nyköping) and 60% (60 Skr/100 Skr for Strängnäs) of the high price.

Valuations in 1997, residents along the Svealand line

Factor	*Eskilstuna (all)*[1]	*Strängnäs*	*Mariefred Åkers stbr.*	*Nykvarn*
Travel mode, value compared to bus				
Train	+12 Skr	(-1 Skr)	-7 Skr	-5 Skr
High speed train	+30 Skr	(+8 Skr)	-5 Skr	(-4 Skr)
Travelling time, value	26 Skr/hr	53 Skr/hr	46 Skr/hr	63 Skr/hr
Incr freq. of service				
2 hrs→1 hr	+11 Skr			
1 hr→0.5 hr		(+6 Skr)	(+4 Skr)	+12 Skr

(...) Not significantly different from 0

[1] A selection error meant that in practice only residents in the centre of Eskilstuna were included

Valuations 1998, residents along the Svealand line

Factor	*Eskilstuna (all)*	*Strängnäs*	*Mariefred Åkers stbr.*	*Nykvarn*
Travel mode, value compared to bus				
Train	+19 Skr	+11 Skr	(+1 Skr)	(+2 Skr)
High speed train	+38 Skr	+18 Skr	(+3 Skr)	+8 Skr
Travelling time, value	43 Skr/hr	54 Skr/hr	51 Skr/hr	58 Skr/hr
Incr. freq. of service				
2 hrs→1 hr	+22 Skr			
1 hr→0.5 hr		+19 Skr	+10 Skr	+15 Skr

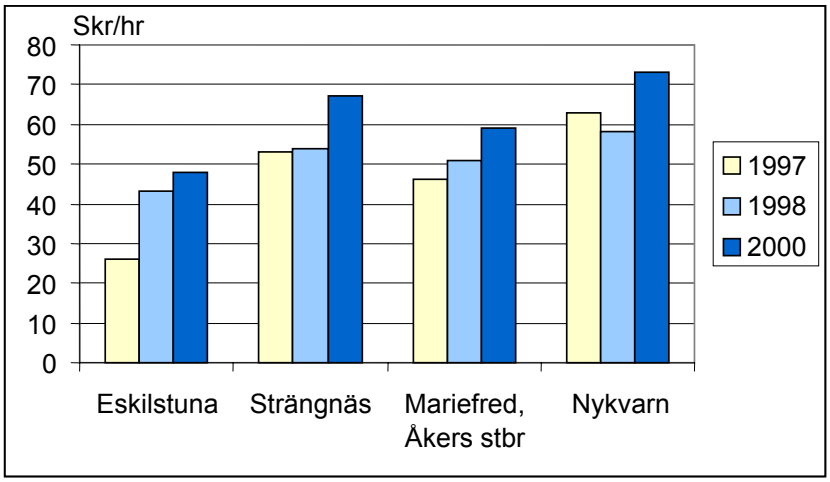
(...) Not significantly different from 0

Valuations 2000, residents along the Svealand line

Factor	*Eskilstuna (all)*	*Strängnäs*	*Mariefred Åkers stbr.*	*Nykvarn*
Travel mode, value compared to bus				
Train	+19 Skr	+9 Skr	(+1 Skr)	(+2 Skr)
High speed train	+41 Skr	+19 Skr	(-0 Skr)	+11 Skr
Travelling time, value	48 Skr/hr	67 Skr/hr	59 Skr/hr	73 Skr/hr
Incr. freq. of service				
2 hrs→1 hr	+26 Skr			
1 hr→0.5 hr		+19 Skr	+14 Skr	+17 Skr

(...) Not significantly different from 0

Valuation of travelling time, residents along the Svealand line



Valuation of travelling time (Skr/hr) for residents along the Svealand line

For Eskilstuna the changes in the sample between the years and the correlations between the factors may explain the low valuation of travelling time in 1997. In order to show how the method and the sample affect the result, the average valuation of the supply factors for Eskilstuna (above) can be compared with the valuation if areas 6 (centre) and 7 (the conurbation without the centre) are analysed individually for 1998 and 2000.

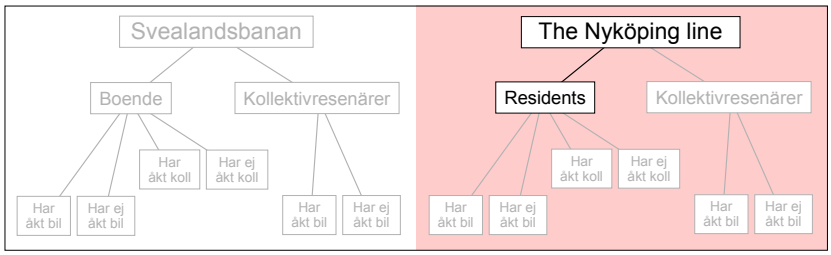
Valuation, residents in the centre of Eskilstuna (6) and the conurbation not including the centre (7)

Factor	*1998*		*2000*	
	(6)	*(7)*	*(6)*	*(7)*
Travel mode, value compared to bus				
Train	+19 Skr	+27 Skr	+27 Skr	+21 Skr
High speed train	+44 Skr	+50 Skr	+64 Skr	+43 Skr
Travelling time, value	(19 Skr/hr)	43 Skr/hr	(8 Skr/hr)	58 Skr/hr
Incr. freq. of service 2 hrs→1 hr	+17 Skr	+26 Skr	+21 Skr	+29 Skr

(...) Not significantly different from 0

The construction of the question in the first study year, 1997, and in area 6 also in the two following studies, has a large correlation between the factors travel mode and travelling time. Evaluating area 6 on its own does not give a good result because the number of respondents is relatively small. Some of the travelling time value is also hidden in the choice of a faster mode.

Residents' valuations in Skr, Nyköping



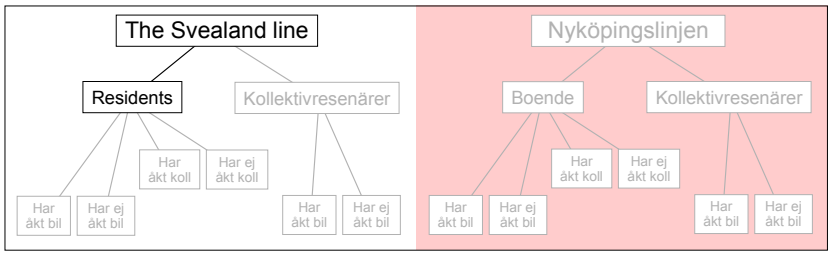
Valuation, Nyköping residents

Factor	*1997*	*1998*	*2000*
Travel mode value compared to bus			
Train	+27 Skr	+23 Skr	+19 Skr
High sp. train	+38 Skr	+30 Skr	+30 Skr
Travelling time, value	(8 Skr/hr)	35 Skr/hr	37 Skr/hr
Incr. freq. of service 2 hrs→1 hr	+15 Skr	+24 Skr	+20 Skr

(...) Not significantly different from 0

The travelling time result for 1997 is not significant. The same problem with correlations between travel mode and travelling time as for Eskilstuna area 6 means that the valuation does not give a relevant result, and some of the travelling time value is hidden in a higher valuation of the travel modes. The time value for Nyköping residents in 1998 and 2000, 35-37 Skr/hr, is lower than for residents along the Svealand line. The values for ordinary train and high speed train compared to bus is steady and positive, as is the value for improved frequency of service from half-hourly to hourly.

Socioeconomic factors affecting the valuations



Residents have different valuations depending on their socioeconomic background. The analysis is supplemented here by calculating the valuations for different socioeconomic groups in Strängnäs in 2000. Only one factor at a time is analysed since the sample will otherwise be too small and the areas can not be combined.

Valuation, Strängnäs 2000; gender and occupation

Factor	Gender		Occupation	
	Women	*Men*	*Gainfully empl.*[1]	*Not gainfully empl.*[2]
Travel mode, value compared to bus				
Train	+10 Skr	+9 Skr	+13 Skr	(+4 Skr)
High speed train	+16 Skr	+22 Skr	+25 Skr	+9 Skr
Travelling time, value	61 Skr/hr	75 Skr/hr	74 Skr/hr	57 Skr/hr
Incr. freq. of service 1 hr→0.5 hr	+18 Skr	+21 Skr	+20 Skr	+17 Skr

(...) Not significantly different from 0

[1] Gainfully employed means self-employed people and people in full- or part-time employment.

[2] Not gainfully employed refers to people on parental leave, living at home, retired people, students etc.

Valuation, Strängnäs 2000; age and distance to station

Factor	Age		Home-station distance	
	16-24	*25-64*	*0-1 km*	*1-3 km*
Travel mode, value compared to bus				
Train	(-2 Skr)	+12 Skr	+11 Skr	+9 Skr
High speed train	+12 Skr	+22 Skr	+20 Skr	+19 Skr
Travelling time, value	62 Skr/hr	71 Skr/hr	63 Skr/hr	73 Skr/hr
Incr. freq. of service 1 hr→0.5 hr	+20 Skr	+20 Skr	+17 Skr	+21 Skr

(...) Not significantly different from 0

Valuation, Strängnäs 2000; education and household income

Factor	Education		Household income	
	upper secon-dary school	*university*	*<200 000 Skr*	*>500 000 Skr*
Travel mode, value compared to bus				
Train	(5 Skr)	+14 Skr	(+3 Skr)	+9 Skr
High speed train	+16 Skr	+22 Skr	+13 Skr	+27 Skr
Travelling time value	66 Skr/hr	78 Skr/hr	62 Skr/hr	94 Skr/h
Incr. freq. of service 1 hr→0.5 hr	+16 Skr	+22 Skr	+22 Skr	+25 Skr

(...) Not significantly different from 0

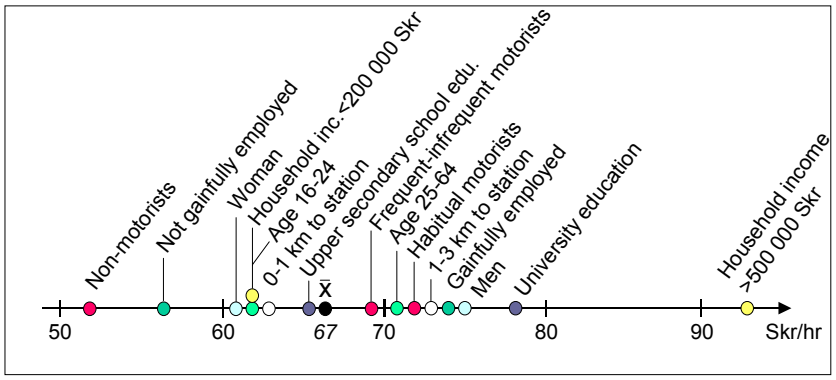
Valuation, Strängnäs 2000; access to car

Factor	*Habitual motorists*	*Frequent-infreq. motorists*	*Non-motorists*
Travel mode, value compared to bus			
Train	+13 Skr	+11 Skr	(-4 Skr)
High speed train	+24 Skr	+20 Skr	(+3 Skr)
Travelling time, value	72 Skr/hr	69 Skr/hr	53 Skr/hr
Incr. freq. of service 1 hr→0.5 hr	+22 Skr	+18 Skr	+14 Skr

(...) Not significantly different from 0

The results show whether a certain socioeconomic factor gives a different valuation of the supply factors than the mean value for the whole sample population. The average for men and women, for example, therefore also hides the other socioeconomic factors. A woman university graduate with a high household income, for example, probably values travelling time higher than the average woman.

Strängnäs residents' socioeconomic factors in the valuation of travelling time



Valuation of travelling time (Skr/hr) for Strängnäs residents in 2000 divided into paired groups of socioeconomic factors. The mean value for the whole of the sample population is 67 Skr/hr.

For the following socioeconomic factors there is no significant difference between ordinary train and bus; not gainfully employed, age 16-24, upper secondary school educated, household income less than 200 000 Skr, non-motorists. Other groups value the train 9-14 Skr higher than the bus.

High speed trains are valued most highly by (in descending order) people with a household income over 500 000 Skr, gainfully employed, habitual motorists, university educated, men, and age 25-64. The lowest value is given by people with a household income less than 200 000 Skr,

age 16-24 and not gainfully employed. Non-motorists give the lowest value of all, and lack a significant valuation of the high speed train compared to the bus. The mean for the whole sample is 19 Skr.

The mean value of travelling time is 67 Skr/hr, varying between 53 and 94 Skr/hr. People with a household income over 500 000 Skr, university educated, men and gainfully employed, value travelling time more highly than women, not gainfully employed and non-motorists.

Non-motorist, Not gainfully employed, Women, Household income less than 200 000 Skr, 16-24, 1 km to station, Upper secondary school, Frequent-infrequent motorists, 1-3 km to station, Gainfully employed, Men, University, Household income over 500 000 Skr.

Increased frequency of service from hourly to half-hourly is valued on average at 19 Skr. The variation is 14-25 Skr for the socioeconomic factors tested, where household income over 500 000 Skr has the highest valuation and non-motorists the lowest.

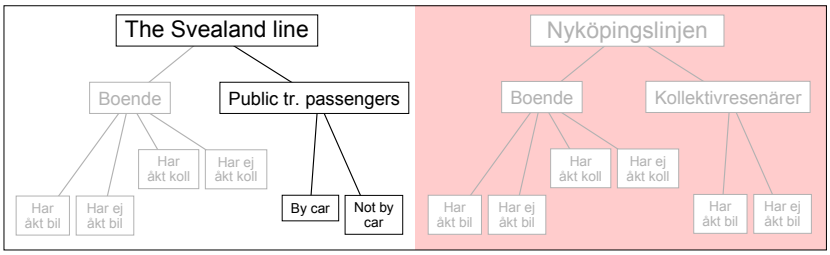
6.2.3 Public transport passengers' valuation

In 1997 train passengers on the Svealand line (and the Nyköping line) were given questionnaires with travel suggestions to rate that were identical to those given to residents, and passengers to and from Eskilstuna also in 1998. The SP studies of passengers were conducted using paired choices.

Public transport passengers' valuations as parameter values

The paired choice SP studies on portable computers in 1998 and 2000 were analysed with two different approaches, which gave different results. The analysis comprises the groups "price%", where all respondents' answers are included by making the prices relative to the fare, and an analysis of only the answers from passengers with single tickets costing up to 160 Skr and monthly pass holders. In "price%" an average ticket is assumed to cost 100 Skr, i.e. 1 Skr is equivalent to 1% when calculating the values of the factors.

The train passengers were asked to do different SP studies depending on whether they had access to a car as an alternative to the public transport journey they were on, or whether they did not have the car alternative. About ¾ of the passengers had access to a car as an alternative (drive or travel as a passenger). Of the passengers on the Svealand line who participated in the SP survey, about 1/5 were travelling on a monthly pass, while 1/3 of the passengers on the Nyköping line had a monthly pass.



In the analysis, parameter values are calculated as described in appendix 6. Some significant trends in the parameter values are that the price of the ticket has become less important between 1998 and 2000 for train passengers on the Svealand line. Travelling time has become less important for passengers without the possibility to travel by car as an alternative, but more important for train passengers with a car alternative.

There is also a difference in valuation depending on the type of ticket. Train passengers with monthly passes (season tickets), i.e. commuters, have higher parameter values for the factors frequency of service, travelling time and ticket price, than passengers with single tickets. The price of the ticket especially is considerably more important for passengers with monthly passes.

Passengers with monthly passes on the Svealand line have a low valuation of the travel modes (ordinary) train and high speed train compared to the bus, than passengers who travel on single tickets. The ordinary train is hardly valued positively at all compared to the bus by monthly pass passengers without a car alternative. An exception, however, is that passengers with the possibility to travel by car as an alternative value the high speed train highly irrespective of the type of ticket.

Public transport passengers' valuations in Skr

The value of the travel modes varies depending on the study year, whether a car alternative exists or not, and the analysis method. The value of the train compared to the bus has risen somewhat between 1998 and 2000. Passengers with the car alternative value the train and high speed train modes more highly in monetary terms than passengers without the car alternative. Travelling time, however, is valued at about the same amount irrespective of the car alternative, about 50 Skr/hr, except in the 1998 study where passengers with the car alternative have a significantly lower valuation, about 30 Skr/h. Monthly pass passengers also have a lower valuation of travelling time. In a discrete evaluation of the frequency of service an improvement from hourly to half-hourly frequency of service does not have a significant value in any of the

cases, while an improvement from every 3 hours to half-hourly has a high value. As an alternative, the calculated values of better frequency of service are also given, where a numerical analysis gave values in Skr per hour of improvement.

Valuation, public transport passengers on the Svealand line without car alternative

Factor	**1998** All (price %)	single tickets	**2000** All (price %)	single tickets	monthly pass
Travel mode *comp. to bus*					
Train	+22 Skr	+17 Skr	+36 Skr	+45 Skr	(+3 Skr)
High sp. train	+36 Skr	(+18 Skr)	+66 Skr	+72 Skr	(+17 Skr)
Travelling time	48 Skr/hr	58 Skr/hr	50 Skr/hr	52 Skr/hr	31 Skr/hr
Incr. frequency		13 Skr/hr		13 Skr/hr	13 Skr/hr
3 hrs →0.5 hr	+37 Skr		+50 Skr		
2 hrs→0.5 hr	+12 Skr		(-1 Skr)		
1 hr→0.5 hr	(-3 Skr)		(+6 Skr)		

(...) Not significantly different from 0

Valuation, public transport passengers on the Svealand line with car alternative

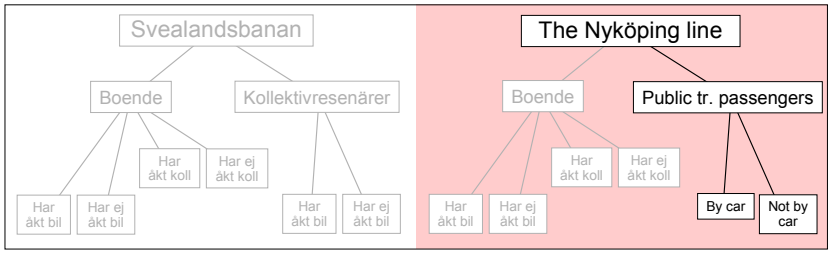
Factor	**1998** All (price %)	single tickets	**2000** All (price %)	single tickets	monthly pass
Travel mode *comp. to bus*					
Train	+54 Skr	+59 Skr	+58 Skr	+79 Skr	(+16 Skr)
High sp. train	+102 Skr	+116 Skr	+95 Skr	+121 Skr	+49 Skr
Travelling time	26 Skr/hr	34 Skr/hr	50 Skr/hr	65 Skr/hr	34 Skr/hr
Incr. frequency		22 Skr/hr		43 Skr/hr	24 Skr/hr
3 hrs→0.5 hr	+53 Skr		+77 Skr		
2 hrs_0.5 hr	+14 Skr		+43 Skr		
1 hr→0.5 hr	(+1 Skr)		(+4 Skr)		

(...) Not significantly different from 0

Some shifts within the analysis groups and between the study years can probably be explained by correlation between the travel mode and travelling time factors. Monthly pass passengers especially are also a relatively small group in the studies, and the number of observations is in some cases too small to give significant results (see appendix 6).

Segerman (see section 2.3.3) gives values for the factors in 1996 that agree well with the studies described here.[271] Karl Kottenhoff evaluated Segerman's study again later, and the value of a journey by train was then given as 17 Skr and by high speed train as 31 Skr compared to the bus. Travelling time is valued at 49 Skr/hr.[272]

Public transport passengers' valuations, the Nyköping line



The parameter values for the train passenger show that travel mode is very important, and that track-bound traffic is valued more highly than buses. Passengers on the Nyköping line value ordinary trains about as highly as high speed trains, in contrast to the train passengers on the Svealand line who show a clear preference for the high speed trains over ordinary trains.

Valuation, public transport passengers on the Nyköping line without car alternative

Factor	***1998*** *All (price %)*	*single tickets*	***2000*** *All (price %)*	*single tickets*	*monthly pass*
Travel mode *compared to bus*					
Train	+51 Skr	+47 Skr	+46 Skr	+51 Skr	(+14 Skr)
High sp. train	+56 Skr	+41 Skr	+52 Skr	+58 Skr	(+20 Skr)
Travelling time	(20 Skr/hr)	(24 Skr/hr)	50 Skr/hr	(31 Skr/hr)	(41 Skr/hr)
Incr. frequency		14 Skr/hr		18 Skr/hr	12 Skr/hr
3 hrs→0.5 hr	+49 Skr		+48 Skr		
2 hrs→0.5 hr	+23 Skr		+22 Skr		
1 hr→0.5 hr	(+5 Skr)		(+12 Skr)		

(...) Not significantly different from 0

[271] Segerman (1997)
[272] Fröidh (1999)

Valuation, public transport passengers on the Nyköping line with car alternative

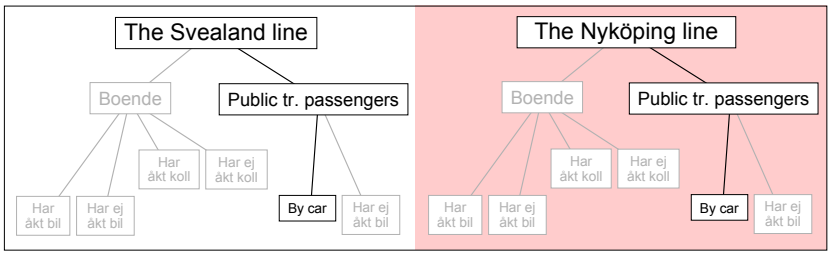
Factor	***1998*** *All (price%)*	*single tickets*	***2000*** *All (price%)*	*single tickets*	*monthly pass*
Travel mode *compared to bus*					
Train	+70 Skr	+86 Skr	+59 Skr	+69 Skr	+31 Skr
High sp. train	+88 Skr	+116 Skr	+65 Skr	+90 Skr	+38 Skr
Travelling time	(9 Skr/hr)	(-6 Skr/hr)	22 Skr/hr	33 Skr/hr	(-8 Skr/hr)
Incr. frequency		12 Skr/hr		19 Skr/hr	7 Skr/hr
3 hrs→0.5 hr	+44 Skr		+44 Skr		
2 hrs→0.5 hr	(+8 Skr)		(+9 Skr)		
1 hr→0.5 hr	(0 Skr)		(+2 Skr)		

(...) Not significantly different from 0

The field surveys of passengers on the Nyköping line comprise about half as many individuals as on the Svealand line, which means that there are more results that are not significant. The value of a shorter travelling time for example has in two cases become negative, which is improbable for the type of traffic being studied here.

Passengers on the Nyköping line show a high willingness to pay for track-bound modes compared to the bus, but the difference between ordinary trains and high speed trains is small, and markedly less than on the Svealand line. With few exceptions the Nyköping passengers also seem to value the travelling time lower than passengers on the Svealand line. Passengers with a car alternative give higher values for track-bound modes, but lower values for travelling time compared to passengers without a car alternative.

Public transport passengers' valuation of the car



The SP study of the public transport passengers included a car alternative for those passengers who have the possibility to travel by car as an alternative to the journey they were making by bus or train. The survey, however, had no factors other than "car", in contrast to the public transport alternatives that had the factors travel mode, travelling time,

frequency of service and fare. The willingness to pay for "car" can be calculated in the logit analysis. On the basis of willingness to pay, the value of the car mode itself can be estimated, given an average travel cost and travelling time.

Expressed in another way, willingness to pay and a positive value (compared to the bus) for the travel mode is assumed to balance the sacrifice in time and money for making the journey;

Willingness to pay = travel cost + travelling time - value of travel mode

According to the studies among the residents, a journey by car cost on average 1.40 Skr/km in 1998. In 2000 the cost had risen to 1.50 Skr/km. The average distance travelled and travelling time are estimated at 100 km and 1 hour 15 minutes respectively.

Valuation of the car alternative, public transport passengers on the Svealand line

Car	***1998***		***2000***		
	All (price%)	*single ticket*	*All (price%)*	*single ticket*	*monthly pass*
Willingness to pay	7 Skr	121 Skr	44 Skr	176 Skr	104 Skr
Travel cost *100 km×*	*1.4 Skr/km* 140 Skr	*1.4 Skr/km* 140 Skr	*1.5 Skr/km* 150 Skr	*1.5 Skr/km* 150 Skr	*1.5 Skr/km* 150 Skr
Travelling time *1:15 hrs×*	*26 Skr/hr* 32 Skr	*34 Skr/hr* 43 Skr	*50 Skr/hr* 62 Skr	*65 Skr/hr* 81 Skr	*34 Skr/hr* 42 Skr
Travel mode *comp. to bus*	165 Skr	62 Skr	168 Skr	55 Skr	88 Skr

(...) Not significantly different from 0

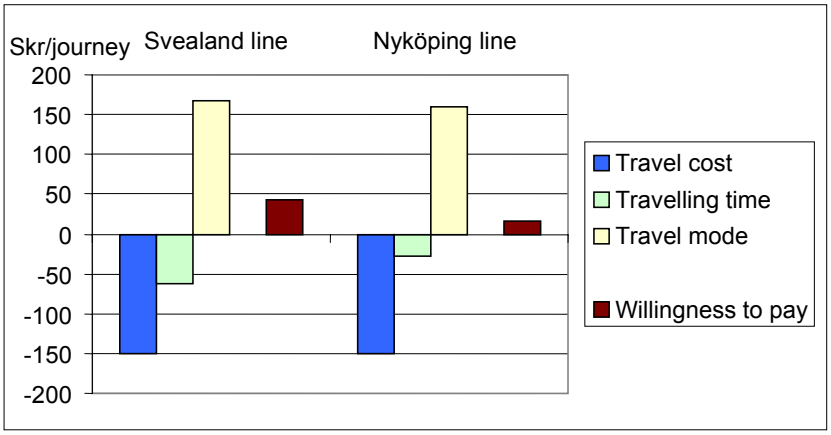
The different analysis methods give significantly different results regarding the value of the car mode. In the case where all passengers are included (price%) the analysis gives a higher value, between 160 Skr and 170 Skr both study years, for passengers on both the Svealand line and the Nyköping line. The analysis of the groups with single tickets costing up to 160 Skr and monthly passes gives the values 35-95 Skr for the car. However, the analysis also showed that shorter travelling time in two cases had a negative effect in the latter interval. All together, the price% method is considered to give the most credible result with regard to the value of the car mode.

Valuation of the car alternative, public trpt. passengers on the Nyköping line

Car	**1998**		**2000**		
	All (price%)	*single ticket*	*All (price%)*	*single ticket*	*monthly pass*
Willingness to pay	-16 Skr	62 Skr	(17 Skr)	155 Skr	44 Skr
Travel cost *100 km×*	*1.4 Skr/km* 140 Skr	*1.4 Skr/km* 140 Skr	*1.5 Skr/km* 150 Skr	*1.5 Skr/km* 150 Skr	*1.5 Skr/km* 150 Skr
Travelling time *1:15 hrs×*	*9 Skr/hr* 11 Skr	*(-6 Skr/hr)* -7 Skr	*22 Skr/hr* 27 Skr	*33 Skr/hr* 41 Skr	*(-8 Skr/hr)* -11 Skr
Travel mode *comp. to bus*	167 Skr	70 Skr	160 Skr	36 Skr	95 Skr

(...) Not significantly different from 0

Value of the car alternative, the Svealand line and the Nyköping line, 2000

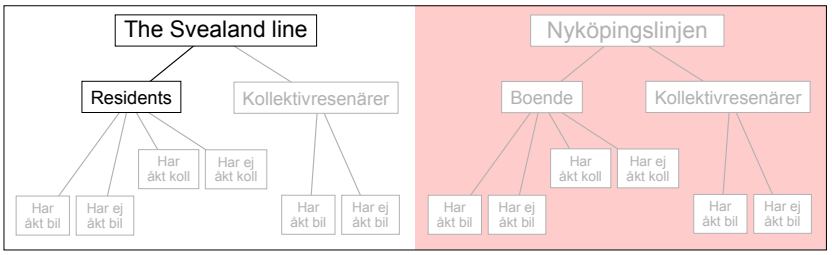


Value in Skr of the car alternative for train passengers on the Svealand line and the Nyköping line, 2000 (All, price%).

6.2.4 Valuation of the whole journey

Residents along the Svealand line

A few concrete examples show how the supply is valued by means of the attributes travel mode, travelling time and frequency of service. A journey by bus is compared to two alternatives; ordinary train and high speed train on the Svealand line. The values of the travel mode, the travelling time and the frequency of service are taken from the regression analysis of the SP study of residents, described in section 6.2.2.



In the example below, where a journey by high speed train is compared to the ordinary train, the gain in travelling time per journey is assumed to be 40 minutes between Eskilstuna and Stockholm, 50 minutes to Strängnäs (change at Åkers styckebruk), 20 minutes to Mariefred and Åkers styckebruk and 10 minutes to Nykvarn. The frequency of service of the high speed trains is assumed to be double that of ordinary trains (see the table).

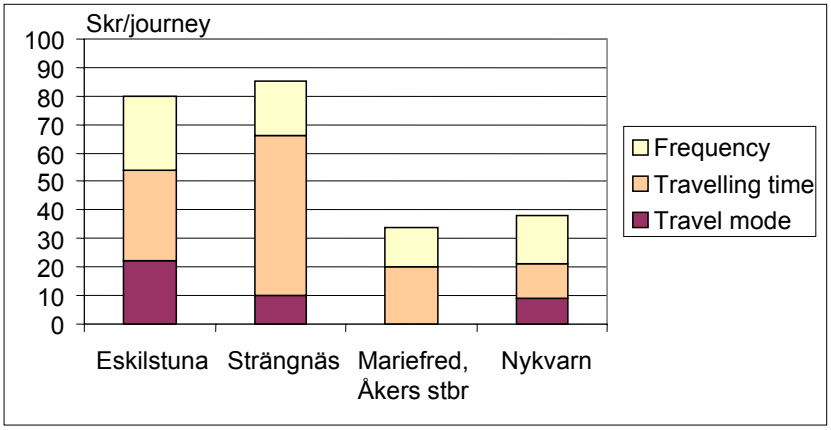
Examples of valuation of high speed trains compared to ordinary trains, residents, 2000

Svealand line	*Eskilstuna*	*Strängnäs*	*Mariefred, Åkers stycke-bruk*	*Nykvarn*
Travel mode	22 Skr	10 Skr	-1 Skr	9 Skr
Travelling time	40 mins× 48 Skr/hr= 32 Skr	50 mins× 67 Skr/hr= 56 Skr	20 mins× 59 Skr/hr= 20 Skr	10 mins× 73 Skr/hr= 12 Skr
Freq. of service				
2 hrs→1 hr	26 Skr			
1 hr→0.5 hr		19 Skr	14 Skr	17 Skr
Summa	80 Skr	85 Skr	33 Skr	38 Skr

The whole journey between Eskilstuna and Stockholm with the high speed train is valued 80 Skr higher than the ordinary train, 85 Skr higher to Strängnäs, 33 Skr to Mariefred and Åkers styckebruk and 38 Skr higher to Nykvarn. The proportions of the total value that can be attributed to frequency of service, travelling time and travel mode vary with the home community.

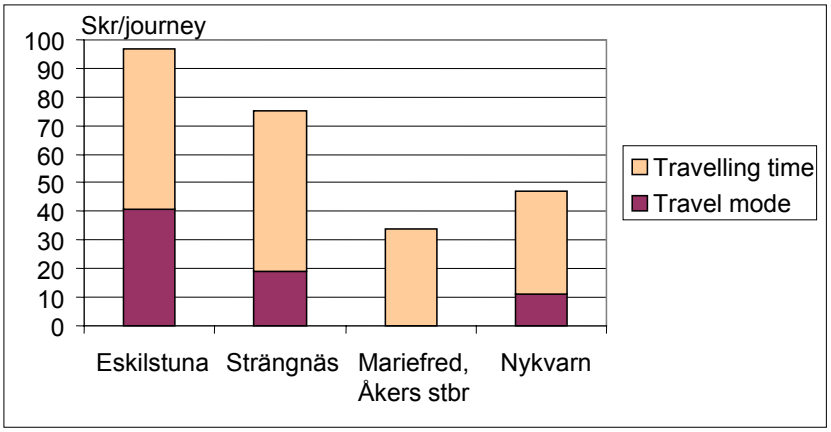
In the same way, the total valuation of a journey by high speed train compared to the bus was also calculated. The estimated time gains were here 70 minutes from Eskilstuna, 50 minutes from Strängnäs, 35 minutes from Mariefred and Åkers styckebruk and 30 minutes from Nykvarn. Frequency of service is assumed to be same for the high speed train service supply as for the bus services (hourly).

Residents' valuation of a journey by high speed train compared to ordinary train, 2000



Value of a journey by high speed train on the Svealand line compared to a train journey on the old line, according to the 2000 study.

Residents' valuation of a journey by high speed train compared to bus, 2000



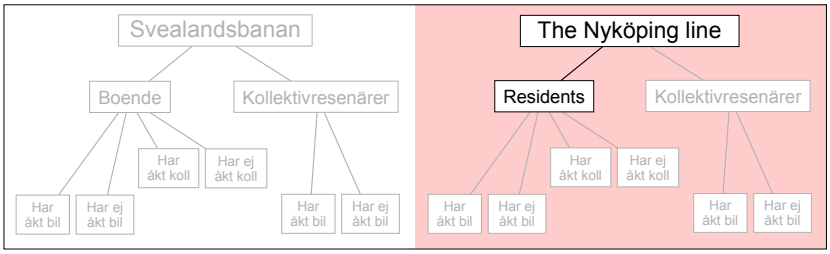
Value of a journey by high speed train on the Svealand line compared to a journey by bus, according to the study in 2000. Frequency of service is the same for both alternatives.

Under these conditions a journey between Eskilstuna and Stockholm is valued almost 100 Skr higher for the high speed train than for the bus, 75 Skr to Strängnäs, 34 Skr to Mariefred and Åkers styckebruk and 47 Skr higher to Nykvarn.

Residents' valuations of a journey by high speed train compared to one by train or bus, show a similar profile irrespective of travel mode. The Eskilstuna residents tend to give the high speed train mode a rather high value. The residents in Mariefred and Åkers styckebruk show no difference between the bus and ordinary train alternatives, and the value

of the high speed train journey is relatively small. The value must be seen in relation to the price of the ticket.

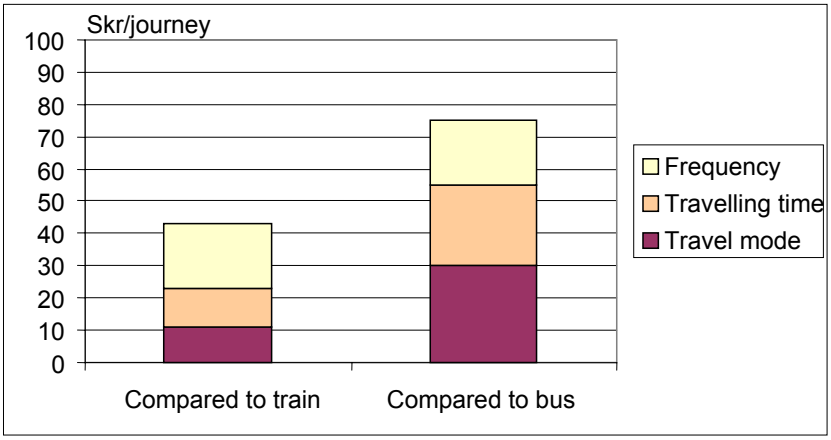
Residents in Nyköping



The alternative with a high speed train taking 45 minutes to Stockholm Central station was analysed for Nyköping residents. With today's trains on the old line, the journey takes 1 hour 5 minutes, and 1 hour 25 minutes by bus on the motorway (with no rush hour traffic jams). Frequency of service for the high speed trains is once an hour, and every two hours for the other alternatives. The short travelling time by high speed train, however, can only become a reality if a planned new line, the so-called Nyköping or Eastern link, is built.

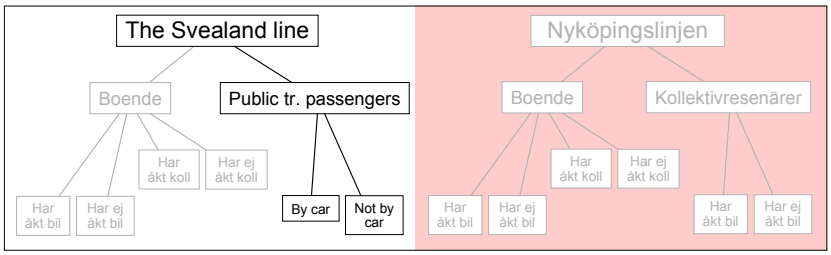
With the values in the table "Valuation, residents in Nyköping" in section 6.2.2 a journey by high speed train is valued 43 Skr higher than one by ordinary train and 75 Skr higher than a journey by bus. The difference between ordinary train and bus is 32 Skr, i.e. the train journey is valued 32 Skr higher than a journey by bus under the above conditions.

Nyköping residents' valuation of high speed train journey, 2000



Value of a journey by high speed train with a travelling time of 45 mins and a frequency of service of 1 hr, compared to a journey by ordinary train with a travelling time of 1 hr 5 mins and frequency of service every 2 hrs, and bus with a travelling time of 1 hr 25 mins and frequency of service every 2 hrs.

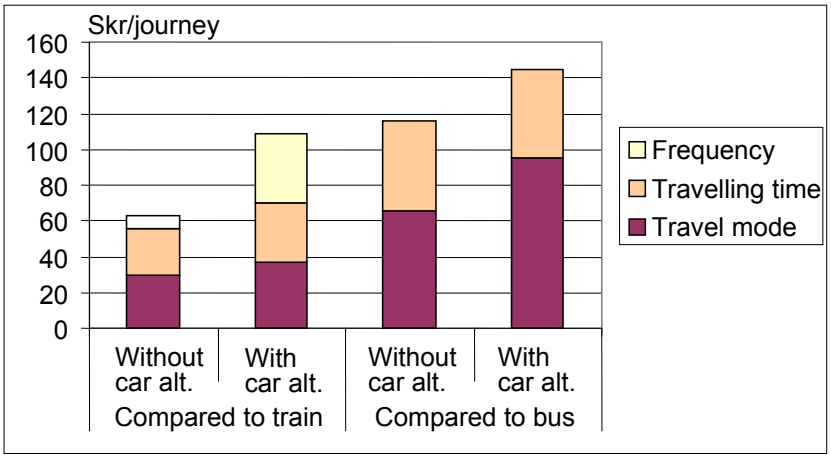
Public transport passengers on the Svealand line



The SP study was divided into two variants depending on whether the passenger had the possibility to travel by car or not instead of making the journey by train. The analysis of the two groups is called "without car alternative" and "with car alternative". The average travelling time along the Svealand line was estimated to be 55 minutes by high speed train, 1 hour 35 mins by ordinary train and 1 hour 55 mins by bus. Frequency of service for the ordinary train is once every two hours, and for the high speed train and the bus once an hour.

The total value of a journey by high speed train on the Svealand line compared to a journey by ordinary train where the passengers do not have a car as an alternative was 56 Skr, and 109 Skr with the car alternative. A journey by high speed train compared to a journey by bus is valued in total at 116 Skr without the car alternative, and 145 Skr if the passenger has a car as an alternative.

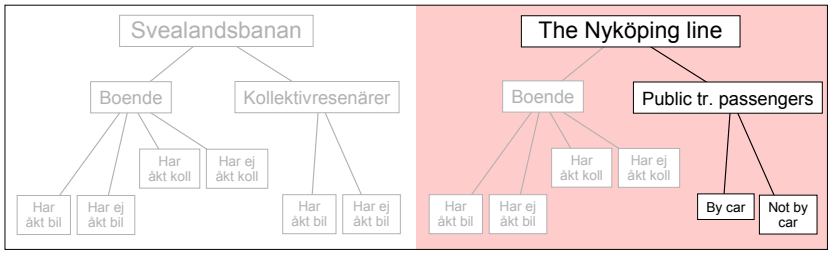
Value of a journey by train, passengers on the Svealand line 2000



Passengers on the Svealand line in 2000, with and without a car as an alternative to the public transport journey they are on. Note that the value of the frequency of service for the journey compared to the train, without a car alternative (the leftmost bar), became negative (-7 Skr, not significant) in the analysis. The total of the values in this case is 56 Skr.

In the interviews with passengers on board the trains on the Svealand line, passengers travelling all the way between Stockholm and Eskilstuna dominate. For this reason, the most relevant thing to do is to compare the passengers' valuations against the valuations the Eskilstuna residents had the same year. One trend is that passengers had higher valuations of the high speed train journey than residents had, except in the case of the passengers without a car alternative, who compare to the ordinary train. Passengers who have a car as an alternative have higher valuations than passengers who do not. Compared to the train the frequency of service stands out as more important for passengers with a car alternative, and compared to the bus the high speed train mode is more important.

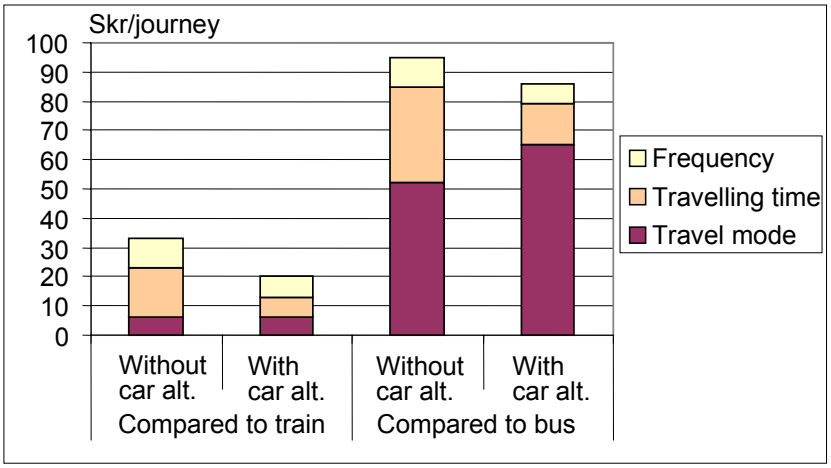
Public transport passengers on the Nyköping line



For passengers on the Nyköping line the same average travelling times are assumed as for residents of Nyköping for a journey to Stockholm, i.e. 45 minutes by high speed train on a new line, 1 hour 5 minutes by ordinary train and 1 hour 25 minutes by bus. Frequency of service is hourly for high speed trains and 2 hours for the other alternatives.

A journey by high speed train between Nyköping and Stockholm compared to the ordinary train is valued at 33 Skr by passengers who do not have a car as an alternative and 20 Skr by passengers who do have a car as alternative. The journey by high speed train compared to the bus is valued at 95 Skr by passengers without a car alternative and 86 Skr by those with a car. Note that the value of increased frequency of service is not significantly different from zero in any of the cases.

Value of a journey by high speed train, passengers on the Nyköping line, 2000



Passengers on the Nyköping line in 2000, with and without a car as an alternative to the journey by public transport they are making. The value of a journey by high speed train with a travelling time of 45 mins and hourly frequency, compared to a journey by ordinary train, with a travelling time of 1 hr 5 mins and a frequency of service once every 2 hrs, and by bus, travelling time 1 hr 25 mins and a frequency of service of once every 2 hrs.

Difference between public transport passengers on the different lines

Characteristic of the passengers on the Nyköping line is that they assign only a small value to the high speed train compared to the ordinary train, but an all the greater value on the high speed train or train compared to the bus. Their valuation of travelling time is lower than for passengers (and residents) along the Svealand line. Passengers with a car alternative on the Nyköping line put a somewhat lower value on journeys by high speed train than passengers without a car alternative, in contrast to passengers on the Svealand line. Common to both the Nyköping line and the Svealand line, however, is that passengers with a car alternative give the high speed train travel mode compared to the bus a higher value than the passengers without a car alternative.

The differences in valuations of the factors on the Nyköping line compared to the Svealand line might depend on a different distribution of passengers' trip purpose, access to a car or sampling error. A check, however, reveals that the differences in trip purpose and access to car, on the other hand, are too small to be expected to affect the valuations. The difference in car access between the passengers on the different lines is that 6% of the interviews on the Svealand line represent passengers who never have access to a car, whereas the corresponding proportion on the Nyköping line is 12%. The respondents who never have

access to a car, however, number roughly the same on both lines (ca 45%).

The conclusion is that both Nyköping residents and passengers on the Nyköping line have lower valuations than their counterparts on the Svealand line.

6.2.5 Most important improvement

In the residents' interviews there was a question about what the respondent as a car traveller most wishes to see for him or her to consider travelling by public transport instead of by car on their latest journey outside their home community, and what he or she would like to improve with regard to their latest journey outside their home community by public transport. The corresponding question is also included in the public transport passengers' interviews, where the question asks what the passenger would most like to improve about the bus or train journey they are on. See also the study reported in section 2.4.1.

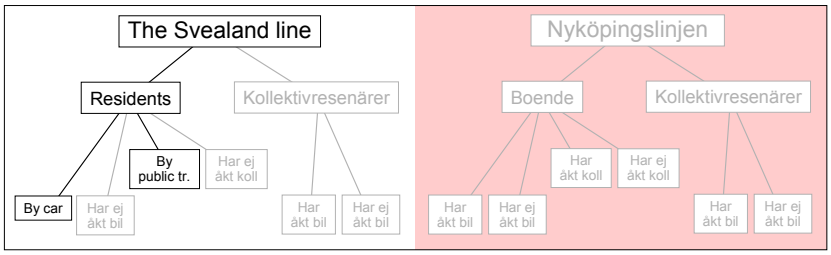
The grouped responses can be divided into four main groups; standard, comfort, service and quality.[273] Standard refers to what the transport company promises to accomplish with "hard" attributes, which include fares, frequency of service, waiting times and connections, or for all practical purposes what the transport companies write in their timetables. Comfort factors are primarily attributes that have to do with the design of the places where the passenger will be, for example heating, ventilation, lighting, sound and noise, vibration, the design of the seats etc. Service refers first and foremost to with what and how the traffic company treats its customers, such as the possibility to obtain information, ticket handling and refreshments. Quality, finally, refers to deviations from what the passenger expects. Deviation from passengers' expectations might be caused by insufficient information, but most often because the transport company does not fulfil what it promises, whether explicitly or implicitly. This includes delays and cancelled trains, having to stand, poor cleaning and closed toilets.

The report below contains most details about standard, while comfort and service each have one category. Quality has two categories of its own; more seats and better punctuality, while other desires with regard to quality are included in the respective categories, for example the view that talking on a mobile phone disturbs other passengers is included in "better comfort". The main reason for this division is that with the brief answers that the respondents could give in the studies, only in rare cases was it possible to decide whether it was it a desire for

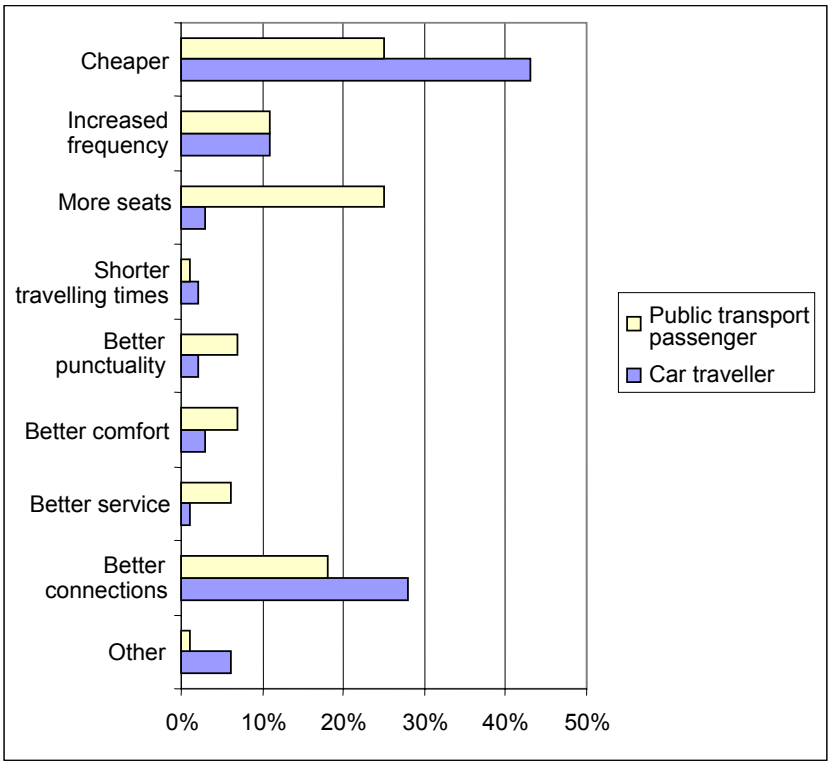
[273] Kottenhoff (1999), chapter 8.3

a quality improvement or not. Where the respondent made several suggestions, only the first is included in the study. One example is that if a respondent wrote "cheaper, more seats" and in that order, this has been interpreted as saying that cheaper tickets are the most important thing.

Residents along the Svealand line



Desired improvement, residents along the Svealand line, 2000



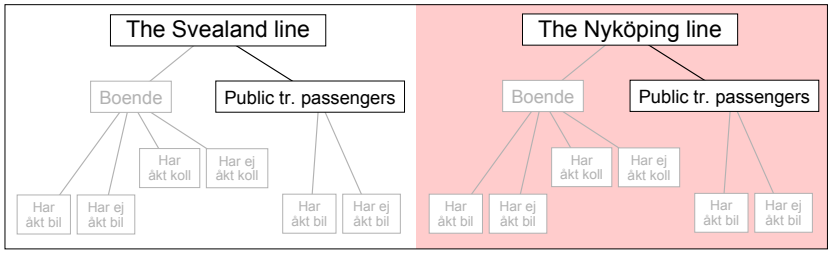
Residents along the Svealand line. Base: Respondents who answered that they wished for an improvement of some kind. "Car traveller" and "Public transport passenger" refer to the desire for an improvement with regard to the latest journey by each mode of travel as described in the mail questionnaire.

The proportion of residents who desired an improvement of some kind in order to consider travelling by public transport for their latest journey outside their home community is about 60%, while the remain-

der, except for a few who stated that they were satisfied, either gave no answer at all, or answered "don't know". The proportion who desired some kind of improvement to their latest journey by public transport outside their home community is almost 50%. A small proportion, 5%, say that they are satisfied, while the remainder did not answer the question or answered "don't know".

Those who travelled by car for their latest journey outside their home community wanted a cheaper journey by public transport more than those who were travelling by public transport, 43% and 25% respectively of all who suggested an improvement. 28% of the car travellers also wanted better connections, compared to 18% of the public transport passengers. The public transport passengers, mainly train passengers on the Svealand line, had more comments to make about the quality of the train services, and 25% asked for more seats (on the trains). Many also wanted better punctuality, comfort and service.

Public transport passengers on the Svealand line and the Nyköping line

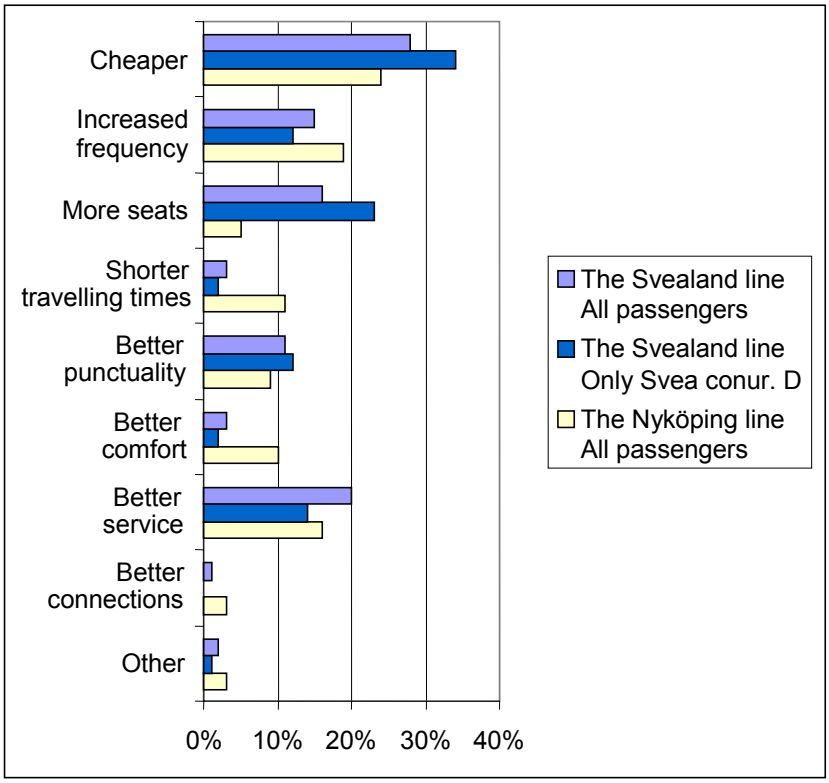


Passengers on the Svealand line have been divided into two groups; all passengers and only those who live in Svea conurbation D, i.e. Eskilstuna, Strängnäs, Åkers styckebruk or Mariefred. The proportion of train passengers who desired some form of improvement to their current journey in the study in 2000 is 64-70% for all three groups. A slightly higher proportion of passengers on the Nyköping line say that they are satisfied with their journey than passengers on the Svealand line, but the proportion is rather small (7-12%). The remaining respondents did not answer or answered "don't know".

Of the train passengers on the different lines in 2000 who suggested a desired improvement, "cheaper" was the most common one. For train passengers on the Svealand line living in Svea conurbations D, lower fares were relatively speaking more important (34%) than for all passengers on the Svealand line (28%), or the Nyköping line (24%). Of the other supply factors, increased frequency of service is the most important. But most important of all is that the transport companies deal with all the quality defects that passengers found unsatisfactory at the time of

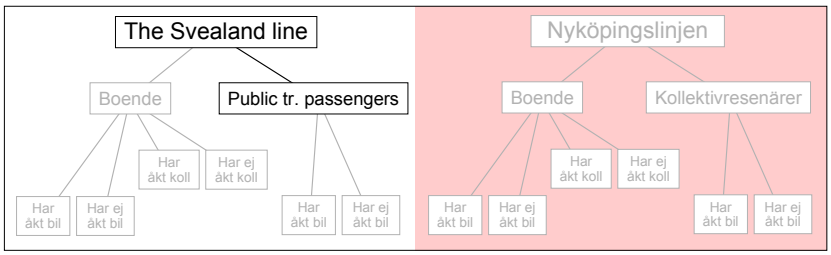
the interview; for example increase the number of seats on the trains on the Svealand line, reduce the number of delays and improve service on both lines.

Public transport passengers' desired improvements, 2000



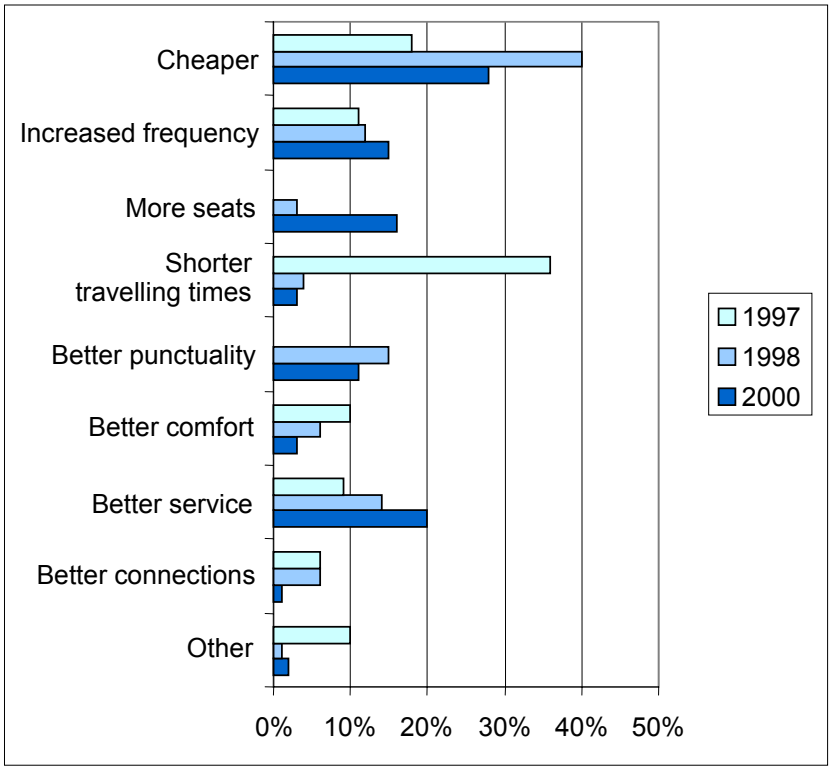
Base: Passengers who answered that they wished to see an improvement.

Public transport passengers on the Svealand line



The proportion of passengers on the Svealand line in 1998 and 2000 and on SJ's buses in 1997 who desired some improvement is 63-70% of all respondents. 7-10% say they are satisfied and the remainder "don't know".

Public transport passengers' desired improvements, the Svealand line



Base: Passengers who answered that wished to see some form of improvement, SJ's bus services in 1997, train services on the Svealand line in 1998 and 2000. In 1997, "Other" includes a group who answered that they wanted trains instead of buses as the most desirable improvement.

During the bus service period, the most frequently desired improvement was shorter travelling times, given by 36% of passengers who wanted an improvement of some kind (cf. section 2.4.1). After the train services began only a few passengers thought that travelling times were the most important thing to improve. The most urgent improvements suggested were instead cheaper tickets, better service, more seats and increased frequency of service. "Cheaper" fell in importance between 1998, when 40% of passengers who wanted to improve something gave this alternative, and 2000, when 28% wanted lower fares. The demand for better service, on the other hand, grew over the period, and 20% of the passengers on the Svealand line said they wanted this in 2000. More seats, increased frequency of service and better punctuality were also important.

6.3 Discussion and summary

6.3.1 Knowledge about the supply

The basic interval timetable, with regular hourly departures, means that many passengers learn the timetable by heart. They do not need to check the trains' departure times. The train services on the Svealand line thus have an advantage over the previous bus services, or the train services on the Nyköping line, where irregular services mean that passengers have to seek information to a greater extent before making a decision about their journey.

Most of the residents have a true picture of the frequency of service on the Svealand line, while there were rather many who assumed that the buses' frequency of service was not as high as it actually was. The most important reason for the excellent knowledge of the high speed train services is probably that the radical change in supply was given good publicity for several years while the line was being built. In Eskilstuna about 90% of the residents assume that the trains run once an hour in the direction of Stockholm during the day. A trend in the study is that people assume that frequency of service will be higher with the trains than it actually was with the buses in 1997, in spite of the fact that the frequency of service in actual fact was in principle the same.

The average journey by public transport outside the passenger's home community was shortened by half an hour for residents along the Svealand line, from 1 hr 50 mins by bus in 1997 to 1 hour 19 mins by train in 2000. Car-travelling residents, too, have noticed that the public transport journey would be faster if they chose the train as an alternative, but the reduction in travelling time is not expected to be as great here; from 1 hr 47 mins in 1997 to 1 hr 23 mins in 2000, i.e. about 20 minutes faster. There are probably three main reasons why travelling time has penetrated to car travellers to a lesser degree. First, their knowledge of the public transport supply might not be so good because they often travel by car. Second, they can choose the mode of travel that is best for the destination in question, and choose the car when the public transport supply is poor. Third, people may often strive to justify their own choices, and the alternative is consequently then not as good as a person who chose that particular alternative thinks.

Car travellers along the Svealand line think that the public transport alternative became more expensive, but faster, between 1997 and 2000. However, it is in fact for both years more expensive and slower to travel by public transport than to make the car journey they described. Public transport passengers believe that the difference in cost for an alternative car journey has decreased, while travelling time has increased propor-

tionally speaking. Public transport passengers therefore believe that the car journey is faster but more expensive both years. The differences, however, have become smaller.

The obvious changes in knowledge of the supply are that the cost of travelling by public transport has risen relative to the car journey, and that travelling time has become shorter between the bus services before (1997) and the train services (2000). Those who travelled by car, however, think that public transport is more expensive for the same journey, whereas those who travelled by public transport believe that the car journey is clearly the more expensive alternative. Both groups agree that the car journey is faster.

When the local public transport authority's bus services parallel to the Svealand line were discontinued, many passengers may have found they had to pay more for the whole journey since SJ operates the train service without any contribution from the community, whereas the local public transport authority's services are partly subsidised from public funds. This explains the reduction in the difference in cost between a journey by car and a journey by public transport. On average, this has been compensated by shorter travelling times. But there are also tours where the gains in travelling time have not been so tangible. Even if the train services have generally meant an improvement, it is probable that some of the people who previously travelled by bus now travel by car.

6.3.2 Valuation of the supply

Valuation in the SP studies

The residents' scores in an SP study of the supply show that the attributes high speed train travel mode and travelling time are valued highly. Among residents with access to a car in Eskilstuna, 1/3 value the high speed train more highly for an imaginary journey to the centre of Stockholm at a higher ticket price (120 Skr), while all of 2/3 value the high speed train higher at a lower ticket price (70 Skr). The corresponding bus journey is valued higher than a car journey by only a very small number of motorists, while the ordinary train is somewhere in-between.

The regression analysis of the residents' scores in the 1998 and 2000 studies gives values of about 40 Skr for the high speed train mode for residents of Eskilstuna, 20 Skr for Strängnäs residents and 10 Skr for Nykvarn residents for a journey to the centre of Stockholm compared to the bus. The ordinary train is valued about 20 Skr higher than the bus by Eskilstuna residents and 10 Skr higher by Strängnäs residents. The scores do not give any significant values for the high speed train and ordinary train modes for residents of Mariefred and Åkers styckebruk

compared to the bus, nor for the ordinary train compared to the bus for Nykvarn residents.

In empirical studies of two cases in the USA, Ben-Akiva and Morikawa have shown that passengers do not have any significant valuation of track-bound traffic compared to bus, if all other attributes are equal (travelling time, frequency of service, fares etc.). A change between bus and train, on the other hand, is valued very negatively compared to a non-stop journey. The higher valuation of the train compared to the bus that nonetheless occurs in different studies can in their opinion probably be attributed to, among other things, better reliability, availability of information, comfort, safety and service as regard trains, and to the fact that the measurement methods do not distinguish these factors from the travel mode.[274]

The conclusion is that with regard to journeys from Mariefred and Åkers styckebruk it is the connecting trip to the railway station at Läggesta that has a strong influence on the valuation of the ordinary train travel mode, compared to (in certain cases) a non-stop journey by bus.

It may also be so that some of the respondents compare a seat on a bus with standing on a train at rush hour. This would explain even more of the low valuation of the travel mode that the passengers from Läggesta and Nykvarn have. These passengers more often found the train full on journeys to Stockholm during the rush hour than passengers from Strängnäs and Eskilstuna did.

The 1997 study gave uncertain results for the travel mode, probably because the factors in the study correlate to some extent, and because the respondents may have had difficulty in imagining what it feels like to travel by train and high speed train on the future Svealand line.

The average valuation of travelling time for residents along the Svealand line was 48-73 Skr/hr in the study in 2000. The value of the travelling time increased considerably more than the consumer price index between 1998 and 2000. It is lowest for residents of Eskilstuna, highest for residents of Nykvarn and Strängnäs. The value of travelling time varies, among other things, with the purpose of the journey, and a greater proportion of leisure time travellers from Eskilstuna probably lowers the value to about 50 Skr/hr for the average resident. It is obvious, however, that a higher proportion of commuters raises the value. Travelling time values around 70 Skr/hr for journeys from Strängnäs and Nykvarn are twice as high as the value given for regional private journeys in Banverket's calculation guide.[275] Nyköping residents' valua-

[274] Ben-Akiva and Morikawa (2002)
[275] Beräkningshandledning, *Calculation guide* (2001)

tion of travelling time is lower than for residents along the Svealand line, the valuation there agrees with Banverket's calculation guide (35 Skr/hr). There is therefore reason to assume that the new passengers on the Svealand line have caused the increase in the valuation of travelling time.

The value of increased frequency of service was about 25 Skr for hourly services instead of two-hourly departures, and 15-20 Skr for half-hourly instead of hourly.

The valuation of the supply factors varies with socioeconomic factors. People with a high household income, university education, men and gainfully employed value travelling time more highly than women, not gainfully employed and non-motorists. The valuation of time is dependent on income; a higher income gives higher time values, as several studies have shown.[276]

One difference in the valuation between train passengers and residents is that the train passengers value the high speed train more highly then residents in general do, but put less emphasis on the fare and the alternative of travelling by car. For the train passengers this reflects their actual choice for the journey they were on. Passengers with monthly passes are more price-sensitive than passengers with single tickets, while the travel mode is not as important for passengers with monthly passes. One exception, however, are passengers with a car alternative who generally speaking value the high speed train mode higher than the ordinary train and bus.

The SP study with paired choices on board the trains confirms the conclusions drawn from residents' SP scores. Passengers on the Svealand line have higher valuations for travelling time and the high speed train mode than passengers on the Nyköping line. On the Svealand line passengers with a car as an alternative have a higher valuation than passengers without a car. This probably correlates to car owners' household income compared to non-car owners', and a high household income gives higher valuations. This may also be an effect of the car's comfort; car owners are prepared to pay more to avoid poorer comfort than non-car-owners. The valuation of the car mode of travel compared to the bus is 160-170 Skr per journey.

The valuation of the whole journey shows that the Eskilstuna residents are prepared to pay 100 Skr more on average for a journey by high speed train to the centre of Stockholm compared to journey by bus, and 80 Skr more than for a journey by ordinary train on the old line. If, on the other hand, the fares for different alternatives were the same, the

[276] See for example Wardman (2001)

high speed train will attract a considerably greater number of passengers than the old train services and the bus services.

Most important improvement

Regarding what passengers consider the most important improvement of a journey by public transport, most would like to see cheaper tickets. There are a few differences between public transport passengers and car travellers; car travellers also emphasise better connections to the stations, whereas the public transport passengers want more seats on the trains. Better punctuality, comfort and service also seem to be more important among the public transport passengers. This is probably an effect of the fact that car-drivers mainly know about the supply from the supply factors stated in the timetables, whereas the public transport passengers observe that the quality expected of the train journey is not reaching the level desired.

The changes between the study years show that in 1997, with the bus services, the most important thing for the public transport passengers along the Svealand line was shorter travelling times. Once the train services began, cheaper fares were what they wanted most. Between 1998 and 2000 the desired improvements changed with somewhat fewer respondents wanting cheaper tickets, while the desire for better service, increased frequency of service and more seats became more important. Demands with regard to standard and quality have thus grown, at the same time as price has decreased in importance.

6.3.3 New fares

One wish expressed by many of the residents and the public transport passengers is that the journey by the Svealand line must be cheaper. The train journey and the connections together may mean that the journey takes a disproportionately long time, is more expensive and thus no longer good value compared to making the journey by car. The border between two counties is hardly noticeable to car travellers, whereas it is extremely tangible for train passengers in the form of considerably higher fares. In addition, the marginal cost of taking a passenger along in the car is in principle 0, while it is anywhere up to 100% for another passenger with public transport. What it really comes down to is that public transport must offer a generalised cost for the whole journey door to door that can compete with the car. If the generalised cost, where the price or fare and the travelling times are the most important components, is high for the journey by public transport in relation to the car journey, the supply is not attractive.

The cost of driving a car was on average 15 Skr/10 km in 2000. A train ticket on the Svealand line the same year cost 10-14 Skr/10 km and 5-9 Skr/10 km with a monthly pass depending on the distance travelled. To this must be added the fact that people who choose a cheaper car can often drive at a lower cost than 15 Skr/10 km, but that they in general do not have the same possibility to obtain a discount on the train journey. If the cost of making a connecting journey is added, the cost of the journey by public transport increases, perhaps to 15 Skr/10 km or even more.

A developed fare should take into consideration competition with the car for the whole journey. This may require some form of fare subsidy, in the same way as the county public transport authority's services are subsidised at present. This must then be weighed against the positive effects for society that can be expected, among other things in the form of increased accessibility to public transport.

6.3.4 Increased frequency of service

Increased frequency of service from 1 train an hour to every half an hour would increase the valuation of the supply by 15-20 Skr per journey in the study made in 2000. To increase the attractiveness of the supply, it is thus possible to consider a differentiated supply (for example with high speed commuter trains and non-stop trains) and increased frequency of service rather than bigger trains. The improved supply would give shorter travelling times and better accessibility, which in turn give greater volumes of travel and the possibility to increase the train services' profitability.[277]

The Svealand line is single-track and was designed for a basic interval timetable which means a regular hourly frequency of service, with trains passing each other without stopping on the short (10 km) double-track section between Ryssjöbrink and Läggesta. All other timetable variants would mean longer travelling times since (at least) one of the trains would have to stop to allow the other one to pass. The Svealand line thus has strictly limited capacity, and increased frequency of service would lead to longer travelling time as long as the line is single track.

To increase the frequency of service on the line, and improve quality in terms of better punctuality, more capacity is needed on the Svealand line. In the long term, it will be probably be necessary to expand the line and make it double track along its length in order to be able to offer train services with a differentiated supply, high capacity and high quality.

[277] Effektiva tågsystem i Mälardalen, *Efficient train systems in the Mälaren valley* (1997)

6.3.5 Hypotheses

Knowledge

3. *Knowledge about the supply of train services is crucial to a high demand. The radical system change that the construction of the line and the start of the services meant should give widely spread knowledge about the supply.*

The population's knowledge about the supply of train services on the Svealand line seems to be very good, and considerably better than during the earlier bus service period, and better again than the corresponding knowledge of the residents of Nyköping. The research project, however, has not explored the reasons for the population's extensive knowledge, or where knowledge fits into the cause and effect relationship. The hypothesis can thus not be accepted, but nothing has been found to contradict it.

Valuation

4. *The valuation of the supply with regard to travelling times, frequency of service and fares ("hard" supply factors) for journeys by public transport can explain most of the demand, irrespective of travel mode. The shorter travelling times by train on the Svealand line consequently give a high value added per journey.*

In this case, travelling times by train are half those of journeys by bus, even if the travelling time door to door, including connections, has not always been shortened as radically. Frequency of service and fares are to all intents and purposes unchanged. A large part of the increased demand can consequently be attributed to the shorter travelling times, even if there are several factors that influence it. The field studies also indicate higher travelling time values since the train service began. The hypothesis can be accepted.

5. *The travel mode in itself influences travellers' choice of travel mode for the whole journey. The high speed trains on the Svealand line have contributed to the increase in demand for travel by public transport through their high level of comfort, service and design ("soft" supply factors).*

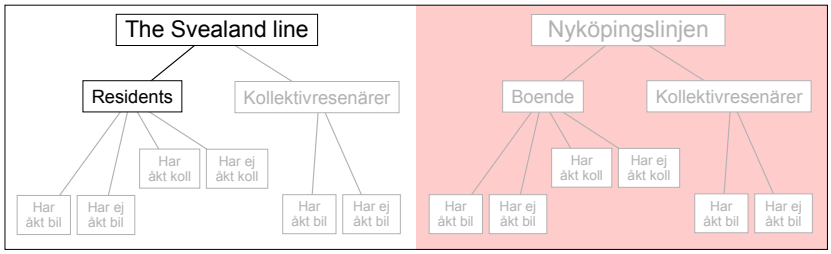
The valuation of the high speed train travel mode is higher than for the ordinary train, which in turn is higher than for the bus. In the field studies, these effects are most noticeable among residents of Eskilstuna and Strängnäs, while there does not appear to be such a great difference in valuation with regard to shorter distances. In the latter case, it may however be assumed that other factors also have some effect on the valuation, for example non-stop bus compared to changing to and from the bus or train in Läggesta. The hypothesis is therefore accepted.

7. Travel behaviour

The change in supply when train services began on the Svealand line also led to changes in travel behaviour. This chapter analyses the magnitude of the changes, and in which areas and socioeconomic groups the changes between before and after are significant. The analyses are based on the results from the field surveys.

7.1 Effects on car ownership

7.1.1 Car ownership along the Svealand line compared to the whole country



Households' car ownership, Svea conurbations AB+D and the whole country, 1997 and 2000

Households' car ownership	*1997*			*2000*		
	Svea conurb. AB+D		*Whole country*[278]	*Svea conurb. AB+D*		*Whole country*[279]
	all [1]	*panel*		*all* [1]	*panel*	
1 car	58%	53%	56%	57%	61%	53%
2 cars	*23%*	*24%*		*21%*	*18%*	
3 or more	*2%*	*2%*		*4%*	*4%*	
2 or more	25%	27%	27%	25%	22%	30%
No car	16%	20%	17%	19%	17%	17%

[1] All: Svea conurbations AB+D', i.e. residents of Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna, weighted. Panel: unweighted

The proportion of respondents in Svea conurbations AB+D' living in households along the Svealand line with two or more cars showed no changes between 1997 and 2000. The panel's car ownership, on the other hand, did change; the proportion of households with a car in-

[278] Svenskarnas resor 1997, *Swedes' journeys in 1997* (1998)
[279] RES 2000. Den nationella reseundersökningen, *National survey of travel habits* (2001)

creased at the expense of the households without a car and the households with two or more. The changes, however, are not significant.

Car ownership in the country as a whole changed, with a somewhat larger proportion of households with two or more cars in 2000 compared to 1997, and slightly fewer households with only one car.[280] [281]

A closer analysis of different areas based on the whole sample population shows that it is mainly the households in Strängnäs that have reduced their car ownership. The proportion of residents living in households with two or more cars fell by 7 percentage points between 1997 and 2000, while the proportion of households with only one car increased over the same period.

Households' car ownership, Strängnäs conurbation residents

Households' car ownership	*1997*	*2000*
1 car	60%	65%
2 or more cars	29%	22%
No car	11%	13%

Residents of Strängnäs living 0-3 km from the station. The changes between the years are not significant at α=0.05 (n_{1997}=140, n_{2000}=284)

It is in the groups of Strängnäs residents living 0-1 km and 1-3 km from the railway station, i.e. in the Strängnäs conurbation, that the changes can be seen clearly. Eskilstuna residents who live 0-1 km from the railway station show a similar tendency, where primarily the proportion of households without a car increased between the years. In other areas studied (Nykvarn, Mariefred, Åkers styckebruk, and Eskilstuna not including the town centre) households' car ownership shows the same trend as for the country as a whole, i.e. an increase in the number of households with more than one car. However, the changes at the area level are not significant because the sample population is small.

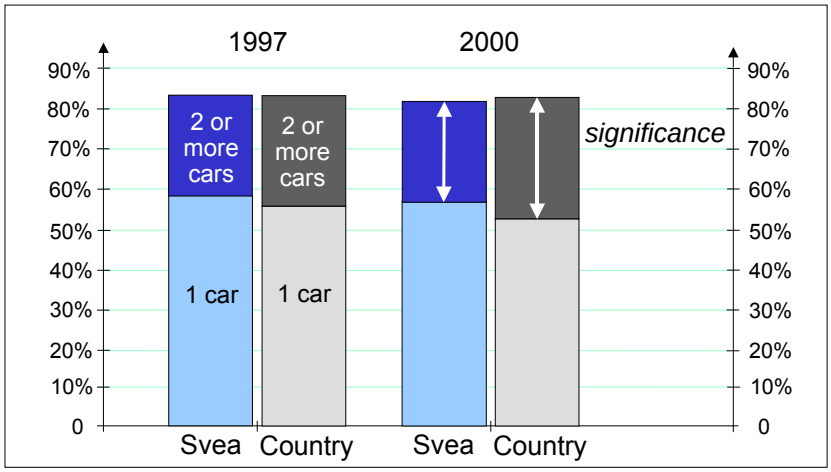
Car ownership varies widely depending on the area, and town dwellers generally speaking show lower car ownership than people who live in rural areas. Eskilstuna residents who live at most 1 km from the town centre (walking distance) owned 465 cars per 1 000 households in 1995. Some households, however, owned several cars, which means that the proportion of households without access to a car is greater than it may seem at first glance. The corresponding values for Eskilstuna residents

[280] Svenskarnas resor 1997 (1998) samt RES 2000. Den nationella reseundersökningen (2001), *Swedes' journeys in 1997* (1998) and *RES 2000. National survey of travel habits* (2001)

[281] It is difficult to check figures against SCB's (Statistics Sweden) car ownership statistics (Bilpak), because of changes in definition of the terms (households vs family). Moreover, SCB changed the definition of "family" between 1997 and 2000.

who live at cycling distance (1-3 km) from the town centre were 577 cars, at 3-5 km from the town centre 859 cars and more than 5 km 993 cars per 1 000 households.[282]

Households' car ownership along the Svealand line and in the whole country



In 2000, there were significantly (*) fewer households with 2 or more cars along the Svealand line than in the country as a whole. In 1997 there was no difference. "Svea" refers to Svea conurbations AB+D', i.e. residents in comparable areas in Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna, weighted.

With a 95% confidence interval the difference between the proportion of households with more than one car in Svea conurbations AB+D' and the country as a whole was significant in 2000, but not in 1997. The proportion of respondents in the panel who live in households with two or more cars was also significantly smaller than in the country as a whole the latter year. This means that fewer households along the Svealand line had two or more cars than in the country as a whole in 2000. In 1997 there was no difference.

7.1.2 Driving licence holders

The proportion of driving licence holders in the whole study (age 16-74) increased by a few percentage points over the period from 1997 to 2000.

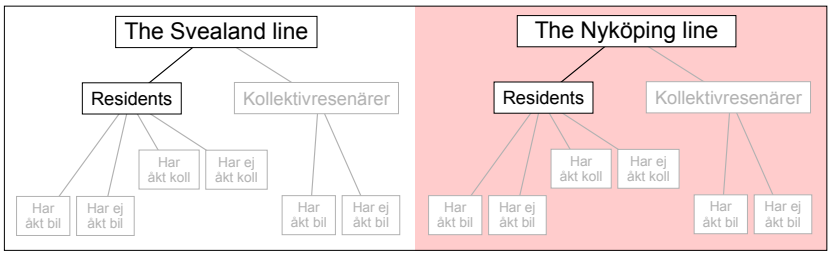
Driving licence holders (for a car)

Hold a driving licence	*1997*	*2000*
Women	74%	77%
Men	86%	88%
All	80%	82%

[282] Reneland (2001)

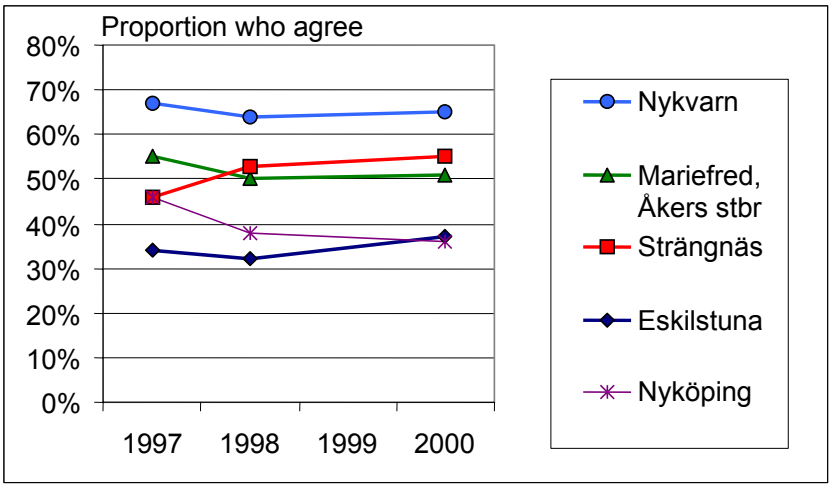
7.2 Effects on willingness to travel

7.2.1 Commuting



The difference in the population's commuting in the different communities is considerable. A larger community has a larger supply of jobs, and there is consequently little commuting outside the community. Nykvarn, Mariefred and Åkers styckebruk stand out as typical commuter communities where 60-70% of the gainfully employed and student residents commuted to other communities in 2000. Eskilstuna and Nyköping are largish conurbations with a small proportion of people commuting out, 10-20%; Strängnäs lies in-between with about 35%. There is a trend that commuting out increased over the period studied, especially in the first-mentioned conurbations.

Want to remain where they live and commute to Stockholm rather than move



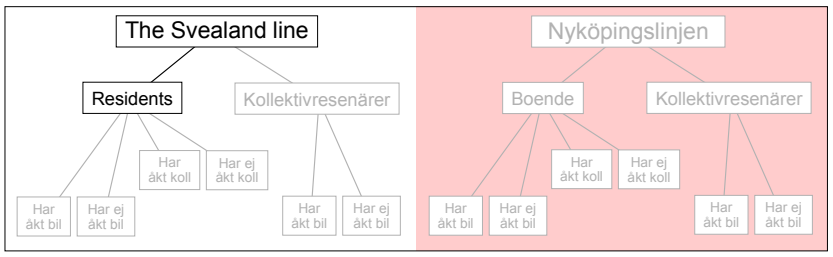
The proportion of residents in the various communities who would want to continue to live in their home community and commute to Stockholm if they were to get a job there, rather than move to Stockholm.

Of the commuters, about 20% commuted on the same route for a year at most, 20% for between one and three years, and 60% for longer than three years. There is no substantial difference between 1997 and 2000. On the other hand, the proportion who had commuted for longer

than three years on the same route decreased from 1997 to 1998, at the same time as the proportion who had commuted for less than a year increased by about five percentage points.

The proportion of residents who can consider commuting to Stockholm if they were to get a job there decreased somewhat from 1997 to 1998, changes which may, though, lie within the margin of error. Strängnäs residents are the exception, however. People who live in Strängnäs showed a greater willingness to commute to Stockholm after the Svealand line opened, and it is also somewhat easier for them today to accept commuting to Stockholm than it is for residents of Mariefred and Åkers styckebruk. Willingness to commute instead of moving correlates strongly to the travelling time, and thus also to accessibility to Stockholm – the further away, the less people's interest in commuting. The changes between the studies reflects, among other things, the fact that the high speed train services have meant a substantial relative improvement for Strängnäs.

7.2.2 Distance working



The study also contained a question as to whether the respondent distance works for whole days. The purpose of the question was to ascertain whether the public transport supply affected people's willingness to travel. Unfortunately, no comparative analysis of the 1998 study is possible because the answers were registered with the wrong base that year.

In 1997, 7% of the residents in Svea conurbations AB+D' answered that they distance worked at least one whole day a month, while the proportion in 2000 was 10%. The increase between the two years in the number of people living along the Svealand line who distance work whole days is significant (***).

Distance work is strongly correlated to education (or perhaps rather occupation or the types of tasks that a certain job entails, but this is not included in the present study). Residents with a university or college education distance work most, and about 1/5 of this group distance work at least one whole working day a month. People with only elementary school education hardly distance work at all. On the other hand, the

analysis showed no significant difference between the proportion of men and the proportion of women who distance work at least one day a month.

Distance works whole days, Svea conurbations AB+D'

Highest education	*1997*	*2000*
Elementary school	1%	1%
Upper secondary school or adult residential college	6%	6%
University or college	17%	21%
All	7%	10%

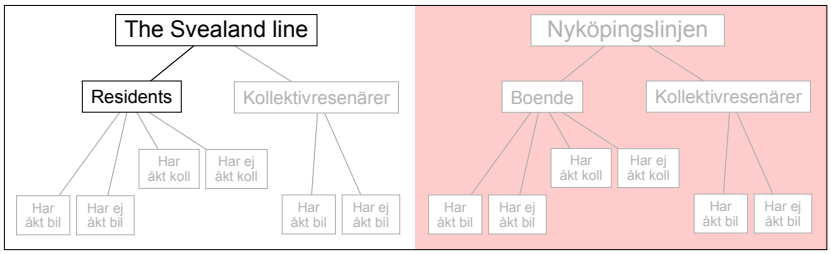
The proportion of residents in Svea conurbations AB+D' (weighted) who distance work at least one whole day a month, divided according to highest completed education.

According to the study, about 4% of the residents distance worked 1-2 days a month in 2000, and 2% in each of the categories 3-5 days, 6-10 days and more than 10 days a month.

In the country as a whole, 8% of the gainfully employed population distance worked in 1998, but only 5% in 1999.[283] More men than women distance work, but distance work is above all more common the higher people's income and education. Of those who distance worked in the whole country, 49% worked whole days, 37% part-days, and 14% both whole days and part-days in 1999.

It is difficult to find any relation between public transport supply and distance working with the information at hand.

7.2.3 Motorist groups in the studies

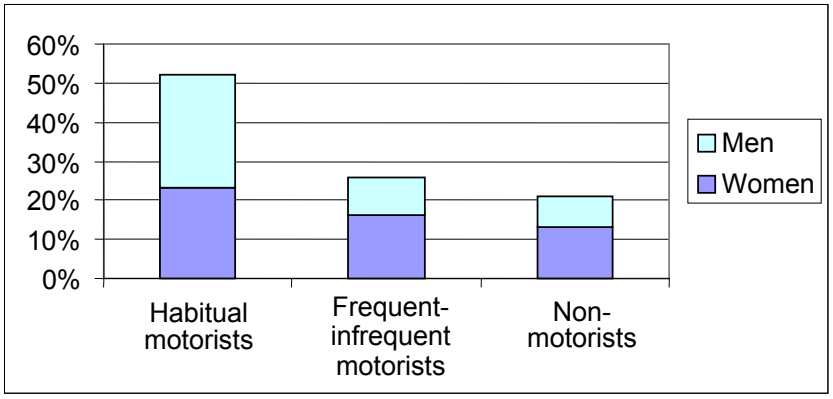


The residents of the conurbations along the Svealand line who were interviewed, i.e. Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna, are below divided into different groups. The groups are named according to access to a car and car ownership in the household. Habitual motorists have access to a car at all times and at least one car in

[283] Fakta om informations- och kommunikationsteknik i Sverige 2001, *Facts about information and communication technology in Sweden 2001* (2001)

the household. Frequent-infrequent motorists have access to a car most of the time or as a rule, and at least one car in the household. Non-motorists never have access to a car, or have no car in the household. These three groups differ both from a socioeconomic point of view and with regard to their willingness to travel.

Residents along the Svealand line divided according to motorist group and gender, 2000



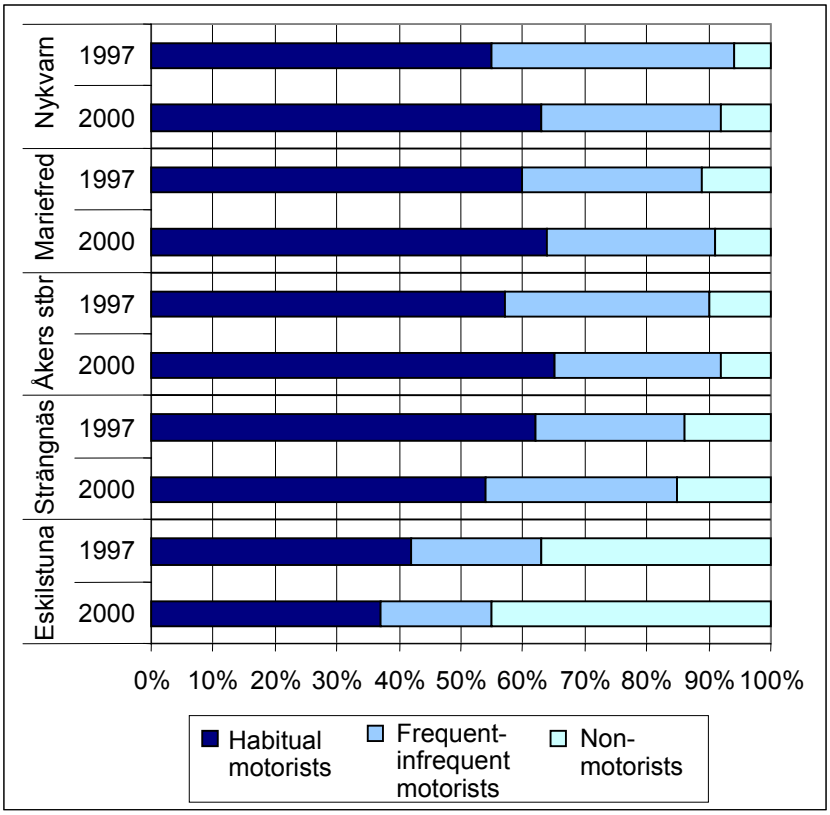
Residents of Svea conurbations AB+D', i.e. Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna, divided according to motorist group and gender.

The habitual motorist group constitutes more than half of the residents of the communities along the Svealand line, and 3/5 of the group are men. In the other two groups, the proportion of men to women is the reverse.

Characteristic for the habitual motorists is that the group largely consists of full-time employed, self-employed, married or cohabiting men. The frequent-infrequent motorists are to a somewhat greater extent in part-time employment or students, but have a high level of education, are very often co-habiting or married, and women. Included among the frequent-infrequent motorists is also a group of young people who have access to their parents' car. The non-motorists are as a rule single and either students, retired or unemployed. This division gives a clear linkage between access to a car and socioeconomic factors.

The proportions of habitual motorists, frequent-infrequent motorists, and non-motorists vary in different areas in the study. In the centre of Eskilstuna the proportion of non-motorists is greater, and the study population's access to a car is less than in the smaller communities along the Svealand line.

Residents by motorist category, along the Svealand line



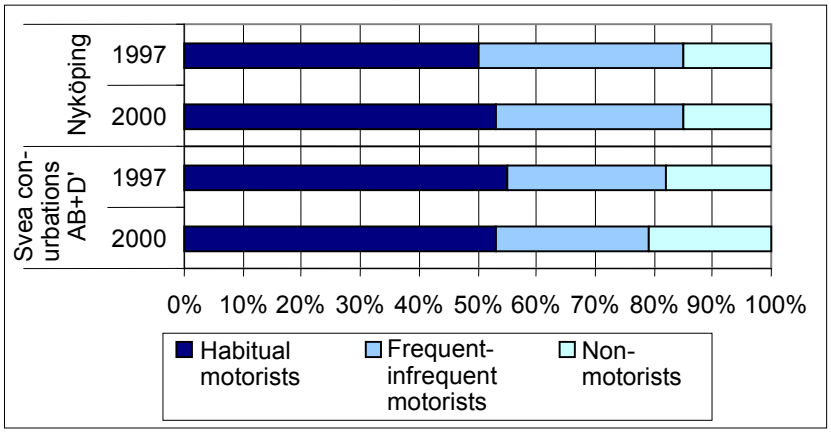
The delimitation of the communities corresponds to Svea conurbations AB+D'. Significant changes are the reduction of habitual motorists between 1997 and 2000 in Strängnäs, and the increase in the proportion of non-motorists in the centre of Eskilstuna. Other changes fall within the margin of error with a 95% one-sided confidence interval.

The proportion of habitual motorists shows an upward trend between 1997 and 2000 in all communities except Strängnäs and Eskilstuna. In Strängnäs the proportion of habitual motorists decreased significantly (*), while frequent-infrequent motorists and non-motorists increased slightly. The same trend can be seen among residents in the centre of Eskilstuna, but there it is the increase in the proportion of non-motorists that is significant (*). The changes in the respective municipalities, however, are not uniform, and the studies' definition of the communities is used here.

A comparison between residents of Nyköping and Svea conurbations AB+D' shows no significant differences for any of the areas in the study between 1997 and 2000. The changes in Strängnäs and the centre of Eskilstuna carry a lot of weight in the Svea conurbations AB+D' group, and therefore show a trend towards a smaller proportion of ha-

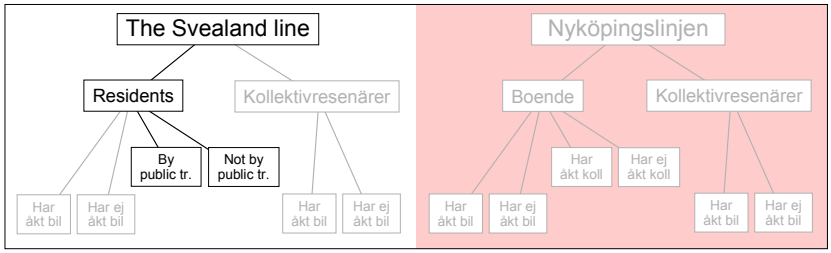
bitual motorists. In Nyköping, on the other hand, development seems to be going in the opposite direction.

Residents by motorist category, Nyköping and Svea conurbations AB+D'



Svea conurbations AB+D' are comparable areas in 1997 and 2000 in Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna, weighted.

7.2.4 Latest journey by public transport



The length of time since respondents' last journey by public transport along the E20/Svealand line route gives an indication of the frequency of travel for groups of residents in the communities along the route. In the comparison between the different years, the Svea conurbations AB+D' sample is used, i.e. those groups that are common to all three studies. In the 2000 comparison between the communities, however, all the data for that year is presented, which means that the percentages differ by a few points.

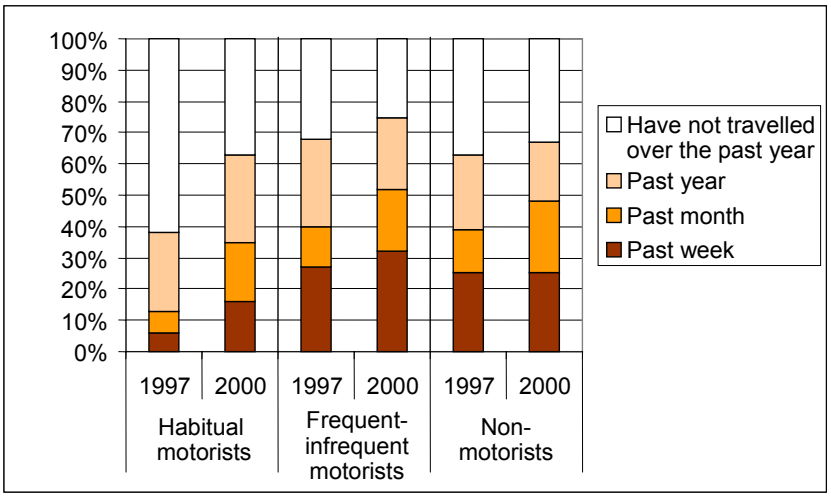
The habitual motorists travel by public transport more often since the train services began on the Svealand line. In 1997, 13% had travelled some time in the past month, of whom 6% had travelled in the past week. In 2000, 35% had travelled the past month, of whom 16% the past week. The increase in the proportion of habitual motorists who had recently travelled by train indicates that people are commuting to work by train more than they did previously by bus.

Latest journey by public transport along the E20/the Svealand line, Svea conurbations AB+D'

Travelled by public transport	*Habitual motorists*			*Freq-infreq motorists*			*Non-motorists*		
	1997	*1998*	*2000*	*1997*	*1998*	*2000*	*1997*	*1998*	*2000*
Past week	6%	13%	16%	27%	28%	32%	25%	21%	25%
Past month	13%	29%	35%	40%	53%	52%	39%	43%	48%
Past year	38%	69%	63%	68%	83%	75%	63%	79%	67%
Not travelled previous 12 months	62%	31%	37%	32%	17%	25%	37%	21%	33%

Svea conurbations AB+D': Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna, weighted.

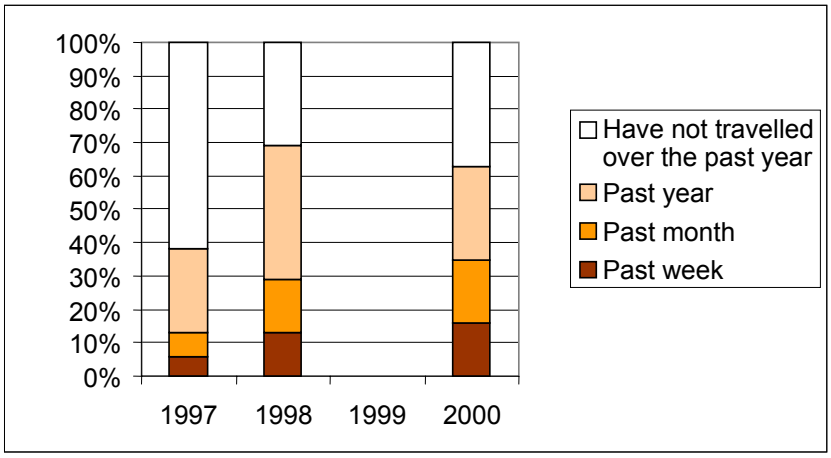
Latest journey by public transport along the E20/the Svealand line, Svea conurbations AB+D'



Latest journey by public transport along the E20/the Svealand line made by residents of the communities along the same route, i.e. Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna, by access to a car. 1997 refers to before the opening of the Svealand line, 2000 after it opened.

For the other groups, the frequent-infrequent motorists and the non-motorists, the changes between before and after the Svealand line are considerably smaller. It is principally travel over the past month that increased for both frequent-infrequent motorists and non-motorists (as it also did in the case of habitual motorists). This indicates that journeys that are made more seldom increased after the Svealand line opened, i.e. mainly leisure-time trips. All in all, the frequent-infrequent motorists travel most, followed by the non- motorists and the habitual motorists.

Habitual motorists' latest journey by public transport, 1997-2000, Svea conurbations AB+D'



The latest journey by public transport made by habitual motorists in Svea conurbations AB+D', i.e. residents of Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and the centre of Eskilstuna who always have access to a car.

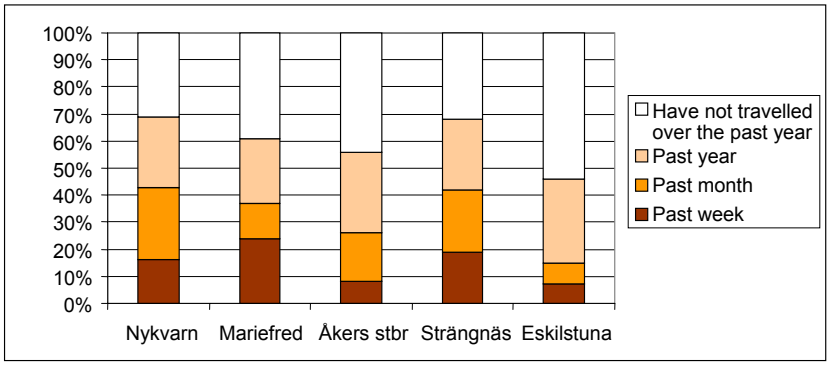
The habitual motorists' increased frequency of travelling by public transport is noticeable for journeys made some time during the past week and the past month between 1997 and 2000. By contrast, the proportion of residents who had made a journey over the past year decreased between 1998 and 2000. "Past year" in the 1998 study includes the opening of the Svealand line in June 1997, and the period of lower fares on the trains during the summer of 1997. The reduction between 1998 and 2000 is probably due to many residents trying the services immediately after they began, but not all of them continued to travel by train regularly. At all events, 60% of the habitual motorists in the sample of residents in the study area had travelled on the Svealand line at some time during the previous twelve months in 2000.

Habitual motorists' latest journey by public transport, 2000

Travelled by public transport	*Past week*	*Past month*	*Past year*	*Not travelled previous yr.*
Nykvarn	16%	43%	69%	31%
Mariefred	24%	38%	61%	39%
Åkers styckebruk	8%	26%	56%	44%
Strängnäs	19%	42%	68%	32%
Eskilstuna	7%	15%	46%	54%
Svea conurb. AB+D'	*16%*	*35%*	*63%*	*37%*
Nyköping	6%	16%	39%	61%

The individual communities include the whole study population, i.e. the delimitation differs from Svea conurbations AB+D'

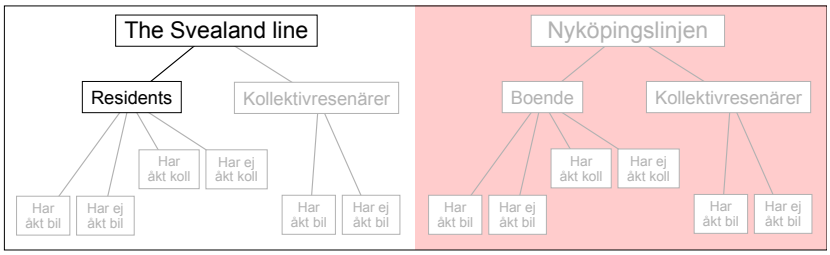
Latest journey by public transport for habitual motorists living along the Svealand line, 2000



Latest journey by public transport along the E20/Svealand line for habitual motorists living in different communities along the Svealand line in 2000. Note that a relatively large proportion of the journeys by public transport outside their home community for residents of Nykvarn and Åkers styckebruk are made by county public transport authority bus.

The differences between residents in the habitual motorists category in different communities are relatively large. The habitual motorists in Mariefred and Strängnäs travel most often by public transport along the E20/the Svealand line. The habitual motorists in Åkers styckebruk and Eskilstuna travel least often. ¼ of the habitual motorists who live in Mariefred had travelled by public transport at some time during the past week, whereas the corresponding figure is just 1/10 in Åkers styckebruk.

7.2.5 Number of journeys along the E20/the Svealand line



Respondents living in the different communities were asked to say how many times they had travelled outside their home community over the past seven days, both by car and by public transport. A return journey counts as one journey. An estimate of public transport's approximate share was made on the basis of the data collected. Significant changes between the years are shown by asterisks in the column for significance. One asterisk (*) is equivalent to a 95% confidence interval, two asterisks (**) 99%, and three asterisks (***) 99,9%. Even just one

asterisk consequently shows that a change in all probability took place between the years. Changes that are not significant may nonetheless have occurred in reality, but due to the small size of the study population or too great variance, there is less probability that such a change in actual fact has taken place. On the other hand, the magnitudes of the numbers of journeys can not be viewed as anything more than approximate values, despite two decimal places in the presentation.

Residents in the different communities are all respondents who answered that they live in the community within the distance from the railway station stated.

Journeys outside home community, Nykvarn residents

No. journeys outside home community over past 7 days	*Nykvarn, home 0-3 km from the railway station*						
	1997	*Sign*	*1998*	*sign*	*2000*	*sign*	*1997*
Car journeys	4.43		4.48		4.42		4.43
of which along E20	3.15		3.18		3.04		3.15
Publ. trpt. journeys	1.28		1.28		1.31		1.28
of which along E20/Svealand line.	0.86		0.84		0.94		0.86
Total journeys	5.71		5.76		5.73		5.71
of which along E20/Svealand line	4.01		4.02		3.98		4.01
Publ. trpt. share total	22%		22%		23%		22%
along E20/Svea. line	21%		21%		24%		21%

Journeys outside home community, Mariefred and Åkers styckebruk residents

No. journeys outside home community over past 7 days	*Mariefred and Åkers styckebruk, 0-10 km**						
	1997	*Sign*	*1998*	*sign*	*2000*	*sign*	*1997*
Car journeys	3.76		3.60		4.15		3.76
of which along E20	2.83		2.73		2.86		2.83
Publ. trpt. journeys	0.97		0.69		0.95		0.97
of which along E20/Svealand line.	0.75		0.56		0.83		0.75
Total journeys	4.73		4.29		5.10		4.73
of which along E20/Svealand line	3.58		3.29		3.69		3.58
Publ. trpt. share total	21%		16%		19%		21%
along E20/Svea. line	21%		17%		22%		21%

* The nearest railway station since the Svealand line opened is Läggesta

Journeys outside home community, Strängnäs residents

No. journeys outside home community over past 7 days	*Strängnäs, 0-3 km*						
	1997	*sign*	*1998*	*sign*	*2000*	*sign*	*1997*
Car journeys	2.53	**	1.66		2.07		2.53
of which along E20	1.57		1.15		1.26		1.57
Publ. trpt. journeys	0.42		0.73		0.72		0.42
of which along E20/Svealand line.	0.26		0.49		0.56	*	0.26
Total journeys	2.95		2.39		2.79		2.95
of which along E20/Svealand line	1.83		1.64		1.82		1.83
Publ. trpt. share total	14%		31%		26%		14%
along E20/Svea. line	14%		30%		31%		14%

The asterisks denote significant differences between the years the studies were made

Journeys outside home community, residents in centre of Eskilstuna

No. journeys outside home community over past 7 days	*Eskilstuna, 0-1 km from the railway station*						
	1997	*sign*	*1998*	*sign*	*2000*	*sign*	*1997*
Car journeys	1.53	***	0.95		0.83	***	1.53
of which along E20	0.42		0.30		0.25		0.42
Publ. trpt. journeys	0.30		0.30		0.46		0.30
of which along E20/Svealand line.	0.13		0.15		0.25		0.13
Total journeys	1.83		1.25		1.29		1.83
of which along E20/Svealand line	0.55		0.45		0.50		0.55
Publ. trpt. share total	16%		24%		36%		16%
along E20/Sveal.	24%		33%		50%		24%

The asterisks denote significant differences between the years the studies were made

A comparison between residents of Mariefred and Åkers styckebruk, up to 10 km from the nearest railway station, shows that total travel by car outside the respondents' home communities was significantly greater (*) in Åkers styckebruk in 2000. Before the Svealand line opened in 1997, there was no difference between the two communities. Travel by public transport, however, is more evenly distributed between the residents of the different communities, and to a large extent takes place in the E20/Svealand line corridor. The difference in car travel, however, gives Mariefred residents a slightly higher proportion for public trans-

port (24% for journeys along the E20/the Svealand line in 2000) than residents of Åkers styckebruk have (20%).

There are great differences in residents' journeys outside the communities along the Svealand line. The number of journeys per week is very stable for residents of Nykvarn in all three rounds of the study. For Strängnäs residents the study shows that the number of journeys by car outside their home community was markedly lower in 1998 than in 1997 and 2000. The same trend, but not significant however, can be observed for residents of Mariefred and Åkers styckebruk who live 0-10 km from the railway station. Eskilstuna residents who live up to 1 km from the railway station show a clear and significant (***) decrease in travelling by car between 1997 and 1998. There was a corresponding, but not significant, increase in travel by public transport between 1998 and 2000.

Travel by public transport increased significantly (*) for Strängnäs residents between 1997 and 2000, but there is no significant difference in the sample population's journeys by public transport in the other communities.

There are no differences in significance if the sample population's residents in Nykvarn and Strängnäs are delimited to people whose homes are at most 3 km from the railway station instead of including all residents in the analysis irrespective of how far away they live, i.e. the sample is in practice already in good agreement with the delimitation for the conurbation.

7.2.6 Differences within the conurbations

Travel outside the home community can be expected to differ depending on how far away people live from the railway station. The analysis that follows studies Eskilstuna residents who in 2000 lived at walking distance (50 m-1.0 km) from the station, at cycling distance (1.1-3.0 km) and those who lived at driving distance (3.1-10.0 km). Further division into smaller groups did not in general give any significant results since the sample populations are too small.

Journeys outside home community by Eskilstuna residents living at different distances from the railway station, 2000

No. of journeys outside home community over past 7 days	Eskilstuna 2000 0.05-1.0 km	sign	1.1-3.0 km	sign	3.1-10.0 km	sign	0.05-1.0 km
Car journeys	0.83	**	1.58		1.94	***	0.83
of which along E20	0.25		0.46		0.42		0.25
Publ. trpt. journeys	0.46	*	0.06		0.34		0.46
of which along E20/Svealand line	0.25		0.05		0.11		0.25
Total journeys	1.29		1.62		2.28		1.29
of which along E20/Svealand line	0.50		0.51		0.53		0.50
Publ. trpt. share							
total	36%		4%		15%		36%
along E20/Svea.	50%		10%		21%		50%

The asterisks denote significant differences between the groups

The markedly low number of journeys by public transport outside residents' home community in the group who live at cycling distance (1-3 km) from the station may be a consequence of too small a sample.

Strängnäs residents show quite other values and public transport shares;

Journeys outside home community by Strängnäs residents living at walking and cycling distance, 1997 and 2000

No. of journeys outside home community over past 7 days	Strängnäs 1997 0.05-1.0 km	sign	1997 1.1-3.0 km	2000 0.05-1.0 km	sign	2000 1.1-3.0 km
Car journeys	2.27		2.89	1.81		2.33
of which along E20	1.49		1.67	0.82	***	1.71
Publ. trpt. journeys	0.49		0.32	0.87		0.57
of which along E20/Svealand line	0.33		0.15	0.67		0.43
Total journeys	2.76		3.21	2.68		2.90
of which along E20/Svealand line	1.82		1.82	1.49		2.14
Publ. trpt. share						
total	18%		10%	32%		20%
along E20/Sveal.	18%		8%	45%		20%

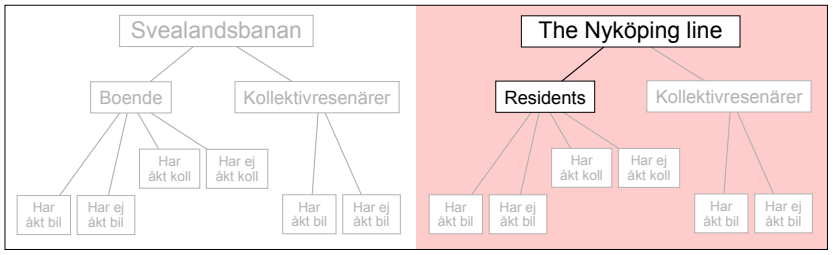
The asterisks denote significant differences between the groups

The differences in market share for public transport are noticeable for residents living at walking distance (up to 1 km) and cycling distance (1-3 km) from the railway station. For journeys outside the home community, public transport has double the market share in round figures of those who live near the station in Strängnäs. This is true both before and after the Svealand line opened.

For residents at walking distance from the railway station, journeys by car along the E20/the Svealand line decreased dramatically between 1997 and 2000. The decrease is significant (**) and in the latter year there is a clear difference in car travel depending on the distance from home to the station (***).

Both Strängnäs and Eskilstuna residents' travel varies depending on the distance to the railway station. People living at walking distance from the station travel significantly less by car outside their home community than residents living at cycling distance in 2000, both along the E20/the Svealand line and in total. The people who live in the central parts of the communities travel most by public transport outside their home communities.

7.2.7 Nyköping residents' travel



There were no significant changes over the period as regards Nyköping residents. The number of car journeys outside the home community over the past seven days decreased however, most of all between 1997 and 1998. A closer analysis, on the other hand, reveals that when the respondents are delimited to residents living within 3 km of the railway station, the total number of journeys by car outside the home community decreased significantly (*) between 1997 and 2000. Public transport's market share has thus seen an upward trend in the E4 corridor, mainly as a result of the decrease in car travel. The increase in market share is thus similar to that along the Svealand line, without any substantial changes in public transport supply and demand along the Nyköping line. The demand for train journeys on the Svealand line, on the other hand, increased over the period.

Journeys outside home community, Nyköping residents

No. journeys outside home community over past 7 days	*Nyköping*						
	1997	*Sign*	*1998*	*sign*	*2000*	*sign*	*1997*
Car journeys	1.89		1.57		1.54		1.89
of which along E4	0.54		0.47		0.51		0.54
Public trpt. journeys	0.32		0.41		0.37		0.32
of which along E4/Nyköping line	0.13		0.17		0.23		0.13
Total journeys	2.21		1.98		1.91		2.21
of which along E4/Nyköping line	0.67		0.64		0.74		0.67
Public trpt. share							
total	14%		21%		19%		14%
along E4/Nyköping l.	19%		27%		31%		19%

The asterisks denote significant differences between the years the studies were made

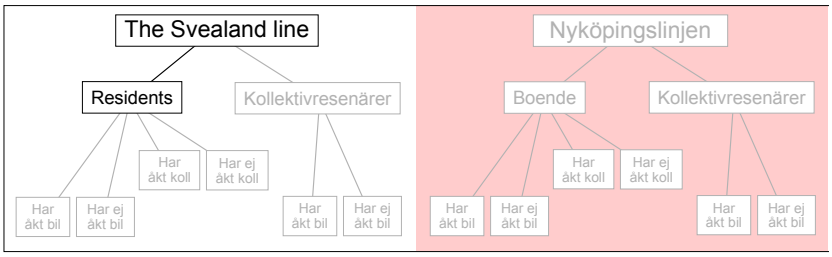
7.2.8 Socioeconomic factors bearing on residents' travel

Journeys outside home community, residents of Svea conurbations AB+D'

No. journeys outside home community over past 7 days	*Svea conurbations AB+D'*						
	1997	*Sign*	*1998*	*sign*	*2000*	*sign*	*1997*
Car journeys	2.82	***	2.34		2.54	*	2.82
of which along E20	1.77		1.59		1.60		1.77
Publ. trpt. journeys	0.64		0.71		0.80		0.64
of which along E20/Svealand line.	0.42		0.47		0.59	*	0.42
Total journeys	3.46		3.05		3.34		3.46
of which along E20/Svealand line.	2.19		2.06		2.19		2.19
Publ. trpt. share							
total	18%		23%		24%		18%
along E20/Sveal.	19%		23%		27%		19%

The asterisks denote significant differences between the years the studies were made

In order to compare the communities with each other, the Svea conurbations AB+D' group was chosen here, i.e. the conurbations along the line weighted by the relation between the size of the sample population and the number of inhabitants in the areas studied in Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and the centre of Eskilstuna. The delimitations of the areas are described in more detail in chapter 3.



Residents in the conurbations along the Svealand line show several significant differences in the analysis. One clear change (***) between the years of the study is the decrease in car travel from 1997 to 1998. Total car travel is significantly (*) less in 2000 than it was in 1997. Travel by public transport along the E20/the Svealand line increased significantly (*) between 1997 and 2000.

Access to a car

Travel outside home community, habitual motorists

7 days	*Car journeys*		*Public transport journeys*	
Svea conurb.		*of which*		*of which along*
AB+D'	*total*	*along E20*	*total*	*E20/Svealand line*
1997	3.70	2.37	0.25	0.14
Significance			*	*
2000	3.39	2.18	0.50	0.38

The asterisks denote significant differences between the years

Travel outside home community, frequent-infrequent motorists

7 days	*Car journeys*		*Public transport journeys*	
Svea conurb.		*of which*		*of which along*
AB+D'	*total*	*along E20*	*total*	*E20/Svealand line*
1997	2.57	1.63	1.20	0.95
Significance				
2000	2.35	1.51	1.21	0.98

Travel outside home community, non-motorists

7 days	*Car journeys*		*Public transport journeys*	
Svea conurb.		*of which*		*of which along*
AB+D'	*total*	*along E20*	*total*	*E20/Svealand line*
1997	0.64	0.23	1.03	0.50
Significance				
2000	0.67	0.28	1.08	0.66

Travel outside the home community varies depending on access to a car. Residents of Svea conurbations AB+D' were divided into three categories according to access to a car. The three categories are habitual

motorists who always have access to a car, frequent-infrequent motorists who most of the time, sometimes or as a rule do not have access to a car, while non-motorist never have access to a car or do not have a car in the household.

Habitual motorists' travel by car in total and along the E20/the Svealand line increased significantly between 1997 and 2000. There are no other significant differences between the years. The main differences between the motorist groups are that habitual and frequent-infrequent motorists travel outside their home community to roughly the same extent, but the latter group has a higher proportion of public transport journeys. Journeys outside their home community by non-motorists are markedly fewer. For journeys along the E20/the Svealand line in 2000 the public transport share is 15% for habitual motorists, 40% for frequent-infrequent motorists and 70% for the non-motorists. For the habitual motorists this is a substantial increase compared to 1997, when their public transport share was 5%. The market shares are in principle unchanged for the other two groups.

Individual socioeconomic factors

The differences in residents' travel before and after train services began on the Svealand line can be analysed more deeply with regard to various socioeconomic factors. To obtain comparable values for before and after, and not too small a sample, the Svea conurbations AB+D' group was chosen as the delimitation.

Travel outside home community, women

7 days Svea conurb. AB+D'	*Car journeys*		*Public transport journeys*	
	total	*of which along E20*	*total*	*of which along E20/Svealand line*
1997	2.24	1.34	0.77	0.50
Significance				
2000	2.16	1.33	0.88	0.62

Travel outside home community, men

7 days Svea conurb. AB+D'	*Car journeys*		*Public transport journeys*	
	total	*of which along E20*	*total*	*of which along E20/Svealand line*
1997	3.37	2.19	0.53	0.34
Significance				*
2000	2.95	1.89	0.71	0.57

The asterisks denote significant differences between the years the studies were made

The factor 'gender' was analysed separately, i.e. the whole study population was divided into women and men.

One significant result emerged in the analysis of gender and travel, viz. that men travelled more along the E20/the Svealand line by public transport in 2000 than they did in 1997. Men's travel seems in general to have been affected more by the train services on the Svealand line than women's travel seems to. The difference between men's and women's travel by car and travel by public transport seems to have decreased, even if none of the changes are significant in the analysis.

Other socioeconomic factors were also analysed. The table below, however, shows only significant differences between 1997 and 2000.

Travel outside the home community (number of journeys over the past 7 days) is distributed differently over different socioeconomic groups. When the factors are analysed one at a time interesting differences can be seen, but the different factors correlate to a greater or lesser degree. It is therefore for example normal for people between 25 and 44 to be married or cohabit, have children of 15 or younger, and work full-time.

The difference in travel between 1997 and 2000 for men is a significant increase in travel by public transport along the E20/the Svealand line. There are no significant differences for women.

Among the different age groups in the study, residents in Svea conurbations AB+D' between the ages of 20 and 24 reduced the amount they travelled by car significantly between the years. One reason might be that less young people held a driving licence at the end of the 1990s than before [284], and also that the Svealand line can have had an effect on travel patterns. Residents between 25 and 44 years of age significantly increased their journeys by public transport along the E20/the Svealand line. The other groups show no significant differences in their travel between 1997 and 2000.

People with children of 15 or younger have also significantly increased their travel by public transport along the Svealand line. As pointed out earlier, though, the period of parenthood correlates with the ages of 25 to 44.

People who are married or cohabit (about 70% of the respondents in the study) travelled by public transport more, both in total and along the E20/the Svealand line, between 1997 and 2000.

[284] Matstoms (2002)

No. of journeys outside home community, past 7 days				
Svea conurb, AB+D'		*1997*	*sign*	*2000*
Gender				
Men	Public transport journeys along E20/Svealand line	0.34	*	0.57
Age				
20-24	Car journeys	2.66	*	1.53
25-44	Public transport journeys along E20/Svealand line	0.40	*	0.69
Parent				
Have child(ren) of 15 or younger	Public transport journeys along E20/Svealand line	0.38	*	0.69
Type of household, Marital status				
Married/cohabiting	Public transport journeys	0.47	**	0.77
	Public transport journeys along E20/Svealand line	0.32	**	0.58
Occupation				
Self-employed	Public transport journeys	0.09	**	0.91
	Public transport journeys along E20/Svealand line	0.08	*	0.82
Employed, full-time	Car journeys	3.65	*	3.19
	Car journeys along the E20	2.55	*	2.10
	Public transport journeys along E20/Svealand line	0.40	*	0.71
Education				
Upper s. school	Car journeys	3.25	**	2.64
Resid. adult college	Car journeys along the E20	2.17	**	1.68
University or college	Public transport journeys along E20/Svealand line	0.56	*	0.91
Household's income				
Less than 400 000 Skr	Car journeys	2.63	*	2.19
	Car journeys along the E20	1.66	**	1.23
More than 400 000 Skr	Public transport journeys along E20/Svealand line	0.62	*	1.08

The asterisks denote significant differences between the years the studies were made

Among the different occupations, it can be seen that self-employed people in the sample hardly travelled by public transport at all in the 1997 study. In 2000 the analysis shows a dramatic significant increase. A large proportion of this group's journeys by public transport is concentrated to the E20/Svealand line corridor. Residents in full-time em-

ployment show a significant decrease in travel by car, both in total and along the E20/the Svealand line, between 1997 and 2000. Journeys on public transport in the corridor by people in full-time employment increased significantly at the same time. On the other hand, neither people in part-time employment, students nor retired people show any significant increases between the two years.

Highest completed education also affects travel. Residents with upper secondary school or residential adult college education reduced their travel by car significantly, both in total and along the E20/the Svealand line, between 1997 and 2000. University and college educated people increased their travel along the E20/the Svealand line. The group with only elementary school as their highest completed education show no significant differences between the years.

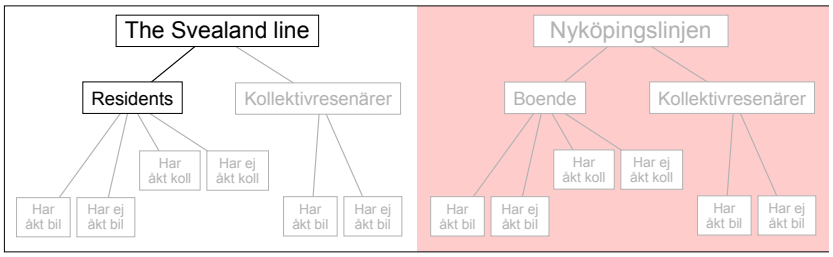
Travel also varies with income. In the analysis the sample population is divided into two groups; households with a pre-tax income up to 400 000 Skr and those with a pre-tax income over 400 000 Skr. Households in the lower income group decreased their travel by car in total and along the E20/the Svealand line significantly, while the other group increased their travel by public transport along the E20/the Svealand line. Household income probably correlates with education very strongly.

Socioeconomic factors together

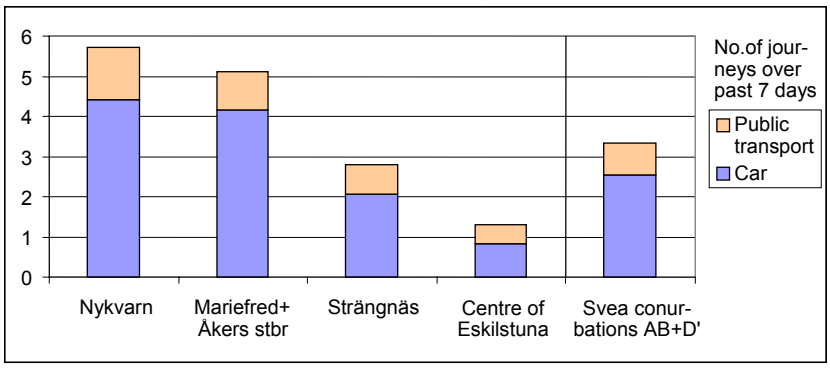
The socioeconomic groups where the differences in travel by public transport along the E20/the Svealand line have changed most between 1997 and 2000 according to the analysis of the factors taken individually, are men, age 25-44, have children of 15 years of age or younger, married or cohabiting, in full-time employment, have university or college education and have a total household income over 400 000 Skr. The group that meets all these criteria, however, proved to be less than 1% of the whole sample. For this reason it has not been possible to determine any significant changes for a "typical" person.

It is, though, possible to discern larger groups when the socioeconomic factors are combined in different ways. A group of gainfully employed people, consisting of self-employed people and people full- or half-time employment, show the same significant changes between 1997 and 2000 as the people in full-time employment do, i.e. they travel less by car and more by public transport along the E20/the Svealand line. People in full-time employment are the predominant group among gainfully employed people.

7.2.9 Summary of residents' travel



No. of journeys outside home community over past 7 days, 2000

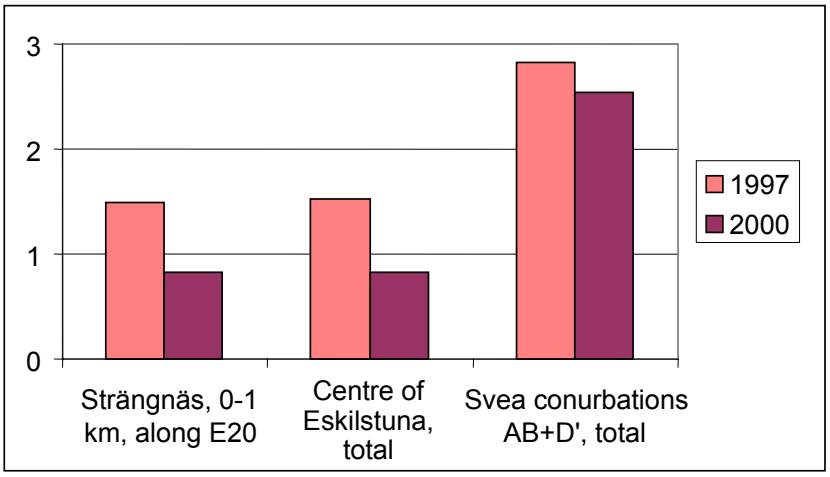


Total travel by car and public transport outside home community for residents in the communities along the Svealand line in 2000. Svea conurbations AB+D' are Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and the centre of Eskilstuna, weighted.

Travel outside the home community must be put in relation to travel within the community. The latter, though, is outside the scope of this study. In large communities, there is generally less travel per person outside the community. Nykvarn and also Mariefred and Åkers styckebruk are characteristic of commuter communities, with the residents for the most part working outside their home community. Nykvarn residents make an average of almost 6 journeys a week, of which 1.3 are by public transport. People living in the centre of Eskilstuna, on the other hand, made only 1.3 journeys outside their home community, 0.5 of them by public transport. The average for residents of the communities along the Svealand line, Svea conurbations AB+D', was 3.3 journeys a week, of which 0.8 were by public transport.

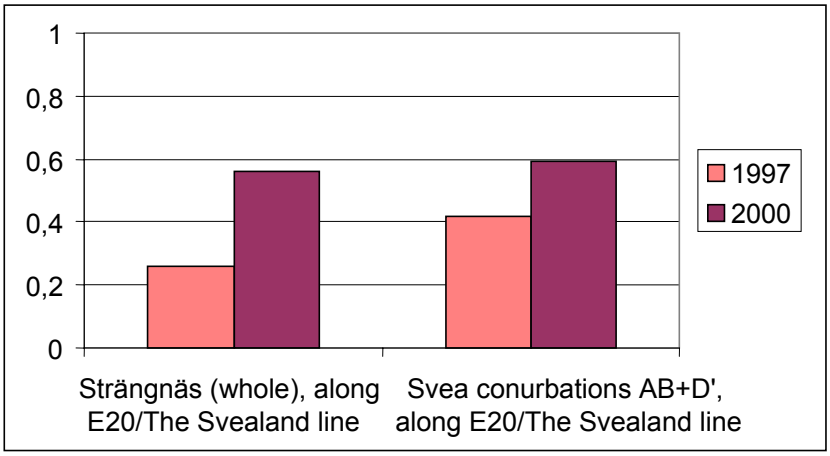
Significant differences (at least 95% confidence interval) in residents' travel outside their home communities can be seen mainly with regard to people living in the central areas of Strängnäs and Eskilstuna. People living at walking distance from the railway stations in Strängnäs and Eskilstuna reduced the amount they travel by car between 1997 and 2000.

Decrease in car travel, significant differences in the areas



Number of journeys by car outside home community over the past 7 days during the bus service period (1997) and with the high speed train services (2000). Svea conurbations AB+D' are Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and the centre of Eskilstuna, weighted.

Increase in public transport travel, significant differences in the areas

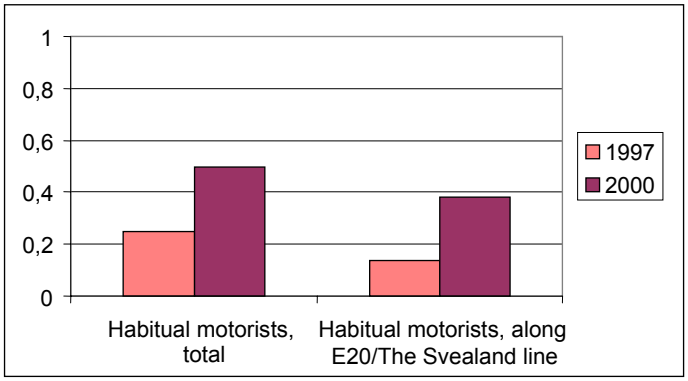


Number of journeys by public transport outside home community over the past 7 days.

For Strängnäs the change in car travel along the E20 is significant; for people who live in the centre of Eskilstuna, total car travel. Residents of Svea conurbations AB+D' also reduced their total car travel.

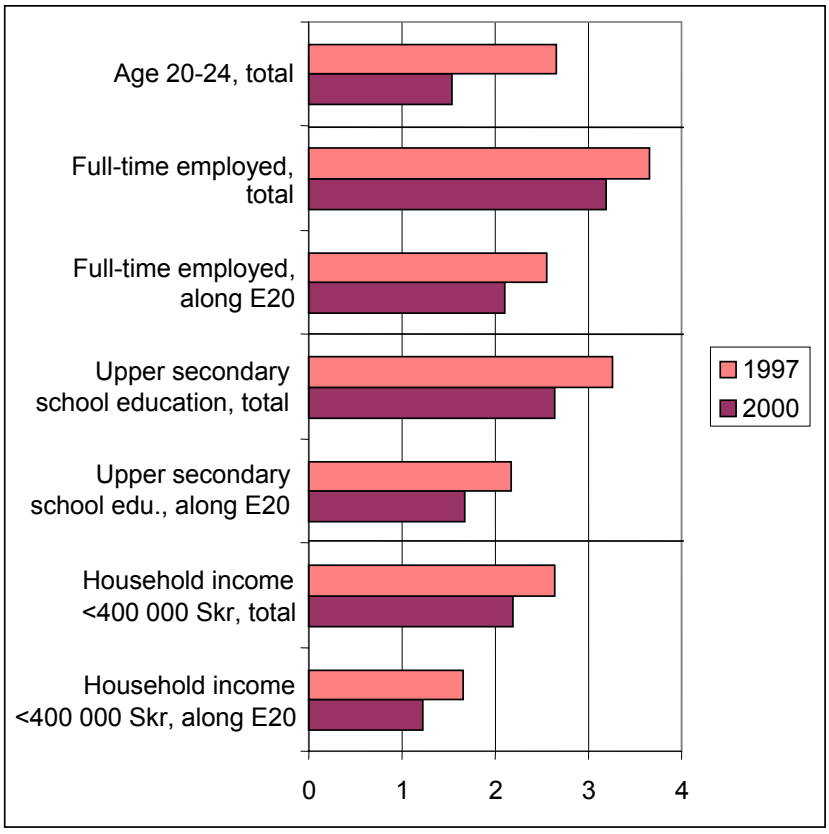
Journeys by public transport increased in the same group. Travel along the E20/the Svealand line increased for all Strängnäs residents between 1997 and 2000, as it did for all the people who live in the conurbations along the line (Svea conurbations AB+D').

Increase in journeys by public transport, significant differences with residents as motorist groups



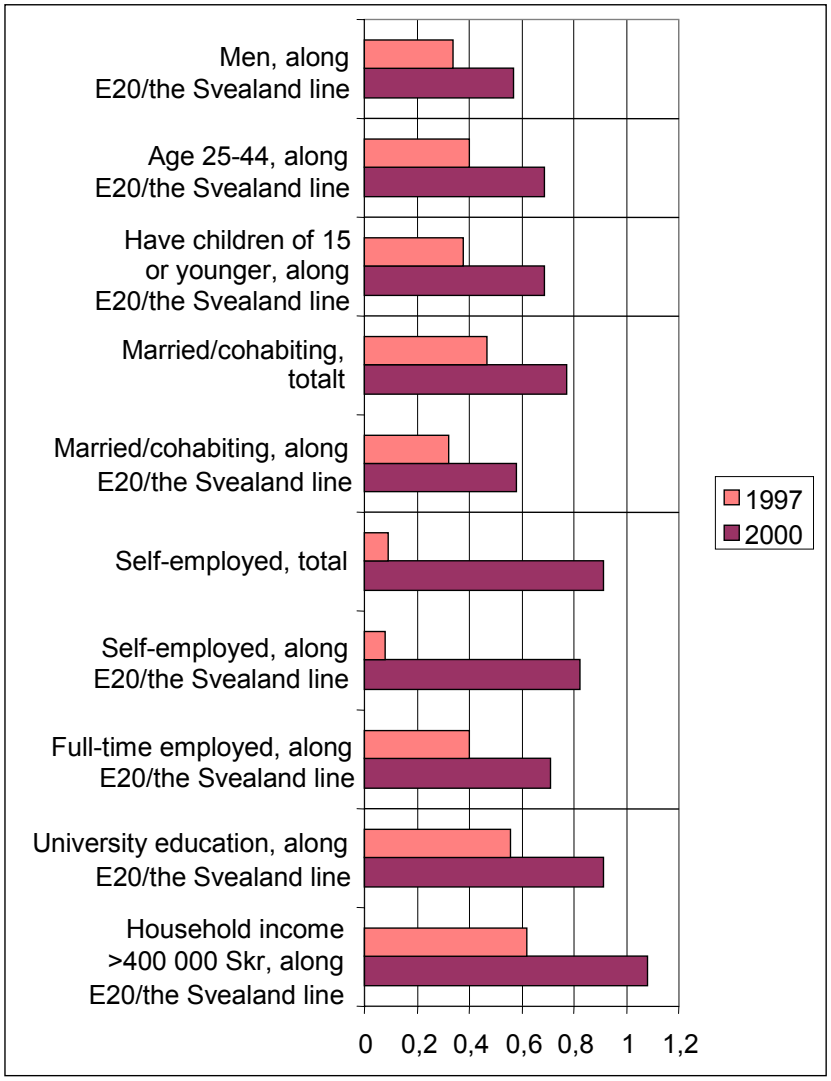
Svea conurbations AB+D', by access to car.

Reduction in travel by car, significant differences for residents, by individual socioeconomic factor



Number of journeys by car outside home community over past 7 days for residents of Svea conurbations AB+D'. No other significant differences in car travel depending on gender, age, children, type of household/marital status, occupation, education or household income could be determined.

Increase in travel by public transport, significant differences for residents by individual socioeconomic factor



Number of journeys by public transport outside home community over past 7 days for residents of Svea conurbations AB+D'. No other significant differences in travel by public transport depending on gender, age, children, type of household/marital status, occupation, education or household income could be determined.

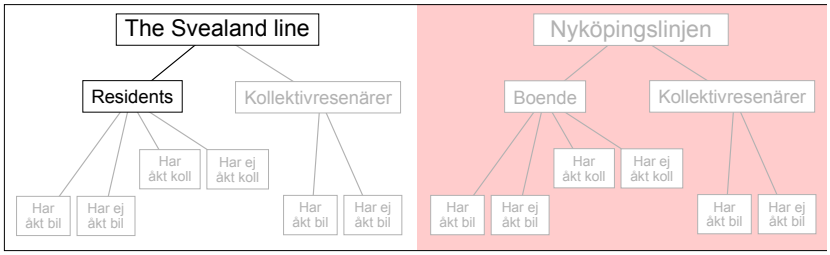
Residents along the Svealand line in Svea conurbations AB+D' who always have access to a car, i.e. habitual motorists, significantly increased the number of journeys they made by public transport between 1997 and 2000. The increase is significant both for the total amount of travel by public transport and for journeys along the E20/the Svealand line. Frequent-infrequent motorists and non-motorists show no significant differences.

The reduction in travel by car for the sample population between 20 and 24 years of age may depend partly on a decrease in the number of driving licences in the age group during the period studied. People who are employed full-time, have upper secondary school education and who have a total household income of at most 400 000 Skr show a significant decrease in travelling by car between 1997 and 2000. The decrease is both in total and along the E20.

Significant increases in travel by public transport along the E20/the Svealand line occurred between 1997 and 2000 for the socioeconomic groups men, age 25-44, have children of 15 or younger, married/cohabiting, self-employed, full-time employed, university or college educated, and people with a household income of more than 400 000 Skr. People who are married or cohabiting, and the self-employed group, show a significant increase in total travel by public transport.

7.3 Effects on the choice of travel mode

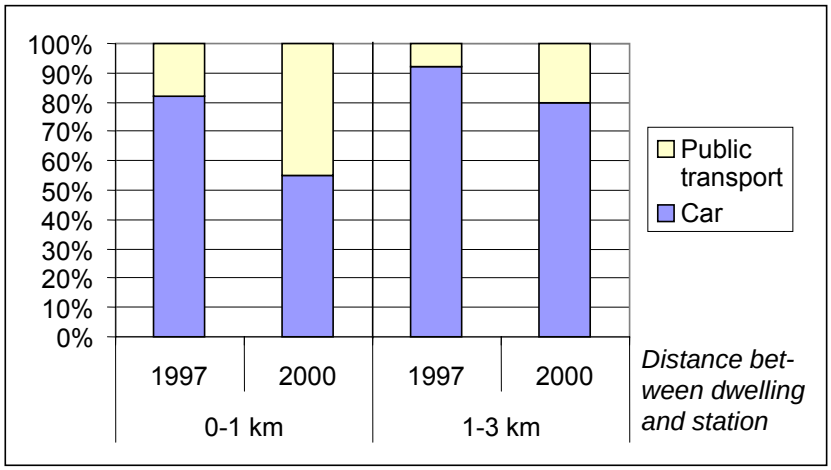
7.3.1 Distribution of travel modes for journeys outside the home community



The number of journeys outside the home community made by residents along the Svealand line over the past 7 days can be analysed with regard to the travel mode, i.e. car or public transport. The greatest differences in travel before and after the start of services on the Svealand line are seen for residents who live at walking distance from the railway stations in Strängnäs and Eskilstuna.

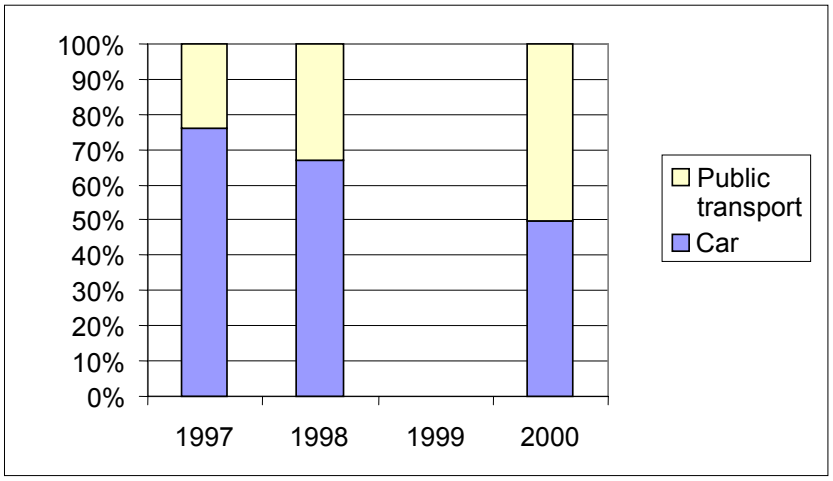
For the people who live at walking distance from the railway station in Strängnäs the proportion of journeys by public transport was 18% for journeys along the E20/the Svealand line in 1997. In 2000 this proportion had more than doubled to 45%. For residents who live at cycling distance from the station, the proportion also doubled, from 8% to 20%, but the proportion of travel by public transport outside the home community along the E20/the Svealand line is still barely half that of the people who live within walking distance.

Distribution of travel mode for people living in Strängnäs



Distribution by travel mode, Strängnäs residents' journeys along the E20/the Svealand line in two different distance classes; 0-1 km: walking distance, 1-3 km: cycling distance from the station.

Distribution by travel mode, people living at walking distance from the station in Eskilstuna, for journeys along the E20/the Svealand line, 1997-2000



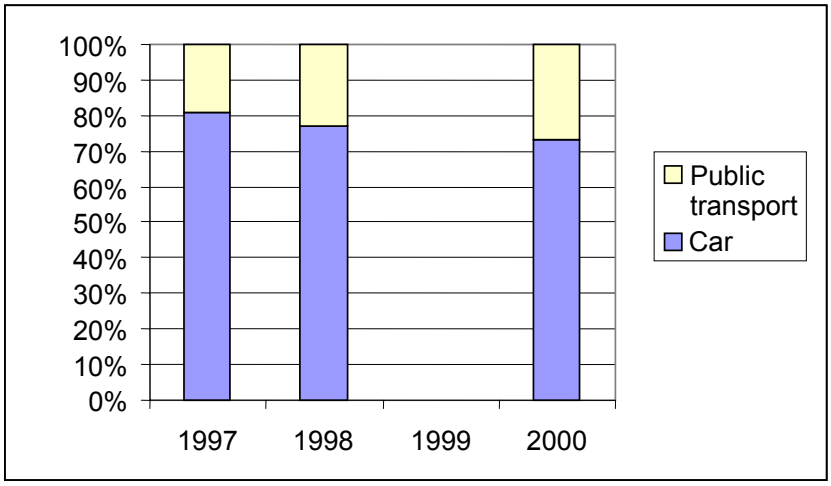
Walking distance; up to 1 km from the railway station.

The proportion of travel by public transport doubled for the group who live at walking distance from the stations in Eskilstuna, from about ¼ in 1997 to half in 2000. The decrease in car travel over the period is significant (***), while the increase in travel by public transport for this group is not.

For residents along the Svealand line (Svea conurbations AB+D') an increase can be seen in the proportion of travel by public transport along the E20/the Svealand line, from 19% in 1997 to 27% in 2000.

Areas that increased are principally the residents in Strängnäs and the centre of Eskilstuna.

Distribution by travel mode, Svea conurbations AB+D', for journeys along the E20/the Svealand line, 1997-2000

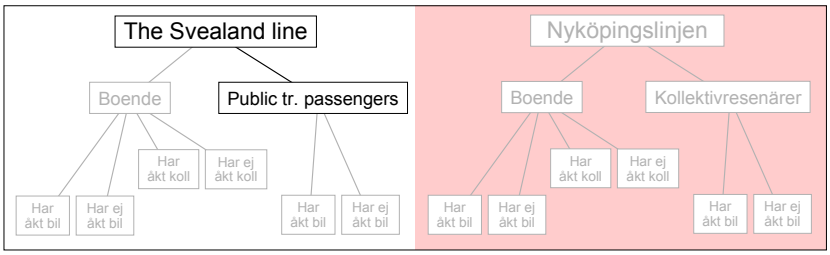


Svea conurbations AB+D' are residents of Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and the centre of Eskilstuna, weighted.

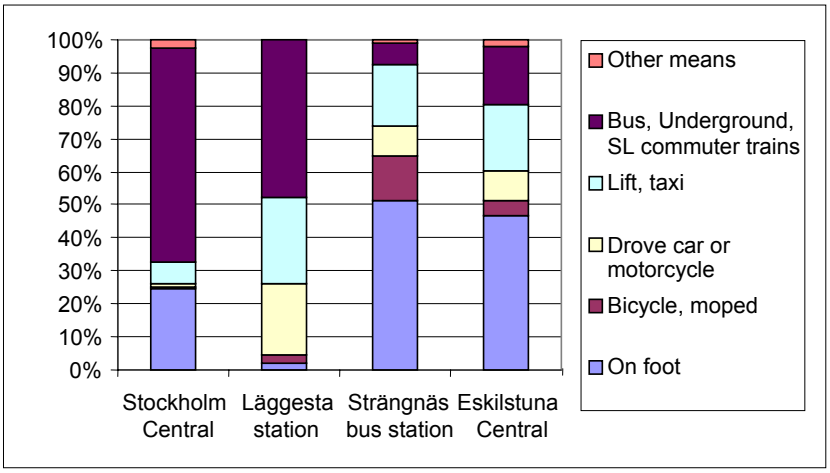
Journeys by public transport made by the residents of the different communities differ from each other somewhat as regards the latest journey outside the home community. Nykvarn residents travel extensively by SL bus, but about half the residents said that they travelled by train on their latest journey by public transport outside their home community. Residents of Åkers styckebruk travel by bus with the county public transport authority (Länstrafiken i Södermanland) more often than the residents of Mariefred. The highest proportion of travel by train with SJ relative to other public transport is shown by the people who live in Strängnäs, followed by Mariefred and Eskilstuna. The latest journey, however, is not directly linked to the frequency of train journeys, because in some cases it is a question of daily commuting and in other cases journeys that are made more seldom.

7.3.2 Connecting journeys

In the course of the interview, respondents were asked how they made any connecting journey to and from the bus or the train along the Svealand line. Only one alternative was allowed for each end of the bus or train journey.

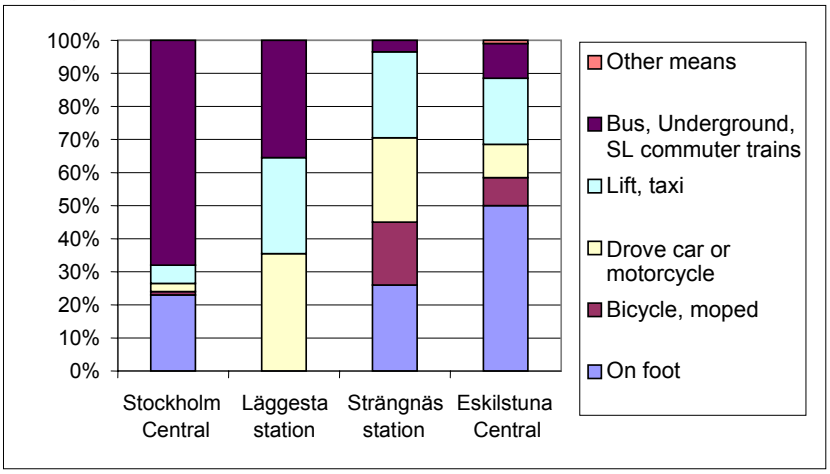


Bus passengers' connecting journey to and from the bus stop, 1997



Public transport passengers' travel mode for connecting journeys to and from the bus stop in 1997 at some of the stops between Stockholm and Eskilstuna.

Train passengers' connecting journey to and from the station, 2000



Public transport passengers' travel mode for connecting journeys to and from the railway station in 2000 at some of the stations between Stockholm and Eskilstuna.

Most travellers in Stockholm use other public transport to reach Stockholm Central station. About 2/3 of them travel by bus, Under-

ground or SL commuter train both in 1997 and 2000. It is also common for passengers to take the bus to and from Läggesta, since Åkers styckebruk, Mariefred, Stallarholmen etc. are too far from the station to walk. In Strängnäs, especially in 1997, and in Eskilstuna, it is common for passengers to walk to the station.

The greatest difference between 1997 (bus services) and 2000 (train services) seems to be an increase in the number of people who travel to or from the stations in Läggesta and Strängnäs by car, especially those who drive. The main reason would appear to be that many motorists choose to park and ride at these stations, now that there are train services, whereas this alternative was not as attractive when the bus services were operating. The number of interviews of passengers on the buses and trains, however, is a little too small to allow any categorical statement as to the distribution between the travel modes. The reason why some stations have not been included in the diagrams is that the number of interviews with passengers to and from these destinations is too small.

A study of connecting journeys of no more than 3 km in length to the regional commuter trains known as Pågatågen in Skåne in the south of Sweden shows that 25-40% of the train passengers there cycle to or from the railway station, 15-20% take the bus, 40-60% walk and 1-5% travel by car or taxi. Cycling to the station has increased in connection with the investments in regional trains in Skåne.[285]

Another comparison can be made, this time with Halmstad,[286] a town almost as large as Eskilstuna, but which – like Skåne – has a more bicycle-friendly climate than the Mälaren valley. According to a travel census, 20% of all passengers walked to or from the station, 15% went by bicycle or moped, 10% travelled by car or motorcycle, 22% got a lift in car or took a taxi, 14% travelled by local or regional bus and 20% by some other means, including a connecting train. Commuters walk and above all cycle to the station more than the average of all the passengers, but get a lift in a car less often.[287]

A comparison between Skåne, Halmstad and the Svealand line shows that there are great differences depending on local conditions. In Halmstad only a small number of passengers walk, but more cycle to the station than in Eskilstuna. In Skåne too, a large number of people cycle. Connecting bus services, however, have shares of only 10-20%, with the

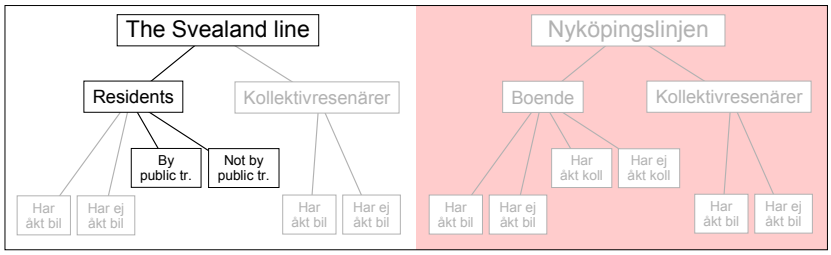
[285] Rystam (1998)

[286] There were 53 487 people living in the Halmstad conurbation on 31 December 2000. Source: SCB, Statistics Sweden

[287] Municipality of Halmstad town-building office, interviews made on Wednesday 1 June 1995. No. of responses n=441, frequency of response 78%.

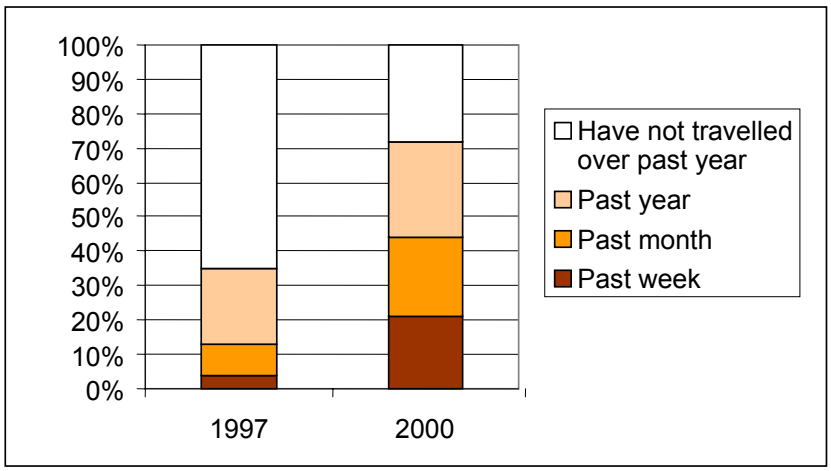
exception of Läggesta on the Svealand line where there is no real local passenger base. Travelling by car to the station also accounts for only a small proportion of the connecting journeys, except in Strängnäs and Läggesta.

7.3.3 Journeys by train in general



Residents' latest train journeys, irrespective of route but not including journeys with SL commuter trains and the Underground vary, partly depending on the accessibility to train services in their home community and partly on different socioeconomic factors. Residents of Åkers styckebruk, for example, thus travelled by train less often than residents of Mariefred and Strängnäs. In 1997, before the Svealand line, there was no (regular) train service in any of the communities, except in Eskilstuna. Nykvarn residents were relatively close to the long-distance trains in Södertälje.

Proportion of the population who recently travelled by train, Svea conurbations AB+D'



Proportion of the population who recently travelled by train in general (not including SL commuter train and the Underground) in the communities along the Svealand line.

Recently travelled by train, residents of Svea conurbations AB+D' by gender

Travelled by train	Women		Men		All	
	1997	*2000*	*1997*	*2000*	*1997*	*2000*
Past week	6%	22%	3%	20%	4%	21%
Past month	14%	47%	11%	40%	13%	44%
Past year	37%	76%	33%	69%	35%	72%

Svea conurbations AB+D': Residents in comparable areas in Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna, weighted

A comparison with some other communities in the 1997 study of residents shows that people who lived along the Svealand line travelled by train less in 1997, but more in 2000, than in these areas. The other areas (values for 1997 in brackets) are Södertälje (10% past week, 36% past year), Nyköping (4% past week, 53% past year) and Örebro (10% past week, 58% past year).

A division by gender shows that women living along the Svealand line travelled by train slightly more often than men. Education levels, on the other hand, show greater differences between the groups.

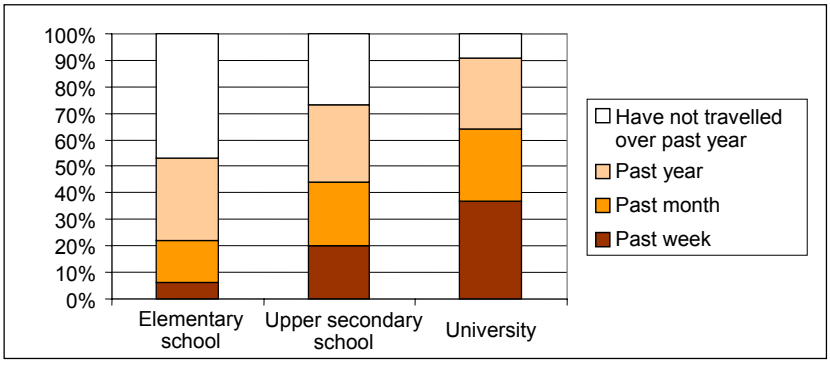
Travelled by train recently, Svea conurbations AB+D', by education

Travelled by train	Elementary school		Upper sec. sch. or adult res. coll.		University or college	
	1997	*2000*	*1997*	*2000*	*1997*	*2000*
Past week	1%	6%	2%	20%	10%	37%
Past month	6%	22%	11%	44%	24%	64%
Past year	21%	53%	36%	73%	53%	91%

Svea conurbations AB+D': Residents of comparable areas in Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and Eskilstuna, weighted. Highest completed education

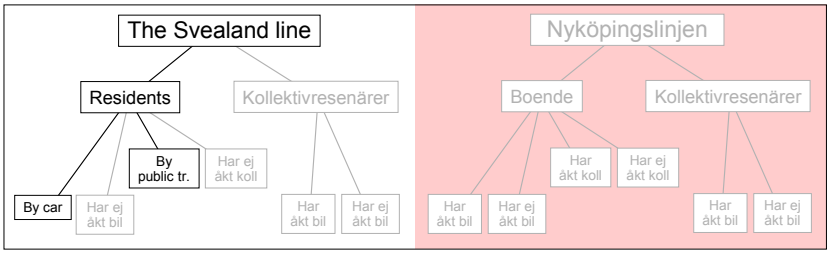
Travel by train among residents living along the Svealand line differs markedly depending on education. People with only elementary school education travel less often than people with higher levels of education. 37% of the residents with university or college education had travelled by train the past week, and 91% during the past year. The corresponding figures for people with elementary school education were 6% the past week and 53% the past year. People with upper secondary school education lie somewhere in-between. A relation therefore exists in that the higher the education a population has the more inclined they are to choose the train, given similar prerequisites. Travel is also related to, for example, commuting distance, occupation and the type of tasks the person's job involves.

Residents who had travelled by train recently, Svea conurbations AB+D', 2000, by education



Residents who had travelled by train in general (not including SL commuter trains and the Underground) in the communities along the Svealand line under during the past year (2000), by highest completed education.

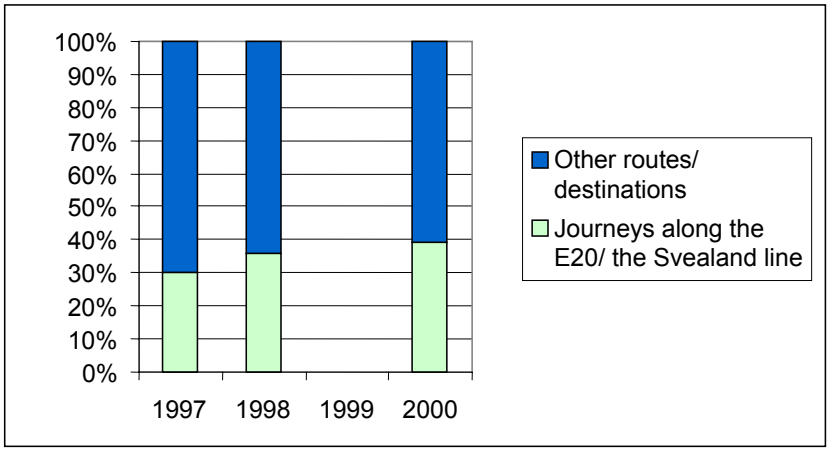
7.4 Effects on the choice of destination



Changes can be observed with regard to the destinations of journeys outside the home community made by residents who live at walking distance from the railway station in Eskilstuna. The proportion of journeys along the E20/the Svealand line increased from about 30% in 1997 to almost 40% in 2000.

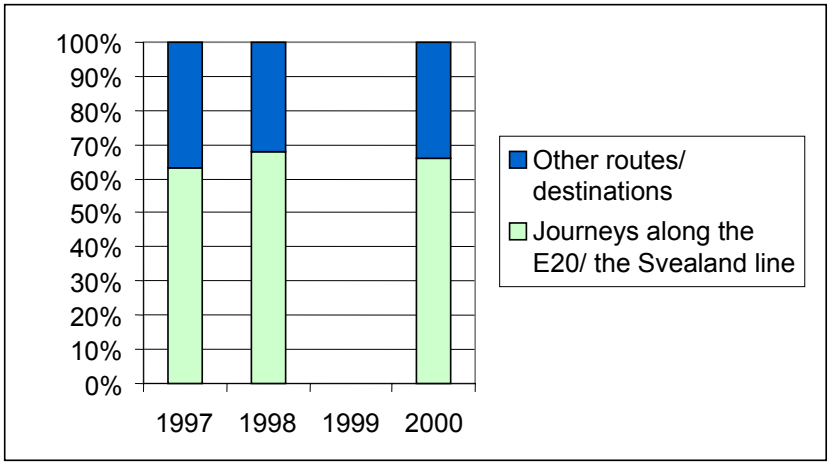
People living along the Svealand line in Svea conurbations AB+D' also showed a tendency to change destination their destination after train services began on the Svealand line, with a greater number of journeys along the E20/Svealand line corridor, although the differences were relatively small. Compared to the choice of destination for people living in the centre of Eskilstuna, it is noticeable that the train services did not have the same impact on travel in the areas further from the railway stations.

Choice of destination for residents living at walking distance from the station in Eskilstuna, 1997-2000



Walking distance; up to 1 km from the station in Eskilstuna.

Choice of destination for residents of Svea conurbations AB+D', 1997-2000



Destinations of journeys outside home community over the past 7 days. Svea conurbations AB+D' are residents of Nykvarn, Mariefred, Åkers styckebruk, Strängnäs and the centre of Eskilstuna, weighted.

7.5 Discussion and summary

7.5.1 Willingness to travel

Car ownership changed over the period from 1997 to 2000 in that the number of households with two or more cars increased by a few percentage points in the country as a whole. Along the Svealand line, however, the proportion of households with more than one car did not increase, and the difference is significant for 2000. One probable explana-

tion may be that the population's need for a car decreased as a result of the train services on the Svealand line. This can be seen principally in the fact that the proportion of households with one car increased, while the proportion of households with more than one car decreased in the central areas of Eskilstuna and Strängnäs.

Residents' latest journey by public transport along the Svealand line has shifted in time since the train services began. In the analysis the population was divided into three groups on the basis of access to a car. Habitual motorists always have access to a car, non-motorists never. Frequent-infrequent motorists have access to a car at times. Among these groups, the proportion of habitual motorists who had recently travelled by train increased substantially, from 13% who had made a journey over the past month (6% over the past week) in 1997 to 35% (16%) in 2000. The frequent-infrequent motorists travelled most by public transport of the three groups, but the increase is smaller than for the habitual motorists. Among the non-motorists, many had travelled during the past month, but fewer who had done so over the past year, i.e. the people who seldom travelled were travelling more. This trend can also be seen among the frequent-infrequent motorists and the habitual motorists, and indicates an increase in social and cultural interchange taking place with the help of the regional high speed trains.

Residents' travel by car and public transport also changed between the situation before the Svealand line and after the train services began. Significant decreases in travelling by car can be seen for residents who live close to the station in Strängnäs for journeys along the E20/the Svealand line, for people who live in the centre of Eskilstuna in total, and for all residents of the conurbations along the Svealand line. Significant increases in travel by public transport can be seen for residents in the whole of Strängnäs for journeys along the E20/the Svealand line, and for all residents of the conurbations along the Svealand line for journeys on the line. Divided over the different groups by car ownership, the habitual motorists have significantly increased their travel by public transport, both in total and just along the E20/the Svealand line.

The frequency of travel for the residents when divided into different socioeconomic groups shows that travel by car has decreased significantly in the 20-24 age group, people in full-time employment, residents with upper secondary school education and a household income below 400 000 Skr. Travel by public transport along the E20/the Svealand line increased significantly for men, for the 25-44 age group, for parents with children 15 years of age or younger, for married or cohabiting couples (also total travel by public transport), for self-employed people (also total travel by public transport), for people in full-time employment, for

residents with a university education and for residents with a household income over 400 000 Skr.

The analysis shows that it is mainly people of productive age with access to a car and relatively good incomes who made more journeys by train. This group, social group 2 or the middle classes, constitute a majority of the country's population.

Men in Sweden on average travel both more and over longer distances than women do, especially when travelling to work or on business trips.[288] In the study of residents of Svea conurbations AB+D' there are significant differences in car travel, where men make more journeys outside their home community, both in total and along the E20/the Svealand line over the past 7 days both in 1997 and in 2000. On the other hand, there was no significant difference between men and women's travel by public transport either year. Men, however, travelled significantly more by public transport once the train services on the Svealand line began.

If the differences between men and women are supplemented with a further selection criterion in the field study, for example university or college education, there is no significant difference between men's and women as regards travel outside their home community. However, the sample population is limited, and if the sample had been larger, the difference that nonetheless is present yet is not significant, might become so.

An individual's sex, male or female, must however be viewed in its socioeconomic and cultural context, i.e. gender. Our genders are a result of existing social and economic power structures.[289] Transferred to the differences between men and women's travel outside their home community, for example, such differences might depend on our respective gender, where men travel more for social or economic reasons. Typical for the male gender is also to regard the car as more than just a means of transport, and the use of the car tends for men in general to be an expression of acknowledgement and power more than for women. Men drive more often, while women are passengers more often than men, despite the fact that both are able to own a car and hold a driving licence.[290]

One might think that small groups of men and women with otherwise equal socioeconomic factors (for example a group of single people without children, who work full-time, have a university education etc.)

[288] RES 2000. Den nationella reseundersökningen, *National survey of travel habits* (2001)
[289] Wajcman (1991)
[290] Polk (1998)

would show the same travel patterns, but since women to a greater extent still have lower incomes, work part-time and manage the household, women in general show less tendency to travel than men do. This is also true when it comes to commuting over long distances. The train services on the Svealand line seem, though, to some degree to have equalised the differences between the genders as regards travelling outside the home community.

7.5.2 Choice of travel mode

The distribution of travel by public transport and by car for journeys along the E20/the Svealand line varies depending on the distance from home to the railway station. Travel by public transport is greatest among people living close, within walking distance, to the station. Between 1997 and 2000 the proportion of public transport travel increased substantially. In Strängnäs, for people who live at walking distance, the proportion increased from 20% to 45%, and for those living at cycling distance from 10% to 20%. People living in the centre of Eskilstuna increased the number of journeys they made by public transport from 25% in 1997 to 50% in 2000. For all residents in the conurbations, the proportion of travel by public transport along the E20/the Svealand line increased from 20% to almost 30%.

The proportions of travellers who choose different modes of transport for getting to and from the stations remained relatively stable in Stockholm and Eskilstuna before and after the Svealand line opened. In Läggesta and Strängnäs, on the other hand, the number of passengers who take the car to and from the station increased. This indicates that the train services attract residents from a wider area, who perhaps choose to take the train to Stockholm rather than travel by car the whole way. This trend is not as strong in Eskilstuna, which might indicate a smaller catchment area around the station due to the longer travelling times that commuting to Stockholm entails.

There is a clear linkage between train travel in general and the level of education. University or college educated people travel by train considerably more than people with a lower level of education. This is naturally connected to income, occupation and the types of tasks involved in people's jobs, and in a broader perspective the personal benefit from the journey that the individual has to weigh against the generalised cost of the journey.

7.5.3 Connecting services

The demand for train journeys is considerably higher among people living close to the railway stations than among people who need to use

some other travel mode to get to the station. The local and regional bus services that connect to the railway stations necessitate at least one extra change, and the supply is often unsatisfactory, with low frequency of service, or too long travelling times for the journey by public transport to be an alternative to making the journey by car.

National planning is crucial to good accessibility and high market shares for public transport. Stations should be located in closely built-up areas and where many people can reach their destinations with a walk to the station. In this context it is probably more important to have many jobs and major service facilities close to the stations, rather than housing, since this would facilitate commuting by public transport for more people than would be possible if the station was situated inside a relatively sparse area of housing. Short journeys to the stations, preferably on foot, are crucial to the attractiveness of the supply.[291]

There are also examples that prove that local bus services can be developed, which in combination with the train services can then function better as a system in a regional perspective. In Ockelbo for example, this has been achieved by coordinating regular bus services, school transport and some of the taxi services for the disabled into a single transport service solution. This has led to a better total supply for all passengers and also a dramatic increase in the number of journeys.[292] Request-driven public transport services and new computer-based information systems in a collaboration between the different players in the market would open up further possibilities to provide an attractive supply from door to door. This could be adapted to individual needs better than today's public transport, but at the same time would be cheaper than car or taxi. Attractive connections to the trains would draw new passengers and expand the area that has good accessibility by train.

7.5.4 Choice of destination

A trend towards destination changes can be seen. The proportion of journeys along the E20/the Svealand line of the total number of journeys outside passengers' home communities has increased among residents along the Svealand line. The trend is most noticeable for people who live near the railway station, for example in the centre of Eskilstuna.

[291] Rietveld (2000)
[292] Börjesson, Ljungberg and Tiderman (1997)

7.5.5 Hypotheses

6. *The radically improved supply of train services with the Svealand line increases accessibility, which means that people travel more and choose other modes of travel and other destinations than before the supply change.*

Changes take place slowly in some cases. Changes, or trends, that have been found are that total travel has increased, more journeys are made by train compared to other modes of travel, and that a shift towards a greater number of destinations along the E20/Svealand line corridor than other destinations is taking place. The field studies and the accessibility study bear out these conclusions. The hypothesis is accepted, but should be followed up over a fairly long period.

7. *The greater attractiveness of public transport means that people's dependence on a car for regional journeys decreases, which means that car ownership decreases.*

A stagnation in car ownership can be seen in the area along the Svealand line, while households' ownership of a second car has increased in the country as a whole. This effect seems to be clearest in the central areas of the conurbations according to the field studies where the proportion of households with more than one car has fallen, but is not in general significant with this degree of disaggregation. The hypothesis can be accepted, but with some reservation.

8. *Connecting journeys to and from the railway stations reduce the accessibility and attractiveness of public transport compared to the car.*

The effects on travel behaviour are very clear among the people who live at walking distance from the railway stations, but less so the further away, as the field studies show. Stations located far from built-up areas and places of work also have smaller market shares for the train than centrally situated stations. It is evident that accessibility to the station is critical to travel by train. Walking distance gives considerably more travel than a connecting journey by some other means of transport, as both the field studies and the accessibility study show. This depends to some extent on the purpose of the journey and the structure of the communities, but as a general observation the hypothesis can be accepted.

8. Accessibility

Accessibility (see the definition in section 2.2) can be a result of changes in the supply of physical transportation. There is therefore a linkage between supply, travel (demand) and accessibility. This chapter describes the results of a number of different methods of studying differences in accessibility before and after train services began operating on the Svealand line.

8.1 Individual accessibility measures

8.1.1 Accessibility as time geography

In time geography an individual's position in space and time can be illustrated through the external constraints on the individual's possibilities to move to another position. Plotting this in a space-time diagram results in prisms. What the figures illustrate is thus accessibility to an area of land within a certain time, or a geographical potential accessibility. The model, however, lacks a valuation of the value the locality in question has for the individual. As a special case, the potential accessibility from a point located at the railway station in Eskilstuna is considered here. Accessibility is then illustrated as the cross section area a prism has after an hour's travel. In more simple terms, the prism may then be said to resemble an inverted cone, the base of which is the accessible area within a given time.

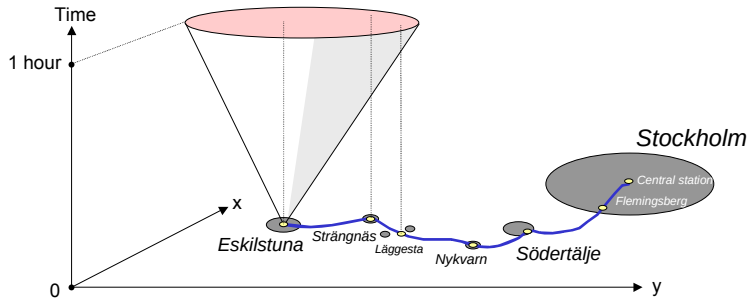
Using the bus services that were available before the Svealand line opened, a person living in Eskilstuna could reach most of the county along the E20 within an hour. A traveller could also come just as far in other directions within the same time, which meant that the area within reach was more or less circular (see the figure).

A characteristic of the high speed train services is that the potential accessibility is extended along the line's longitudinal direction, forming an asymmetric cone along the line. In addition, a number of satellite cones are formed around the railway stations to which travelling time is less than an hour, and where it is possible to reach an area around the station within an hour.

The conclusion drawn from the time geography approach is that the Svealand line has increased potential accessibility. Even if the area of the prism's cross-section can be calculated, i.e. the bottom of the inverted cone, the area is nonetheless an unsatisfactory measure of the value of

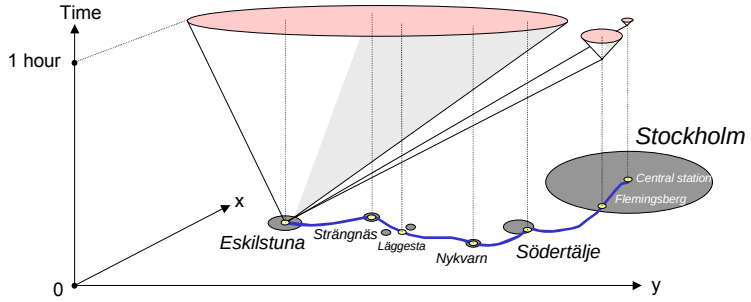
the accessibility because a graphical analysis lacks detailed information about an area's characteristics.

Potential accessibility from Eskilstuna before the Svealand line



The time geographic view of accessibility. The prism's (i.e. the cone's) cross section area shows the size of the land area that could be reached within an hour by public transport from Eskilstuna before the Svealand line opened.

Potential accessibility from Eskilstuna with the Svealand line



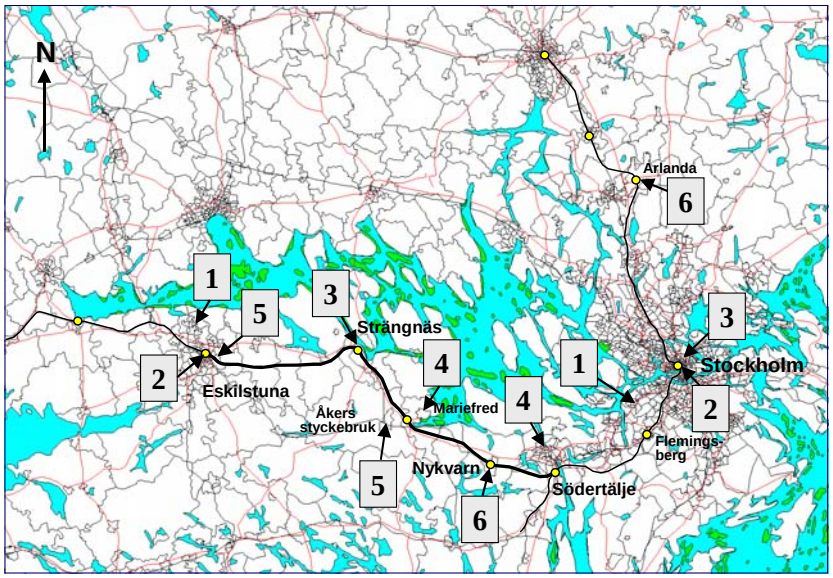
The land area that can be reached within an hour by public transport from Eskilstuna with the Svealand line. An asymmetric cone in the longitudinal direction of the line and some satellite cones are a typical effect of high speed train services.

8.2 Distance measures

8.2.1 Travelling times for six typical journeys

Travelling time can be used as a simple form of accessibility measure. Travelling times are given here in terms of real time, i.e. the time that a passenger would be able to find in bus and train timetables. The example shows the travelling times for six different typical journeys, where at least one link in the journey chains is a journey by bus along the E20/the Svealand line or one by train on the Svealand line. The intention of the typical journeys is to show how travelling time has changed for some typical tours and trip purposes before and after the change in supply.

Typical journeys along the Svealand line



	Starting point	*Destination*
1	Torshälla, Östra torget	IKEA, Kungens kurva, Huddinge
2	Centre of Eskilstuna	Ministry of Industry*, Jakobsgatan 26, Stockholm
3	Centre of Strängnäs	KTH, Teknikringen 72, Stockholm
4	Centre of Mariefred	AstraZeneca R&D H.Q., Kvarnbergagatan 12, Södertälje
5	Centre of Åkers styckebruk	Mälar Hospital, Eskilstuna
6	Centre of Nykvarn	Terminal 5, Arlanda airport

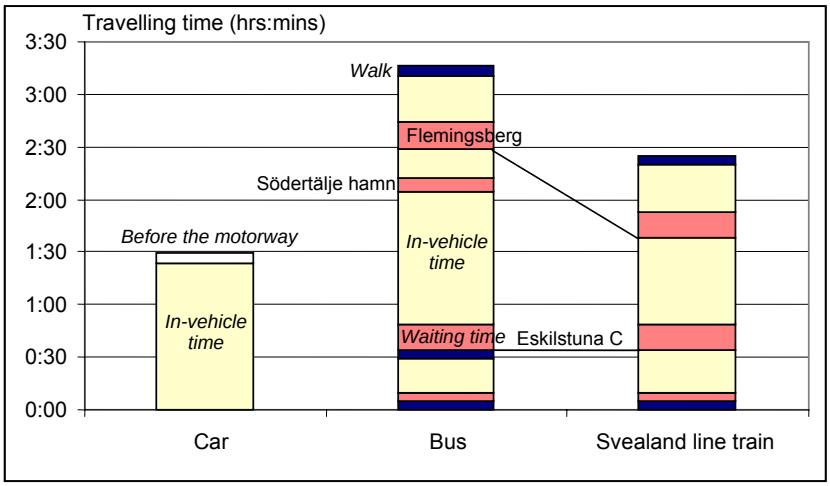
* The full name of Näringsdepartementet is "Ministry of Industry, Employment and Communications"

The typical journeys can also be made in the opposite direction. Detailed calculations of the routes and times are shown in appendix 9.

Travelling times by car have been calculated using the Sampers modelling system and are for 1998. Extra time for possible traffic jams in the road system is included in the travelling time. One change for 2000 is that the section of motorway between Eskilstuna and Arphus (Härad/Strängnäs) had been opened, and is here estimated to shorten travelling time by car by 5 minutes. Travelling times by public transport, on the other hand, have been calculated on the basis of the timetables that applied in spring 1997, before the Svealand line, and spring 2000, with train services operating on the Svealand line. The public transport travelling times include walking time (on foot), waiting time and in-vehicle time. In all the alternatives the first walking time to the bus stop

or the railway station is assumed to be 5 minutes, followed by 5 minutes' wait before the bus or train leaves. Real times are used for changes between travel modes, i.e. real waiting time according to the timetable (weighting = 1). In such cases, waiting time includes short walks between travel modes.

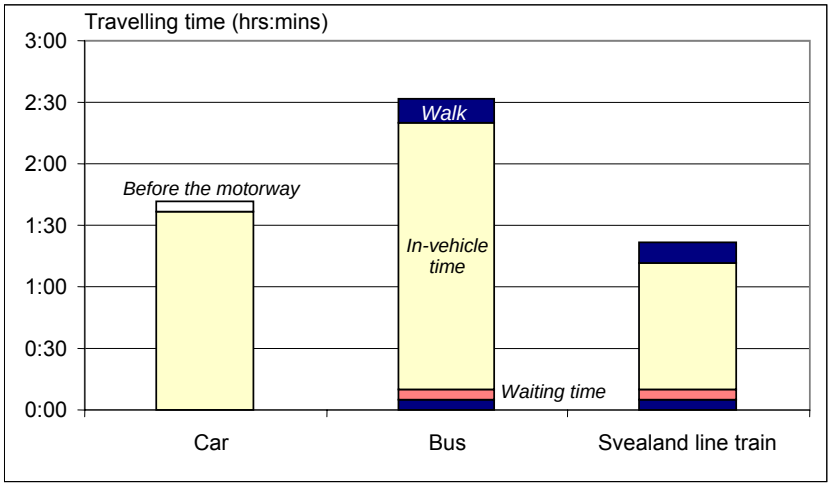
Typical journey 1: Torshälla–Kungens kurva



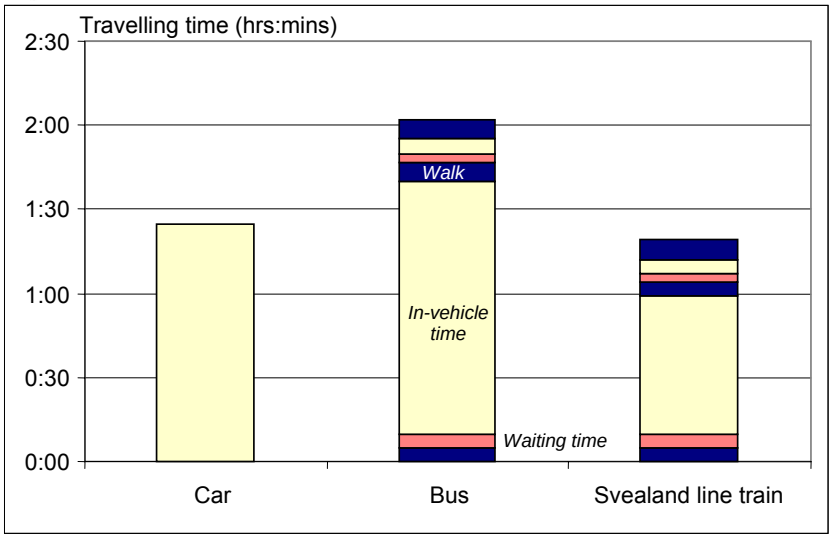
Travelling time by car between Torshälla (just outside Eskilstuna) and Kungens kurva in the municipality of Huddinge, a sizeable area with places of work and trade, was 1 hr 30 mins (1:30) in 1997, and 1 hr 25 mins in 2000 after the Eskilstuna–Arphus section of motorway had opened. For the public transport passenger before the Svealand line (on the bus in 1997), the journey took 3 hrs 15 mins, and 50 minutes less by train on the Svealand line, i.e. 2 hrs 25 mins. The travelling times are too long for daily commuting and travelling by public transport involves several connecting journeys, which with waiting times and the slow speeds of the local bus services mean long travelling times.

In the typical journey no. 2 travelling time by car from the centre of Eskilstuna to the centre of Stockholm was 1 hr 40 mins before the Eskilstuna–Arphus stretch of motorway was opened, and 1 hr 35 mins once it had opened. Travelling time by bus was 2 hrs 30 mins, and by train on the Svealand line about 1 hr 20 mins. It is therefore faster to travel by train than by car between the two centres. A prerequisite, however, is that no connecting 'journeys' other than short walks are necessary.

Typical journey 2: Centre of Eskilstuna–Centre of Stockholm

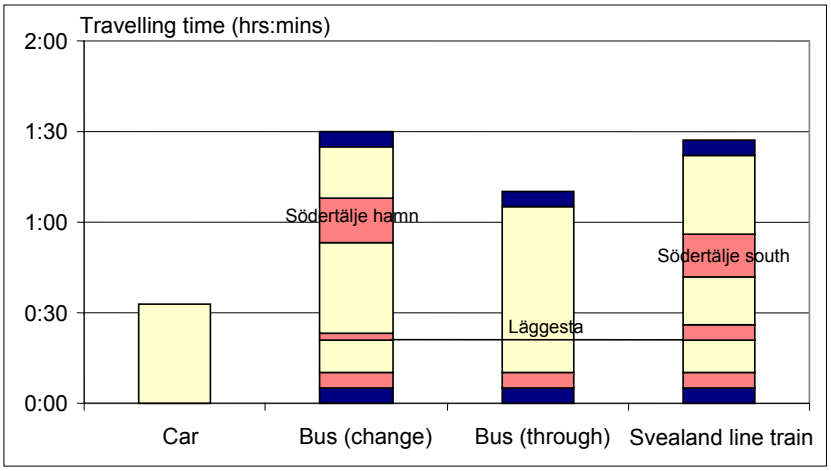


Typical journey 3: Strängnäs–Stockholm city centre



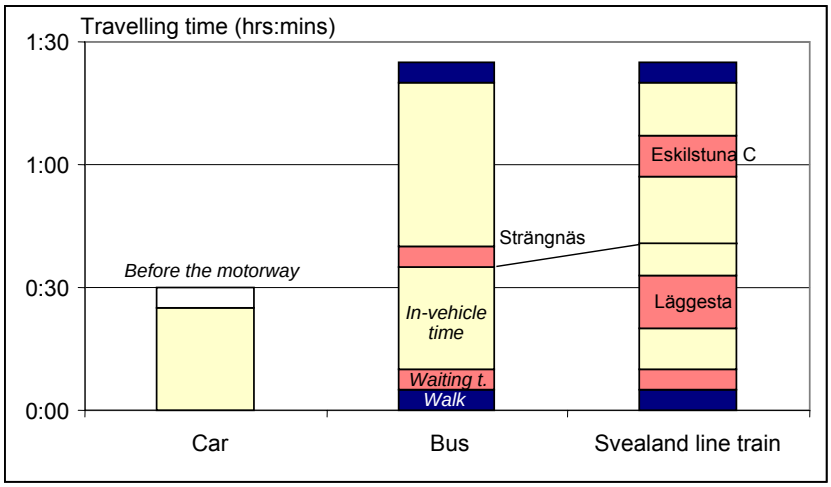
Strängnäs is closer to Stockholm than Eskilstuna. This means that accessibility to Stockholm's labour market is greater. A traveller from Strängnäs can reach the whole of the city centre of Stockholm in the same time it takes for someone coming from Eskilstuna just to reach the central area, despite the fact that a connecting journey on the Underground is included. Travelling time by car was 1 hr 25 mins, by bus 2 hrs and by train from start to destination 1 hr 20 mins.

Typical journey 4: Mariefred–Södertälje



Travelling time by car between Mariefred and Södertälje (Astra-Zeneca) is slightly more than half an hour. Travelling time by public transport bus in 1997 was 1 hr 30 mins, with changes at the Läggesta and Södertälje hamn stations. Travelling time is almost the same by train on the Svealand line, but the through bus, on the other hand, takes 1 hr 10 mins. The difference between travelling time by car and travelling time by public transport, however, is considerable in all the alternatives.

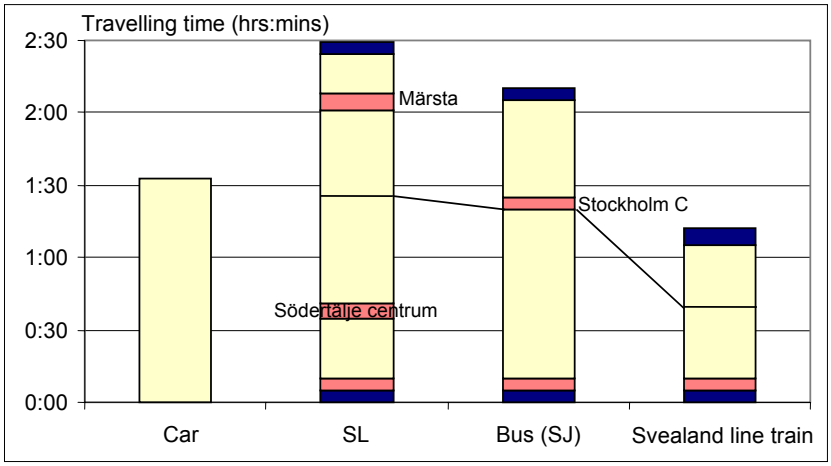
Typical journey 5: Åkers styckebruk–Eskilstuna



By car it took half an hour to travel from Åkers styckebruk to Mälar Hospital in Eskilstuna in 1997. When the new stretch of motorway on the E20 opened, travelling time by car fell to 25 minutes. On the county public transport authority bus service, the same journey took 1 hr 25 mins, changing in Strängnäs. Travelling time by train was the same,

changing from bus to train in Läggesta and from train to local bus at Eskilstuna Central station. Even on this short journey, it is much faster to take the car than travel by public transport.

Typical journey 6: Nykvarn–Arlanda airport



The car journey from Nykvarn to Arlanda airport took a little more than 1 hr 30 mins. With SL, first bus from Nykvarn to Södertälje centrum station, then commuter train from there to Märsta and finally bus again between Märsta and Arlanda, the journey takes 2 hrs 30 mins. By SJ bus from Nykvarn to the city terminal in and then the airport express bus from there to Arlanda the journey took 2 hrs 10 mins in 1997. Note that the difference in travelling time to Stockholm Central station was minimal, just 5 minutes to SL's disadvantage, (1 hr 25 mins compared to 1 hr 20 mins). This can be explained by the fact that SJ's buses took a relatively long time to get to the railway stations in Södertälje and to get into the centre of Stockholm. On the Svealand line in 2000 the travelling time to Stockholm Central station was just 40 minutes, and to Arlanda airport 1 hr 10 mins. The train is thus faster than the car.

8.2.2 Differences between real travelling times and those calculated in the model

The timetable-based travelling times used in the typical journeys between defined forecast areas (see appendix 9), differ from the travelling times calculated by means of the traffic network used in Sampers (see appendix 8).

The differences, however, are not fully proportionally distributed between the real travelling times and those calculated in the model for the different typical journeys. Possible causes of the differences compared to the traffic network used in the modelling system might be that the

calculated times for connecting journeys, waiting and interchanges differ from the real times. The time it takes to walk to the station (the first link) may in some cases have been underestimated in the real travelling times. In certain cases there might also be differences in the route.

Differences between real travelling times and travelling times calculated in the model for the typical journeys

	Bus (SJ) 1997			Train, Svealand line, 2000		
Typical journey	Real trav. time	Trav. time, model	Diff.	Real trav. time	Trav. time, model	Diff.
Journey 1	3:16	3:29	0:13	2:25	2:29	0:04
Journey 2	2:32	3:13	0:41	1:22	2:19	0:57
Journey 3	2:02	3:25	1:23	1:19	2:21	1:02
Journey 4	1:30	1:48	0:18	1:27	1:40	0:13
Journey 5	1:25	2:30	1:05	1:25	2:30	1:05
Journey 6	2:10	3:01	0:51	1:12	2:11	0:59

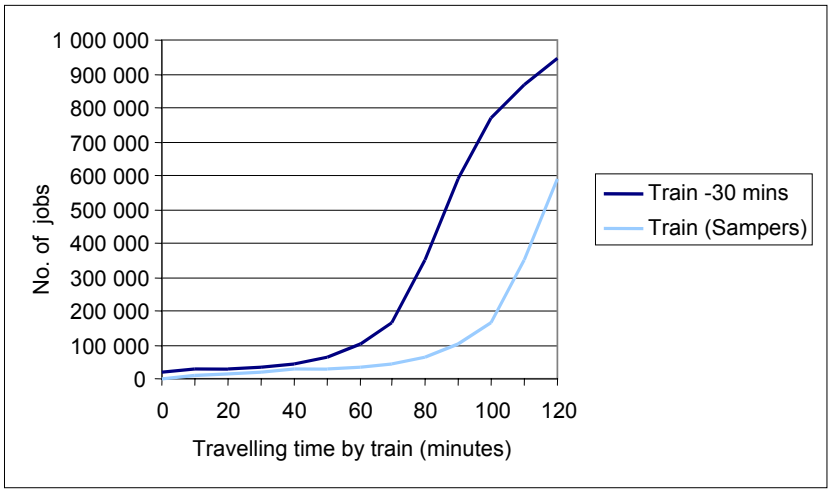
Moreover, errors in the coding of the supply and in the network used in the model with links and nodes can not be excluded. One error that has been established is that the node for Läggesta station is wrongly positioned in the network. There, Läggesta has been placed in Mariefred, which means that the modelling system believes that people in Mariefred live at walking distance (walking link) from the station, while residents of Åkers styckebruk instead have a bus journey longer that is longer than it in actual fact is. This explains the relatively small difference between real and calculated travelling time in typical journey 4 (Mariefred–Södertälje).

Typical journey 1, Torshälla–Kungens kurva, has in principle the same real travelling times as the ones calculated by the model. One reason for this may be that the two or three interchanges that this public transport journey entails are not coordinated between SJ and the county public transport authority, which means that the interchange time is close to the service interval also in reality. Typical journey 4, Mariefred–Södertälje, also contains several interchanges, but here the modelling system disregards a bus connection through the wrong positioning of Läggesta station. In the latter case it is also unclear how much the non-stop buses between the communities, with shorter travelling times but infrequent service, affect the travelling time for the bus journey calculated in the model.

The other four typical journeys in general show a difference of about an hour between the timetable-based travelling times and the travelling times calculated by the model. Considering that the frequency of service

on the Svealand line is a train an hour, just under half an hour of the difference can be explained by the interchange time calculated by the model, which is half the service interval. The remainder of the difference means that the public transport services in the model do not appear to be as good as they should be.

Accessibility to jobs from the centre of Eskilstuna



Potential accessibility from the centre of Eskilstuna. Travelling times for trains on the Svealand line calculated using the Sampers system and corrected modelled travelling times, reduced by half an hour's travelling time (Train -30 mins).

One example of potential accessibility is described here to illustrate the difference; accessibility to jobs by train from the centre of Eskilstuna. The lighter curve, "Train (Sampers)", shows how many jobs can be reached by train (public transport) from the centre of Eskilstuna within two hours with the travelling times calculated by the modelling system. The darker curve "Train -30 mins" shows how many jobs can be reached within the same time if the travelling times calculated by the model are shortened by half an hour. In practice, this means that door to door travelling time from the centre of Eskilstuna to the centre of Stockholm, typical journey 2, is calculated by Sampers to 2 hrs 19 mins by high speed train on the Svealand line, which with a correction of 30 minutes gives a travelling time of 1 hr 49 mins. The real travelling time, however, is only 1 hr 22 mins in typical journey 2, but it may be reasonable to assume a certain margin for the same reasons that the model calculates average times (frequency of service, interchange penalty, waiting time weighting).

The example shows that there is a considerable difference between the travelling times. With the original travelling times calculated in the model, 35 000 jobs can be reached within 60 minutes. According to the

second curve with the corrected travelling times, 100 000 jobs can be reached within the same time. With a travelling time of 90 minutes the difference is even greater; 100 000 jobs with uncorrected travelling times, but 600 000 when travelling time is half an hour shorter. The travelling times assumed in the model consequently have a great impact on trip generation. With a travelling time of one hour, three times as many jobs can be reached with corrected travelling times, and with a travelling time of an hour and a half, six times as many, which generates more journeys to work.

In the cumulative diagrams that follow, 30 minutes have been subtracted from the travelling times calculated using Sampers. In the other calculations of accessibility, presented in the form of maps, the original travelling times calculated in the model are used.

8.3 Cumulative-opportunity measures

8.3.1 Accessibility to jobs

The number of jobs within a certain time radius for a door to door journey are shown here in cumulative diagrams, with the situation before (buses) and after the Svealand line (trains). The travelling times have been calculated using the Sampers modelling system, but corrected by 30 minutes. An exception, however, is the diagram for Mariefred, where the travelling times from the model have been shortened by 20 minutes. The reason for this is that Läggesta station in the network used in the model is in the wrong place, in Mariefred, and a 10-minute bus journey has been added.

The shorter travelling times mean that the curve does not pass through the zero point, since the community's own labour market can be reached in less than 30 minutes even in Sampers. The main intention, however, is to show how potential accessibility, primarily to Stockholm's large labour market, has been affected by the faster public transport services.

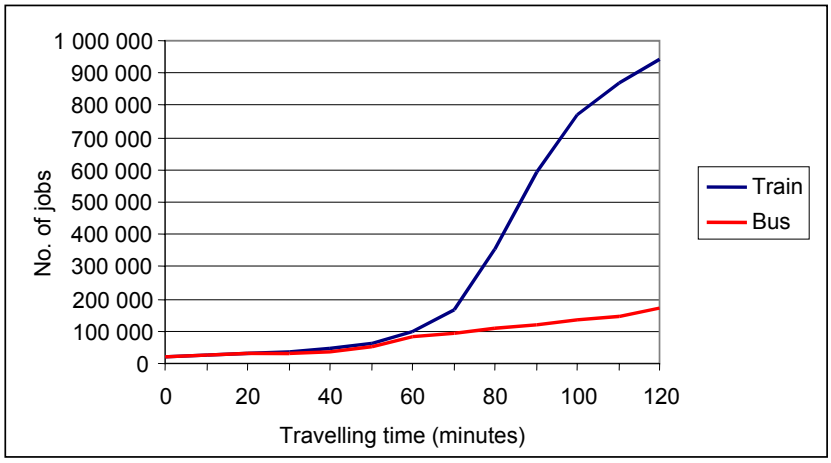
From another perspective, the number of gainfully employed people (manpower) that can be reached within a certain travelling time is of more interest than the number of jobs. This applies for example when companies look for places to locate. The number of jobs and the available manpower, however, give very similar results, which means that the diagrams can also be interpreted as the number of gainfully employed people who live within a certain travelling time.

Travelling times from door to door for journeys to work in general are in most cases shorter than 60 minutes. There are, however, indica-

tions that commuting by train can attract more commuter journeys over longer distances. This is the reason for the two-hour time-frame in the diagrams, even though it is very unusual for journeys to work to be quite that long.

Eskilstuna

Accessibility to jobs from the centre of Eskilstuna within two hours' travelling time

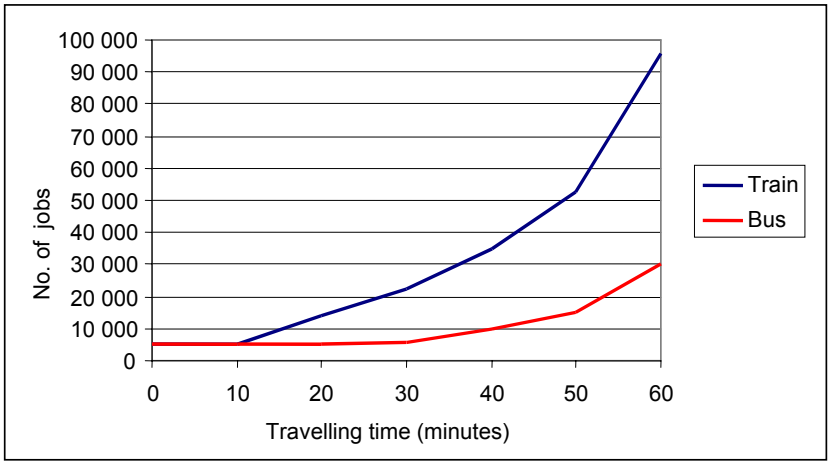


The number of jobs that can be reached with a travelling time of up to 120 minutes by public transport from the station in Eskilstuna.

With the bus services that operated before the Svealand line, about 85 000 jobs could be reached within 60 minutes from the centre of Eskilstuna. This is primarily equivalent to the places of work in Eskilstuna and Västerås and their immediate surroundings. Only after a travelling time of one and a half hours could the jobs in the county of Stockholm be seen in the diagram, but not even two hours was enough to reach Stockholm itself.

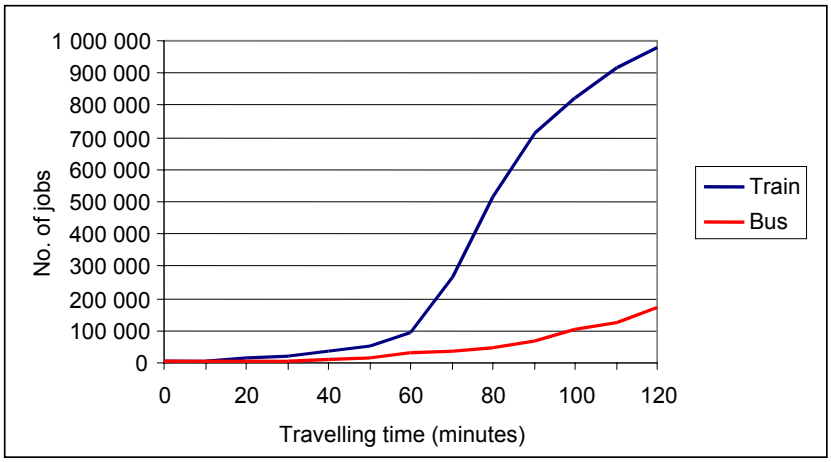
Only slightly more jobs can be reached within 60 minutes, about 100 000, with the train services. The increase over the route that is most common for journeys to work is thus comparatively modest. The whole of Södertälje's labour market lies within 70 minutes, and half a million jobs can be reached within a travelling time of 1 hr 25 mins. Within two hours, most of Stockholm's labour market can be reached from the centre of Eskilstuna.

Accessibility to jobs from the centre of Strängnäs within one hour's travelling time



The number of jobs that can be reached with a travelling time of up to 60 minutes by public transport from Strängnäs.

Accessibility to jobs from the centre of Strängnäs within two hours' travelling time



The number of jobs that can be reached with a travelling time of up to 120 minutes by public transport from Strängnäs.

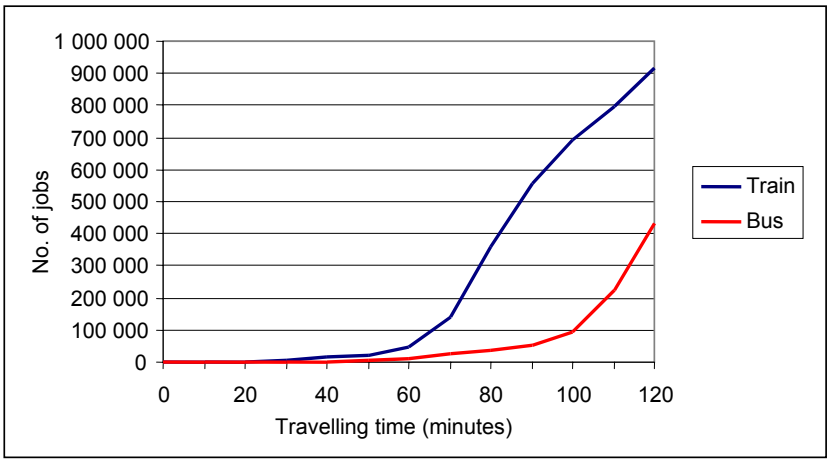
Strängnäs

The main point that the diagram of accessibility to jobs within a travelling time of on hour from Strängnäs makes, is that Eskilstuna's labour markets have come closer. The labour markets in the centre of Eskilstuna could be reached in about 40 minutes, by train in about 20 minutes, and the whole of Eskilstuna with about 20 minutes' more travelling time in both cases.

The number of jobs that can be reached by train within 60 minutes' travelling time from the centre of Strängnäs increased from 30 000 till 100 000, an increase of about 220%. Half a million jobs can be reached by train within 1 hr 20 mins, and a million within 2 hrs (two hours, though, is generally too long to commute to work every day). Stockholm's labour markets could not be reached at all by bus inside a reasonable commuting distance.

Mariefred

Accessibility to jobs from Mariefred within two hours' travelling time

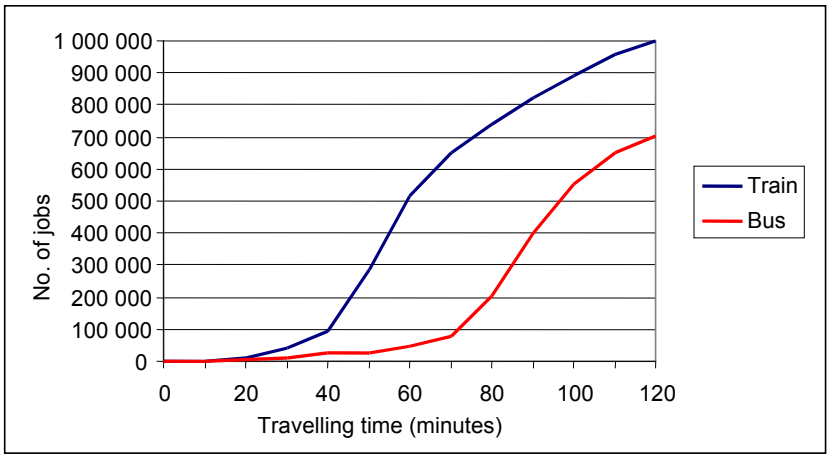


The number of jobs that can be reached with a travelling time of up to 120 minutes by public transport from Mariefred.

Accessibility within an hour's travelling time from Mariefred has improved. About 12 000 jobs could be reached within 60 minutes by bus, and about 48 000 by train, an increase of 300%. By bus, the people living in Mariefred could reach the edge of Stockholm's labour market in 1 hr 40 mins (100 minutes), whereas Södertälje and Eskilstuna could be reached somewhat faster. Half a million jobs could be reached after about two hours. Half a million jobs can be reached by train on the Svealand line in just under 1 hr 30 mins.

Accessibility is about the same from Åkers styckebruk as from Mariefred. In the network used for the calculations in the model, Läggesta station is not in the right place, and for this reason no separate diagrams for Åkers styckebruk are presented here. The error has been compensated for in the diagrams for Mariefred.

Accessibility to jobs from Nykvarn within two hours' travelling time



The number of jobs that can be reached with a travelling time of up to 120 minutes by public transport from Nykvarn.

Nykvarn

The train services on the Svealand line mean that the number of jobs that can be reached from Nykvarn by public transport within 60 minutes increased from 45 000 before to 520 000 after the services began, an increase of about 1000%. This means that potential accessibility has vastly improved for Nykvarn with large parts of Stockholm's labour markets now within an hour's reach.

8.4 Utility-based measures and other Sampers results

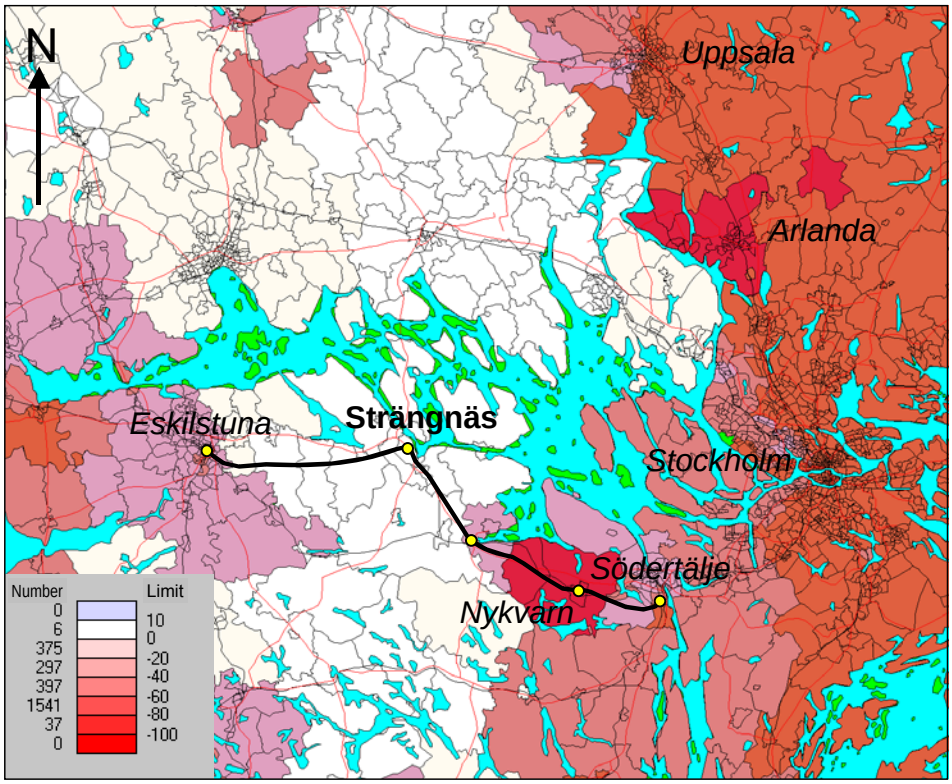
This section begins with the forecast results from the Sampers modelling system with regard to travelling time gains, distance travelled and the proportion of car and public transport journeys to work. This is followed by a presentation of the accessibility calculations of the utility-based measure known as logsum.

In the following, travelling times calculated with the Sampers system are used without exception. With regard to relative differences between before and after the Svealand line, the calculated gains in travelling time are in good agreement with the real gains.

8.4.1 Travelling time gains by public transport

Travelling time gains on journeys by public transport are an important part of the improvements in accessibility that can be assumed to result from the Svealand line.

Gains in travelling time by public transport from Strängnäs



Reduction in travelling time (minutes) for journeys by public transport from Strängnäs to all other areas of the Mälaren valley on the Svealand line compared to before. The darker the colour the greater the gains in travelling time as a result of the Svealand line.

The greatest reduction in total travelling times by public transport for Strängnäs can be seen for journeys to and from the municipality of Nykvarn, largely because of the increased frequency of service with all trains stopping at Nykvarn, in contrast to the previous bus services. Journeys to Stockholm and the corridor northward to Uppsala via Arlanda/Märsta are also much faster; in the latter case this is an effect of the through trains to Uppsala on the Svealand line. For westward journeys, in the direction of Kungsör, Arboga and beyond, travelling time gains are also substantial, thanks to the through-train services to Hallsberg.

8.4.2 Distance travelled on journeys to work

The shortest journeys to work, on average, from each area are found in the larger conurbations. Long journeys to work are an indication of lower accessibility, and the areas from which journeys to work are longest are consequently rural areas far from the larger conurbations.

Average distances travelled on journeys to work by one of the motorised travel modes, i.e. not including walking and cycling, for the residents of the respective areas in the 22-64 age bracket was 22 km in the centre of Eskilstuna in the areas in the vicinity of the railway station, 32 km from Strängnäs conurbation and 37 km from Nykvarn conurbation after the train services began running on the Svealand line. From these average distances the model calculated that the regional high speed trains on the Svealand line meant an increase of up to 8 km for people living in the centre of Eskilstuna, whereas the increase in the centre of Strängnäs was just under 4 km. In Nykvarn conurbation the increase was slightly more than 5 km.

The increases are primarily a result of more long distance commuting by train on the Svealand line, but can also be attributed in part to less congestion on the roads as a consequence of some motorists now preferring to travel by train instead. This allows the remaining (and new) car travellers to travel further inside a given travelling time, up to the point where a new equilibrium is attained.

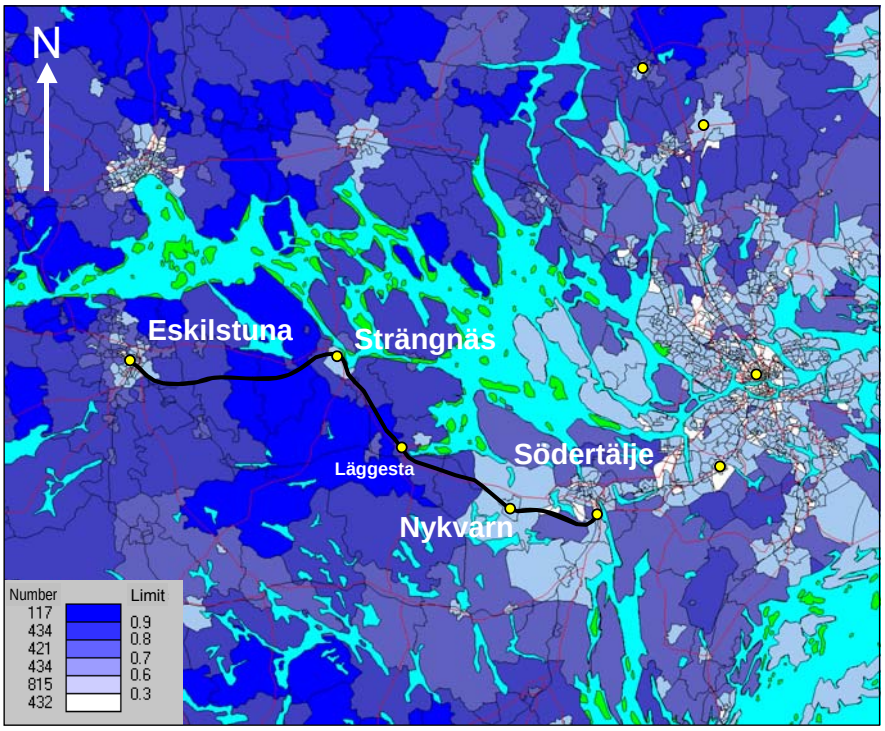
8.4.3 Proportion of journeys to work by car and by public transport

Regional journeys to work in north Södermanland are made mainly by car, but some are made by train or bus. The maps show journeys to work with the proportions made by car or public transport and the difference between before and after the Svealand line.

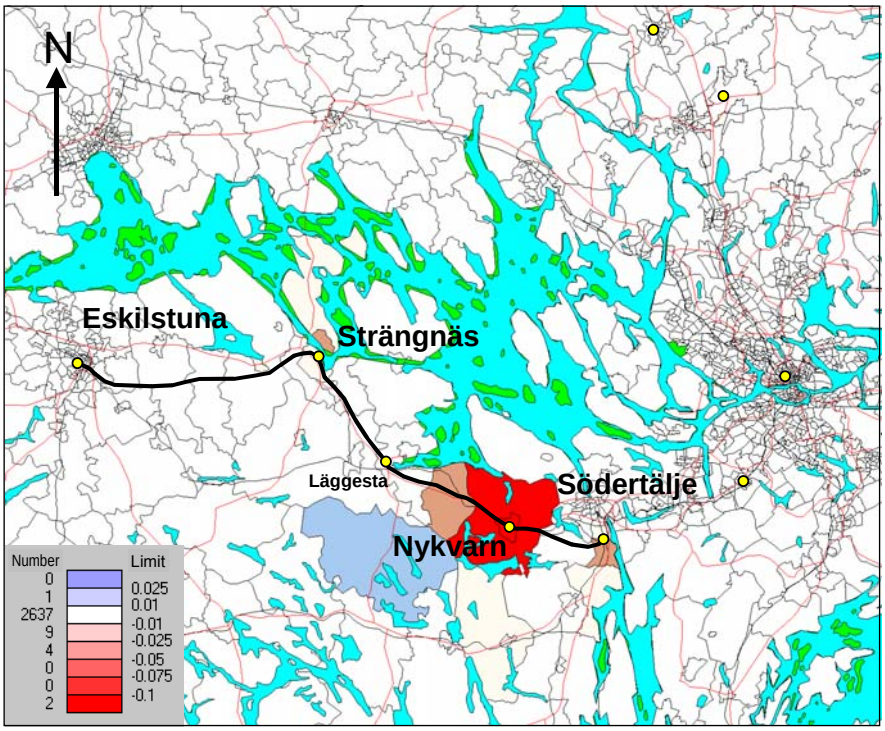
Proportion of car journeys

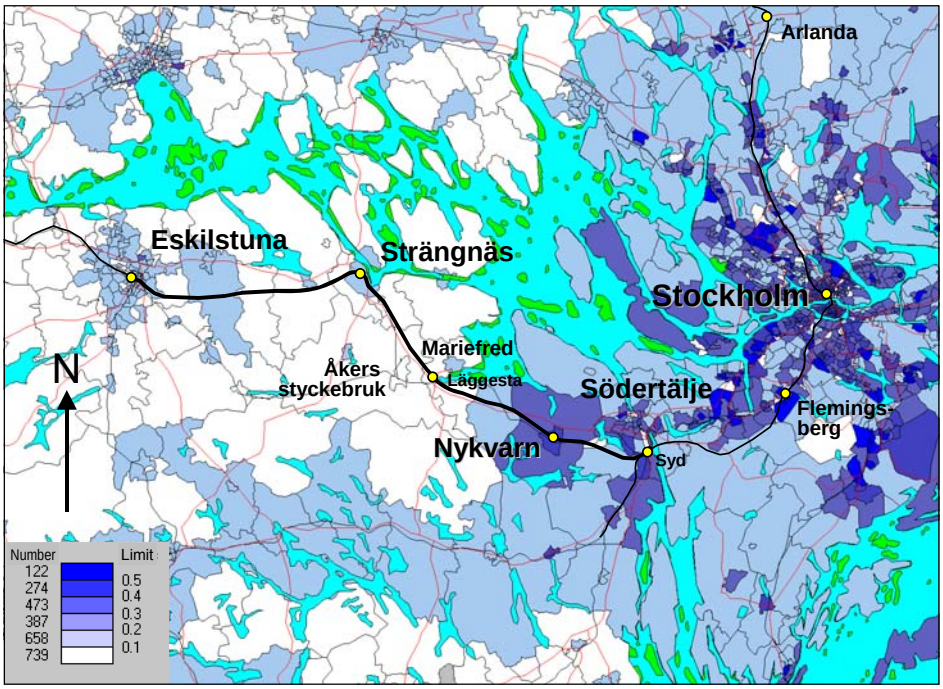
In the centre of Eskilstuna around the railway station, the lowest proportion of regional journeys to work by car has been calculated to 25-30%, but the figure is considerably higher in the peripheral areas of the conurbation. In Strängnäs conurbation the proportion is 58%, in Mariefred 61% and in Åkers styckebruk 74%. Nykvarn conurbation has a proportion of 52% for journeys by car.

In almost all areas close to the railway stations along the Svealand line, the Sampers system's calculations show reductions in the proportion of car journeys to work. In Eskilstuna municipality, the reductions are calculated to be less than 1 percentage point. In Strängnäs including Abborrberget, the proportion of car journeys fell by between 2 and 3 percentage points, but less in the rest of the municipality. The greatest reduction in travelling to work by car was calculated for Nykvarn municipality, where the reduction in the conurbation was calculated to be more than 10 percentage points.

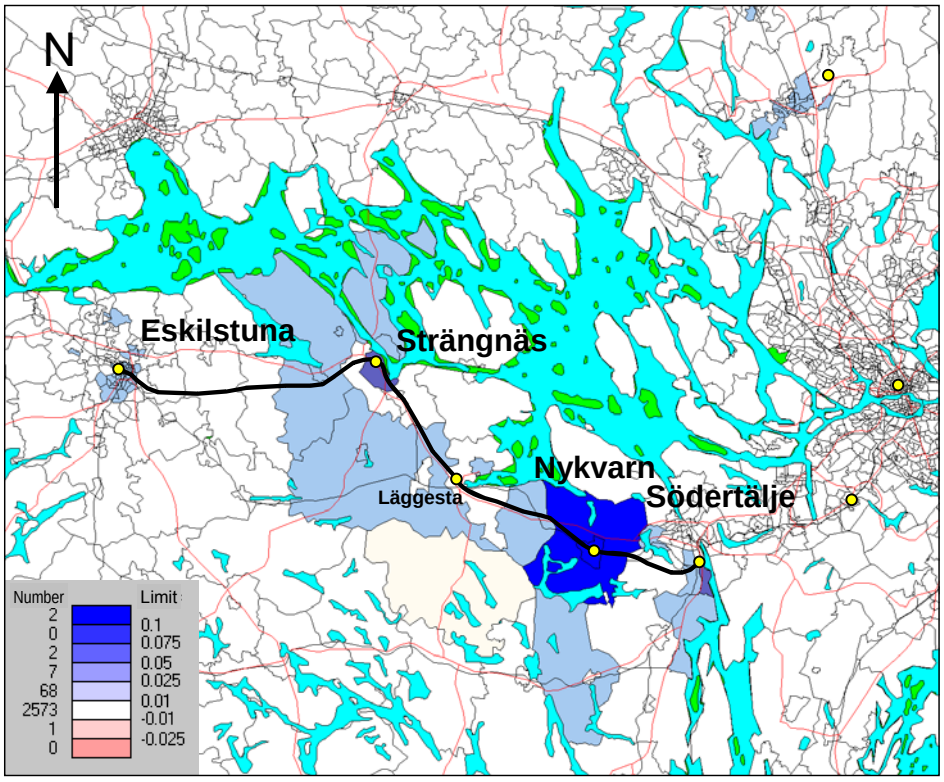


Proportion of regional journeys to work by car, on the Svealand line (above), and the difference compared to before the train services began operating (below).





No. of regional journeys to work by train on the Svealand line (above) and the difference compared to before the train services began operating (below).



Proportion of journeys by public transport

The proportion of travel by public transport for regional journeys to work on the Svealand line from Eskilstuna is calculated to be at most 20-30% in the centre of the town around the railway station, and about half in the rest of Eskilstuna. Further away, the proportion is smaller. In Strängnäs municipality the proportions are 12% from the central conurbation, 19% from Mariefred and 7% from Åkers styckebruk after the train services began on the Svealand line. The proportion of journeys by public transport is 41% in Nykvarn conurbation and 31% in the surrounding areas. In several areas in and around Stockholm the proportion of journeys to work by public transport may be considerably higher.

An increase in the proportion of journeys to work by public transport was calculated for all areas in the municipalities of Eskilstuna, Strängnäs and Nykvarn, and part of the municipality of Södertälje. The increase reflects the decrease in car travel and is estimated to be between a few tenths of a percentage point in the most peripheral areas far from the railway station in Eskilstuna to up to 17 percentage points in Nykvarn conurbation. The increase in journeys to work by public transport is 3 percentage points in the areas closest to the railway station in Eskilstuna, in Strängnäs 5 and in Mariefred 2 percentage points.

Other areas that show a marked increase in travel by public transport include Märsta and Knivsta, where the increase is principally a result of the increase in the supply between Stockholm and Uppsala with the Svealand line.

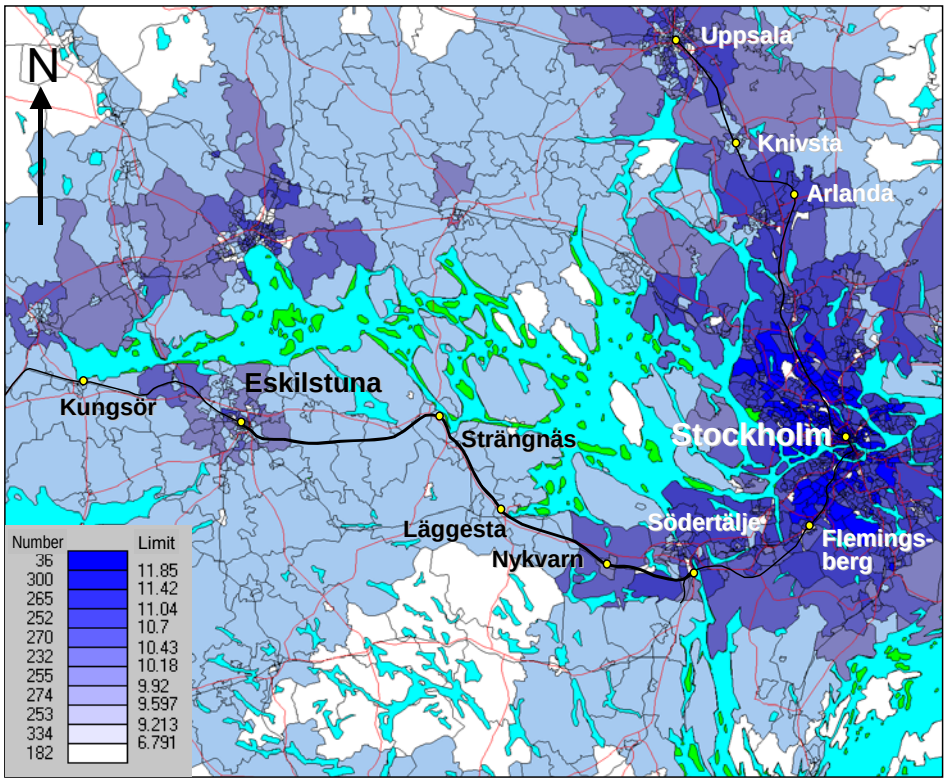
8.4.4 A total accessibility measure – logsums

Logsums (see section 2.2.3) are used here as a measure of the modelled accessibility to jobs by car and public transport. The higher the value of the logsum, the better the accessibility. In the examples, accessibility is realised accessibility, i.e. accessibility in relation to the number of journeys by different modes of travel. The number of journeys, however, is calculated using a forecasting model, which means that it is justified to use the term forecast accessibility instead.

Zones that are completely white in some maps, for example two zones in the middle of Eskilstuna, have 0 inhabitants according to the Sams database and are also given a logsum of 0. These areas are for example industrial estates.

Accessibility to jobs in the Mälaren valley is best in the centre of the region, i.e. Stockholm. Accessibility to jobs is also quite good for residents of other large conurbations. Accessibility is lowest in some peripheral areas, for example in the Stockholm archipelago. These areas are relatively sparsely populated and there are few jobs.

Logsums with the Svealand line; the Mälaren valley

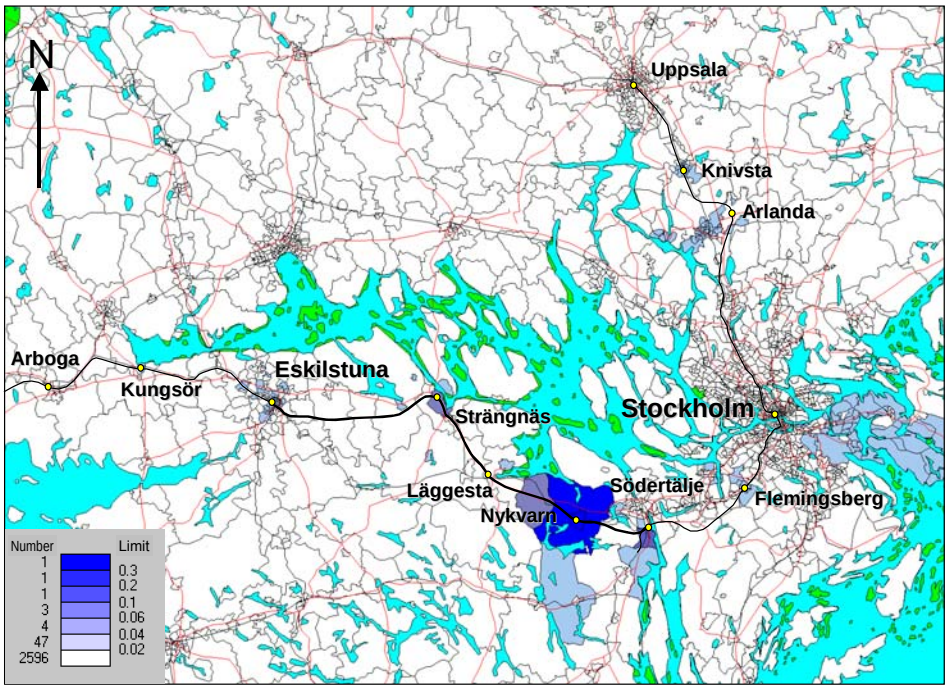


Accessibility measured as logsums with the Svealand line in the Mälaren valley. The darker the colour, the better the accessibility. Accessibility is best in the central areas of the Stockholm conurbation, and least good in rural areas far from conurbations.

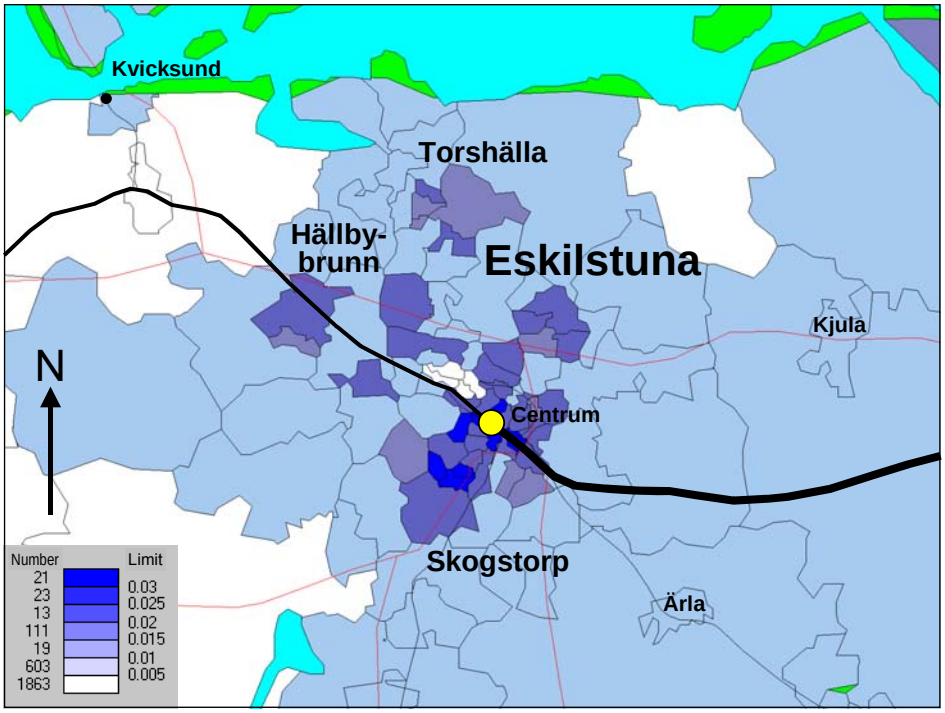
Logsums for the whole of the Mälaren valley

In this calculation, it is the municipality of Nykvarn that receives the largest improvement in accessibility to jobs by high speed train on the Svealand line. Strängnäs conurbation and Pershagen in Södertälje (close to Södertälje syd station) are also areas that see relatively large improvements. Improvements in accessibility also appear in colour on the map for other areas in Eskilstuna, Strängnäs, Södertälje, Huddinge (Flemingsberg), Nacka, Värmdö, Sigtuna/Märsta/Arlanda and Knivsta. In some of these areas the effect of the through-trains to Uppsala on the Svealand line via Märsta/Arlanda is evident.

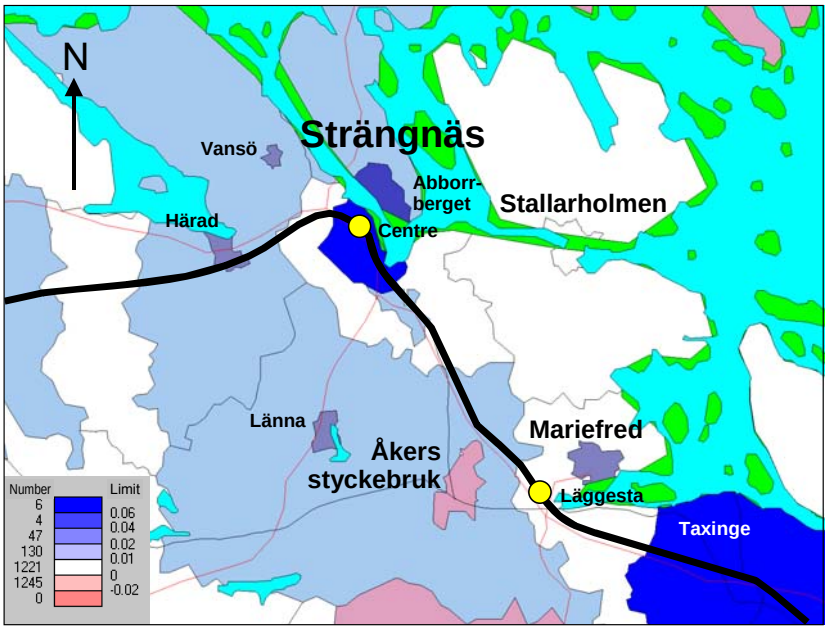
In Eskilstuna municipality it is primarily the conurbation of Eskilstuna itself that has gained improved accessibility through the train services on the Svealand line. Accessibility has also improved in certain areas in the suburbs of Eskilstuna such as Torshälla and Hällbybrunn, despite the fact that a connecting journey to the railway station is needed from these areas.



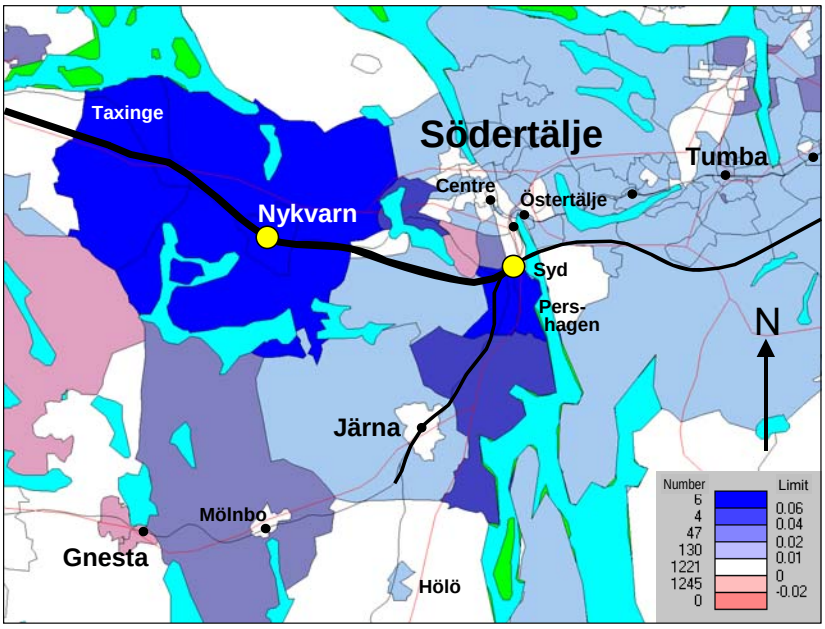
Accessibility to jobs presented as the change in logsums before and after train services on the Svealand line began (above). Differences in logsums with the Svealand line compared to before in Eskilstuna municipality (below). Note that the scale differs from that in the following maps of Strängnäs and Nykvarn/Södertälje.



Differences in logsums with the Svealand line compared to before; Strängnäs



Differences in logsums; Nykvarn and Södertälje municipalities



In Strängnäs municipality, the train services on the Svealand line have primarily given the conurbation of Strängnäs including Abborrberget an increase in total accessibility. In addition to the conurbation itself, the shorter travelling times by train compared to the bus also affect the smaller communities of Vansö, Härad and Länna. By contrast, there are

no noticeable improvements in accessibility in Åkers styckebruk or Stallarholmen, the explanation being that SJ's and the county public transport authority's non-stop buses have been replaced by an interchange with another travel mode in Läggesta. The deterioration calculated for Åkers styckebruk in the model, however, is a result of Läggesta station's being wrong located in Mariefred in the network used in the calculations in the model. The possibility to park and ride at Läggesta seems to give some small improvements in accessibility.

The great improvement in accessibility along the Svealand line for Nykvarn calculated in the model can be attributed partly to the shorter travelling times by train compared to SJ's bus services or SL's supply with a bus service to Södertälje and commuter train on to Stockholm, and partly to the higher frequency of service with SJ's train supply. The magnitude of the improvement in accessibility, however, is overestimated in the calculation in the model since the travelling costs are assumed to be same for all forms of public transport (see the discussion below).

Accessibility also improved in some areas in Södertälje municipality, mainly the Pershagen district around Södertälje syd station. The rural areas between Södertälje and Järna and around Mölnbo also gain some degree of improved accessibility, as do some peripheral areas in the Södertälje conurbation. Feeder trips by car to the railway station in Nykvarn are probably the explanation for the greater accessibility for the rural areas around Mölnbo (there is no bus service on this particular route). The train services on the Svealand line have otherwise not affected accessibility in the municipality of Södertälje to any noticeable degree. The areas where accessibility has improved are consequently a number of areas that have not been developed to any great extent, i.e. relatively few people live there and there are few places of work.

Logsums for the conurbations along the Svealand line

By calculating the logsum for all possible journeys to work in the Mälaren valley based on the communities along the Svealand line, and then multiplying with a cost for time, it is possible to calculate the travelling time for journeys to work from each community. The spreadsheet with the calculations was designed by Transek with data from the accessibility calculations in Sampers.

In the example, the time cost is assumed to be 50 Skr/hr for journeys to work. The weighting for waiting time is assumed to be 1, and no extra time in the form of an interchange penalty is included. This means that it is the travelling time from area to area calculated in the model that is included in the generalised cost while changes and waiting time

do not affect the travelling time more than in-vehicle time (unlike the other calculations and in Sampers in general). Journeys by public transport are assumed to be made by the faster of the bus and train travel modes. The cost for public transport journeys is assumed to be the same before and after.

The results are to be interpreted as an average generalised cost in Skr (time and cost of journey) of travelling to a place of work in a randomly selected area in the Mälaren valley. In reality, however, most journeys to work are made to places of work that are very close, but the measure nonetheless gives an idea of the improvement brought about by the train services on the Svealand line compared to the earlier bus services.

Generalised travel costs, journeys to work

	Nykvarn	*Åkers stbr.*	*Mariefred*	*Strängnäs*	*Eskilstuna*
Car	201 Skr	235 Skr	235 Skr	241 Skr	258 Skr
Publ. trpt. with Svealand line	148 Skr	287 Skr	233 Skr	238 Skr	250 Skr
Publ. trpt. before Svealand line	177 Skr	295 Skr	263 Skr	274 Skr	273 Skr
Svealand line's improvement (publ. trpt.)	*16%*	*3%*	*11%*	*13%*	*8%*
Difference, car-publ. trpt with Svealand line	*26%*	*-22%*	*1%*	*1%*	*3%*

The greatest improvement is in Nykvarn, with an improvement of 16% for public transport passengers, followed by Strängnäs with 13% and Mariefred with 11%. Eskilstuna has improved by 8% for journeys to work. Compared to the accessibility to jobs that travelling by car gives, public transport on the Svealand line has a lead over the car, most of all in Nykvarn, while the opposite is true for Åkers styckebruk. The prerequisite is the same fares as with the bus services before the line opened, which is probably an underestimation with regard to SJ's current fares compared to SJ's previous fares and the fares on SL.

If the valuation of travelling time for journeys to work was increased to over 50 Skr/hr, the speed of journeys by car would be seen in an increase in the difference in favour of the car. The same applies if fares on public transport are raised and if waiting time is weighted higher than 1.

Logsums for municipalities

The results of the Sampers logsum calculations for journeys to work can be presented as tables and put in relation to the population. The table of

municipalities also includes Nykvarn conurbation as an approximation of Nykvarn municipality, since Nykvarn municipality is not separate from Södertälje in the Sampers data from 1998.

Logsums for municipalities along the Svealand line

	Logsum			*Population*
	Before	*After*	*Diff.*	*(Sampers data)*
Eskilstuna municipality	10.01	10.02	0.01	89 030
Strängnäs municipality	9.53	9.57	0.04	28 550
Södertälje municipality	10.30	10.33	0.03	82 080
of which Nykvarn conurbation	*9.91*	*10.22*	*0.31*	*5 900*
City of Stockholm	11.36	11.37	0.01	707 800

The difference between the logsum before and after train services began on the Svealand line is relatively modest when spread over whole municipalities. The greatest improvement is in Nykvarn, where the trend has been strengthened by the fact that only the conurbation round the railway station is presented in the table. When larger areas (municipalities) are presented, the improvement in accessibility for people living round the station is spread over all the municipality's inhabitants. In relation to the population of the municipality, most of the improvement in accessibility then ends up in the conurbation.

8.5 Discussion and summary

8.5.1 Accessibility

The results show that the changes in accessibility are somewhat locally distributed to the areas around the railway stations along the Svealand line. There are a few exceptions, even if the improvements are relatively small for the other areas. The improved accessibility to jobs, however, is not entirely attributable to the Svealand line but also to the doubling of the frequency of service on the Stockholm–Uppsala section with the Svealand line trains. In this context it must be pointed out that the train supply with other trains to Arlanda airport not included in the accessibility calculation, which means that the advantage of the train service to Arlanda is here attributed to the Svealand line trains, albeit with a frequency of service in the model scenario that is lower than in actual fact.

There is good reason to be sceptical about some of the results obtained using the Sampers system. Sampers has shortcomings when it comes to estimating demand for the type of journey made on the Svealand line, i.e. longish regional journeys by train in the Mälaren valley

(see appendix 7). In the chosen application the route choice model uses average service intervals (mean times). The result is that the limited frequency of service that regional bus and train services often have leads to overestimations of the travelling times by public transport compared to commuters with flexible working hours and other people who plan their journey on the basis of timetables. An accurate description of the supply and an accurate depiction of the traffic network are naturally crucial for a correct result, which in practice is not always the case.

The improvement in accessibility with the Svealand line calculated in the model is noticeably very small in Strängnäs and Eskilstuna. Other, simpler methods appear to give more realistic results; a comparison of travelling times, for example, shows that the train services on the Svealand line have greatly improved accessibility to Eskilstuna. The conclusion drawn from this is that the Sampers system underestimates the increase in accessibility over long distances, which means that Strängnäs and Eskilstuna appear to have gained too small relative improvements in accessibility in the calculation in the model.

Nykvarn appears to gain a great improvement of accessibility in the calculations in the model. This is mainly a result of travelling times to the labour markets in central Stockholm being radically shortened by the introduction of the high speed regional trains. The comparison with SL's buses and commuter trains indicates a reduction in travelling time from over an hour to half an hour. In addition, the frequency of service has become more regular with the trains, compared to the irregular, low frequency of service that SJ's bus services had (SL's bus to Södertälje, however, had an even higher frequency of service both before and with the high speed train services). In the description of the supply, however, the higher fares on the regional trains on the Svealand line have not been taken into consideration, which means that the increase is overestimated in the calculation in the model. In the description of the supply it is thus faster and cheaper to travel by public transport to Nykvarn, whereas in reality it is either fast on the Svealand line or cheap with SL for passengers with a monthly pass. This, and the fact that Läggesta station is wrongly located in the model, are two errors in the input data that most definitely effect the results.

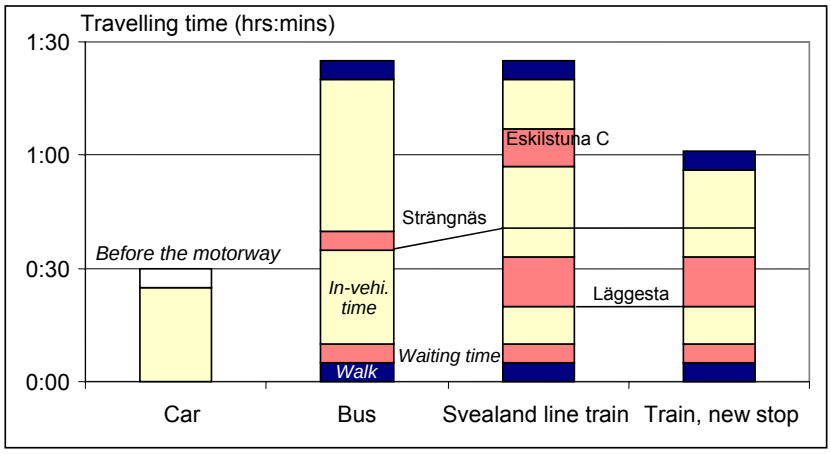
Accessibility by car was relatively good even before train services began on the Svealand line, which limits the improvement in accessibility that the new train services bring about. Despite the relatively small general effects, there is reason to draw the conclusion that the train services really have brought about general improvements in accessibility, above all concentrated to the conurbations and the areas around the railway stations. Where feeder trips with changes by public transport are neces-

sary, the benefit is much smaller. It is also a fact that it takes time for an improvement in accessibility to have full effect on individuals' change of job and domicile and on car ownership. The location effects will in time generate more journeys, which may have an effect on realised accessibility.

Presenting accessibility in a map has the disadvantage that it is the area of the locality affected that appears to be the result. What is more important, however, is the number of people who gain improvements, and the magnitude of such improvements. One conclusion is that while it is true that the accessibility calculations made by the Sampers system do in fact give an indication of changes in accessibility, there are differences compared to empirical data in numerous cases. It would therefore seem to be necessary to use several different methods of analysis to determine the magnitude of the changes in accessibility.

8.5.2 Increased accessibility with a new station in Eskilstuna

Travelling times between Åkers styckebruk and Mälar Hospital



An example showing that travelling time by public transport between Åkers styckebruk and Mälar Hospital in Eskilstuna can be shortened by about 25 minutes, from 1 hr 25 mins to 1 hr with a new stop. If the bus services were better coordinated with the trains at Läggesta a further 10 minutes could be gained. Note that the journey by the "Bus" alternative is calculated for the county public transport authority's bus services for the whole journey.

A new station or stop on the Svealand line, Eskilstuna östra (Eskilstuna East), could be located about 1.5 km east of Eskilstuna Central station. This would give primarily staff and visitors to Mälar Hospital in Eskilstuna shorter travelling times and better regional accessibility, but the residential areas and other places of work around the stop would

also gain better accessibility to the train services. Another important factor is the possibility to arrange more parking spaces for the park and ride scheme. The gains from the new stop must naturally be weighed against the longer travelling time for those who are not going to board or alight from the train. With a differentiated supply it would be possible to allow high speed commuter trains to stop there without affecting travelling times for other passengers on other trains.

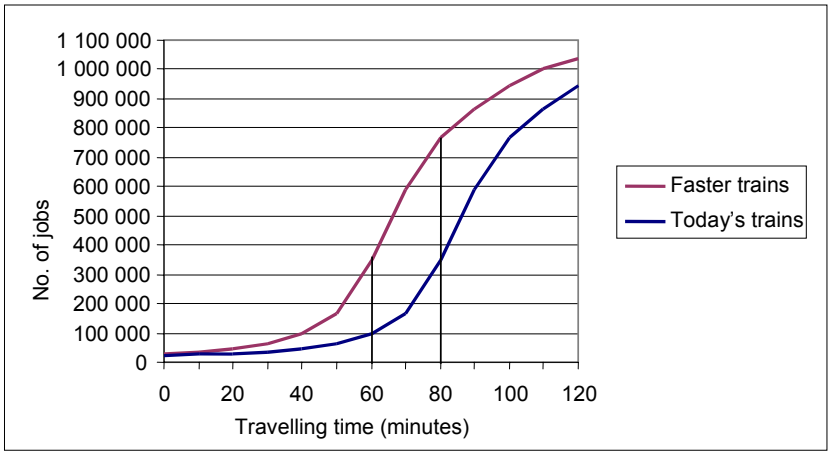
8.5.3 Shorter travelling times

Shorter travelling times than today on the Svealand line would have substantial effects. The diagram shows the number of jobs that can be reached by train within two hours from the centre of Eskilstuna for two different travelling times. Travelling time by train today from Eskilstuna Central station to Stockholm Central station is 1 hour, and the example shows an alternative with 20 minutes' shorter travelling time. For a travelling time of 40 minutes a double track line is needed to avoid trains needing to stop to pass each other, and an increase in speed to 250 kph with new trains. A differentiated supply is also needed with more trains, of which some are non-stopping trains to enable shorter travelling times on longer routes.

The curve in the cumulative diagram is steep for the area studied. This means that each minute cut from the travelling time gives a relatively large increase in potential accessibility. From the centre of Eskilstuna, 20 minutes' shorter travelling times mean that it would be possible to reach 350 000 jobs within one hour instead of 100 000, and almost 800 000 instead of 350 000 within 1 hr 20 mins (few people would be able to manage longer travelling times than this in the long run). The situation is similar for Strängnäs. The travelling time by train in 2000 (48 minutes) is almost what is necessary to give substantial potential accessibility to the whole of Stockholm's labour market. 10 minutes less travelling time between Strängnäs and Stockholm would mean that 250 000 more jobs would be within an hour's reach of people in Strängnäs.

In practice, faster trains would put more of Stockholm's labour market within reach. Another aspect is that 20 minutes' shorter travelling times would also improve accessibility for people living a little further away from the railway stations on the Svealand line than the central areas of the conurbations. This would then widen the areas around the railway stations in both home and activity localities.

The effect of faster trains



With 20 minutes' shorter travelling time to Stockholm the number of jobs that can be reached within reasonable commuting times by train from the centre of Eskilstuna is greatly increased.

Travelling time elasticity (see section 3.2.7) for residents in Strängnäs for journeys to Stockholm in 1997 was about -5.5 with the bus services. This means that halving the travelling time (-50%) would increase travel by 275%. No exact values for Strängnäs residents' increased travelling are available, however, and the real result also includes the effects of other attributes, for example the high speed train mode of travel, comfort and service. This underlines the fact that travelling time elasticity can only be used as an approximate measure. Considering the character of the method, however, the value would appear to be tolerably accurate.

Travelling time elasticities for residents' journeys to Stockholm, 2000

2000	*Eskilstuna*	*Strängnäs*
Market share	Approx. 35%	Approx. 35%
Parameter value, travelling time[1]	-0.0411	-0.0768
Travelling time to Stockholm	62 mins	48 mins
Travelling time elasticity	-1.7	-2.4

[1] From the SP study of residents, see appendix 4:1

The travelling time elasticity of -1.7 for residents of Eskilstuna in 2000 means that a reduction in travelling time of 20 minutes (-32%) between Eskilstuna and Stockholm would increase residents' travel by train by about 50%. For people who live in Strängnäs the corresponding travelling time elasticity is -2.4, which means that 10 minutes' (-21%) shorter travelling times between Strängnäs and Stockholm would increase Strängnäs residents' travel by train by 50%.

The result is to be interpreted as an indication that residents, and especially residents of Strängnäs, have a strong preference for shorter travelling times. A reduction in travelling time of 10 minutes or more will give relatively large increases in travel. There is therefore good reason to make an effort to save every possible minute of travelling time in this border zone.

Both accessibility to work places and residents' own preferences show that great potential exists for increased travel through shorter travelling times. The level of ambition for the train services on the Svealand line may therefore have been set too low with regard to regional commuting. If future development, threshold effects and areas with high demand elasticities had been given greater consideration, society could have chosen a higher standard for the traffic system. In order to study different alternative standards the people who plan the traffic system need vision, and the alternative that is chosen must be profitable in a social economic perspective. The subject of this thesis, however, is not the business or social economics of the Svealand line, and further discussion of the effects must therefore be deferred.

8.5.4 Hypotheses

9. *The increase in demand can be explained by the improvement in regional accessibility to the communities along the Svealand line brought about by the high speed train services.*

The studies of accessibility show that it has been improved by the faster train services. The effects, however, are generally speaking small when accessibility is measured as a total measure. Substantial changes can be seen in some geographical areas, trip purposes and tours. One example is commuting between Eskilstuna and Stockholm, where accessibility by public transport shows definite improvement. There would seem to be a clear linkage to demand. The hypothesis accepted.

10. *Within the communities the greatest relative improvement in accessibility has been in the areas around the railway stations which has resulted in a greater impact close to the stations.*

The results of the field studies and the accessibility studies are in agreement in that the greatest improvement has taken place close to the railway stations. Travel is the basis for further impacts on the social structure, but the latter has not been studied in this project. The hypothesis is, however, accepted.

9. Discussion and conclusions

This chapter contains a concluding discussion, on the basis of which it is intended to draw general conclusions about the investment in a regional high speed train service. The effects of the Svealand line are discussed at the end of chapters 5-8, while this chapter concentrates on the generalisable effects.

9.1 Changes in the travel markets

The high speed train service on the new line meant a considerable improvement in supply along the Svealand line. This prompted an immediate market response in the form of considerably greater demand. The trains replaced buses, which meant that a group existed who already travelled by public transport. But these passengers constituted only about half of all the train passengers on the Svealand line. Consequently, there were passengers on the trains who had previously not travelled at all, and some who had previously preferred to travel by car (transferring travellers). The new passengers are a kind of quantitative measure of the attractiveness of the supply and the effects on accessibility.

The train service's market share has risen from 6% for the old line to approximately 30% for regional trips on the E20/Svealand line. For trips between Eskilstuna/Strängnäs and Stockholm the market share is even greater. The shortcomings in the old train service supply were so great that it was largely people who had no alternative who used it. During the construction of the Svealand line, the bus service had twice the number of passengers as the old train service, which can largely be attributed to the greater frequency of service, and the fact that all routes went by way of Strängnäs, instead of necessitating a change and a connecting service. The new train service halved travelling times, which meant that it was faster to travel by train than by car in certain tours, and this paved the way for the threefold increase in travelling. The new supply means that also motorists choose to travel by train, and the train service attracts passengers on its own merits.

One general conclusion that can be drawn is that there is a clear linkage between supply and demand in public transport. When supply is sufficiently good, demand increases substantially, and by extension also the possibility to achieve economic development in the region. The prerequisite is that there are sufficient resources to invest in new infrastructure and new train systems. The greatest effects are achieved if passengers can be offered short travelling times, high frequency of ser-

vice, low ticket prices and a high degree of comfort all at the same time. The system must also be reliable. Short travelling times are the most important factor in attracting people to public transport, given a reasonable price, but the high speed train mode of transport in itself is also important.

As regards the Svealand line it is perhaps principally the relatively high ticket prices and shortcomings in the quality of the supply (standing room and delays) that have checked the development in travelling. Other investments have also had primary limitations; the Kustpilen train in Blekinge, for example, has long travelling times, and this is holding back the development of travel.

9.2 Changes in knowledge and valuations

The surveys show that residents' knowledge of the supply was good, and that their valuation of it was high. Motorists especially are attracted by high speed trains, both with regard to travelling times and comfort, and probably also image. A number of other surveys also point in the same direction; design, a clean and fresh impression and modern trains, and a high degree of comfort are important to attract travellers.[293] This is otherwise often one of the weaknesses of the railways; the trains last longer, they can still operate even though they are old, outmoded and uncomfortable. But, as seen, this results in fewer passengers. Consequently it would seem that the Svealand line has got off to a good start with more passengers thanks to the high speed trains that SJ operated on the line during the first years it was open.

The low, or insignificant, valuation of trains and high speed trains as compared to buses that is evident among the residents of Mariefred, Åkers styckebruk and Nykvarn, can probably be attributed partly to the change to and from bus and train in Läggesta, and partly to the fact that these travellers often find that the Stockholm-bound trains are full at peak periods. The advantages of high speed trains can not compensate for the need to change and perhaps having to stand on the train. Commuters care less, however, about the mode of transport, and more about travelling time, frequency of service and the fare. Residents of Eskilstuna and Strängnäs on average value the high speed train mode of transport at 40 Skr and 20 Skr respectively, and the ordinary train at 20 Skr and 10 Skr respectively more than the bus. This value includes, then, the greater comfort and better service of the train compared to the bus.

[293] See for example Kottenhoff (1999)

Another conclusion is that the valuation of the new supply is higher than the valuation of a mediocre supply. The travelling time for regional journeys by the Svealand line (50-70 Skr/h) is valued up to the same level as for interregional journeys (70 Skr/h), twice the figure for regional journeys given in Banverket's calculation guide (35 Skr/h). For the Nyköping line, however, the valuation of the regional journeys agrees with the values in the calculation guide. There are presumably several reasons for this.

First, a good supply seems to increase the valuation of the travelling time. This might be explained by the fact that the short travelling times make it possible for new groups to take the train, and for more trip purposes, given that the frequency of service is sufficiently high. The new groups value their time more highly, due in part to higher incomes. Consequently, the value of the shorter travelling time is higher.

Second, some research findings suggest that the value is not a linear utility function; small gains or losses of time (3-5 minutes) are practically unimportant, while the value increases dramatically according to a non-linear function for gains greater than 10-15 minutes. The value also proved to be lower for long journeys than for short ones, which runs contrary to previous results obtained using different methods.[294] Transferring these results to the Svealand line, this means that a gain in time of the magnitude given by the new train service compared to the old supply, would increase the valuation of the travelling time compared with the mean value that is normally applied, partly because the travelling times are radically shortened, and partly because the distances travelled have become shorter, causing shifts in travel frequency and the reasons for travelling. A greater number of business trips and more commuting mean high valuations of time compared to leisure-time journeys.

Third, there are also differences between the valuation of a supply before and after a change. Generally speaking, the supply is valued more highly after the change than the same supply described before the change.[295] [296] This would explain part of the difference between the before and after studies of the Svealand line and between the Svealand line and the Nyköping line.

Using standardised factors for travelling time without differentiating between commuting and leisure-time travel, and without differentiating between a good and a bad supply, and with a linear valuation of im-

[294] Hultkrantz and Mortazavi (2001)
[295] Kottenhoff and Lindh (1996)
[296] Bråthen and Hervik (1997)

provements, will consequently disadvantage new investment in a good supply. The valuation of the saving in travelling time on fast regional journeys is so far apparently too low, which means that the calculated economic benefit to society is too small for this type of object.

9.3 Changes in travelling behaviour

The Svealand line has led to changes in travelling behaviour. The effects are most evident in those areas where accessibility to the stations is high, i.e. for residents, and also places of work, close to the stations. One conclusion is therefore that it is important that the distance to the station is short; for regional journeys, the station must be located in the centre of the town so that the catchment area is as wide as possible.

The groups who have changed their travelling behaviour most are the ones who always have access to a car. One noticeable effect is that gainfully employed people now choose the train to a greater extent than previously. It is clear from this that the supply is attractive enough to persuade groups who can choose how they want to travel and groups who have traditionally preferred to travel by car to switch to travelling by train. Some other groups also travel more often when the supply improves.

The large increase in demand can therefore be explained partly by a switch from car to train and partly by a switch from bus to train, but also by a large amount of new travel. The new travel is interesting. While the substituted travel can be presumed to have positive effects for the environment and a gain in travelling time that can be used for productive work or improved quality of life, the new travel should to a greater degree contribute to the regional effects of the investment. The new journeys can be assumed to be business travel, commuting and leisure-time trips, but with different degrees of sensitivity to changes in the supply depending on the purpose of the journey. Consequently, the greater economic and social exchange between the various parts of the region can be assumed partly to increase growth in the region and partly to contribute to strengthening the functional region, and thus contribute to equalise local variations in, for example, the labour markets.

The changes in the public transport supply will in time have an effect on car ownership and taking only the railway into consideration, car ownership should diminish in the communities around the stations. In particular the number of households owning more than one car has stagnated in the communities along the Svealand line since the train service began, while the number of households owning two or more cars in the rest of the country has increased. Car ownership may none-

theless increase for a considerable period for other reasons, for example the general economic development, but compared with other areas without the improved accessibility to public transport, the increase should be smaller. A changed structure in the urban centres will also contribute to this, if the train service contributes to increased development in the central areas. The new individuals who move into the districts following the opening of the Svealand line also make this deduction plausible on the premise that there are fast train connections, which reduce both dependence on a car and the need to own one. In this particular case, the region in question is one that is gradually being incorporated into the metropolitan conurbation of Stockholm by reason of the improved accessibility.

9.4 Changes in accessibility

Accessibility improved along the line when the train services began operating on the Svealand line. However, it appears to be difficult to gain accessibility over wider areas generally speaking, since it entails a need to change and travel by public transport feeder connections. Improvements in accessibility between before and after the change in supply are therefore greatest close to the railway stations. The stations' catchment areas appear to be rather limited in size. On the other hand, there is a certain demand for car parking at the stations. Experience from AVE in Spain, among others, indicates that demand can be assumed to increase if the train service becomes even faster compared to travelling by car for the whole journey.

Accessibility by car is already good, which reduces the overall improvement in accessibility resulting from the new train service. In spite of the comparatively small general effects, there is reason to draw the conclusion that the train service really has brought about considerable improvements in certain areas and for certain categories of people. Small general effects should not be allowed to conceal large specific effects, which in this case can be substantial. In particular, accessibility to the central parts of Stockholm has increased. The conversion of the E20 road to a motorway running parallel to the Svealand line has shortened travelling times only marginally. Journeys by car to the city centre of Stockholm mean coping with traffic standstills and probably also parking problems which limit the accessibility in the road system.

One of the most noticeable results of the increased accessibility is that commuting in both Eskilstuna and Strängnäs shows a marked increase. The train service on the Svealand line has put Eskilstuna within commuting distance of Stockholm. Travelling times are too long to

make the car an attractive alternative here. Consequently, the improved supply has resulted in a leap in accessibility.

9.5 Market – behaviour – accessibility

The market effects of the high speed regional train service are dependent on changes in the supply, which has led to changes in demand and accessibility. A number of background factors have been especially advantageous over the Svealand line's introduction period. Employment and private consumption have risen, at the same time as the price of petrol increased between 1998 and 2000. As regards the communities along the Svealand line, their population and the influx of new residents have both increased over the same period, while car ownership has stagnated and even declined, relative to the country as a whole, in the areas closest to the railway stations. The three last effects, and also the increase in employment, can partly be explained by the improved accessibility that has resulted from the train services on the Svealand line.

Factors determining demand for train services

Factor	*1990-1997*	*1998-2000*
Population	↓↑	↑
Influx	↓↑	↑
Employment	↓	↑
Car ownership	0	0 (↓)
Private consumption	↓	↑
Price of petrol	0	↑

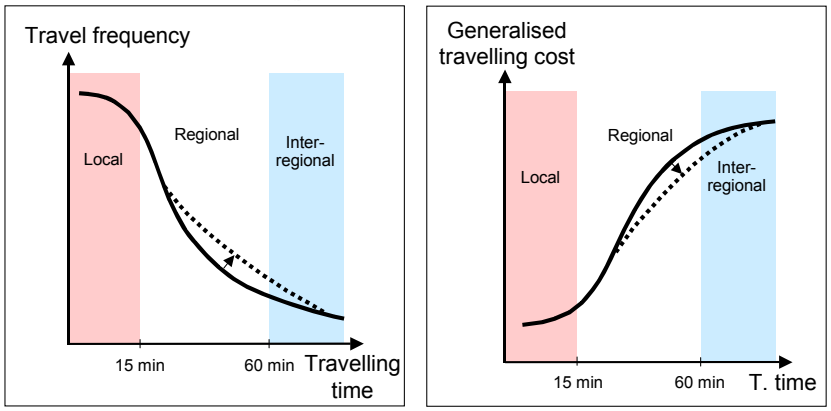
There are also other factors that influence demand, but which on comparison with the reference population centre of Nyköping can be eliminated from the analysis. Such factors include housing costs, tax regulations, access to leisure homes, valuation of the housing environment, etc.

Conditions in the Stockholm region are not unique in an international perspective, but they probably contribute to the comparatively large effects that the train services on the Svealand line have had. What is important is that Stockholm is the centre of the region, but at the same time also a national centre, which means a large supply of qualified places of work, and household and company services. It also means a heavy traffic load, along with high generalised costs for car driving in the form of standstills and high parking charges in the city centre. Compared to the car alternative, regional high speed trains therefore offer an attractive way of providing this supply.

Commuting by train has also proved to be attractive on the Eskilstuna–Stockholm section, a distance of 115 km and an hour's journey by train. This is somewhat longer, both in time and distance, than is considered to be the general norm for journeys to work. In an accessibility context, the usual length of acceptable journeys to work sustainable in the long run is 45 minutes by car or 60 minutes by train door to door, based on surveys of travel habits. The real travelling times by high speed train are consequently acceptable to more people than earlier surveys of travel habits indicated. Under these circumstances fast regional trains contribute to longer commuting distances through the reductions in generalised travelling costs.

The limitations as to which sections are acceptable for commuting are, however, not absolute for the individual, and they can be assumed to be a function of the generalised cost of the journey (travelling time, fare, comfort etc.) and the individual's benefit of commuting a certain distance. The reasons for long journeys to work might therefore be that the income difference is so great that regional commuting is economically profitable, that people take other members of the family into consideration when choosing where to live, or that the journey is comfortable and that the time may also be used for work.

The effects of regional high speed trains



The effects of regional high speed trains can be described by the broken line; increased frequency of travel in a time interval with longer regional, and also to a certain extent interregional journeys, resulting from lower generalised travelling costs. Travelling times are approximate.

Regional high speed trains attract new travellers, principally because of their speed, but also for reason of other attributes such as high comfort and good service. The new supply means that the generalised travelling costs are lower. The consequences of this are that frequency of travel increases in the regional high speed trains' market niche, and that

daily journeys on average are longer. At the same time as the total transportation increases, a greater proportion of the journeys will be made by high speed train instead of by other means of transport. Some of the new journeys will be substitutions for slower journeys by other means of transport.

Generally speaking, commuting has increased over the period studied. There are, however, differences between the various locations, as can be seen by a comparison with Nyköping. The increase is greatest in Eskilstuna, but the increase is also substantial in Strängnäs, and both increases coincide with the introduction of the new train service on the Svealand line. Eskilstuna appears to have come within reasonable commuting distance of Stockholm's labour market by train. It is also noticeable that commuting in the opposite direction, from Stockholm, has increased to both Strängnäs and Eskilstuna, even if the increase has been from a relatively low level. Local changes in the labour markets are, of course, generally a contributory cause of changes in commuting patterns but the conclusion is that the Svealand line has contributed to the increase in commuting.

The proportion of new journeys is especially large from Eskilstuna to Stockholm. Strängnäs already had considerable commuting to and from the county of Stockholm before the Svealand line opened. Strängnäs is within the range of the car from Stockholm, i.e. the area that can be reached by car for daily commuting, even if daily car journeys take a relatively long time. The transferral of trips from the car to the train is large here. Outside this area, the high speed trains have made daily commuting by train possible, which it hardly was earlier by train, by bus or even by car, and this has resulted in a large number of new journeys being made by train. The range of the car does not stretch to the area between Eskilstuna and Stockholm for daily commuting, whereas the regional high speed train services do.

One conclusion that can be drawn is that clear goals for travelling time based on accessibility should be set when planning new infrastructure, where leap effects are identified. Will commuting to work, business trips etc. increase with a certain travelling time, or are more (or less) comprehensive measures needed? With these prerequisites it is important to realise that effects are non-linear, and that there are threshold values.

The possibility for society to support commuting also for greater distances over today's county borders has not been exploited on the Svealand line. The example of travelling along the Blekinge coastal line (Blekinge Kustbana) shows that subsidised fares can also constitute an effective instrument for achieving the desired effects on the labour mar-

kets through commuting. Longer travelling times can thus be compensated by lower fares in the generalised travel cost for each individual, even if this in practice shifts the distribution between price sensitive and travelling time sensitive individuals. When choosing a strategy, the most appropriate course seems to be to have a holistic view of society and its function, and view the traffic generated in its context.

9.6 Summary of results and conclusions

9.6.1 Results

Population, influx of new residents and commuting

- The negative development in Eskilstuna municipality has changed to a positive development with a growing population since the Svealand line opened. It is probable that the train services on the Svealand line have contributed to the turnaround through greater accessibility.
- Commuting from Eskilstuna to Stockholm has increased by 125% between 1996 and 2000. The increase has also been dramatic in the opposite direction. Commuting between Strängnäs and Stockholm has increased by 40-60%, albeit from a higher level, during the Svealand line's first four years. The increases are significantly greater than for the reference centre of population of Nyköping.

Supply and demand

- The market share of regional travel along the Svealand line increased from 6% with the old train to 30% on the new line.
- Regional travel by train between Eskilstuna/Strängnäs and Södertälje/Stockholm with the Svealand line has a market share of about 35%. Travel to Södertälje by public transport has to all intents and purposes not increased at all, which means an even higher share for journeys to Stockholm.
- Compared to the old train service supply, the greater frequency of service and a direct service to Strängnäs without having to change led to a doubling of the number of journeys by bus while the line was being built between 1994 and 1997.
- The new train service supply from 1997 with halved travelling times immediately attracted three times as many passengers as SJ's buses, or six times as many passengers as the old train.
- The new train passengers are estimated to have come from SJ's old bus service (30%), the county transport authority's old bus service (25%), car (15%) and new passengers (30%). The last category also in-

cludes a number of passengers who had previously travelled to other destinations.

- Road traffic on the E20 has followed the general economic development, which meant a falling off in the middle of the 1990s, but traffic has probably also increased as a result of the road's conversion to motorway. In spite of its conversion to motorway parallel to the Svealand line in both time and space, car traffic was in principle the same in 2000 as in 1990.
- Journeys by train on the Svealand line continued to increase by 10-15% annually between 1997 and 2000. The increase coincided in whole or in part with higher petrol prices, the economic boom and increased private consumption, which have probably contributed to the increase in travelling.
- In 2001 the number of regional journeys across the county border totalled 1.6 million, or seven times as many as with the old train.
- From 2001, the number of journeys on the Svealand line has fallen off, coincident with a somewhat deteriorated supply with longer travelling times and a lesser degree of comfort when the high speed trains were replaced by ordinary locomotive trains, poor quality of supply, a general economic slowdown and falling petrol prices.

Knowledge of and valuation of the supply

- Knowledge of the train service supply is considerably greater than it was for SJ's bus service among residents along the Svealand line. 90% of residents in the centre of Eskilstuna between the ages of 6 and 74 presumed, or knew, that the trains ran with a frequency of one an hour in 2000.
- The cost of travelling by car was on average assessed to be 13 Skr/10 km in 1997, 14 Skr/10 km in 1998 and 15 Skr/10 km in 2000 by residents along the Svealand line.
- The average travelling time for door to door journeys by public transport outside the home community was half an hour, or 30%, shorter with the train service in 2000 compared to the bus service in 1997 for residents along the Svealand line. The surveys indicate that the gains in time are even greater for the average public transport passenger.
- Compared to the bus service, more people travel by train on the Svealand line because it is faster, simpler and more comfortable than the car.
- For an imaginary journey from home to the centre of Stockholm 70% of the residents with access to a car value a journey by high speed train at reduced rate (such as a monthly ticket) higher than a journey by car.

Considerably fewer value the ordinary train and bus higher than the car.

- The valuation of travelling time has increased between 1997 and 2000. Residents along the Svealand line value the travelling time at 50-70 Skr/h for the latter year, higher in places where there is more commuting.
- Residents of Nyköping give travelling time a lower value than residents along the Svealand line, about 35 Skr/h. The high speed train compared to the ordinary train is also given a lower value by residents of Nyköping, 10 Skr as compared to 20 Skr in Eskilstuna. The valuation compared to the bus, however, is higher and more similar between the Svealand line and Nyköping.
- The valuation of the high speed train is higher for long journeys than for short journeys, and is not significant for residents of Mariefred and Åkers styckebruk when a connection to Läggesta is necessary. Crowding on the trains is also assumed to have a negative effect on the valuation compared to the bus. The valuation compared to the bus was 0-40 Skr and compared to the ordinary train 0-20 Skr per journey.
- The value of an increase in frequency of service from every two hours to every hour was 25 Skr per journey for the residents of Eskilstuna, and from every hour to every half-hour 15-20 Skr per journey for residents of the other communities along the Svealand line.
- The factors frequency of service, travelling time and especially ticket price are considered to be more important by commuters using the train than by passengers who travel more seldom.
- Infrequent travellers have a higher valuation of the high speed train and the ordinary train than commuters have. One exception, however, is that travellers with the opportunity to travel by car as an alternative value the high speed train highly regardless of the reason for the journey.
- The shortcomings in quality that passengers experienced, mainly during the Svealand line's first few years in operation, i.e. too few seats during peak periods and frequent delays, can be assumed to have had a negative effect on travelling.

Travel behaviour

- The number of households with two or more cars has increased in the country as a whole by 3 percentage points between 1997 and 2000. Households with more than one car along the Svealand line, on the other hand, have not increased in number, and the proportion was significantly smaller compared with the country as a whole in 2000.

- The trend towards less car ownership is most noticeable in the area closest to the railway stations in Eskilstuna and Strängnäs.
- People with permanent access to a car, the habitual motorists, have increased their travelling by public transport most along the E20/Svealand line since the new train service began. Those without access to a car, however, and principally those who only have a car at times still travel more by public transport.
- Significant increases in travel by public transport can be seen among the whole group of residents along the Svealand line, and in several geographical subareas and socioeconomic subgroups, as can reductions in travelling by car since the train service on the Svealand line began.
- An increase in travel by public transport can be seen in the socioeconomic groups men, age group 25-44, parents, married or cohabiting, self-employed, full-time employed and university educated people.
- The Svealand line has contributed to an equalisation of the differences between men's and women's travelling by public transport and car outside the home community.
- For residents along the E20/Svealand line the choice of transport mode has changed since the train service started, with a larger proportion of journeys by public transport compared to the car. In the centres of Strängnäs and Eskilstuna the proportion of journeys by public transport has increased from 20-25% to 45-50% among the residents.
- The proportion of journeys by public transport along the E20/Svealand line is more than twice as large in Strängnäs and Eskilstuna at walking distance (up to 1 km) from the station compared to greater distances which require a connection.
- The proportion of passengers who park their cars at the stations in Läggesta and Strängnäs has increased for the high speed train service compared to the bus service. In Eskilstuna, however, there has been no increase, which might be explained by the long travelling times for commuters.
- Some degree of change in the choice of destination can be seen before and after the opening of the Svealand line, with a slightly larger proportion of journeys in the E20/Svealand line corridor than in other directions and to other destinations.

Accessibility

- Studies of accessibility using a travelling time measure show that a train journey on the Svealand line is faster than the car, especially between Eskilstuna, Strängnäs and Nykvarn and the centre of Stock-

holm, while travelling times for many other tours by public transport with changes are still shorter by car.

- The number of places of work that can be reached within 60 minutes' travelling time from home has increased, principally in Nykvarn. For other places along the Svealand line, travelling times to the large labour markets in Stockholm are generally longer than an hour even after the improvement in the train service supply.
- Accessibility to places of work would be considerably improved by further reductions in travelling times on the Svealand line. 40 minutes' travelling time from Eskilstuna and from Strängnäs to Stockholm would give considerably higher accessibility and more journeys.

9.6.2 Possible improvements to the Svealand line traffic system

On the whole, the Svealand line investment has had positive effects, with a large increase in travel by public transport and changes in travel behaviour. However, there are measures that can be considered that can further improve the traffic system. The measures proposed are described in more detail in other sections;

- Differentiated supply with the introduction of high speed commuter trains which use the old line via Södertälje hamn station for better accessibility (see section 5.3.2).
- Direct bus services from Mariefred and Åkers styckebruk to major places of work in Södertälje for commuting without the need to change (5.3.3).
- Lower fares for the whole journey including connections also for journeys across the county border will increase the catchment area (6.3.3).
- Greater frequency of service will improve accessibility (6.3.4).
- Better connecting services to the railway stations will broaden the market and improve accessibility in a whole-journey door-to-door perspective (7.5.3).
- A new stop, Eskilstuna east, would shorten travelling times to Mälar Hospital and enable several car parks to be extended close to a new railway station in Eskilstuna (8.5.2).
- Shorter travelling times would markedly increase accessibility to the labour markets along the line, principally in Stockholm, and increase travelling (8.5.3).

9.6.3 Conclusions about regional high speed trains

- When planning traffic systems it is important to identify critical intervals and leaps in the effects on travelling and social structure to ensure

the best results of the investments. Evaluations and effects tend to be non-linear. At certain threshold values, therefore, a good supply is evaluated more highly than a poor one.

- Evaluations of the supply vary between different types of trip and between different socioeconomic groups. In order to take into account the distribution aspects of changes in supply, the groups in the analyses need to be separated.
- The collective effects on demand of a radical improvement in supply through the use of regional high speed trains are relatively large, given that the supply is sufficiently good compared to other travel opportunities.
- Short travelling times, high frequency, and a reasonable price are decisive for train services' ability to take a greater market share and generate new regional journeys.
- The trains' soft supply factors, high comfort, good service and modern design, contribute to their attractiveness and lead to more travelling.
- People with access to a car often prefer regional high speed trains because of their attractive characteristics, while an unsatisfactory supply of train or bus services will to a great extent only serve as a reserve alternative to the car.
- Walking distance to and from the railway station is important for the attractiveness of the train service supply in the case of regional travel.
- Falling generalised travel costs in the regional high speed trains' niche increase both the number of trips made and their length. Travelling times also tend to be longer than would otherwise be regarded as acceptable for daily trips.
- Many journeys are transferred from the car to regional high speed trains, which also has an effect on car-ownership.
- Regional high speed trains contribute to expand the region as daily commuting is possible over greater distances than the range of the car permits. This generates a relatively large proportion of new train journeys compared to journeys transferred from the car.
- The high concentration of places of work and the congestion on the roads in the centre of the region are factors that contribute to promote regional high speed train services in metropolitan conurbations.
- Regional high speed trains contribute to better accessibility as a whole in the region, and can thus provide a stimulus to the economic development of the region if the necessary prerequisites exist.

9.7 Methodology issues

9.7.1 The field surveys

None of the methods employed in the research project can alone give a true picture of the changes between before and after the opening of the Svealand line with acceptable accuracy. The combination of several methods and different approaches, on the other hand, can identify the changes and their magnitude. The time aspect is important; there is no way to obtain reliable answers to questions about how a person would have travelled in the past with different prerequisites, or in the future with unknown, or possibly only partly known, prerequisites.

Regarding the interviews, the importance of having a verified and representative sample of respondents cannot be emphasised enough. Despite high ambitions, this has not been possible in all parts of this research project, but the shortcomings are not more severe than that the knowledge has been able to be obtained from other, overlapping questions and other methods. The main objection in the field study involving passengers onboard buses and trains is that the selection in the sample is not truly representative. Another method, for example a total survey over one or more days with questionnaires, would probably have given more useful results as regards representative public transport travellers, in the same way that car number recording on the E20 would have given representative car travellers. It was estimated from the very beginning that a field survey of residents along the line should be able to compensate for these shortcomings. Aggregated statistics also need to be included to obtain a better picture.

The regional effects are difficult to identify since the effects are often slow to appear and are sometimes very diffuse. In the Svealand line research project this has largely had to be deferred. A longer survey period and more resources for analysis would improve the prerequisites for describing the regional effects. The regional effects are nonetheless a result of changes in accessibility, manifested in changes in the demand for travel. There are therefore very good prospects that it will be possible to pinpoint the regional effects of the train service on the Svealand line if the current research should continue.

9.7.2 Accessibility using Sampers

Despite the various efforts to measure accessibility that have been made, it is nonetheless difficult to arrive at an unambiguous, measurable concept. Different methods give different results, and also with regard to accessibility it is a great advantage to use several alternative approaches to get an idea of the magnitude of the changes.

There would appear to be a difference between real changes and the changes in demand and accessibility that the modelling system for forecasting travel demand, Sampers, calculates. Analyses of travelling and accessibility made using the modelling system show that there are differences between Sampers' way of calculating travelling times (and generalised costs) and real values. Conditions that can affect the results are found in the core of the model with the estimation and application of the logit models, both in various submodels and in the route choice model and the car ownership model. The modelling system is, for example, estimated on very little input data for regional train trips before the investments were made in the Mälaren valley, which may contribute to Sampers underestimating travel with regional high speed trains.

There are consequently reasons for questioning how Sampers in its present form calculates the effects that regional high speed trains have on travelling, especially with regard to regional trips in the Mälaren valley (or metropolitan conurbations). Otherwise, the model will underestimate the effects, which will have consequences for future investment decisions.

9.7.3 Conclusions

Several methods need to be used to identify the full effects of an improvement in supply. The methods give different results and are appropriate in different areas.

The modelling system for forecasting travel demand that is most used in Sweden today, Sampers, underestimates the effects on demand, and consequently also the accessibility, of high speed rail connections in the Mälaren valley.

All in all, the conclusions regarding the effects of the supply on the Svealand line on demand and accessibility can nonetheless be assumed to stand on fairly solid ground. This is due to the fact that many of the effects are relatively large and distinct and that several different methods have been used to analyse the effects. In most cases, the results point in the same direction.

9.8 Future research

The need for continued research after the conclusion of the Svealand line research project can be divided into three main areas.

9.8.1 Development of the theories

The theories that form the basis for the linkage between traffic and social structure have a number of weaknesses. First, the time dynamics

are difficult to handle. The time it takes for different effects to occur and the time it takes to achieve a new theoretical equilibrium are different. On the other hand, time contributes to producing dynamics in the changes, which do not always follow the prerequisites that applied when the theory was established. The strong linkage between economic development and transportation shows, for example, a tendency to deteriorate in certain cases. Time is also pushed into the background since the time dimension is difficult to describe in a figure or a diagram of the effects at the same time as, for example, geographical differences.

Second, the theories concern general changes. The effects of traffic and social structure, however, are not spread evenly over different socioeconomic groups, but are often described as an average for society as a whole. By including socioeconomics in the theories and analysing the distribution more closely, society's resources would be able to be put to more effective use.

A developed theory should focus on the dynamics in society, and the linkages between traffic, social structure and other individual values. One group of values is the one that is generally referred to as quality of life. Quality of life can include both a good living environment, natural environment, and social relations such as culture and pleasure trips, and is therefore a factor that affects the linkage between traffic and social structure. The constant state of flux between the values would therefore in certain situations be able to produce substantial changes in traffic and social structure.

On the whole, these questions about the formation of the theories provide several reasons for continuing the research and developing the theories. In response to the shortcomings of traditional equilibrium models, international research is currently being pursued, among other things around activity based models.

9.8.2 Changes in social structure

The Svealand line research project stopped at the linkage between supply, demand and accessibility during its first years of operation, an introduction period. It has not been possible to investigate the influence of the train services on regional development within the framework of the project. It would have been rewarding to study the long term effects of the greater accessibility on the social structure. Will further studies show any effects on the social structure and, if so, what effects? According to the theories there will be an effect on the social structure – on condition that a number of interacting measures are applied that will give synergies and promote the development of rail travel. There is reason to believe that this is the case for the Svealand line.

An example of how such a comprehensive study can be carried out can be found in the research project currently in progress at the Royal Institute of Technology into the effects of the Öresund Link.[297] The Öresund study is divided into four areas, traffic, land use, economics and environment, and will be carried out over the period from 1998 to 2008 (the link was opened for traffic in July 2000).

9.8.3 General changes in supply and demand with regard to regional train services

The effects of the Svealand line on travel demand will probably continue to develop over the years to come. In order to investigate the course of events further, it may be of interest to make one or several new studies, but at greater intervals than the studies that have hitherto been made over the introduction period.

The Svealand line case study shows that a greatly improved supply stimulates a large increase in demand and better accessibility. But is it possible to achieve equivalent effects with smaller changes in the supply and if so, how great will the changes be? Is a new railway needed to attract new passengers, or is it sufficient that travelling times by train are "rather good" compared to the car if longer travelling time can be compensated by lower fares? A research project to study the effects of several different regional train systems would clarify the general market effects better. The purpose might then be to further knowledge of what general supply and background factors influence demand. Instead of a study of time, a study could embrace geographical differences. It might therefore be profitable to compare the Svealand line with other equivalent regional railway traffic investments around the country.

[297] Lundqvist and Snickars (2001)

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1:1 Survey areas 1997

	Area	*Gross sample 1997*	*Postal code areas*	*Questionnaire*
1	Stockholm	215	112 xx-118 xx, 120 xx	A
2	Södertälje	215	151 xx, 152 xx	A
3	Örebro	215	70x xx	B
4	Nyköping	250	611 30-66	C
5	Nykvarn	250	155 30-34	D
6	Eskilstuna, centre	250	632 20, 21, 25	E
7	Eskilstuna	250	See area 6	E
8	Strängnäs	250	645 30-34, 40-44, 50, 51	F
9	Mariefred conurbation, Läggesta, Åkers styckebruk	250	640 60, 647 30-32, 92	G
15	Nykvarn rural areas	19	155 91, 93, 94	D
16	Eskilstuna rural areas		644 30-36	E
17	Eskilstuna rural areas	118	635 06, 07, 10-13, 18, 19	E
18	Strängnäs rural areas	30	645 91	F
19	Mariefred, Åkers styckebruk rural areas	83	640 60, 647 91, 93	G
	Total 15-19	250		
	Total	2 395		

1:2 Survey areas 1998 and 2000

Compared to the 1997 survey, the survey areas have in certain cases been changed, as well as included postal codes.

	Area	*Gross sample*		*Postal code area*	*Questionnaire*
		1998	*2000*		
1	Stockholm	215	-	112-118 xx, 120 xx	A
2	Södertälje	215	-	151 xx, 152 xx	A
3	Örebro	215	-	70x xx	B
4	Nyköping	250	499	611 30-66	C
5	Nykvarn	250	496	155 30-34	D
6	Eskilstuna, centre	250	247	632 20, 25-27	E
7	Eskilstuna	250	247	632 21-23, 28-37, 633 40-62	F
8	Strängnäs	250	498	645 30-34, 40-44, 50,51	G
9	Mariefred conurbation, Åkers styckebruk incl. rural area	250	497	640 60, 647 30-32	H
15	Nykvarn rural area	17	20	155 91, 93, 94	D
16	Eskilstuna rural area	142	358	632 39, 633 69-70, 644 30-36	F
17	Eskilstuna rural area			635 02-20, 640 43	F
18	Strängnäs rural area	44	80	640 61, 645 91-94	G
19	Läggesta, Mariefred rural area	47	39	647 91-93	H
	Total 15-19	*250*	*497*		
	Total gross sample	2 395	2 981		

2:1 Levels of factors in question 4.1 in the 1997 survey

Journey to Stock-holm from	**Eskilstuna**	**Strängnäs**	**Läggesta**	**Nykvarn**	**Nyköping**
4.1 A					
Travel mode	Bus	Bus	Bus	Bus	Bus
Travelling time	2:00	1:30	1:10	1:00	1:30
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	70 Skr	60 Skr	45 Skr	30 Skr	70 Skr
B					
Travel mode	Bus	Bus	Bus	Bus	Bus
Travelling time	2:00	1:30	1:10	1:00	1:30
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	120 Skr	100 Skr	80 Skr	55 Skr	130 Skr
C					
Travel mode	Ord. train	Ord. train	Ord. train	Ord. train	Ord. train
Travelling time	1:30	1:00	0:50	0:45	1:00
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	70 Skr	60 Skr	45 Skr	30 Skr	70 Skr
D					
Travel mode	Ord. train	Ord. train	Ord. train	Ord. train	Ord. train
Travelling time	1:30	1:00	0:50	0:45	1:00
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	120 Skr	100 Skr	80 Skr	55 Skr	130 Skr
E					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	1:00	0:45	0:35	0:30	0:45
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	70 Skr	60 Skr	45 Skr	30 Skr	70 Skr
F					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	1:00	0:45	0:35	0:30	0:45
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	120 Skr	100 Skr	80 Skr	55 Skr	130 Skr

2:2 Levels of factors in question 4.2 in the 1997 survey

Journey to Stock-holm from	**Eskilstuna**	**Strängnäs**	**Läggesta**	**Nykvarn**	**Nyköping**
4.2 A					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	1:00	1:00	0:50	0:45	1:00
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	70 Skr	60 Skr	45 Skr	30 Skr	70 Skr
B					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	1:00	1:00	0:50	0:45	1:00
Frequency	2 hr	0,5 hr	0,5 hr	0,5 hr	2 hr
Fare	120 Skr	100 Skr	80 Skr	55 Skr	130 Skr
C					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	0:45	0:45	0:35	0:30	0:45
Frequency	2 hr	0,5 hr	0,5 hr	0,5 hr	2 hr
Fare	70 Skr	60 Skr	45 Skr	30 Skr	70 Skr
D					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	0:45	0:45	0:35	0:30	0:45
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	120 Skr	100 Skr	80 Skr	55 Skr	130 Skr
E					
Travel mode	Own car Cost Travelling time	Own car Cost Travelling time	Own car Cost Travelling time	Own car Cost Travelling time	Own car Cost Travelling time

2:3 Levels of factors in question 4.1 in the 1998 and 2000 surveys

Journey to Stockholm from	**Eskilstuna***	**Strängnäs**	**Läggesta**	**Nykvarn**	**Nyköping**
4.1 A					
Travel mode	Bus	Bus	Bus	Bus	Bus
Travelling time	2:00	1:30	1:10	1:00	1:30
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	70 Skr	60 Skr	45 Skr	30 Skr	70 Skr
B					
Travel mode	Bus	Bus	Bus	Bus	Bus
Travelling time	1:30	1:00	0:50	0:45	1:15
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	120 Skr	100 Skr	80 Skr	55 Skr	130 Skr
C					
Travel mode	Ord. train	Ord. train	Ord. train	Ord. train	Ord. train
Travelling time	1:15	0:45	0:35	0:30	1:00
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	70 Skr	60 Skr	45 Skr	30 Skr	70 Skr
D					
Travel mode	Ord. train	Ord. train	Ord. train	Ord. train	Ord. train
Travelling time	1:30	1:00	0:50	0:45	1:15
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	120 Skr	100 Skr	80 Skr	55 Skr	130 Skr
E					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	1:15	0:45	0:35	0:30	1:00
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	70 Skr	60 Skr	45 Skr	30 Skr	70 Skr
F					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	1:00	0:35	0:25	0:25	0:45
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	120 Skr	100 Skr	80 Skr	55 Skr	130 Skr
G					
Travel mode	Own car Cost Travelling time	Own car Cost Travelling time	Own car Cost Travelling time	Own car Cost Travelling time	Own car Cost Travelling time

* Residents in the centre of Eskilstuna, area 6, had the levels of the 1997 survey also in the 1998 and 2002 surveys

2:4 Levels of factors in question 4.2 in the 1998 and 2000 surveys

Journey to Stockholm from	**Eskilstuna***	**Strängnäs**	**Läggesta**	**Nykvarn**	**Nyköping**
4.2 A					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	1:00	1:00	0:50	0:45	1:00
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	70 Skr	60 Skr	45 Skr	30 Skr	70 Skr
B					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	1:00	1:00	0:50	0:45	1:00
Frequency	2 hr	0,5 hr	0,5 hr	0,5 hr	2 hr
Fare	120 Skr	100 Skr	80 Skr	55 Skr	130 Skr
C					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	0:45	0:45	0:35	0:30	0:45
Frequency	2 hr	0,5 hr	0,5 hr	0,5 hr	2 hr
Fare	70 Skr	60 Skr	45 Skr	30 Skr	70 Skr
D					
Travel mode	HS train	HS train	HS train	HS train	HS train
Travelling time	0:45	0:45	0:35	0:30	0:45
Frequency	1 hr	1 hr	1 hr	1 hr	1 hr
Fare	120 Skr	100 Skr	80 Skr	55 Skr	130 Skr

* Residents in the centre of Eskilstuna, area 6, had the levels of the 1997 survey also in the 1998 and 2002 surveys

3. Residents' score, questions 4.1 and 4.2

Mean score, residents in Nykvarn

	1997	*1998*	*2000*
	n=138	*n=134*	*n=213*
4.1A Bus, 1:00/1hr/30Skr	5,5 (5,1-6,0)	4,6 (4,1-5,1)	4,4 (4,1-4,8)
4.1B Bus, 1:00/1hr/55Skr	2,7 (2,4-3,1)		
4.1B Bus 0:45/1hr/55Skr		3,4 (3,1-3,8)	3,7 (3,4-4,0)
4.1C Train 0:45/1hr/30Skr	7,0 (6,6-7,3)		
4.1C Train 0:30/1hr/30Skr		7,8 (7,4-8,1)	7,4 (7,0-7,7)
4.1D Train 0:45/1hr/55Skr	3,9 (3,6-4,3)	3,9 (3,5-4,3)	4,3 (4,0-4,6)
4.1E HS train 0:30/1hr/30Skr	9,4 (9,2-9,6)	9,2 (9,0-9,5)	9,0 (8,8-9,2)
4.1F HS train 0:30/1hr/55Skr	5,9 (5,5-6,3)		
4.1F HS train 0:25/1hr/55Skr		6,2 (5,8-6,6)	6,8 (6,5-7,1)
	n=142	*n=132*	*n=213*
4.2A HS train 0:45/1hr/30Skr	7,0 (6,6-7,4)	6,7 (6,3-7,1)	6,6 (6,3-6,9)
4.2B HS train 0:45/0.5hr/55Skr	4,9 (4,5-5,3)	5,1 (4,7-5,5)	5,3 (5,0-5,6)
4.2C HS train 0:30/0.5hr/30Skr	9,7 (9,6-9,8)	9,5 (9,3-9,7)	9,5 (9,3-9,6)
4.2D HS train 0:30/1hr/55Skr	5,8 (5,4-6,2)	6,0 (5,6-6,4)	6,2 (5,9-6,5)
	n=74	*n=101*	*n=148*
4.2E Car	7,6 (7,0-8,2)		
4.1G Car		7,3 (6,8-7,8)	6,7 (6,3-7,1)
Car travelling time	40 mins	44 mins	47 mins
Car cost	52 Skr	69 Skr	75 Skr

Mean score (95% confidence interval) for different journey suggestions between the respondent's domicile and the centre of Stockholm at a rating scale of 1-10, where 10 is excellent. Travelling time and cost for the car alternative are given as 5% trimmed mean values, for those who had possibility to drive a car or have a lift. Please note that questions 4.1F and 4.2D are the same in the 1997 survey.

Mean score, residents in Mariefred and Åkers styckebruk

	1997	*1998*	*2000*
	n=174	*n=104*	*n=183*
4.1A Bus 1:10/1hr/45Skr	6,3 (5,9-6,7)	5,1 (4,5-5,7)	4,9 (4,5-5,3)
4.1B Bus 1:10/1hr/80Skr	2,6 (2,3-2,8)		
4.1B Bus 0:50/1hr/80Skr		3,5 (3,1-3,9)	3,5 (3,2-3,8)
4.1C Train 0:50/1hr/45Skr	7,3 (7,0-7,7)		
4.1C Train 0:35/1hr/45Skr		7,8 (7,4-8,2)	8,2 (7,9-8,5)
4.1D Train 0:50/1hr/80Skr	3,3 (3,0-3,7)	3,8 (3,4-4,3)	3,9 (3,6-4,2)
4.1E HS train 0:35/1hr/45Skr	9,2 (9,0-9,5)	9,0 (8,6-9,3)	9,1 (8,8-9,3)
4.1F HS train 0:35/1hr/80Skr	4,7 (4,3-5,1)		
4.1F HS train 0:25/1hr/80Skr		5,5 (5,0-6,0)	5,6 (5,2-6,0)
	n=166	*n=101*	*n=186*
4.2A HS train 0:50/1hr/45Skr	7,4 (7,1-7,7)	6,9 (6,5-7,4)	6,7 (6,3-7,0)
4.2B HS train 0:50/0.5hr/80Skr	4,0 (3,6-4,3)	4,0 (3,5-4,5)	4,0 (3,6-4,3)
4.2C HS train 0:35/0.5hr/45Skr	9,0 (8,8-9,3)	9,2 (8,9-9,5)	9,4 (9,2-9,6)
4.2D HS train 0:35/1hr/80Skr	4,8 (4,4-5,2)	5,2 (4,7-5,7)	5,0 (4,7-5,4)
	n=96	*n=77*	*n=123*
4.2E Car	8,2 (6,8-9,6)		
4.1G Car		7,4 (6,9-7,8)	7,4 (7,0-7,8)
Car cost	74 Skr	90 Skr	108 Skr
Car travelling time	54 mins	58 mins	60 mins

Mean score (95% confidence interval) for different journey suggestions between the respondent's domicile and the centre of Stockholm at a rating scale of 1-10, where 10 is excellent. Travelling time and cost for the car alternative are given as 5% trimmed mean values, for those who had possibility to drive a car or have a lift. Please note that questions 4.1F and 4.2D are the same in the 1997 survey.

Mean score, residents in Strängnäs

	1997	*1998*	*2000*
	n=153	*n=104*	*n=219*
4.1A Buss 1:30/1hr/60Skr	4,7 (4,3-5,1)	4,0 (3,5-4,5)	4,0 (3,7-4,4)
4.1B Buss 1:30/1hr/100Skr	2,5 (2,2-2,8)		
4.1B Buss 1:00/1hr/100Skr		3,3 (2,9-3,7)	3,7 (3,4-4,0)
4.1C Train 1:00/1hr/60Skr	7,4 (7,0-7,7)		
4.1C Train 0:45/1hr/60Skr		8,0 (7,6-8,4)	8,0 (7,7-8,2)
4.1D Train 1:00/1hr/100Skr	4,0 (3,6-4,3)	4,2 (3,7-4,7)	4,5 (4,2-4,8)
4.1E HS train 0:45/1hr/60Skr	9,6 (9,4-9,7)	9,1 (8,8-9,3)	9,2 (9,0-9,3)
4.1F HS train 0:45/1hr/100Skr	5,5 (5,1-6,0)		
4.1F HS train 0:35/1hr/100Skr		6,1 (5,5-6,6)	6,7 (6,4-7,0)
	n=147	*n=106*	*n=213*
4.2A HS train 1:00/1hr/60Skr	8,1 (7,8-8,4)	7,5 (7,1-7,9)	7,5 (7,2-7,8)
4.2B HS train 1:00/0.5hr/100Skr	5,1 (4,7-5,5)	5,3 (4,8-5,8)	5,5 (5,2-5,8)
4.2C HS train 0:45/0.5hr/60Skr	9,4 (9,2-9,6)	9,4 (9,2-9,7)	9,5 (9,4-9,6)
4.2D HS train 0:45/1hr/100Skr	5,8 (5,4-6,2)	5,7 (5,2-6,2)	6,1 (5,7-6,4)
	n=71	*n=75*	*n=152*
4.2E Car	7,7 (7,2-8,1)		
4.1G Car		7,5 (7,0-8,0)	6,5 (6,1-6,9)
Car cost	95 Skr	109 Skr	120 Skr
Car travelling time	64 mins	66 mins	66 mins

Mean score (95% confidence interval) for different journey suggestions between the respondent's domicile and the centre of Stockholm at a rating scale of 1-10, where 10 is excellent. Travelling time and cost for the car alternative are given as 5% trimmed mean values, for those who had possibility to drive a car or have a lift. Please note that questions 4.1F and 4.2D are the same in the 1997 survey.

Mean score, residents in centre (6) and the rest of the town (7) in Eskilstuna

	1997	*1998*	*2000*
	(6+7) n=279	*(6) n= 98*	*(6) n=71*
		(7) n=125	*(7) n=140*
4.1A Buss 2:00/1hr/70Skr	5,2 (4,9-5,5)	4,6 (4,1-5,1)	4,6 (4,0-5,2)
(7)		3,9 (3,5-4,3)	3,8 (3,4-4,2)
4.1B Buss 2:00/1hr/120Skr	2,4 (2,2-2,6)	2,1 (1,8-2,4)	2,2 (1,8-2,6)
4.1B (7) Buss 1:30/1hr/120Skr		3,6 (3,2-3,9)	3,6 (3,2-3,9)
4.1C Train 1:30/1hr/70Skr	7,1 (6,9-7,3)	6,9 (6,5-7,4)	6,8 (6,2-7,3)
4.1C (7) Train 1:15/1hr/70Skr		7,4 (7,0-7,7)	7,3 (6,9-7,7)
4.1D Train 1:30/1hr/120Skr	3,8 (3,6-4,1)	3,7 (3,3-4,1)	3,7 (3,2-4,2)
(7)		4,4 (4,1-4,8)	4,2 (3,8-4,6)
4.1E HS train 1:00/1hr/70Skr	9,4 (9,3-9,6)	9,6 (9,5-9,8)	9,3 (9,0-9,6)
4.1E (7) HS train 1:15/1hr/70Skr		8,8 (8,5-9,1)	8,6 (8,3-8,9)
4.1F HS train 1:00/1hr/120Skr	5,8 (5,5-6,1)	5,7 (5,2-6,2)	6,0 (5,5-6,6)
(7)		6,9 (6,5-7,2)	6,8 (6,4-7,2)
	(6+7) n=280	*(6) n=95*	*(6) n=73*
		(7) n=126	*(7) n=147*
4.2A HS train 1:00/1hr/70Skr	8,9 (8,7-9,1)	9,2 (8,9-9,4)	9,3 (9,1-9,6)
(7)		9,2 (8,9-9,4)	8,9 (8,7-9,2)
4.2B HS train 1:00/2hr/120Skr	5,0 (4,7-5,3)	4,6 (4,1-5,2)	5,0 (4,4-5,6)
(7)		5,4 (5,1-5,8)	5,1 (4,7-5,5)
4.2C HS train 0:45/2hr/70Skr	8,9 (8,7-9,1)	8,5 (8,2-8,9)	8,0 (7,5-8,5)
(7)		8,6 (8,2-8,8)	8,4 (8,0-8,7)
4.2D HS train 0:45/1hr/120Skr	6,2 (5,8-6,5)	6,1 (5,6-6,7)	6,3 (5,7-7,0)
(7)		6,8 (6,4-7,2)	6,8 (6,3-7,2)
	n=127	*(6) n=47*	*(6) n=33*
		(7) n=85	*(7) n=101*
4.2E Car	7,4 (7,0-7,8)	7,3 (6,6-7,9)	6,7 (5,7-7,7)
4.1G Car (7)		8,1 (7,7-8,5)	7,6 (7,3-8,0)
Car cost	115 Skr	128 Skr	137 Skr
(7)		137 Skr	153 Skr
Car travelling time	89 mins	95 mins	91 mins
(7)		90 mins	89 mins

Mean score (95% confidence interval) for different journey suggestions between the respondent's domicile and the centre of Stockholm at a rating scale of 1-10, where 10 is excellent. Travelling time and cost for the car alternative are given as 5% trimmed mean values, for those who had possibility to drive a car or have a lift. Please note that questions 4.1E and 4.2A are the same in the 1997 survey, and in area 6 also in 1998 and 2000.

Mean score, residents in Nyköping

	1997	*1998*	*2000*
	n=134	*n=83*	*n=188*
4.1A Buss 1:30/1hr/70Skr	6,0 (5,6-6,4)	6,2 (5,6-6,8)	6,1 (5,7-6,4)
4.1B Buss 1:30/1hr/130Skr	2,8 (2,5-3,1)		
4.1B Buss 1:15/1hr/130Skr		3,8 (3,3-4,2)	3,4 (3,1-3,7)
4.1C Train 1:00/1hr/70Skr	8,1 (7,8-8,5)	8,6 (8,2-9,0)	8,5 (8,2-8,8)
4.1D Train 1:00/1hr/130Skr	4,4 (4,0-4,8)		
4.1D Train 1:15/1hr/130Skr		4,7 (4,2-5,2)	4,1 (3,8-4,5)
4.1E HS train 0:45/1hr/70Skr	8,9 (8,5-9,2)		
4.1E HS train 1:00/1hr/70Skr		8,9 (8,5-9,3)	9,0 (8,7-9,2)
4.1F HS train 0:45/1hr/130Skr	5,2 (4,8-5,7)	6,4 (5,8-7,0)	6,2 (5,8-6,5)
	n=135	*n=84*	*n=183*
4.2A HS train 1:00/1hr/70Skr	8,6 (8,2-8,9)	8,8 (8,4-9,2)	9,0 (8,8-9,3)
4.2B HS train 1:00/2hr/130Skr	4,4 (3,9-4,8)	4,7 (4,2-5,2)	4,6 (4,3-5,0)
4.2C HS train 0:45/2hr/70Skr	7,8 (7,4-8,2)	7,8 (7,3-8,3)	8,1 (7,8-8,4)
4.2D HS train 0:45/1hr/130Skr	5,3 (4,9-5,7)	5,9 (5,3-6,4)	5,9 (5,5-6,3)
	n=64	*n=62*	*n=132*
4.2E Car	7,7 (7,0-8,3)		
4.1G Car		7,9 (7,4-8,4)	7,5 (7,1-7,8)
Car cost	124 Skr	144 Skr	142 Skr
Car travelling time	72 mins	76 mins	74 mins

Mean score (95% confidence interval) for different journey suggestions between the respondent's domicile and the centre of Stockholm at a rating scale of 1-10, where 10 is excellent. Travelling time and cost for the car alternative are given as 5% trimmed mean values, for those who had possibility to drive a car or have a lift. Please note that questions 4.1F and 4.2D are the same in the 1997 survey, and 4.1E and 4.2A in the 1998 and 2000 surveys.

4:1 Parameter values of the regression analyses of residents' score

Regression analyses, Nykvarn

	1997		*1998*		*2000*	
R^2	0,475		0,454		0,416	
df regression	5		5		5	
df total	1420		1354		2151	
Cf Bus	*b*	*t-value*	*b*	*t-value*	*b*	*t-value*
(constant)	18,729	22,278	16,021	24,641	15,000	29,078
Train	-0,607	-2,446	*0,208*	*0,944*	*0,168*	*0,956*
HS train	*-0,512*	*-1,549*	0,848	3,742	0,982	5,454
Travelling time	-0,131	-11,877	-0,107	-13,571	-0,108	-17,138
Frequency	-1,540	-4,678	-1,648	-4,916	-1,546	-5,820
Pris	-0,124	-26,442	-0,111	-23,384	-0,0885	-23,460

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Mariefred and Åkers styckebruk

	1997		*1998*		*2000*	
R^2	0,498		0,429		0,451	
df regression	5		5		5	
df total	1724		1044		1871	
cf Bus	*b*	*t-value*	*b*	*t-value*	*b*	*t-value*
(constant)	18,166	20,728	16,600	20,138	17,951	29,790
Train	-0,846	-3,183	*0,0599*	*0,224*	*0,0998*	*0,501*
HS train	-0,605	-1,713	*0,342*	*1,223*	*-0,0109*	*0,053*
Travelling time	-0,0874	-8,531	-0,0843	-10,009	-0,0998	-16,112
Frequency	*-0,498*	*-1,623*	-1,015	-2,476	-1,421	-4,779
Price	-0,114	-36,988	-0,0998	-24,054	-0,101	-33,241

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Mariefred

	1997		*1998*		*2000*	
R^2	0,488		0,437		0,437	
df regression	5		5		5	
df total	892		543		1155	
cf Bus	*b*	*t-value*	*b*	*t-value*	*b*	*t-value*
(constant)	19,344	15,413	17,415	15,078	17,589	23,036
Train	-1,166	-3,071	*-0,0657*	*-0,175*	*0,189*	*0,747*
HS train	-1,101	-2,181	*0,0032*	*0,008*	*0,0847*	*0,324*
Travelling time	-0,101	-6,859	-0,0901	-7,638	-0,102	-13,034
Frequency	-0,864	-1,966	-1,345	-2,346	-1,386	-3,679
Price	-0,114	-25,980	-0,104	-17,982	-0,0945	-24,417

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Åkers styckebruk

	1997		*1998*		*2000*	
R^2	0,513		0,430		0,480	
df regression	5		5		5	
df total	831		500		715	
cf Bus	*b*	*t-value*	*b*	*t-value*	*b*	*t-value*
(constant)	16,928	13,929	15,696	13,505	18,551	18,995
Train	*-0,510*	*-1,380*	*0,200*	*0,529*	*-0,0474*	*-0,147*
HS train	*-0,0850*	*-0,173*	0,718	1,815	*-0,112*	*-0,336*
Travelling time	-0,0736	-5,175	-0,0775	-6,530	-0,0957	-9,557
Frequency	*-0,105*	*-0,247*	-0,657	-1,136	-1,483	-3,074
Price	-0,114	-26,510	-0,0947	-16,189	-0,113	-22,811

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Strängnäs

	1997		*1998*		*2000*	
R^2	0,523		0,478		0,474	
df regression	5		5		5	
df total	1516		1077		2190	
cf Bus	*b*	*t-value*	*b*	*t-value*	*b*	*t-value*
(constant)	17,073	15,835	16,527	20,430	16,382	29,752
Train	*-0,110*	*-0,311*	0,872	3,374	0,646	3,729
HS train	*0,679*	*1,505*	1,409	5,301	1,291	7,200
Travelling time	-0,0722	-7,001	-0,0698	-10,289	-0,0768	-16,735
Frequency	*-0,473*	*-1,531*	-1,465	-3,997	-1,297	-5,150
Price	-0,0814	-29,971	-0,0771	-22,872	-0,0685	-29,896

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Eskilstuna area 6

	1997		*1998*		*2000*	
R^2	0,526		0,555		0,531	
df regression	5		5		5	
df total	2833		977		736	
cf Bus	*b*	*t-value*	*b*	*t-value*	*b*	*t-value*
(constant)	14,155	15,142	13,337	8,187	11,277	6,096
Train	0,777	3,067	1,299	2,951	1,603	3,196
HS train	1,940	4,027	2,968	3,541	3,868	4,059
Travelling time	-0,0286	-3,880	*-0,0212*	*-1,650*	*-0,0076*	*-0,521*
Frequency	-0,726	-6,559	-1,122	-5,830	-1,265	-5,776
Price	-0,0652	-41,734	-0,0667	-24,720	-0,0600	-19,353

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Eskilstuna area 7

	1997		*1998*		*2000*	
R^2	0,526		0,489		0,435	
df regression	5		5		5	
df total	2833		1274		1473	
cf Bus	*b*	*t-value*	*b*	*t-value*	*b*	*t-value*
(constant)	14,155	15,142	13,747	18,641	14,503	18,906
Train	0,777	3,067	1,263	5,871	1,038	4,625
HS train	1,940	4,027	2,358	8,146	2,072	6,859
Travelling time	-0,0286	-3,880	-0,0408	-7,464	-0,0468	-8,205
Frequency	-0,726	-6,559	-1,228	-7,765	-1,389	-8,478
Price	-0,0652	-41,734	-0,0475	-20,450	-0,0484	-20,040

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Eskilstuna (whole)

	1997		*1998*		*2000*	
R^2	0,526		0,513		0,464	
df regression	5		5		5	
df total	2833		2252		2210	
cf Bus	*b*	*t-value*	*b*	*t-value*	*b*	*t-value*
(constant)	14,155	15,142	14,518	23,536	14,337	22,277
Train	0,777	3,067	1,044	5,737	0,977	5,116
HS train	1,940	4,027	2,126	7,781	2,131	7,662
Travelling time	-0,0286	-3,880	-0,0400	-8,635	-0,0411	-8,525
Frequency	-0,726	-6,559	-1,209	-9,870	-1,361	-10,400
Price	-0,0652	-41,734	-0,0558	-31,587	-0,0518	-27,204

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

	1997		*1998*		*2000*	
R^2	0,423		0,389		0,434	
df regression	5		5		5	
df total	1373		843		1868	
cf Bus	*b*	*t-value*	*b*	*t-value*	*b*	*t-value*
(constant)	11,783	11,133	13,880	14,091	14,448	21,730
Train	1,613	4,001	1,165	4,021	1,048	5,412
HS train	2,221	4,329	1,557	4,128	1,713	6,753
Travelling time	*-0,0077*	*-0,652*	-0,0303	-2,908	-0,0351	-4,996
Frequency	-0,854	-4,848	-1,215	-5,815	-1,156	-8,116
Price	-0,0580	-27,942	-0,0516	-19,799	-0,0565	-32,146

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

4:2 Parameter values divided by socio-economic factors

Regression analyses, Strängnäs 2000; by gender

	Women		*Men*	
R^2	0,493		0,462	
df regression	5		5	
df total	1052		1137	
cf Bus	*b*	*t-value*	*b*	*t-value*
(constant)	17,152	21,185	15,676	21,010
Train	0,758	2,978	0,542	2,303
HS train	1,249	4,740	1,328	5,461
Travelling time	-0,0779	-11,551	-0,0758	-12,190
Frequency	-1,359	-3,666	-1,240	-3,636
Price	-0,0773	-22,969	-0,0603	-19,418

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Strängnäs 2000; by occupation

	Gainful.	*employed*	*Not g.*	*employ.*
R^2	0,482		0,485	
df regression	5		5	
df total	1419		670	
cf Bus	*b*	*t-value*	*b*	*t-value*
(constant)	15,556	23,448	18,149	17,572
Train	0,800	3,846	*0,301*	*0,922*
HS train	1,535	7,115	0,791	2,344
Travelling time	-0,0753	-13,648	-0,0808	-9,358
Frequency	-1,222	-4,021	-1,403	-2,976
Price	-0,0607	-22,015	-0,0844	-19,601

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Strängnäs 2000; by age

	Age 16-24		*Age 25-64*	
R^2	0,474		0,486	
df regression	5		5	
df total	313		1621	
cf Bus	*b*	*t-value*	*b*	*t-value*
(constant)	16,194	11,642	16,268	25,511
Train	*-0,130*	*-0,295*	0,795	3,972
HS train	0,823	1,820	1,452	6,992
Travelling time	-0,0733	-6,322	-0,0788	-14,846
Frequency	-1,417	-2,239	-1,307	-4,475
Price	-0,0707	-12,189	-0,0663	-25,009

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Strängnäs 2000; by education

	Upper sec ond. school		*University*	
R^2	0,474		0,544	
df regression	5		5	
df total	937		764	
cf Bus	*b*	*t-value*	*b*	*t-value*
(constant)	16,361	20,081	16,863	18,816
Train	*0,337*	*1,307*	0,933	3,362
HS train	1,076	4,043	1,518	5,246
Travelling time	-0,0763	-11,194	-0,0883	-11,931
Frequency	-1,104	-2,975	-1,504	-3,632
Price	-0,0693	-20,405	-0,0679	-18,295

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Strängnäs 2000; by household income

	<200000	*Skr*	*>500000*	*Skr*
R^2		0,383		0,553
df regression		5		5
df total		390		387
cf Bus	*b*	*t-value*	*b*	*t-value*
(constant)	16,507	11,290	16,529	13,553
Train	*0,178*	*0,386*	*0,544*	*1,412*
HS train	0,867	1,816	1,579	3,965
Travelling time	-0,0708	-5,804	-0,0927	-9,100
Frequency	-1,510	-2,259	-1,478	-2,651
Price	-0,0690	-11,343	-0,0594	-11,707

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Strängnäs 2000; by car access

	Habitual	*motorists*	*Frequ.-infrequ.*	*motorists*	*Non-*	*motorists*
R^2		0,510		0,474		0,426
df regression		5		5		5
df total		1090		781		309
cf Bus	*b*	*t-value*	*b*	*t-value*	*b*	*t-value*
(constant)	16,062	21,661	16,076	17,596	18,345	11,054
Train	0,867	3,727	0,713	2,481	*-0,335*	*-0,636*
HS train	1,564	0,241	1,350	4,531	*0,298*	*0,550*
Travelling time	-0,0773	-12,537	-0,0762	-10,001	-0,0780	-5,611
Frequency	-1,378	-4,055	-1,215	-2,904	*-1,217*	*-1,612*
Price	-0,0644	-20,893	-0,0662	-17,436	-0,0880	-12,698

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Regression analyses, Strängnäs 2000; by distance domicile–station

	0-1 km		*1-3 km*	
R^2	0,513		0,446	
df regression	5		5	
df total	1065		970	
cf Bus	*b*	*t-value*	*b*	*t-value*
(constant)	16,493	21,865	16,310	18,955
Train	0,790	3,322	0,565	2,092
HS train	1,418	5,776	1,233	4,403
Travelling time	-0,0759	-12,069	-0,0786	-10,972
Frequency	-1,227	-3,560	-1,357	-3,443
Price	-0,0718	-22,864	-0,0647	-18,080

R^2 : Degree of explanation

df : Degrees of freedom

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

5. Levels of public transport passenger's SP-studies

Factor	*Levels*			
Travel mode and Travelling time	Bus: Random about 180% of real travelling time	Ord. Train: Random about 130% of real travelling time	HS train: Random about 110% of real travelling time	Extra fast HS train: Random about 50% of real travelling time
Car	Only if the passenger has car as an alternative. No travelling time, frequency of service or cost are given			
	The levels below can be combined freely with travel mode and travelling time (except car);			
Frequency of service	0,5 hr (more often in peak hour)	1 hr (more often in peak hour)	2 hr (more often in peak hour)	3 hr (more often in peak hour)
Fare	50% of real fare	100% of real fare	120% of real fare	160% of real fare

6. Parameter values, public transport passenger's SP-studies

Logit analyses, price %, The Svealand line without car

	*1998**		*2000*	
"R^2"	0,41		0,35	
No. of observations	557		632	
	b	*t-value*	*b*	*t-value*
Bus	-1,129	-3,1		
Train	-0,456	-1,9	0,774	3,1
HS train			1,397	4,3
cf Frequency 0.5hr				
Frequency 1hr	*0,0795*	*0,4*	*-0,134*	*-0,7*
Frequency 2hr	*-0,369*	*-1,6*	*0,0313*	*0,1*
Frequency 3hr	-1,160	-4,7	-1,052	-5,1
Price %	-0,0310	-10,8	-0,0212	-9,9
Travelling time	-0,0246	-4,0	-0,0177	-3,7

* Analysis by Karl Kottenhoff, Royal Institute of Technology

"R^2" : (fictitious) degree of explanation

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Logit analyses, numerical, the Svealand line without car, only passengers with single tickets at 160 Skr maximum

	1998		*2000*	
"R^2"	0,43		0,38	
No. of observations	388		429	
	b	*t-value*	*b*	*t-value*
Train	0,634	1,9	0,982	3,1
HS train	*0,662*	*1,4*	1,548	3,6
Travelling time (minute)	-0,0360	-4,5	-0,0187	-2,9
Frequency (minute)	-0,0079	-4,1	-0,0046	-3,1
Price (Skr)	-0,0374	-8,9	-0,0216	-8,2

"R^2" : (fictitious) degree of explanation

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Logit analyses, price %, all passengers on the Svealand line with bil

	*1998**		*2000*	
"R^2"	0,29		0,25	
No. of observations	1758		1841	
	b	*t-value*	*b*	*t-value*
Bus	-2,121	-12,0		
Train	-1,010	-7,6	0,954	6,1
HS train			1,562	8,7
Bil	-2,267	-13,2	-0,721	-2,6
cf Frequency 0.5hr				
Frequency 1hr	*-0,0134*	*-0,1*	*-0,0596*	*-0,5*
Frequency 2hr	-0,291	-2,2	-0,709	-5,5
Frequency 3hr	-1,101	-7,8	-1,261	-9,3
Price %	-0,0207	-14,8	-0,0165	-12,9
Travelling time	-0,0089	-4,5	-0,0136	-6,1

* Analysis by Karl Kottenhoff, Royal Institute of Technology

"R^2" : (fictitious) degree of explanation

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Logit analyses, numerical, the Svealand line with car, only passengers with single tickets at 160 Skr maximum

	1998		*2000*	
"R^2"	0,27		0,23	
No. of observations	1078		1179	
	b	*t-value*	*b*	*t-value*
Train	0,958	4,7	0,973	4,9
HS train	1,894	7,5	1,479	6,6
Bil	-1,973	-5,0	-2,158	-5,8
Travelling time (minute)	-0,0093	-2,6	-0,0133	-4,4
Frequency (minute)	-0,0060	-5,7	-0,0088	-8,7
Price (Skr)	-0,0163	-10,0	-0,0123	-8,9

"R^2" : (fictitious) degree of explanation

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Logit analyses, price %, all passengers on the Nyköping line without car

	*1998**		*2000*	
"R^2"	0,41		0,40	
No. of observations	366		326	
	b	*t-value*	*b*	*t-value*
Bus	-1,790	-3,3		
Train	*-0,155*	*-0,5*	1,359	3,2
HS train			1,538	2,9
cf Frequency 0.5hr				
Frequency 1hr	*-0,158*	*-0,6*	*-0,363*	*-1,3*
Frequency 2hr	-0,749	-2,6	-0,640	-2,2
Frequency 3hr	-1,553	-5,0	-1,429	-4,5
Price %	-0,0319	-9,0	-0,0296	-8,3
Travelling time	*-0,0105*	*-1.1*	-0,0243	-2,1

* Analysis by Karl Kottenhoff, Royal Institute of Technology

"R^2" : (fictitious) degree of explanation

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Logit analyses, numerical, the Nyköping line without car, only passengers with single tickets at 160 Skr maximum

	1998		*2000*	
"R^2"	0,49		0,41	
No. of observations	210		180	
	b	*t-value*	*b*	*t-value*
Train	1,598	2,6	1,556	2,7
HS train	1,418	1,9	1,779	2,3
Travelling time (minute)	*-0,0136*	*-1,0*	*-0,0158*	*-0,9*
Frequency (minute)	-0,0081	-3,1	-0,0092	-3,3
Price (Skr)	-0,0343	-7,2	-0,0306	-6,3

"R^2" : (fictitious) degree of explanation

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Logit analyses, price %, all passengers on the Nyköping line with car

	*1998**		*2000*	
"R^2"	0,28		0,31	
No. of observations	865		860	
	b	*t-value*	*b*	*t-value*
Bus	-2,065	-7,7		
Train	-0,423	-2,4	1,676	5,9
HS train			1,852	6,1
Car	-1,692	-6,3	*-0,482*	*-1,0*
cf Frequency 0.5hr				
Frequency 1hr	*-0,0069*	*0,0*	*-0,0522*	*-0,3*
Frequency 2hr	*-0,183*	*-1,0*	*-0,246*	*-1,3*
Frequency 3hr	-1,033	-5,2	-1,265	-5,9
Price %	-0,0235	-11,4	-0,0285	-12,3
Travelling time	*-0,0035*	*-0,9*	-0,0103	-2,0

* Analysis by Karl Kottenhoff, Royal Institute of Technology

"R^2" : (fictitious) degree of explanation

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Logit analyses, numerical, the Nyköping line with car, only passengers with single tickets at 160 Skr maximum

	1998		*2000*	
"R^2"	0,25		0,33	
No. of observations	489		380	
	b	*t-value*	*b*	*t-value*
Train	1,588	4,6	1,491	3,7
HS train	2,151	5,7	1,951	4,3
Car	-1,152	-1,9	-3,367	-4,5
Travelling time (minute)	*0,0018*	*0,3*	-0,0119	-1,7
Frequency (minute)	-0,0038	-2,4	-0,0069	-3,5
Price (Skr)	-0,0185	-8,7	-0,0217	-7,7

"R^2" : (fictitious) degree of explanation

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Logit analyses, numerical, the Svealand line 2000, only passengers with monthly passes

	Without car		*With car*	
"R^2"	0,34		0,31	
No. of observations	137		329	
	b	*t-value*	*b*	*t-value*
Train	*0,126*	*0,3*	*0,513*	*1,3*
HS train	*0,746*	*1,2*	1,539	3,3
Car			-3,257	-4,1
Travelling time (minute)	-0,0233	-2,3	-0,0177	-2,8
Frequency (minute)	-0,0094	-3,2	-0,0124	-5,5
Price (Skr)	-0,0011	-4,9	-0,0008	-5,7

"R^2" : (fictitious) degree of explanation

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

Logit analyses, numerical, the Nyköping line 2000, only passengers with monthly passes

	Without car		*With car*	
"R^2"	0,44		0,40	
No. of observations	94		274	
	b	*t-value*	*b*	*t-value*
Train	*0,843*	*1,1*	2,191	3,7
HS train	*1,167*	*1,2*	2,652	4,1
Car			-3,103	-2,8
Travelling time (minute)	*-0,0399*	*-1,6*	*0,0099*	*0,9*
Frequency (minute)	-0,0117	-2,9	-0,0087	-3,5
Price (Skr)	-0,0015	-4,1	-0,0018	-7,7

"R^2" : (fictitious) degree of explanation

Coefficients where the t-value is within the interval -1,64<t<1,64 is not significant (one-sided 95% confidence interval). Those results are written in *italics*.

7. Travel by train and accessibility calculations with Sampers

Appendix 7 is based on a paper written by the author in connection with a researchers' course entitled 'Methods of train service planning', at the Division of Transportation and Logistics of the Royal Institute of Technology (Kungliga Tekniska Högskolan, KTH) in spring 2002.

Introduction

A new model for forecasting demand for passenger transportation was commissioned by the Swedish Institute for Transport and Communications Analysis, SIKA, and the first version of the new system, Sampers, was ready for use in 1999. Compared to the previous demand forecast models, greater effort has been made to make the modelling system modular and user-friendly. This means that Sampers will appear to the user to be first and foremost a system, not several separate models, but still be easy to develop and change.

Sampers was used in the research project, "The establishment of new train services – their effect on travel demand and social structure. The Svealand line", to calculate accessibility. The project was primarily a before and after study of accessibility by regional bus and train services to the areas around the Eskilstuna–Södertälje section of the Svealand line with 1998 as the base year. The credibility of the results in some cases is questionable, however, due to the errors and shortcomings that have hitherto come to light in both the software and the data. By attempting to establish the known weaknesses in the whole chain up to the finished result, the intention is to be able to make a critical assessment of the results, which may also be of use in the continued development of the models in the Sampers system.

The version of Sampers used in the calculations here is 1.2.643. A new version (2.0), which among other things has better calibrating capabilities and also allows the model maker to work with the population divided into different income categories, was delivered to SIKA during 2002. In so far as there are differences between the versions, this paper refers to earlier versions of Sampers than 2.0.

The Sampers modelling system

In Sampers the land is divided into zones of varying geographical size and with different aggregated attributes and characteristics (for example car ownership and the number of inhabitants and workplaces). The

zone is the unit where trips are generated and to which journeys are made. The aggregated, descriptive approach is generally speaking appropriate for large-scale, long-term traffic planning.[298] It is considered a tried and tested, reliable method with the right prerequisites, i.e. in cases of minor changes, towards long-term levels of equilibrium.

Use

The Sampers forecasting system in its entirety can be used as a basis for calculating

- Demand effects of new infrastructure and new transport supply
- Demand effects of changing factors, for example socioeconomic, demographic, commercial etc.
- Traffic safety effects
- Environmental effects
- Energy consumption effects
- Accessibility effects
- Regional effects
- Effects transportation policy (taxes, charges, legislation)

One of the most important areas of application for forecasting models is to calculate the effects of new, improved train services, for example new high speed train services.[299]

Model structures

Sampers is divided into five different regional models, in a national model, and a model for international travel. All the models include socioeconomic parameters (gender, age, occupation etc.) and type of journey (trip purpose). The parameters in the model are calculated on the basis of disaggregated data obtained from different surveys of travel behaviour, the most important source of data being Riks-RVU 94-98 (the National Survey of Travel Behaviour). There are also a small number of associated models which are of especial interest, including the car ownership model and a route choice model which are described in more detail below.

The model calculates demand in four steps. Three of them are handled by Sampers; traffic generation, trip distribution (destination choice) and mode split (choice of travel mode).[300] To calculate the fourth step, the route, a route choice model is used, in this case EMME/2.

[298] Fischer (2000)

[299] Widlert (2001)

[300] The terminology here (Traffic generation, Travel distribution, Mode split and Route choice) follows that of Beser et al (1996)

EMME/2 consequently describes the infrastructure and the scheduled services in the form of networks of nodes and links.

The regional models calculate the demand for local and regional journeys up to 100 km. For journeys to work, however, the demand over longer distances than 100 km is also calculated in the regional models. The travel modes in the regional models are car (as driver and passenger), bus, local or regional train, bicycle and walking. Underground and tram services are classified as "bus" in the model. The five regional models cover different areas of Sweden, which together comprise 8 500 forecast areas, known as zones. Densely populated areas, the built-up areas in the towns and cities, are geographically speaking divided into small zones, while sparsely populated areas may be divided less precisely into larger zones. The model that includes the Mälaren valley is called SAMM and contains 2 300 zones.

The national model comprises 670 zones in Sweden and calculates the demand for long-distance journeys of more than 100 km between these areas. The travel modes in the national model are car, bus, intercity train (ordinary train), the X 2000 train and plane. The model contains various fare and price parameters. The supply of long-distance train and air services can be described by time tables in the national model, whereas bus services are described in the form of service frequency.

The international travel model covers the same 670 zones in Sweden as the national model, with an additional 180 zones outside the country. Sweden's closest neighbours (Finland, Norway, Denmark and Germany), are divided into zones but the general principle for Europe is that a whole country is one zone. An exception is that the north Zealand region of Denmark is also included in the regional model for Skåne in the south of Sweden. The forecast long-distance travel, both national and international, is then entered on the links in the regional models.[301]

Known problems

Sampers was developed under pressure of time.[302] A few early forecasting runs gave results that were obviously erroneous, largely caused by the fact that the models had not been sufficiently calibrated and validated. The supply descriptions for public transport were also inadequate. Moreover, in some cases the prerequisites changed during the period the system was being developed. The models are successively being improved and possibilities to further develop parts of the fore-

[301] Beser and Algers (2001)
[302] Letter from Staffan Widlert, 4 July 2000

casting system and adapt it to new functions and applications later on have also been specified. However, there are several known problems which can affect results in undesirable ways, that still remain to be resolved.

Dynamics

The type of model that Sampers constitutes, a nested logit model, also has a number of built-in weaknesses. One of these is that the model is estimated on the basis of a state of equilibrium, and is consequently not able to satisfactorily calculate the effects of dynamic changes, i.e. major changes or continuous changes in a the population's travel habits, behaviour and activities. Dynamic effects are as a rule results of rapid economic development, major changes in the housing and labour markets, and perhaps also rapid changes in car ownership.

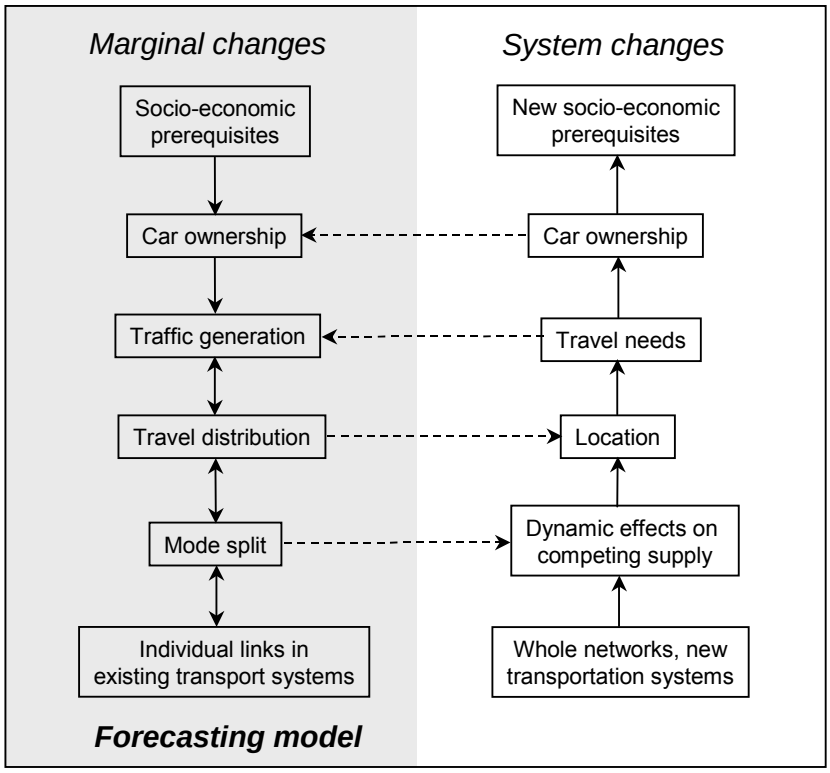
If dynamic (or otherwise large-scale) changes in demand occur, for example as a consequence of a radically changed supply, the result may be that the changes go outside the model's real field of application. A traffic generation model estimated on the basis of a state of equilibrium can not capture the hidden demand, or long-term changes in travel behaviour, in a satisfactory manner. Nor can the traffic generation that is affected by the relationship between social structure and traffic be calculated in a model of this kind.[303]

A state of equilibrium can be said to be a theoretical simplification of reality to enable a model to be designed that is of practical use. In practice, however, there is good reason to assume that a new state of equilibrium will never be attained. An equilibrium model will consequently never produce forecast errors since it does not sufficiently consider the time dynamics and individual, general changes in travel behaviour. The question is whether activity-based models, which are currently being researched, would be able to calculate the time dynamics in a better way.[304] [305] [306] [307]

Another weakness that by definition is built into the model is that it ages. The model structure was designed in the late 1990s. The coefficients were mainly estimated on the basis of the National Travel Survey Riks-RVU, where the data was collected between 1 April 1994 and 31 December 1997.[308]

[303] Fischer (2000)
[304] Ortúzar and Willumsen (1994), p. 350
[305] Goodwin (1998)
[306] McNally (2000b)
[307] Algers, Eliasson and Mattsson (2002)
[308] Sampers technical documentation (2001)

Effects of changes in supply



Forecasting models, like Sampers, can be used for demand forecasts in cases of marginal changes in the supply. Source: Nelldal et al (1996)

The modelling system and the databases both need to be successively modernised and updated in order to capture new product supplies, changed factors in the world around, and new valuations on the part of the population. This updating process can normally run in phase with the real world. One example is people's valuation of travelling time, which tends to increase with higher incomes. People who travel by car and people who travel by public transport value travelling time differently, and for public transport passengers it varies to a certain degree with the supply. But a drastically improved supply or a new travel mode can be assumed to attract people with other valuations than the supply as it was previously. The modelling system then needs to be modified, for example with a segmentation of the new travel mode, to be able to handle the new supply.

The logit model

Sampers is a conventional nested logit model, or a logit model with a tree structure.[309] The nested logit model can be briefly described as a multi-level probability calculation. Every individual's probability of choosing one of the alternatives on every level is calculated, for example on the travel mode level with the alternatives bus, car and train. The parameters leading to the probabilities have been estimated from different surveys of travel habits. Probability for an individual can be converted into proportions of a group of individuals on an aggregated level.

In Sampers, linear utility functions are generally used in the logit model (some variables, such as waiting time, however, have been made linear on an individual basis to correspond better to the real valuations).[310] Research results from estimating demand for travel by high speed train in Germany and freight traffic in Canada show that a non-linear logit model with a Box-Cox transformation can calculate the demand better than the linear logit model. The linear model principally overestimates short journeys and underestimates long journeys, largely because the price elasticities are too low and the travelling time elasticities too high in the linear model. A non-linear function also has the advantage that it takes the utility's starting point into consideration better in the specific case, i.e. that a gain in time of for example 15 minutes has a greater effect on a short journey than on a long one.[311] [312] There are many ways of improving the results of the forecast, but the core, with its linear logit model, does not have the best of known prerequisites to give a good result. The linear logit model is relatively simple, though, which explains the wide popularity it enjoys.[313] [314]

The regional models and the national model

The division into regional models and a national model in the modelling system has the advantage that relatively detailed demand forecasts can be produced for one or several areas without needing to have the same level of detail for the whole country, giving a smaller model and saving computer time. Special attention, however needs to be paid to the interface between the regional models and the national model (and the one for international travel).

[309] Lundqvist and Mattsson (2001), p. 2
[310] Köhler, by e-mail, 18 October 2002
[311] Mandel, Gaudry and Rothengatter (1994)
[312] Picard and Gaudry (1998)
[313] Jong (2000), p. 563
[314] Ben-Akiva and Lerman (1985), p. 179

The regional models are based on surveys of travel habits for journeys up to 100 km, the national model journeys longer than 100 km. All journeys to work, however, are generated by the regional models, regardless of the length of the journey (only a small proportion of journeys to work, however, are longer than 100 km). The problem of choosing a distance, and not time, as the limit for journeys to work has been brought to the fore by, among other things, the new train services in the Mälaren valley. The short travelling times by regional high speed train mean that range increases, and in many cases it is possible to travel further than 100 km in about an hour. One example is that the regional high speed train services have made the large supply of qualified jobs in the centre of Stockholm more accessible for a greater proportion of the people living in the Mälaren valley. This means that commuting over longer distances than 100 km can be expected to increase in the region. Journeys in the border zone between the national and the regional models, around 100 km, also show relatively large forecast errors, which will be discussed more below.

Due to the small number of observations in the surveys of travel habits it was decided that the same base model should also be used in all five regional submodels, despite the large differences between different parts of the country with regard to supply and demand for train services. Calibration provides a degree of regional adaptation.

Input data for estimation of the regional model

The national travel survey contained few observations of regional train travel. For regional journeys to work by train, there were only 150 usable responses in the whole survey.[315] Business trips by train over distances up to 100 km were even fewer and gave no significant results at all.[316] The regional models in Sampers can thus not calculate any proportions for business trips made by train. On the other hand, the regional models overestimate leisure time travel by train. The distribution of journeys by travel mode between men and women also diverges from the national travel survey. The new regional high speed train services can in practice be expected to attract a large proportion of the new long-distance commuters as passengers, and also more business trips, but the model is based on too few relevant observations of real travel.

The estimation of the common regional model has consequently been made on the basis of surveys of travel habits that do not fulfil requirements as regards the size of the sample for the individual travel

[315] Sampers technical documentation (2001)
[316] Beser and Algers (2001)

modes, and for different trip purposes and for different socioeconomic groups. The shortcomings in the data in turn mean that the model is unable to make demand forecasts that are in line with empirical results. Sensitivity to supply changes will show deviations from observed data, and the error term, that which can not be explained by the model, will be unreasonably large. These deficiencies could be rectified with complementary surveys, but this has not been done.

Travel mode

The method of segmenting intercity trains and the X 2000 as separate travel modes in the national model seems to be somewhat antiquated viewed from today's perspective. The distinction is based on the fact that the X 2000 was previously an exclusive train for business travellers, clean and fresh, with a considerably higher level of comfort and service, but also shorter travelling times and higher fares than ordinary (intercity) trains. The travel mode constants, i.e. that which can not be explained by travelling time, frequency of service or fare, thus differ substantially between intercity trains and the X 2000 in Sampers. Kottenhoff, for example, has pointed out the importance of "soft" factors (comfort, service, design) when it comes to attracting new passengers. These factors naturally also have the same advantages for a new train supply also in the intercity train category.[317]

Conversely, differences in the travel modes' parameter values (frequency of service, travelling time, fare) can mean that in situations where the two types of train are used in parallel on the same service, as in the Mälaren valley at the end of the 1990s, the results may differ depending on the type of train despite directly comparable attributes. It is thus difficult to assess the results of future improvements in train service supply because of the division and the fact that the travel mode constants are estimated from the supply as it was in the mid-1990s. The model is consequently in need of modernisation.

The route choice model

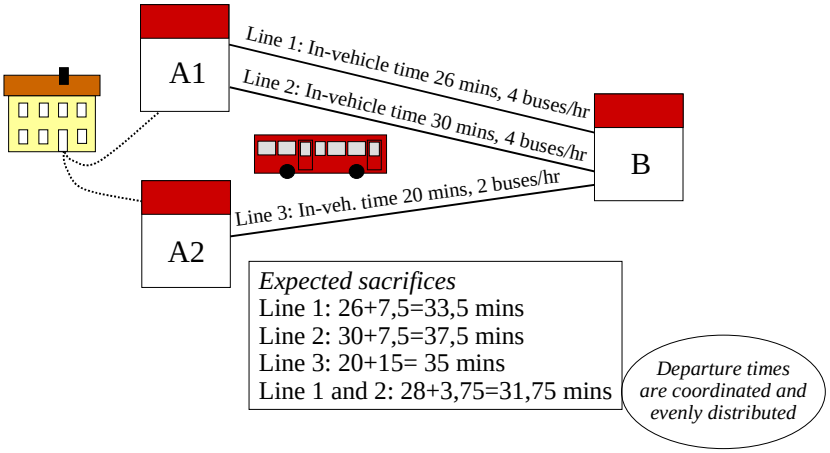
After SIKA had tested four different route choice models, EMME/2 was chosen for this function in Sampers modelling system.[318]

EMMA was developed as a route choice model for road traffic. Among its advantages can be mentioned that it is able to take road capacity into account since volume delays with accompanying lower journey/travelling speeds by car can be modelled. As the need arose,

[317] Kottenhoff (1999)
[318] Johansson Sveder (2001), p. 94

EMMA was gradually further developed to be able to also handle public transport in networks. Today the model is called EMME/2 and the version in use is considered to function well as regards road traffic.

How the mean time model handles frequency of service and expected sacrifice



If a mean time model calculates the expected sacrifice for the journey as the in-vehicle time and half the service interval, according to the optimum strategy all passengers would choose the stop with the least expected sacrifice, A1 in the example. 50% of the passengers would then choose service 1 and 50% service 2 if the services are coordinated. In reality, the distribution would be different (given that the passengers read the timetable), which a real time model would be able to handle better than a mean time model. Source: Beser, Eliasson, Karlström, Mattsson and Rosenlind (1996)

In its traditional application for public transport the route choice model is used with interchange times and waiting times based on half the service interval (the mean time model). Given a starting point, a destination and the desired times of departure and arrival, and that the timetables are known, it is however possible to make a deterministic model for a scheduled trip, in which the disadvantages of a model based on service frequency are avoided. Such a deterministic real time model has also been developed for EMME/2.[319] SIKA do not intend to retain the mean time model in the regional models in Sampers.

Average frequencies of service can function as a good approximation for public transport services in towns and cities with high frequency of service. Where journeys are long and when frequency is low, for example in rural areas, the demand for travel will very much depend on how well the timetable suits potential passenger.[320] A model based on service interval means that journey chains with interchanges are not assumed to be coordinated. If the subtrips are in reality coordinated, for example a

[319] Constantin, Florian and Speiss (2001)
[320] Lundqvist and Mattsson (2001), p. 6

connection feeder bus to a train, travel impedance will be unreasonably high in a mean time model with half the service interval since the model assumes that the services are evenly distributed without any coordination. The same applies for parallel and coordinated services, where the distribution of passengers between the different services may be unrealistic if the frequencies are different.

Passengers' preferences when choosing one of several alternative public transport travel modes or stops also depend in the mean time model on the assumption that that passengers only know the frequency and not the exact departure times. In the application of EMME/2 in Sampers, however, one service interval is used for peak periods (number of departures around 6-8 a.m.) and another for the rest of the day (number of departures).

Choosing to use a mean time model means that the problems involved in forecasting public transport in the regional models where timetables play an important role and where there are alternative supplies, i.e. especially as regard frequent journeys, remain for the present in all results generated by Sampers.

The car ownership model

Access to a car has a decisive influence on the population's travel. The single most important explanatory factor for the increase in transportation by car over the past few decades is the increase in car ownership. In the passenger transport demand models, therefore, car ownership plays a central role. Sampers uses an aggregated non-linear model for the population's car ownership. The model has been estimated on the basis of data on car ownership in Sweden collected between 1980 and 1995.[321]

The growth in car ownership can be described as a process of diffusion, i.e. a process in which car ownership is successively spread and distributed in different socioeconomic groups, but gradually approaches an assumed relative saturation level. The differences in car ownership and car use between towns and rural areas are considerable. The populations of (large) towns and cities show a markedly lower degree of car ownership than rural populations. The cost of using a car is a significant factor for car ownership in this respect. The car ownership model in its present form can only describe the period of constantly increasing car ownership, but as car ownership approaches an assumed saturation level, the results will probably become unreliable.[322] [323]

[321] Matstoms (2002)
[322] Jansson (1996)
[323] Medlock and Soligo (2002)

The car ownership model (including submodels) calculates changes from a starting point by estimating the probabilities for people to acquire a car during the year (disposition to enter) and get rid of the car during the year (disposition to exit). The parameters in the model include the person's previous car ownership, annual income, age, year of birth, gender, and the price of petrol, the relative increase in GDP, the proportion of leased cars and the type of municipality in which the person lives.[324]

The country's municipalities are divided into seven classes depending on their character, the distance to major towns and a number of other factors. The probability that a person will acquire a car or get rid of it is assumed to be different in the seven classes. A higher class is in principle assumed to correspond to a higher degree of car ownership among the municipality's population. A few examples are that the city of Stockholm is in class 1, Eskilstuna and Södertälje (including Nykvarn) are in class 4, and Strängnäs is in class 5.

Each municipality contains a varying number of Sams areas, geographical areas to which are linked different statistical data about the population and their car ownership. The model calculates the changes year by year in a demand forecast at the municipality level, after which it distributes the changes over the Sams areas by calculating the different areas' car ownership potentials. A weakness in the model is that it is certain demographic factors (age, gender, a certain socioeconomic class) that characterise car ownership in the Sams areas, whereas the conurbation's characteristics or changes in the area's accessibility are not taken into account directly. In the car ownership model, a municipality's population's need for a car can consequently only be changed by moving the municipality to a different class, which is a very coarse method.

The model uses a variable that represents the probability of a car owner owning more than one car. There are strong linkages between households with more than one car, and primarily the parameters of two adults in the household, especially gainfully employed, and whether the household already has a company car at its disposal. There are also strong linkages between car ownership and accessibility, and a second car in the household is more unusual in areas with good accessibility, such as large towns. Examples of factors that change (increase) the need for a car that the model can not calculate either, are a greater number of leisure houses owned by a municipality's population, and the development of outlying areas of the municipality.[325]

[324] Matstoms (2002)
[325] Han (2001)

The shortcomings of the car ownership model are largely that it is not highly appropriate for analysing policy measures, i.e. general changes in costs, laws and regulations. The dynamics of individuals' car ownership, for example changes in taste and valuation, can not be captured in this type of model, either. One example is the fall in car ownership among young people during the 1990s, especially in the big towns and cities.

The only controllable variable in the car ownership model is the price of petrol. The model does not directly consider accessibility to public transport, the standard of public transport or the road network or direct operating costs for owning and driving a car.[326] [327] Many of the shortcomings that have been found in the model interact to overestimate car ownership in the Stockholm area. Examples include the division into areas, the disposition to enter, the effect of public transport, and the fact that an assumed saturation level of car ownership is not taken into account.[328]

Validation

Generally speaking the Sampers modelling system is well documented and internally validated.[329] The internal validation showed that Sampers is able to reproduce tolerably well the journeys in the national travel surveys (Riks-RVU and others) upon which the estimation of the coefficients in the model are based. It is, however, the total volumes that turn out well. Large discrepancies occur at different disaggregated levels, for example trips by different modes, different trip purposes, or different socioeconomic groups.

The old modelling system (the second generation, the IC and IR models) was tested in a research project on travel forecasts and the real results. It was the intention to validate the models in connection with the development of Sampers by means of passenger censuses on the Svealand line, before with the bus services in 1997 and after with the train services in 1998, and comparisons with demand forecasts for the same route, for the real supply and for the same times.[330] Transek's own passenger census on a Thursday in May both years gave at the time 480% more passengers in 1998 than in 1997. By way of comparison, Trafik i Mälardalen (TiM) held their own census over some Tuesday to

[326] Han (2001)
[327] Beser, Eliasson, Karlström, Mattsson and Rosenlind (1996)
[328] Matstoms (2002), p. 92
[329] Documentation is available free of charge from SIKA
[330] Modell och verklighet. Svealandsbanan, *Model and reality, the Svealand line*. (1997-98)

Thursday periods in February 1998, in which the increase was 330%.[331] The increase calculated in the model in the forecast project, using the old IC and IR models, amounted to 230% more journeys by train in 1998 than by bus the year before. With the same prerequisites, the result using Sampers was 270% more passengers.[332] It should however be pointed out that the demand calculated in the model is for a mean weekday, i.e. an average for a weekday over the whole year, whereas the passenger censuses are for a weekday during term time.

For the regional models the internal calibration shows that Sampers overestimates the total regional travel by train in the country as a whole by 10% compared to the national travel survey. For the Mälaren valley model, on the other hand, it underestimates the number of regional train journeys by 6%, and the number of long regional journeys, more than 50 km regardless of mode, by 19%.[333] Travel by train is mainly underestimated on the borderline between regional and interregional journeys, i.e. distances of around 100 km. There is therefore reason to suspect that Sampers' regional model consistently underestimates regional travel by train in the Mälaren valley. SIKA have confirmed that Sampers underestimated the demand for train journeys on the Svealand line by about 20% compared to the real increase in travel when the train services took over from the bus.[334] The manifestly greater demand for train journeys in the Mälaren valley is hidden in the national average in the common regional model, despite calibration, and the model is also estimated on the basis of a travel survey which was for the most part carried out before the Svealand line and similar investments had been implemented.

The scope of the external validation of Sampers can also be questioned. In an external validation the calculated passenger flows are compared to real counts, but they are not the same counts to which the model is designed in order to be able to compare the model with real results. Sampers has not undergone any form of systematic external validation of the same calibre as the internal validation. No comparison has been made, for example, of the results against regional public transport traffic counts. Inadequate external validation is the same as an incomplete quality inspection.

At an earlier stage (2000) SIKA emphasised that uncertainties and problems remain in the regional models, principally in the regional model for Stockholm (the Mälaren valley). The models gave less than

[331] En undersökning av TiM, *A survey of TiM* (1998)
[332] Letter from Staffan Widlert (4 July 2000)
[333] Sampers technical documentation (2001) (without secondary destination)
[334] Letter from Staffan Widlert (4 July 2000)

credible results as regards the distribution between bus and Underground, train journey price elasticity, and sensitivity to economic development. SIKA have, though, pointed out that the external validation of the national model using back casting for the demand for journeys by train between Stockholm and Göteborg gave satisfactory results.[335]

There is thus good reason to develop the validation methodology. Lundqvist and Mattsson (2001) present a four-part scheme for validating forecasting models: [336]

- Practical validation. System design and scope of application. How does the system function in the environment for which it is intended? Can the system be used without the risk of error?
- Theoretical validation. What is the system's theoretical foundation? Do the causal relationships function?
- Internal validation. How well does the model reproduce the data on which it has been estimated? Are the parameters statistically significant?
- External validation. How well can the model reproduce independent data (not used in the development or calibration of the model)? How well can the model forecast both previous years' results and future development?

Calibration

External validation comprises a (longish) period of checking that a forecast agrees with the real results. Calibration, on the other hand, is done against real traffic flows at a single point in time to align the model to prevailing conditions and thus improve the prerequisites for generating a realistic forecast. Calibration can thus to some degree compensate some of the model's shortcomings.

Calibration is done when the model is implemented, and subsequently only at certain times and not every time a forecast is generated. With regard to regional train journeys the model was calibrated at the outset with fairly large values to adjust the results. The values were different for the different regions.[337]

Conclusions

The development of Sampers shows not only that validation is important, but also that the methodology and the modelling system are in need of further development. The prerequisites changed during the course of the work, not least as regards the world around and peoples'

[335] Letter from Staffan Widlert (4 July 2000)
[336] Lundqvist and Mattsson (2001), p. 9
[337] Sampers technical documentation (2001)

valuations, which means that the model is in need of modernisation and further development.

The Sampers modelling system has several shortcomings that mean that the results in some cases should be regarded as very uncertain. This applies in particular to segments of the total travel markets, while forecasts of total travel have improved. One segment identified as having inadequate prerequisites for a true forecast is long regional journeys, especially commuting to work and business trips by train in the Mälaren valley. One cause of this is that the estimation of the model as regards regional train journeys was made on the basis of a minimum of data before the market effects that high speed regional train services give had materialised. There is also a good deal of uncertainty, for example as to whether linear logit models can in fact satisfactorily estimate demand where supply changes are substantial, and concerning the use mean times in the route choice model, and the car ownership model. Due to inadequate external validation the model has nonetheless been accepted.

The route choice and car ownership models were not primarily developed for forecasting public transport, but car traffic. With the approach chosen, with a mean time model in regional transportation fast, but not so frequent services will appear in the model to be not as good as passengers with timetables probably think, and not as good as those a real time model would arrive at. The interfaces between the regional and national models are to the disadvantage of long regional journeys by train, and the division into various track-bound travel modes (intercity trains and the X 2000 in the national model, tram and Underground as bus in the regional models) does not function well, either.

Where the forecast period is longer, various background factors are crucial for the results. Economic development has a substantial effect on the total demand, as do transportation policy and other overarching parameters. Long-term forecasts are therefore always uncertain. One way of handling uncertainty about the future is to pinpoint the most probable development with "minimum" and "maximum" forecasts, i.e. with a certain estimated probability development will take place within that interval. Unfortunately, this is perhaps done too seldom, because a broad interval is difficult for decision-makers to handle. There are also practical problems in that the forecasts require much more work, and the amounts of work and computer time are already extensive today.

The problem of forecasts' uncertainty, however, is a general one and not specific to Sampers. It reflects the fact that minor supply changes are easier to handle than trip generation and total travel. Forecast results as a rule control investment decisions and policy measures, and are therefore to a certain degree self-fulfilling, regardless of whether they

were “right” or “wrong” to begin with. A model, however, can never be perfect or show an ideal state; it is impossible to make a model of reality without simplifications, rationalisations and random errors. More serious, though, is the fact that the model has not to a satisfactory extent been subjected to a full quality inspection by means of external validation. Forecasts of future train travel that are clearly erroneous and underestimated have thus come to be regarded as true and correct.

The references are included in chapter 10.

8. Technical report from the accessibility study

The Sampers accessibility study technical report is not translated to English, and published in the Swedish edition only. Please contact the author when required.

9. Real travelling times of the typical journeys

Typical journey 1: Torshälla (748406)–Kungens kurva (710363)

(hr:mins)	*Car*	*Bus*		*HS train, the Svealand line*	
Walk			0:05		0:05
Waiting time			0:05		0:05
In-vehicle time		Bus 1/2	0:19	Bus 102	0:24
Walk		Fristadstorget-Eskilstuna C	0:05		0:00
Waiting time		Eskilstuna C	0:15	Eskilstuna C	0:15
In-vehicle time	1:24	SJ Bus	1:15	SJ Train	0:49
Before motor-way	0:05				
Waiting time		Södertälje hamn	0:08		0:00
In-vehicle time		Commuter train	0:17		0:00
Waiting time		Flemingsberg	0:15	Flemingsberg	0:15
In-vehicle time		SL Bus 740	0:27	SL Bus 740	0:27
Walk			0:05		0:05
Total	*1:29*		*3:16*		*2:25*
Sampers	1:29		0:31+2:58		0:31+1:58

Typical journey 2: Eskilstuna, centre (748484)–Stockholm city (718220)

	Car	*Bus*		*HS train, the Svealand line*	
Walk			0:05		0:05
Waiting time			0:05		0:05
In-vehicle time	1:37	SJ Bus	2:10	SJ Train	1:02
Before motorway	0:05				
Walk		Cityterm.	0:12	Stockholm C	0:10
Total	*1:42*		*2:32*		*1:22*
Sampers	1:42		03:13		02:19

Typical journey 3: Strängnäs (748602)–KTH, centre of Stockholm (718234)

	Car	*Bus*		*HS train, the Svealand line*	
Walk			0:05		0:05
Waiting time		Strängnäs	0:05	Strängnäs station	0:05
In-vehicle time	1:25	SJ Bus	1:30	SJ Train	0:49
Walk		City terminal	0:07	Stockholm C	0:05
Waiting time		T-centralen	0:03	T-centralen	0:03
In-vehicle time		Underground	0:05	Underground	0:05
Walk			0:07		0:07
Total	*1:25*		*2:02*		*1:19*
Sampers	1:25		3:25		2:21

Typical journey 4: Mariefred (748607)–AstraZeneca, Södertälje (712870)

	Car	*Bus (byte)*		*Bus (direkt)*		*HS train, the Svealand line*	
Walk			0:05		0:05		0:05
Waiting time		Mariefred	0:05	Mariefred	0:05	Mariefred	0:05
In-vehicle time		LT Bus 40	0:11			LT Bus 307	0:11
Waiting time		Läggesta	0:02			Läggesta	0:05
In-vehicle time	0:33	SJ Bus	0:30	LT Bus 340	0:55	SJ Train	0:16
Waiting time		Södertälje hamn	0:15			Södertälje syd	0:14
In-vehicle time		SL Bus 754	0:17			SL Bus 755	0:26
Walk			0:05		0:05		0:05
Total	*0:33*		*1:30*		*1:10*		*1:27*
Sampers	0:33		01:48		1:48		01:40

Typical journey 5: Åkers styckebruk (748611)–The Mälar Hospital, Eskilstuna (748452)

	Car	*Bus*		*HS train, the Svealand line*		*Train, new stop*	
Walk			0:05		0:05		0:05
Waiting time		Åker	0:05	Åker	0:05	Åker	0:05
In-vehicle time		LT Bus 40	0:25	LT Bus 306	0:10	LT Bus 306	0:10
Waiting time		Strängnäs	0:05	Läggesta	0:13	Läggesta	0:13
In-vehicle time	0:25	LT Bus 20	0:40	SJ Train	0:24	Train	0:23
Before motorway	0:05						
Waiting time				Eskilst. C	0:10		
In-vehicle time					0:13		
Walk		Mälar Hospital	0:05	Mälar Hospital	0:05	Mälar Hospital	0:05
Total	*0:30*		*1:25*		*1:25*		*1:01*
Sampers	0:30		2:30		2:30		

Typical journey 6: Nykvarn (718149)–Terminal 5, Arlanda airport (719136)

	Car	*SL*		*Bus (SJ)*		*HS train, the Svealand line*	
Walk			0:05		0:05		0:05
Waiting time		Nykvarn	0:05	Nykvarn	0:05	Nykvarn	0:05
In-vehicle time	1:33	SL Bus 780	0:25	SJ Bus	1:10	SJ Train	0:55
Waiting time		Södertälje centrum	0:06				
In-vehicle time		Commuter train	1:20				
Waiting time		Märsta	0:07	City terminal	0:05		
In-vehicle time		SL Bus 583	0:16	Airport coach	0:40		
Walk		Termin. 5	0:05	Terminal 5	0:05	Arlanda Central	0:07
Total	*1:33*		*2:29*		*2:10*		*1:12*
Sampers	1:33		3:01		3:01		2:11