Railway Group KTH
Transportation and Logistic

Efficient train systems for freight transport

A systems study

Principal Report

Summary
and
Chapter 1-3

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Royal Institute of Technology
Stockholm 2005

Report 0505

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Foreword

Efficient train systems for freight transport is an interdisciplinary that was conducted by ”Railway group KTH” at the Royal Institute of Technology, and financed by the Swedish National Rail Administration, the Swedish Transport and Communication Board, the Swedish Agency for Innovation Systems, the Swedish State Railways, and Green Cargo. The major part of the study was conducted from 2002-2004. One of the points of departure in the present project is the report ”Järnvägens utvecklingsmöjligheter på den framtida godstransportmarknaden” (The Railways' Development Prospects in a uture Freight Transportation Market) that was published in 2000.

The project was conducted as an interdisciplinary project, principally involving senior researchers from different departments at the Royal Institute and also a number of outside experts. The project manager was Associate Professor Bo-Lennart Nelldal at the Division of Transportation and Logistics, who also wrote this principal report. A great many partial reports have been published during the course of the project. A list of these can be found on page 5. The partial reports were written by the sub-project managers, as detailed below.

Sub-project manager for wagonload and unit trains was D.Eng. Peter Bark at the Transport Research Institute (TFK), for intermodal traffic Professor Evert Andersson at the Division of Railway Technology, and for express freight trains doctoral candidate Gerhard Troche at the Division of Transportation and Logistics.

Sub-project manager for duo locomotives was Professor Stefan Östlund at the Division of Electrical Machines and Power Electronics, for running gear doctoral candidate Per-Anders Jönsson at the Division of Railway Technology, for lightweight designs lecturer Per Wennhage at the Division of Lightweight Structures, for noise and vibration D.Eng. Ulf Carlsson at the Marcus Wallenberg Laboratory (MWL) and for infrastructure and bridges Professor Håkan Sundqvist and D.Eng. Gerhard James at the Division of Structural Design and Bridges. Rune Bergstedt at the Division of Railway Technology was subproject manager for automatic couplings, braking systems, remote-controlled locomotives and intelligent information systems.

M.Eng Jakob Wajsman, Green Cargo/Banverket, contributed market analyses and forecasts. Peter Bark, TFK, also contributed market analyses and analyses of terminal technology and load carriers for intermodal traffic. Lars-G. Ahlstedt of European Rail Consulting contributed analyses of industrial siding and transport concepts.

The project was monitored by a reference group consisting of Alf Ekström, Banverket; Peder Wadman, Banverket/The Association of Swedish Train Operators; Björn Bryne, Green Cargo; Peeter Puusepp, The Association of Swedish Train Operators; Sven-Olov Nehrer, TGOJ Trafik; Kenneth Ramberg, The Confederation of Swedish Enterprise; Olle Ek, Bombardier, Catharina Lindahl, Traintech; Lennart Sparring, Green Cargo and Börge Eliasson, Green Cargo.

Stockholm, April 2005

Bo-Lennart Nelldal

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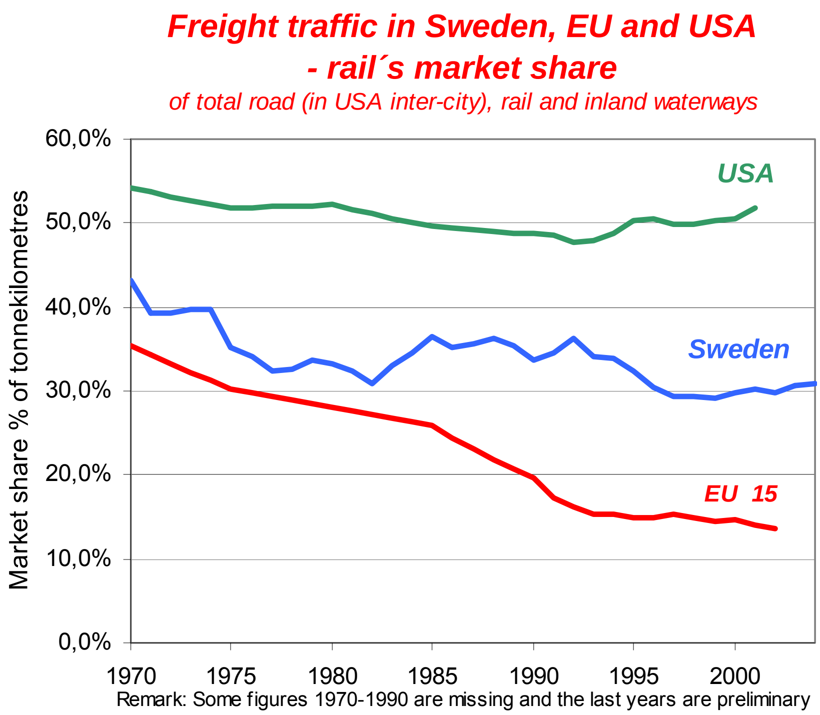
Summary

The railways in Europe have lost market shares in an expanding market – almost all the increase has gone to road haulage. This is true of both high-value freight and low-value freight. The railways' position is especially weak when it comes to international traffic, despite the long distances and substantial volumes. This is a result of bureaucracy and high track access charges, that make it difficult to control the whole transport chain and guarantee the customers adequate quality at competitive prices.

The European Union has proposed a number of measures to deregulate the rail market but these have hitherto only been implemented to a limited extent. The most important measures needed are for infrastructure to be separated from operation, track access charges to be set on the basis of economic principles, and for all operators to be able to compete on the same terms in all countries without bureaucratic obstacles. What is most essential in the short term is for the railways to really be deregulated. This is primarily a question of politics and organisation, rather than a technical issue.



When this has been done, the railways must also develop products, traffic systems, and technology that permit higher levels of quality and lower transportation costs, and consequently a greater market share. This project has aimed to identify development potential in a long-term perspective. The point of departure was on the one hand the customers' requirements in different sub-markets and on the other the possibilities that exist to develop the supply both on the part of the railways themselves and in combination with other modes of transport.

Wagonload traffic constitutes the backbone of the railways' freight transportation systems today; wagonloads are complete wagons that the customers themselves load and unload on industrial sidings and at terminals. This is for reasons of transport economy – much more freight can be loaded on a railway wagon or truck than in an equivalent number of containers. There exists a great potential for reducing trade and industry's transportation costs by developing wagonload traffic.

With higher loads, i.e. 25-30 tons compared to today's 22.5 tons, the load capacity per wagon can be raised from 30 to 34-38 tons, which means a reduction in transportation costs of 10-20%. A higher loading gauge is also important for volume freight and may lead to even larger cost reductions. However, this will require the infrastructure to be upgraded. Wagons with better suspension may mean that only limited investments in track are needed and may also reduce the damage caused to freight. Industrial sidings are crucial, since they mean that customers avoid costly transhipping.

Table: Freight transport conditions in Sweden, Germany & the USA in 1996. Source: Statistics from Swedish State Railways (incl. northern ore line), German Rail (DB) and the Association of American Railroads (AAR).

	Sweden	*Germany*	*USA*
Average payload per train (tons)	490	332	2,624
Average hauling distance (km)	343	235	1,355
Average revenue per ton-km (SEK)	0.19	0.42	0.13
Maximum rail axle load (tons)	22.5	22.5	35
Maximum gross truck weight (tons)	60	40	36

The traffic system can be developed by operating liner traffic instead of node systems. The trains can pick up and drop wagons along the way and wagons are shunted between trains at a small number of marshalling yards in Europe. With a combined electric and diesel locomotive, a duo locomotive, the same locomotive can be used for shunting during the day and for long-haul traffic at night. The trains do not then need to change locomotives to enter a terminal. The principle is rather to have several locomotives that can be used flexibly both for feeder trains and long-haul trains and where several locomotives and trains can be coupled together if long, heavy trains are desired (Train Coupling Sharing, TCS).

Great development potential exists in information technology and automation. Intelligent wagons make up an intelligent train, that can monitor both wagons and load continuously. With remote-controlled automatic couplings, the train driver can shunt the wagons at the stations himself, and the wagons' speed can be controlled from a marshalling tower. In the long term, a high-capacity, high-quality, prioritised rail network adapted to freight traffic must be established in Europe, equipped with the pan-European signalling system ERTMS.

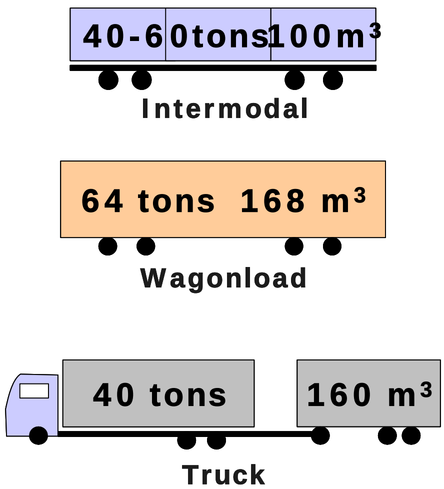


Figure: Comparison between a Swedish 24-metre truck with a gross weight of 60 tons, a wagonload with 22.5 tons axle load and a normal loading gauge, and an intermodal configuration with three 20-foot containers on a bogie.

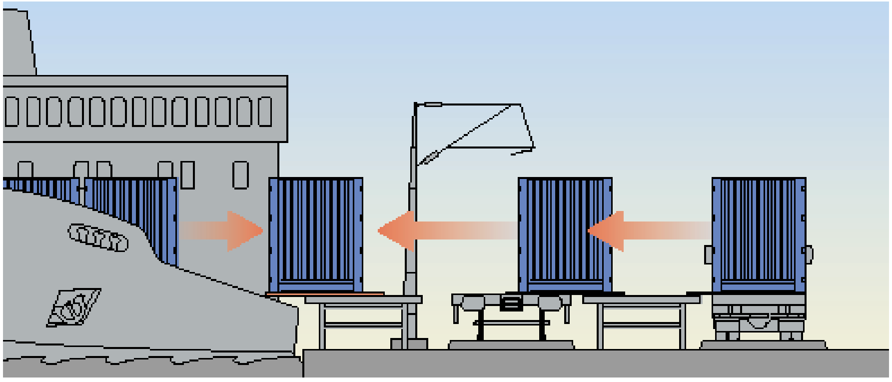


Figure: Example of a horizontal transfer system, the Swedish CarConTrain system (CCT). The system can transfer containers and swap-bodies of different widths and lengths between different modes of transport and to and from storage positions. The system can be fully automated.

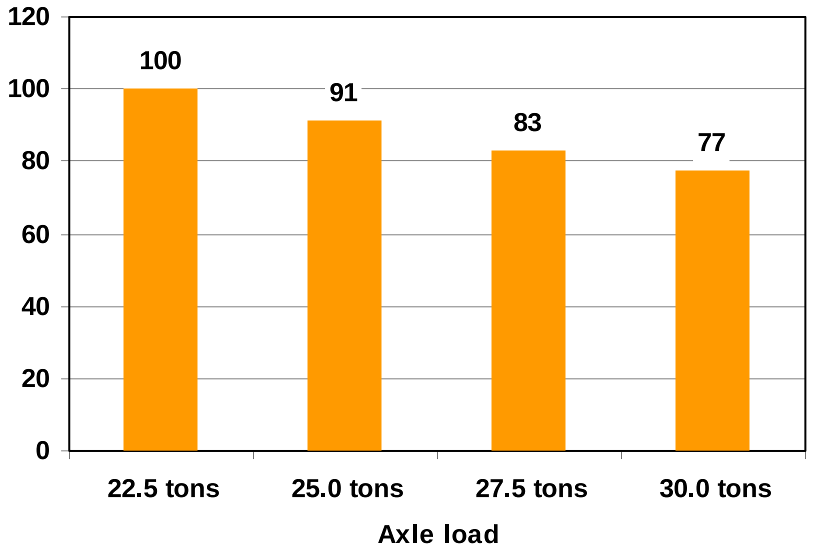


Figure: Transportation cost index for maximum permitted axle load 22.5, 25.0, 27.5 and 30 tons for heavy freight.. Two fully loaded covered bogies between Helsingborg and Sundsvall.

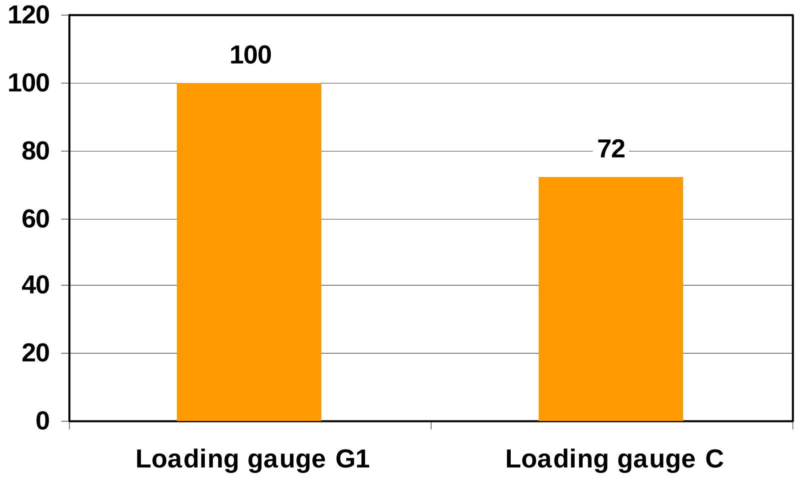


Figure: Transportation cost index with loading gauge G1 and loading gauge C for volume freight. Two fully loaded covered 2-axle wagons between Helsingborg and Sundsvall of 101 and 149 m^3 respectively.

Table: Capacity of Swedish truck and railway wagons of different configurations

Vehicle	*Max. axle load*	*Loading gauge*	*Capacity*	*Max. volume*	*Capacity*	*Max. volume*
Truck in Sweden			40 tons	160 m^3	40 tons	160 m^3
Truck in the EU			26 tons	100 m^3	26 tons	100 m^3
Railway wagons			*2-axle wagons*		*4-axle wagons*	
	22,5 tons	G1 (EU)	30 tons	108 m^3	64 tons	168 m^3
	25,0 tons	G1 (EU)	34 tons	122 m^3	72 tons	189 m^3
	27,5 tons	G1 (EU)	38 tons	135 m^3	81 tons	200 m^3
	25,0 tons	C (S)	33 tons	164 m^3	71 tons	251 m^3
	27,5 tons	C (S)	40 tons	204 m^3	81 tons	281 m^3
	30,0 tons	C (S)	42 tons	209 m^3	88 tons	310 m^3

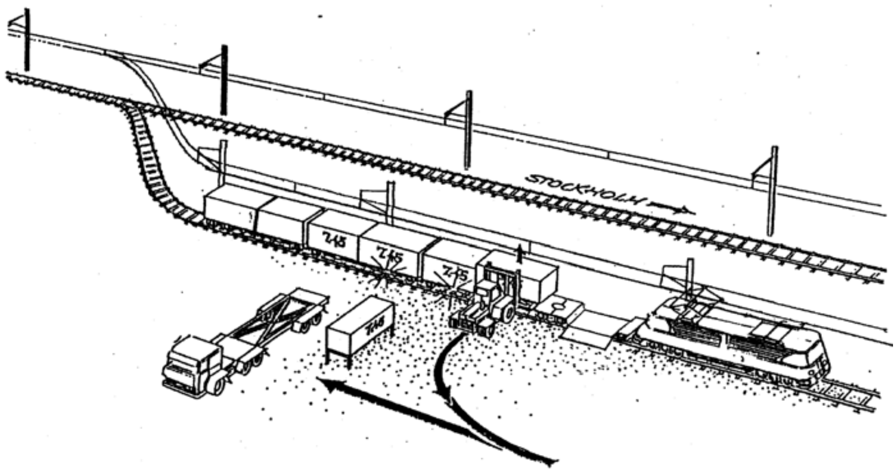


Figure: In the "Light Combi" system, terminals may be situated at sidings directly accessible from the main line. Loading and unloading are performed under live catenary using a fork lift truck. The fork lift can be carried on the train and is operated by the train driver.

Today's intermodal traffic with trailers, heavy containers, and swap-bodies, requires large terminals, which are very costly. This means a small number of large terminals with relatively high costs for transhipping, and feeder distances that tend to be long, and the market is limited to relatively long distances between termini. Large-scale systems are very well developed in the USA, with for example long trains and Double-Stack containers. They function in roughly the same way as a container ship on land, and are efficient for long distances and large volumes. Intermodal traffic's main problem in Europe is that it has difficulty competing over short distances, which is where the large volumes are.

Liner train traffic, which means that the train follows a route and stops at several places along the way, makes it possible to reach a larger market. With simple terminals on a through-siding, the train can drive in and load and unload during a short stop. The Light Combi (LC) system uses containers and swap-bodies with a maximum weight of 24 tons and a maximum length of 11 metres, which means that normal forklifts can be used. Light Combi can be competitive over distances of 200-400 km, and conventional intermodal traffic, Heavy Combi, can be concentrated to the large terminals and logistics centres. A fully automated system for loading and unloading can be developed – prototypes already exist (the CCT system), Express freight trains for mail, parcels, and express freight use the passenger train network and can both interoperate with and compete with air services. Today, a large proportion of air freight is transported by truck in Europe. Rail connections for passenger traffic are being built at many airports, but it is important that rail freight connections are also planned. Multiple units can be developed for freight that are just as fast as high-speed trains and the railways could really be “faster than by road – cheaper than by air”.

It is important to establish long-term development projects. The operators can not be expected to be able to afford to run such projects themselves; joint action is required from the member states of the European Union. In the short term, closures of industrial sidings should stop. The number of industrial sidings is falling rapidly in many countries at the same time as many new operators are asking for industrial sidings. A prioritised European freight network must be established, first organisationally through free access and reasonable track access charges, and then in the engineering perspective through high capacity and interoperability. Demonstration projects need to be set up to develop new products.

In the long term, new technology and new traffic systems must be developed, which include the following components:

- Duo locomotives, continued technical development and construction of a prototype
- Automatic terminal technology for horizontal transfer, development of prototype
- Intelligent information technology for controlling and planning freight trains
- Electronically controlled brakes and robust technology for the intelligent freight train
- Introduction of automatic coupling, evaluation of effect on costs and market in Europe
- Remote-controlled automatic coupling, demonstration project
- Development of light materials to reduce noise and vibration and increase payload
- More cost-effective infrastructure, covering everything from bridges to industrial sidings.

Forecasts for rail traffic in Sweden show that if nothing is done, the railway’s market share will continue to fall, from 24% in 2002 to 22% in 2020. When international traffic has been fully deregulated, and with regional operators who can offer customers good service, and a 30-ton axle load, the railways’ market share will increase to 31%. If new, efficient train systems are developed as described above, the railways' market share will have increased to 35% by 2020.

An increase to 35% may seem a very large one, but it also assumes a paradigm shift. A comparison with road haulage shows an increase from 25% to 35% in just 11 years from 1985 to 1996. If railways' market share increases to 35%, long-distance truck haulage will fall by 23%, compared with if nothing is done. At the same time as industry’s transport costs will be reduced as a result of greater efficiency in the railway’s transport system, the environment will be subjected to less strain, and better prerequisites will be created for long-term sustainable development.

Introduction

Background

In recent decades the railways have been losing market share in the freight transport market both in Europe and in Sweden, despite a rapid increase in volume. This is true both of the traditional market for low-value freight where price competition is stiff, and of the rapidly growing market for high-value freight, where the railways have not been able to offer sufficiently high quality. This is partly because the railways have not been efficient and customer-oriented enough, and partly because the railway’s technical development as a transportation system has lagged behind. At the same time, significant improvement potential exists as regards organisation, technology, and traffic systems.

The Railway Group KTH is an interdisciplinary group that tries to combine the economic perspective, where costs are set against customer benefit and revenues, with a system view of the railways where technology meets the market. The train system can both compete and interoperate with other modes of transport and it is important to try to define where the train’s future market lies with regard to the possibilities that exist for development. Freight transport must also be viewed in an international perspective with Europe as its base.

The Railway Group has already conducted a corresponding project for passenger transport, where the aim was to achieve “rail transport at half the price”. This involves on the one hand reducing costs and thus the price to the customer, and on the other raising the level of quality and thus the value to the customer and revenues. This aim was also achieved, and some of the results are beginning to be seen in the market, while others are still the object of continued R&D and may be realised at some later date.

The same aim, “Rail transport at half the price” also applies to efficient train systems for freight transport. It is partly a question of reducing the cost, and thereby the price, of transporting more low-value freight, and partly of raising the level of quality so that rail can also become an attractive alternative for more high-value freight. In many cases, both are needed. This can only be achieved through an interdisciplinary project and a system view where technology, economics and market meet.

Purpose and delimitation

The purpose of the study is

- To describe how future rail freight transport systems can be designed taking into consideration the railways’ development potential, the market, and the customers’ requirements and values
- To identify the critical factors on the basis of sub-markets and the railways’ possible future performance on the basis of available technology and how it can be used in different products
- To evaluate the future products in a business economics perspective on the basis of different sub-markets and customers' requirements
- To study inertia and adaptation mechanisms in the market and the environmental aspects
- To define strategically important factors that should be the object of continued R&D.

The study is primarily limited to long-haul freight transport in Sweden, where international traffic in Europe constitutes one of the important foundations. An international perspective is applied as regards technological development, where the USA is an important reference. The study is focused on the railway system, but other modes of transport are also taken up where they are used in combination with rail.

Method description

The following method is used in the preliminary stages of the study.

The demand side is analysed with regard to different types of goods/levels of processing and their characteristics that are then aggregated to different sub-markets with similar requirements as regards transport supply.

The supply side is analysed on the basis of different products and production systems, where possible developments in technology and traffic are analysed using the supply and cost model.

An evaluation of future products is made in a business economics perspective where the railways' future market is defined on the basis of a competition and interoperation perspective.

The demand side is analysed in the following steps:

A description of the transport market’s structure and development taking into consideration scope and extent, transportation distances, degree of processing, consignment sizes, transportation cost etc.

Analyses of different types of goods, the requirements of different degrees of processing with regard to properties such as weight, volume, consignment size, geographical distribution, customer requirements, and the competitive situation.

Aggregation of types of goods with similar characteristics and customer requirements in order to define a least common denominator for different products and production systems.

The supply side is analysed in the following steps:

Identify the cost drivers for freight traffic for the railways' different products.

Identify deficiencies in the railways' supply for different sub-markets taking costs and quality into consideration.

Map existing, feasible technology and system development projects and their effect on the railways' performance and quality.

Optimise the future transport products and production systems for different markets.

The evaluation is made as follows

Evaluate the future products on the basis of a number of typical types of transport undertaking.

Analyse the market's adaptation mechanisms and the significance of the environmental issues.

Define the critical development factors and the need for continued research and concrete development projects.

The cost drivers will primarily be identified using the supply and cost models developed at the Division of Transportation and Logistics by Bo-Lennart Nelldal and Gerhard Troche.

The evaluation is made primarily in a business economics perspective both as regards the railways' finances and customers' valuation of the supply and their choice of mode of transport. Any problems and opportunities that exist with regard to development are also reviewed.

The aim is that the project will result partly in a number of concrete development proposals that can be pursued in the rail sector and industry and partly in a number of long-term research projects that can be pursued by The Railway Group KTH and at other universities.

The railways' market and competitiveness

The transportation market and the development of the railways

The structure of the market

The freight transportation market can be divided into different sub-markets depending on the nature of the transportation and the competitive situation. The categories in such a division are short-haul transportation, long-haul domestic and long-haul international transportation.

Short-haul is defined as transport assignments carried out over distances of less than 100 km. These are almost exclusively carried by trucks. Almost half of all short-haul transportation consists of construction material transportation and the other half is largely distribution. Rail and shipping do not have an infrastructure adapted to short-haul transports. Their share of such transportation is therefore insignificant. Rail and ships are in fact used over distances under 100 km, but here it is generally a question of special systems. On the other hand, rail transportation assignments of 100-200 km can sometimes compete in the general transportation market.

In both domestic and international long-haul traffic, certain transportation takes place in dedicated transportation systems where there is in practice no competition between different modes of transport. This type of transportation principally consists of ore and oil transports, both domestic and international, and transoceanic shipping.

The total freight transportation effort in Sweden in 2003, including international shipping along the Swedish coast, amounted to 91 billion ton-kilometres. Short-haul truck transportation, that does not compete with rail and shipping, accounted for slightly less than 10% of the transportation effort. The major portion of all transportation is thus long-distance. Long-distance domestic transportation accounts for about 50% and long-distance international transportation for about 40% of the total transportation effort in Sweden.

The development of the total transportation market

The development of the transportation effort is closely linked to economic development in society. The total domestic transportation effort thus increased very markedly during the post-war years, when the railways were also beginning to feel some competition from trucks for long-haul transportation.

This period can be roughly divided into the following phases:

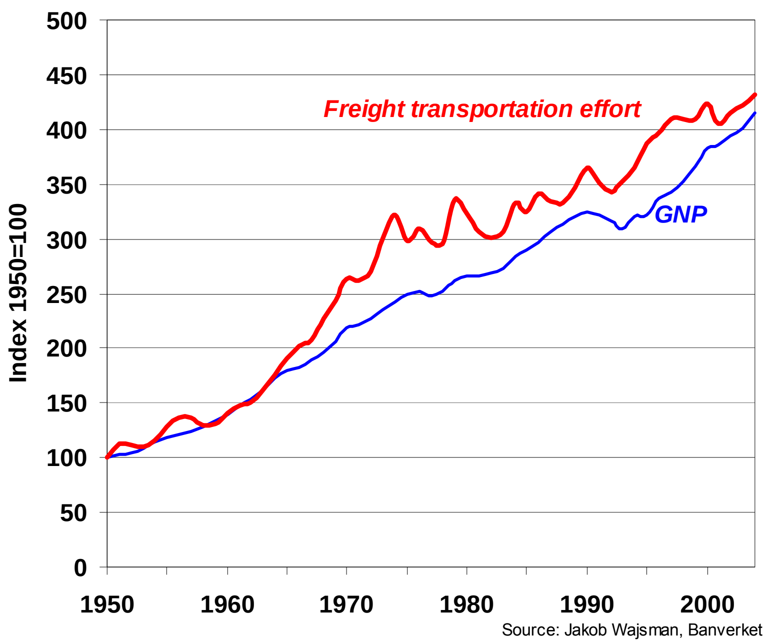
1950-1974: Rapid growth of the economy and the total transportation effort. Development was especially fast during the 1960s, when the transportation effort doubled. All modes of transport increased but road haulage increased fastest.

1974-1982: The energy crisis affects the economy that is characterised by large cyclical fluctuations and structural changes. The railways' market share remains constant.

1983-1990: Devaluations lead to growth of the economy and the total transportation effort. The service sector grows. The railways' market share remains constant.

1991-2003: The economic crisis reduces the transportation effort to begin with but the depreciation in the value of the Swedish krona and the development of the European Union leads to a steep increase in foreign trade and especially truck transportation. The railways' market share falls dramatically until 1996, before levelling out once again.

GNP and freight transportation effort 1950-2004



There are several factors behind the rapid development of the transportation effort. Economic growth has naturally been of fundamental importance. Structural change in industry has also been a significant factor. Production has been concentrated to fewer and larger facilities at the same time as the degree of specialisation has risen. the markets have expanded, partly as a result of the availability of cheaper, better transportation. This has also been a prerequisite for the increase in the international interchange of commodities that has become increasingly important also for domestic transportation. Distribution has been rationalised through the centralisation of warehouses, which has also increased the transportation effort.

Long-distance transportation over distances greater then 100 km have increased most in recent decades, while short-haul transportation has remained relatively unchanged since 1970. For both shipping and the railways, international transportation increased during the 1950s and 1960s and have remained relatively constant since then. International road haulage, on the other hand, has been increasing the whole time,

The railways' transportation effort more than doubled, from 8 billion ton-kilometres in 1950 to about 19 billion ton-kilometres in 1990 and has remained at that level all through the 1990s and up until today. Development was strongest during the 1960s, when iron ore and international transportation increased rapidly. This growth continued until 1974 but stagnated over the 1970s as a whole. The stagnation can largely be attributed to a fall in demand for products from the basic industries, principally iron ore but also steel and forest products.

Traffic policy measures in the form of investments etc effect the development of rail traffic in different ways. Parts of the rail network with little traffic have been closed. This has, though, not been of such great significance for the freight transport system. It is primarily passenger traffic that has been discontinued and many lines with some significant freight traffic have in fact been kept open as pure freight lines. A more serious problem for the future is that many industrial sidings have been closed and that new industrial estates have been located far from the mainline railway, with or without a rail connection.

The railways' technical development has meant that the supply has improved through higher speeds and axle weights and the introduction of intermodal freight traffic, express freight and direct trains. Operation has also been greatly rationalised by the introduction of centralised traffic control and other technical systems. This development primarily raises the quality of the supply and slows transportation cost increases in relations with a great deal of traffic and for customers with substantial, frequent goods flows. For other transportation. the railways' service level has not developed in the same way, especially compared to trucking.

Long-haul transportation by truck, i.e. distances greater than 100 km, has increased rapidly from about a billion ton-kilometres at the beginning of the 1950s to 31 billion ton-kilometres in 2003. International road haulage developed quickly, from 0.9 million tons in 1960 to about 29 million tons in 1999. The increase was especially great between 1960 and 1979 during which period the amount of freight increased tenfold.

The expansion of road haulage is due in part to the extension of the road network in combination with heavier, longer vehicles being permitted and in part to the fact that the haulage companies have been able to offer a consistent, high standard of transportation, thereby creating the prerequisites for new markets and production systems for trade and industry. Driving this development is thus a combination of traffic policy measures regarding the liberalisation of licensing, government investment primarily in the road network, and private investment, among other things in vehicles.

Shipping’s domestic transportation effort was approximately 2.5 billion ton-kilometres during the whole of the 1950s and the first half of the following decade. During the second half of the 1960s and the whole of the 1970s, shipping expanded and the transportation effort in 1999 totalled 8 billion ton-kilometres. This increase is due to an increase in oil transports as a result of a restructuring of the transports from international to domestic shipping in connection with the switch to domestic refining. Shipping’s domestic transportation effort remained largely unchanged during the 1980s.

Shipping’s total transportation effort can be wholly attributed to long-distance transportation. Shipping accounts for the bulk of international transports and the amount of freight transported almost tripled during the post-war years, from 28 million tons in 1950 to 72 million tons in 1990. The transportation effort for international shipping along the Swedish coast amounted to approximately 25 billion ton-kilometres in 2003. It is thus almost three times as great as domestic shipping’s transportation effort.

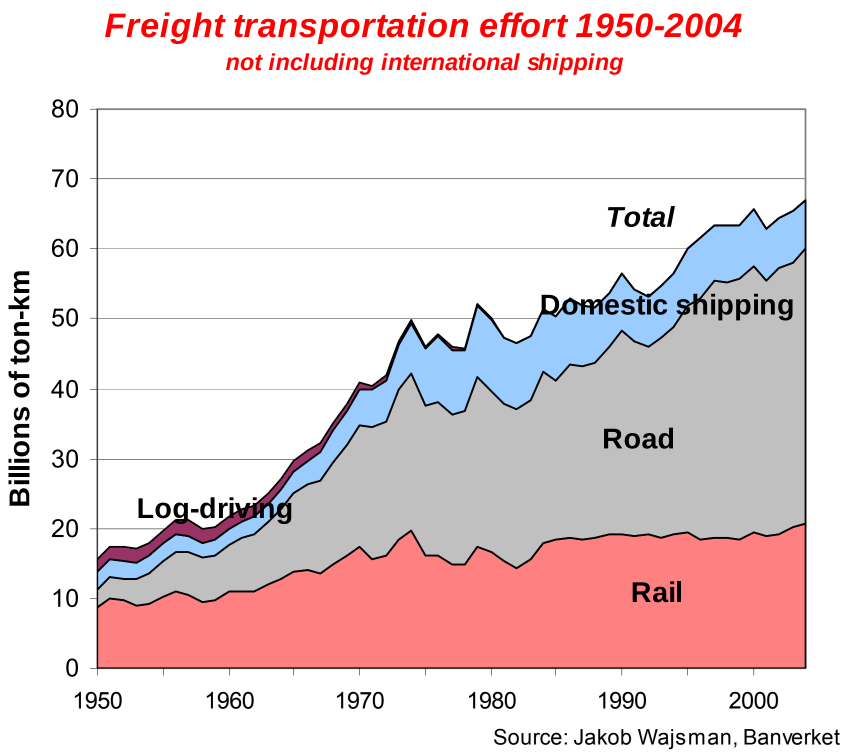


Figure: Freight transportation effort 1950-2004 (not including international shipping)

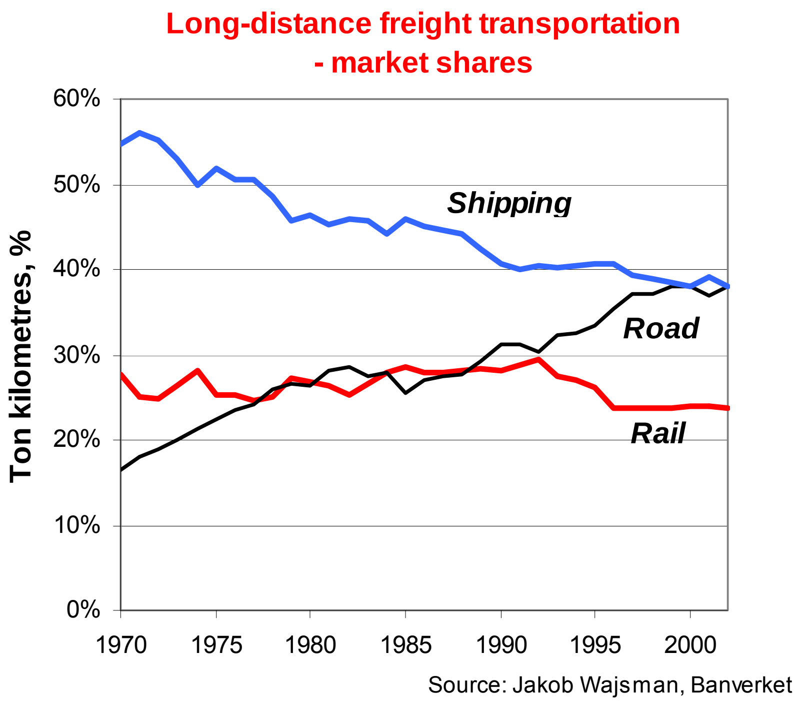


Figure: Market shares of long-distance freight transportation 1970-2004, including international shipping

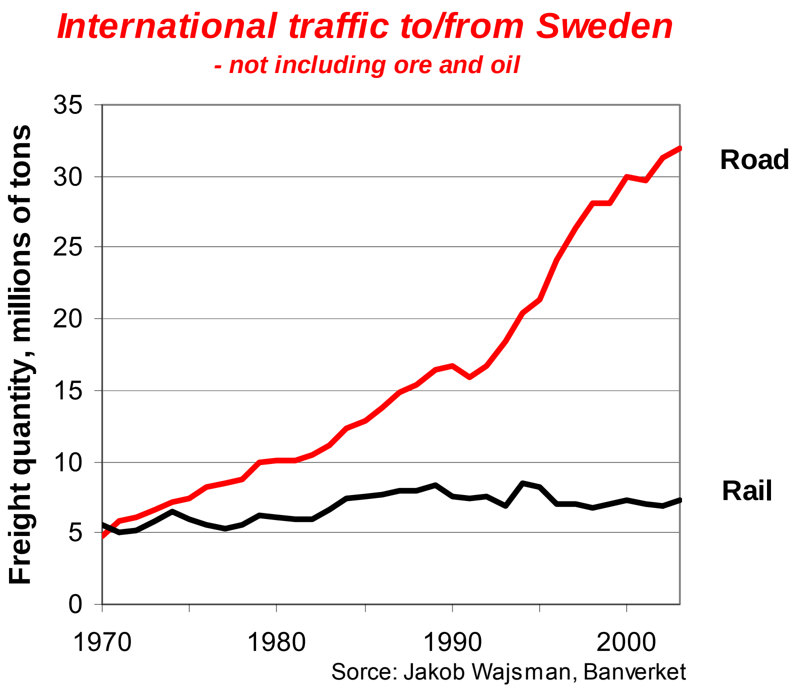


Figure: Development of international rail and truck transportation 1970-2004

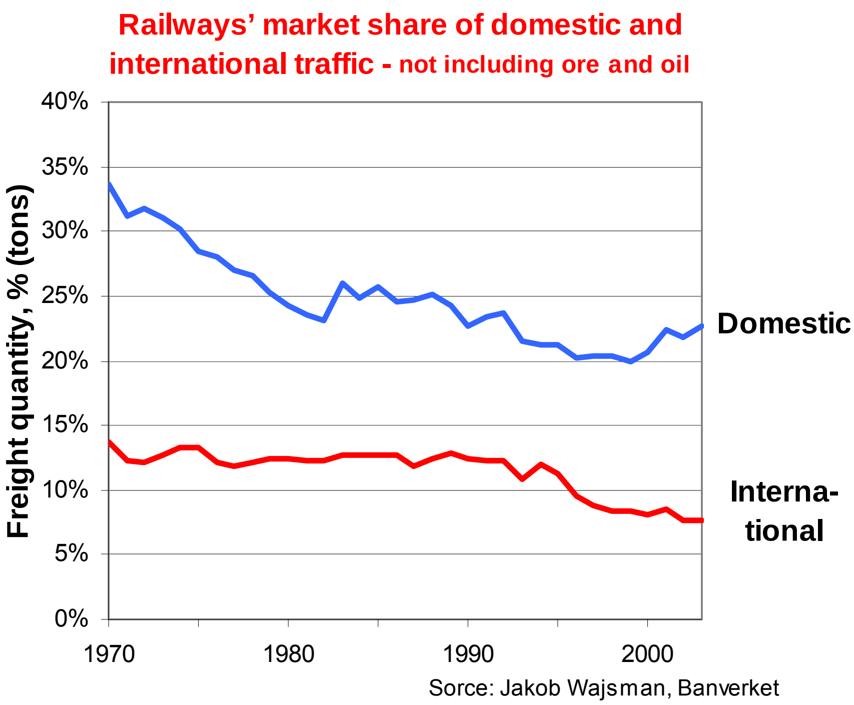


Figure: Development of the railways' market shares of domestic and international transportation 1970-2004

Development in different sub-markets

A summary of the development of transportation in the different sub-markets during the period from 1987 to 1997 shows that

- the transportation effort in the product market increased by 57% at the same time as the railways' market share of the freight fell dramatically

- the transportation effort in the basic market increased by 7% at the same time as the railways' market share fell somewhat
- the bulk freight transportation effort increased by 12% at the same time as the railways' market share fell somewhat

Table: Development of the railways' market share of different commodity groups 1987-1997

Commodity group	The railways' market share 1987	The railways' market share 1997	Total market, billions of ton-kilometre ton-kilometres, 1997	Development of total market index 1987-1997
Bulk freight	22%	20%	24	112
Basic market	33%	31%	34	107
Product market	26%	17%	22	157
Total	28%	24%	80	121

The railways have thus lost market shares in the high-value freight market, which is the fastest growing market. High-value freight has placed higher demands for transport quality and ”just-in-time”, where trucks often have an advantage today. At the same time, the railways have also lost market shares in low-value freight, where trucks have become much more efficient through their increased gross weight.

The higher gross weight for trucks was brought in when European axle/bogie weights were allowed to apply for long Swedish trucks while maintaining the length (and even increasing it to 25.25 m). An adaptation to the EU norm of 18 metres was discussed but did not materialise and was turned into an increase in gross weight. In addition, the kilometre tax on trucks was also abolished. naturally with the intention of improving industry’s possibilities as regards transportation.

The positive effect for industry’s transportation becomes quite clear when a normal 40-ton EU truck is compared to a Swedish 60-ton truck. The transport cost in Sweden is then approx. 30% lower per ton-kilometre.

The higher gross weight of Swedish trucks means that the ton-kilometre price in Sweden fell by approx. 20%, with the negative consequences for the Swedish railways listed below:

- The truck became more competitive compared to the railway for longer distances and for increasing freight volumes
- The market price of transportation fell, which also put rail transportation under pressure
- Both SJ’s and private operators’ profitability thereby deteriorated significantly.

This meant that despite the fact that SJ rationalised its freight traffic very extensively to achieve profitability, the company was unable to catch up.

That a shift in break-even point should affect the railways' market share so much is also due to the fact that the longer the distance, the smaller the volumes transported. The biggest volumes are thus in short-haul traffic. Even if longer distances give a greater transportation effort, transportation assignments over less than 500 km still only account for approximately 70% of the transportation effort for long-haul transportation (over 100 km).

Track access costs for the railways were introduced to try to the railways' competitiveness; a measure, however, that is based on a fair cost responsibility in the perspective of social economics. The introduction of higher axle loads, metre loads, and loading profiles is of greater importance both for trade and industry and for the railways. This would radically reduce trade and industry’s transport costs and increase the railways’ market share of heavy freight in the long term.

Development of the railways' products

Traditional wagonload traffic is still the foundation of the railways' transportation system and accounts for approximately 50% of the amount of freight in tons if the northern ore line is excluded. Wagonload traffic has been extensively rationalised and the number of industrial sidings has been gradually reduced from about 1,200 in 1990 to about 600 in 2000. The rationalisation effort has been going on the whole time, but was extremely fast during the 1990s when, among other things, the number of national marshalling yards was reduced from 30 to 3.

Some wagonload traffic has instead been turned into unit trains as volumes have risen. A number of completely new unit trains were also introduced during the 1990s. They are often part of the specialisation of industrial production. The freight volumes may be partly new freight, and partly freight that has been switched from shipping or truck transportation. The 1960s and the 1970s saw the end of almost all log driving and the transportation of felled trees was taken over by logging trucks or unit trains. These unit trains have partly been rationalised to a smaller number of terminals as a consequence of changes in felling tracts and more efficient truck transportation.

Intermodal traffic began in the 1960s. During the 1970s it began to expand, reaching 4-5 million tons at the end of the 1980s, at which level it has remained since. The increase in trucks’ gross weight in Sweden put intermodal traffic at a disadvantage compared to direct trucking. The rationalisation measures taken were necessary to meet falling prices in the transportation market and maintain profitability. A new, small-scale intermodal system, “Light Combi”, was introduced in 1998 but was discontinued in 2001.

Single consignment freight, that was once considerable on the railways, was discontinued in 1987, after several attempts at rationalisation. The so-called node system was introduced in the 1970s, with 30 terminals that were also located at the train formation points and single consignment traffic was partly containerised using standardised swap-bodies. The warehousing operations, however, are still maintained. A system called Cesam, where the freight was transported in mini-containers, saw the light of day briefly in the 1980s. It was discontinued in 1992. No regular single consignment service exists in Sweden today, other than that transported in intermodal traffic where the railways may be the subcontractor.

Until the mid-1990s, the railways carried considerable amounts of mail, both in the form of parcels in single consignment and wagonload traffic and letters in special mail handling compartments on passenger trains. Mail traffic has since been restructured and sorting on the trains has been replaced by automatic sorting at the terminals. A growing demand for late departure and early arrival has led to the introduction of special, fast (160 km/h) mail trains for second-class mail. This was made possible as a result of the expansion of the infrastructure.

Express freight has been transported on passenger trains for a long time. This was an example of a high-quality rail transport system, since it allowed consignments of up to a pallet in size and several tons in weight to be delivered to most places in Sweden. After being sold to different operators, express freight by rail ceased to exist at the beginning of the present decade.

An brief international survey

A comparison between development in Sweden, Europe, and the USA

In 1970, the railways in Europe (EU 15) had a market share of 31% of the total freight transportation effort measured in ton-kilometres. Road haulage accounted for 54% at that time and domestic shipping transported the remaining 15%. By 1995, the railways' market share had fallen to 15%, while that of road haulage had increased to 77% and shipping's share had fallen to 8%. Over the past 25 years, the railways' market share has been halved at the same time as the total freight transportation market has grown by almost 75%. This means that the railways have not been able to maintain the volume transported even in absolute measures.

Table: The railways' market share in Sweden, Europe, and the USA, Total transportation effort in ton-kilometres, international shipping and pipelines not included, short-haul road freight included (not included for USA). Source: ECMT and AAR statistics.

	1970	*1995*	*Development of total transportation effort* *Index 1970=100*
Sweden	43%	32%	150
Europe (EU 15)	31%	15%	173
USA	51%	49%	186

At 32%, Sweden's railways had the highest market share in Europe. The corresponding figure for road haulage was 55% and for domestic shipping 14%. Finland had the next highest market share with 27%. Sweden had the most efficient railways in Europe counted in traffic units per employee (ton-kilometres + passenger-kilometres per employee), with Finland once again in second place. The railways in France had a market share of 22% in 1995, in Germany 18%, and in England 7%.

The railways in the USA have a significantly higher market share than in Europe and Sweden. Their market share in 1995 was 49%, while road haulage had a market share of 33% (only long-distance) and domestic shipping 18%. The railways had roughly the same market share as in 1970, when it was 51%. The USA differs from Europe in that they have a large market with no national borders and that the railways are not owned by the government or any of the states. The freight railways are privately owned and run on business terms with normal profitability demands. The railways own and maintain their own infrastructure, which also defines their market. Trucks in the USA are often smaller than in Sweden at the same time as American railways have considerably bigger and heavier wagons and trains than in Europe.

Studying developments over the past few decades, we also find that the railways' market share has remained relatively unchanged in the USA. This has also been the case in Sweden and Finland, while it has been steadily falling in other European countries. In recent years, however, and especially after 1992, Swedish railways have seen a sharp decline in market share. Since 1988, road haulage has increased by approximately 10 billion ton-kilometres, while the railways have remained constant at approximately 19 billion ton-kilometres, which is where long-distance road haulage was in 1988. The whole increase has thus gone to road haulage. It is primarily international traffic that has increased, since this market has expanded fastest. In Sweden, the railways' market share of international traffic is only half the market share they have of domestic traffic, despite the fact that distances are longer and the trucks are shorter (18.75 m).

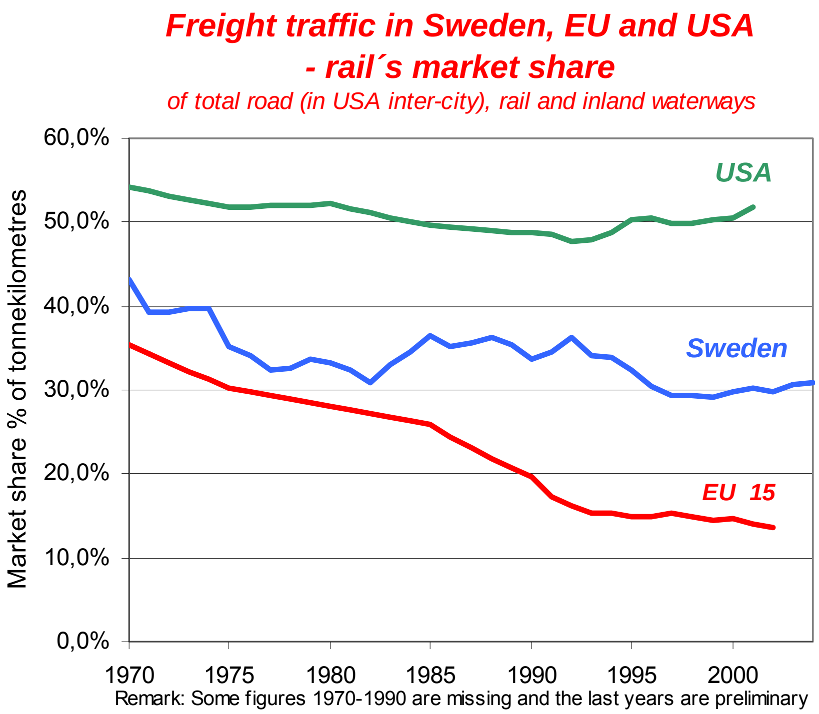


Figure: Development of the railways' market share in Sweden, Europe, and the USA,

The picture in Sweden is largely due to the introduction of heavier trucks. The development in international traffic is due to the deregulation of road haulage and the railways in Europe. The deregulation of road haulage has meant that rules governing the allocation of quotas etc have been abolished and that foreign haulage companies can compete for transportation assignments to and from Sweden. This has led to both an increase in capacity and downward pressure on prices in the marketplace.

The deregulation of the railways in Europe, often with infrastructure separated from traffic, has brought about a rationalisation and restructuring process in the companies responsible for their operation. In a first stage, this has meant that the railways have concentrated more on their own problems with transportation assignments than on solving others' transport problems. In order to improve profitability quickly, they have also tried to raise their prices for foreign railways' transportation. Infrastructure charges in Germany are also very high.
At the same time as road haulage has become more efficient, it has become more expensive to transport freight by rail, which has meant that international traffic has not developed as positively as before. Quality, which was not good even previously, has not improved either, apart from a few individual flows where a railway company has managed to gain control of the whole flow. The biggest problem is that the rail freight companies find it difficult to guarantee transportation times.

In order to understand how the present situation arose, we must compare the railways prerequisites in the different countries as regards organization and performance (see the figure).

In the USA, the railways are private enterprises, make a profit, and are operated in a very businesslike manner. They combine large-scale and small-scale traffic and their technical performance level is far above that of European lines. At the same time, wagonload freight accounts for a large share of the traffic, and has a well-developed infrastructure that includes industrial sidings comparable to what we had in Sweden in the 1960s.

Table: Freight transport conditions in Sweden, Germany & the USA in 1996. Source: Statistics from Swedish State Railways (incl. northern ore line), German Rail (DB) and the Association of American Railroads (AAR).

	Sweden	*Germany*	*USA*
Average payload per train (tons)	490	332	2624
Average hauling distance (km)	343	235	1355
Average revenue per ton-km (SEK)	0.19	0.42	0.13
Max. rail axle load (tons)	22.5	22.5	35
Max. gross truck weight (tons)	60	40	36

The railways in Sweden have rationalised extensively and though they are the most efficient in Europe, performance-wise they lag far behind the USA as regards axle load and volume. Compared to the rest of Europe, they are very customer-oriented and business-like, but are still a step behind the best railways in the USA and road haulage companies in Sweden. Sweden also has the heaviest trucks in Europe and the industrial sidings that once existed are slowly but surely disappearing one after the other.

In Germany, the railways have been converted into an independent subsidiary company, but to a large extent still have the character of a state-controlled enterprise, even though this is changing and the railways are becoming more customer-oriented and business-like. The technical standard is relatively good, even if much of the old infrastructure, for example track and signalling systems, is still in use. Germany is well ahead as regards development of new technology for freight transportation and many projects are also tried out in practical operation.

The problems that occur with international rail transportation in Europe are largely due to the railway companies' inability to cooperate with each other in an efficient manner. A railway freight haul between Sweden and Spain requires the involvement of six different railway companies. A transport agent in Sweden has to contact colleagues in Denmark, Germany, Belgium, France, and Spain to discuss rates and conditions before he can give his customer a price. A road haulage contractor can very often work out the cost in his head and give the customer a price straightaway.

We can compare Europe and the USA by laying Union Pacific's rail network over Europe – it covers almost the whole of Europe and the main line from Chicago to San Francisco is about the same length as from Stockholm to Seville. Even the railways in the USA often need to cooperate with each other, however, but such cooperation is generally on business-like terms without any negative effects for the customer. Feeder lines, also called short lines, feed freight to the major railways who compete where possible and cooperate with each other when necessary.

Some key figures for freight transportation in Sweden, Germany, and the USA have been compiled in the table. A freight train in Sweden carries an average payload of approximately 500 tons, in Germany about 300 tons, and in the USA over 2,500 tons. The average transportation distance in the USA is 1,350 km, 350 km in Sweden, and 250 km in Germany. This is not the whole truth, however, because an international transportation assignment in Europe is counted as a separate assignment in each country. The USA, on the other hand, has a large common market with very large transportation flows over long distances. With the common market that now exists here, perhaps Europe will begin to move in the same direction.

Average income per ton-kilometre is 19 öre in Sweden, 42 öre in Germany, and 13 öre in the USA. There are several factors behind these figures, such as volumes, hauling distance, and the competitive environment. Nonetheless, the fact remains that the railways in the USA are highly profitable, in Sweden almost profitable, and in Germany not profitable at all.

The final figures are trucks' gross weight, which in the USA is often 36 tons, in Germany 40 tons, and in Sweden 60 tons. The maximum axle load on American railways is 35.7 tons, while in Europe it is only 22.5 tons. This means that in the USA, a truck is roughly equivalent to one freight wagon axle, while in Germany the figure is almost two axles and in Sweden almost three.

There is, though, one important difference between Europe and the USA: Europe has a considerable amount of rail passenger traffic, but in the USA there is only a fraction left in the form of commuter trains around the major cities and a few long-distance trains. As late as the early 1950s, rail passenger traffic in America was still substantial both over long distances, in the countryside and around the major cities. Much of the railways' passenger traffic infrastructure is now gone and has been replaced by motorways. Today it is once again beginning to be realised that railways also hold possibilities for passenger traffic; the starting point, though, is not the best that can be imagined and a great deal of investment will be needed to implement new systems.

Deregulation and development in Europe

In Europe, the most important short-term goal to be achieved must be that of making long international hauls function satisfactorily for customers. By contacting *just one* railway company, the customer must be able to learn directly about the transportation terms, and the fundamental quality requirement – a guaranteed transportation time – must be met. If this is to work, railways must begin to realise the entire transport needs of their customers and make an effort to co-operate on this, in order to increase their volumes instead of raising their freight rates!

In recent years, some rail freight companies have been merged, partly with the aim of creating a larger international liner network. One example is Railion GmbH – an amalgamation of the German, Dutch and Danish freight companies. The fact that the railway companies are becoming bigger and more integrated may support this endeavour, but small-scale operators may sometimes also have the opportunity to break into new markets. Conversions into independent subsidiary companies and privatisations may be necessary to accomplish radical change.

Even if those mergers and alliances that we can see in Europe today lead to larger railway companies geographically speaking, they are still relatively small by North American standards. Rail traffic in the USA with its 48 mainland states is dominated today by four large railway companies in combination with 500 small ones. In the European Union, with its 15 member states, each country has its own national railway company and the small-scale operators have only marginal significance. Each country also has its own more or less "sacrosanct" technical systems, rules, regulations, and administrative procedures.

Track access charges affect the railways' competitiveness with road haulage to a very large extent. With low track access charges based on the socio-economic marginal cost, the break-even point between road and rail is about 450 km for a single wagonload in international traffic. High access charges equivalent to full cost coverage shifts the break-even point to around 700 km. These figures are based on the calculated full cost for truck freight – actual price levels will often be lower due to competition from road haulage companies in the former eastern states and because it is often possible to transport a load on the return journey. At such low price levels, the break-even point is then about 900 km where track access charges are high, and up 2,500 km where they are low.

Figure: Cost comparison between wagonloads with different track access charges and road haulage with different price levels. Single wagonload with a payload of 30 tons and an 18 m long truck with a payload of 26 tons in international traffic.

This explains why it is sometimes possible to compete with the railways on price for hauls across the European continent. The problem can hardly be solved by regulation of road freight traffic, but the railways' competitive situation would be vastly improved if low track access charges applied throughout Europe.

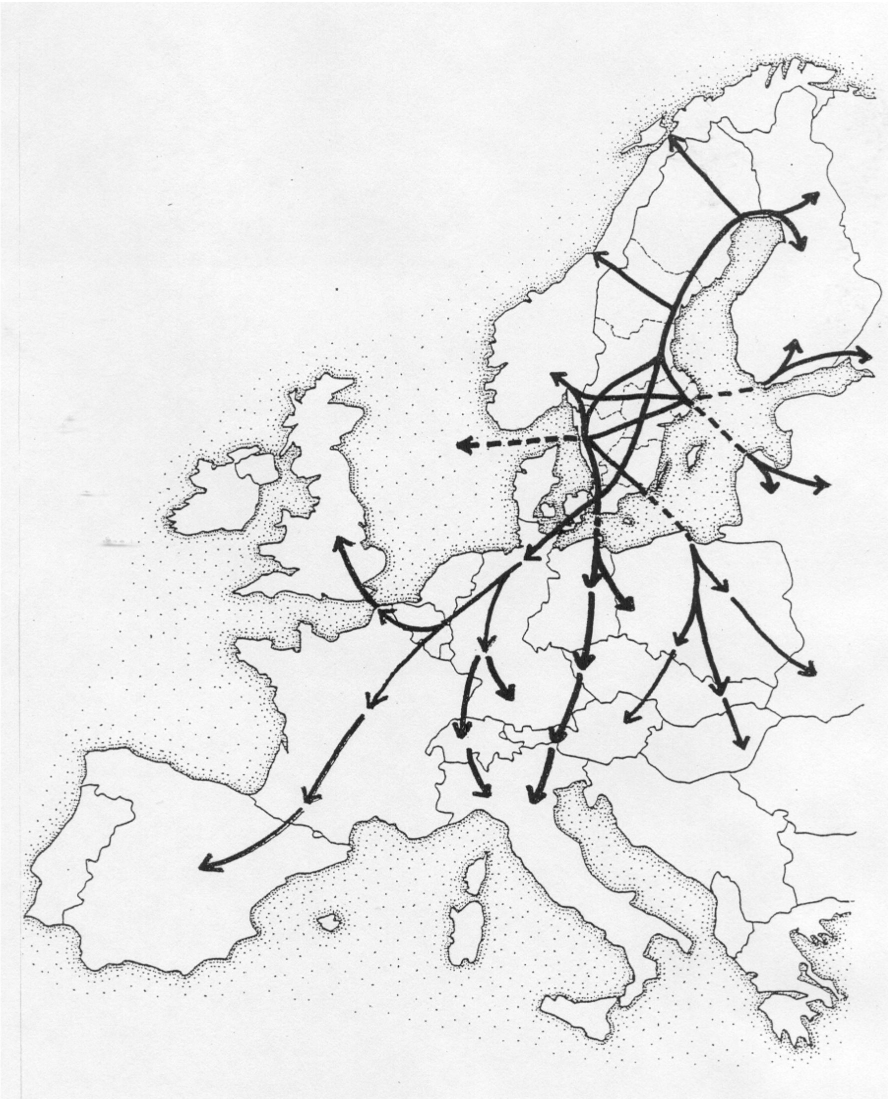
All the decisions made in the European Union have aimed to open the railway market to new operators and thus put pressure on the traditional operators. These proposals have not yet been realised to a sufficient extent. It is obvious that there are still obstacles, including red tape and high track access charges in some countries. Even if some positive trends can be discerned, with new transportation concepts and operators, the majority of the intended measures still remain to be put into practice. It is therefore important that Sweden contribute to changes within the European Union and stimulate new alternatives. The market is enormous. Distances are very great and the volumes of freight are eminently suitable for transportation by rail. There is thus an enormous potential for increased rail transportation.

Measures taken to institute a modern railway infrastructure in Europe have so far mainly been directed at passenger traffic. For freight traffic, factors such as loading gauges, axle loads, weight per metre, and train lengths are crucial. The variations in loading profiles, permitted axle loads and restrictions on train lengths that apply in different countries are one of the major problems today. If we can achieve an “interoperable” rail network that permits the same locomotive to be used all the way from Sweden to Spain for example, this would be a very positive state of affairs. For freight traffic, however, it is an even more pressing issue to be able to operate modern, efficient freight wagons with high load capacity all the way.

It is the wagons with the freight that are to be taken to the recipient, not the locomotives. Switching locos does not need to take more than 10-15 minutes; transferring freight between wagons, on the other hand, is impossible in many cases – so it is transported by road instead. Continuing to operate freight wagons, that because of axle loads, loading gauges, etc only fulfil today’s “lowest common denominator”, is not a tenable solution in the long term, either. This will probably lead to more and more freight being transported by road. The infrastructure owners ought therefore to cooperate at the pan-European level in order to adapt the infrastructure to the needs of freight traffic quickly.

In order to ensure positive development of railway freight traffic in Europe, measures are needed that affect both transport policy, organisation, and technology. The development of international trade and the unified market in Europe will have a great impact on how freight transportation develops. This may lead to the same specialisation and restructuring of industry in Europe that we have already seen in Sweden. The railways can play a highly significant role in this respect, because such a development will mean that enormous freight volumes will need to be transported over great distances.

Integration within the European Union and developments in Eastern Europe may also bring about a shift in pivotal points in Europe and Sweden. Increased trade with Eastern Europe will probably be a counteracting force to the gradual southward shift in the economic foci that is taking place in Europe today. As far as Sweden is concerned, the fixed links to the continent may involve a southward shift, while increased trade with counties in Eastern Europe may mean an easterly shift.



The railways' competitive situation measured in different ways

The total transportation market has been analysed using different measures of which the most important are:

- Transport effort (ton-kilometres)
- Transport effort (m^3-kilometres)
- Freight quantity (tons)
- Volume (m^3)
- Freight value (SEK/ton)
- Freight value (SEK/m^3)
- Accessibility to railway at departure point and destination
- Number of relations, movements, and consignments.

The market has also been sub-divided by the degree of processing (freight value in SEK/ton) as described below:

- highly refined goods (foodstuffs, engineering products, other manufactures, and trade)
- refined goods (pulp/paper, wood products, iron/steel, and chemicals)
- unprocessed goods (agricultural produce, forest products, minerals, other)
- bulk freight (mining, sand/gravel, and energy).

Highly refined goods account for a quarter of the long-distance transportation effort**.** They account for half the volume, but only a quarter of the freight quantity and is consequently dimensioned by volume. International hauls account for only a fraction of all long-distance hauls, while at the same time transportation distances in Sweden are relatively long. The goods value is more than ten times as high as that of refined goods, which increases the risk of theft or damage. The transportation costs measured in SEK/ton-kilometre are considerably higher than for other levels of processing, at the same time as they are low when measured in SEK/m^3 kilometres. The freight's geographical spread is very great. The number of relations is considerably greater than for other levels of processing at the same time as consignments are smaller. A great many and a large proportion of the flows go from places in the rail network to other places in the rail network.

Refined goods account for a quarter of the long-distance transportation effort. The weight and to a certain extent also the volume are the dimensioning factors for the freight transportation, which is subject to stiff competition, as illustrated by the fact that road, rail and sea account for one third each of all the transportation. Much of the freight consists of traditional Swedish exports; two thirds of the freight quantity is international freight, while transportation inside the country is long-distance. The value of the goods is low compared to highly refined goods, and also high compared to other levels of processing, and sufficiently high to be able to bear a relatively high transportation cost. Competition between the different modes of transport probably contributes to lower transportation costs than for highly processed goods and unprocessed goods.

Unprocessed goods account for 17% of the freight quantity, and 15% of the transportation effort, but only 11% of the volume. Consequently, weight is the dimensioning factor. A large proportion of the freight consists of raw products transported directly from collection points close to forests, farmland, quarries, etc. Accessibility for the railways and shipping is thereby very limited. Only a limited portion of the freight that is transported by truck today could be transferred to another mode of transport. The value of the goods is very low at the same time as transportation costs are high compared to the other levels of processing. The high transportation costs are due largely to the fact that the hauling relations are fairly special and the goods flows are one-way.

Bulk freight accounts for a quarter of the transportation effort and a third of the freight quantity, but only a fifth of the volume. The freight is consequently dimensioned by weight. Two thirds of all bulk freight transportation is international at the same time as transportation distances inside the country are short. Goods value and transportation costs are extremely low compared to other levels of processing. The low transportation costs are partly due to the low goods value, since the transportation costs' share of the goods' value would otherwise be too high. Bulk freight's geographical spread is very small. There are fewer relations than for other levels of processing. Consignments, on the other hand, are very large. The market is often divided naturally between the different modes of transport since they are transported in specially devised systems in fixed relations.

The differences between the levels of processing are thus quite substantial, and could therefore form a basis for a division into market segments. The differences between the levels of processing give rise to different requirements as regards the modes of transport.

Transportation of **highly refined** goods requires:

- high volume capacity
- frequent runs
- the possibility of wide geographical spread
- the possibility to transport long distances
- a transportation system adapted to Swedish conditions
- little risk of theft
- little risk of damage
- volume-based revenue calculation
- a road- or track-bound mode of transport

Transportation of **refined goods** requires:

- high load and volume capacity
- a nationally and internationally adapted transportation system
- low transportation costs
- short transportation times

Transportation of **unprocessed goods** requires:

- high load capacity

• access to road haulage

Transportation of **bulk freight** requires

• high load capacity

• an internationally adapted transportation system

• high transportation capacity

• system-based transportation

Table: Summary of characteristics of long-distance freight transportation

	Bulk freight	*Un-processed*	*Refined*	*Highly refined*	*Total*
Transportation effort					
ton km (%)	30	15	29	26	100
m^3 km (%)	19	9	18	54	100
Freight quantity					
tons (%)	36	17	23	24	100
Volume					
m^3 (%)	21	11	18	50	100
Freight value					
SEK/ton index	11	22	78	789	100
SEK/m^3 index	14	29	100	286	100
Consignment size					
tons/wagon index	159	165	129	65	100
m^3/wagon index	59	100	94	119	100
Transportation cost					
SEK/ton-km index	35	141	106	171	100
SEK/m^3 km index	60	230	140	80	100
Accessibility of railway					
dep. point (%)	72	37	64	77	65
dest. point (%)	59	67	73	80	74
both (%)	45	25	13	28	32
Relations					
movements (%)	7	14	19	60	100

Customer requirements and traffic products

Customer requirements regarding freight transportation and logistics

Customer requirements

The most important requirements that transportation customers have are *cost* and *quality*. The environment is also coming increasingly to the fore, depending on the consumers. The figure below gives a fuller picture of the customer requirements:

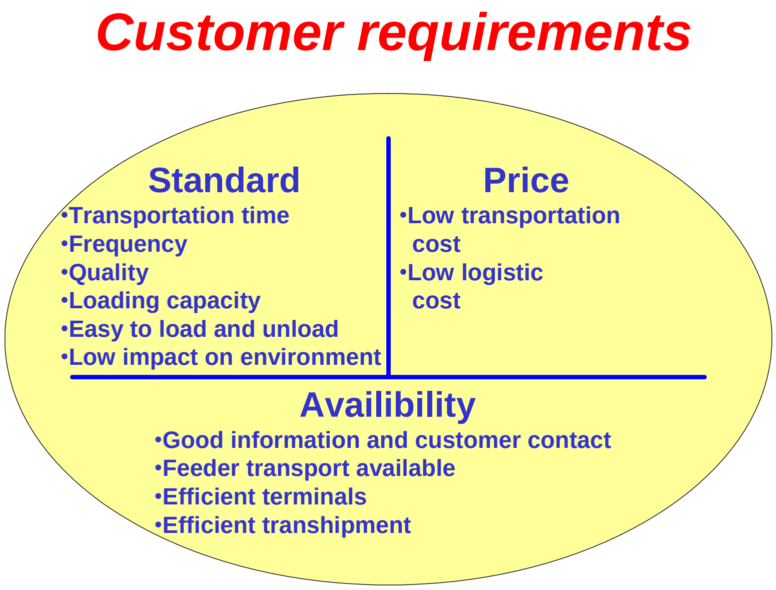


Figure: Customer requirements

Customer requirements vary widely depending on the market. A rough division into sub-markets can be achieved by breaking down the volumes of freight transported into *bulk freight, basic commodities, product market, and service market.* Average goods values are of the order of 200 SEK/ton for bulk freight, about 2,000 SEK/ton for basic commodities, about 20,000 SEK/ton for product market, and over 200,000 SEK/ton for the service market.

The railway has the strongest position in the basic commodities market, road haulage in the product market, shipping in the bulk freight market, and air freight in the service market. Somewhat simplified, we can say that price is according to market: 10 öre/ton-kilometre for bulk freight, 20 öre/ton-kilometre for basic commodities, 60 öre/ton-kilometre in the service market and approaching 30 SEK/ton-kilometre in the service market, see the table below.

The basic commodities market accounts for 56% of rail transportation, while the product market and bulk freight account for 25% and 19% respectively. For road haulage, on the other hand, the product market accounts for 57% , basic commodities for 37%, and bulk freight for 6%. For shipping, the corresponding figures are bulk freight 56%, basic commodities 40% and product market about 4%. Air freight operates primarily in the service market, but some air cargo is in reality transported by road, as shown in the table below.

The service market principally refers to mail, parcels and express freight, i.e. freight with a very high goods value and which is often transported as air cargo. There are no comprehensive figures available for the transportation effort for this particular segment, but counted in billions of ton-kilometres, it is hardly measurable.

Looking at how transportation has developed in different sub-markets between 1987 and 2000, it is quite clear that the railways have lost market shares in the product market, and primarily high value goods that is the fastest growing market. High-value freight has placed higher demands for transport quality and ”just-in-time”, where trucks often have an advantage today. At the same time, the railways have also lost market shares in the basic commodities market, i.e. low-value freight, where trucks have become much more efficient through their increased gross weight. See the table below.

Trade and industry’s requirements with regard to freight transportation depend on the nature of the product, at what point in the production process the product is, its financial strength, and the market. The railways are principally used for long-distance freight transport, where requirements can also differ between domestic and international transportation.

Requirements also differ between different types of transportation depending on capacity and quality. Different types of industry and geographical structure may also place special demands with regard to transportation. Yet other dimensions are the size of the company and the size of the consignments. All of this must be put in relation to the products that the railways can offer. A lowest common denominator must then be found in the different customer segments so that as much as possible of the market is covered by the railways' products.

The table shows the requirements that apply in a number of sub-markets. These are stated in the form of transportation time, frequency, and price. There is also a quality requirement that can vary within each group.

With regard to bulk freight, i.e. raw materials for the process industry, the demand for continuous dispatch is often more important than a certain transportation time. Here it is a matter of large-volume system transportation, resulting in a demand for high capacity at low prices. The demand for precision is also high, since the railway is often operating as a warehouse on wheels in this case.

Basic commodities, e.g. raw materials and semi-manufactures that are transported between industries and warehouses, are generally produced during the day and transported overnight, preferably with daily departures. In the case of international haulage, however, the daily routine is often different. As a rule, prices must be low, because the goods in question are not highly refined. This means a demand for high capacity in weight or volume. Quality requirements vary.

Goods in the product market category consist of semi-manufactures and finished goods that are transported to warehouses or directly to consumers. They are subject to the same transportation time demands as basic commodities, but the overnight requirement is more precise, i.e. generally between 5 p.m. and 7 a.m. the next day. Higher quality is also required with regard to handling, securing the cargo, temperature etc, and the products have a more disparate structure. The higher service level means that rates are higher than in the basic commodities market.

The service market comprises mail, parcels, and spare parts and the requirements are the same as for passenger traffic: high average speed, frequent service, available most of the day, and extensive geographical coverage. Prices in this market are relatively high compared to the other types of freight transportation.

Table: Markets, customer requirements and the railways' products

Market segment	*Time requirement*	*Frequency*	*Main product*	*Interoperates mainly with*
Bulk freight	less than	continuous	unit trains	shipping
- raw materials	24 hours			
Basic market				
- raw materials	domestic: 0-1 days	daily	wagonload traffic	shipping
- semi-manufactures	international: 1-3 days	several/ week		
Product market	overnight	daily	intermodal traffic	truck
- semi-manufactures	17:00 – 07:00			
- finished products				
Service market				air cargo
- mail, parcels	overnight	daily	express freight train	truck
- express freight	same day	several/day	passenger train	delivery service

Table: Rough division of freight by sub-market with certain characteristics

Sub-market	*Total market, billions ton-kilometres*	*Typical consignme nt size*	*Typical goods value, SEK/ton approx.*	*Typical price level, SEK/ton approx.*	*Principal mode of transport*
Bulk freight	24	400 tons	200	0,10	shipping
Basic market	34	40 tons	2,000	0,20	rail
Product market	22	10 tons	20,000	0,60	truck
Service market	0.3	10 kg	200,000	30	air cargo

Table: The different transport modes' transportation effort by sub-market (1997)

	Shipping	*Rail*	*Truck*	*Air cargo*
Bulk freight	56%	19%	6%	-
Basic market	40%	56%	37%	-
Product market	4%	25%	57%	-
Service market	-	0%	0%	100%
Total	100%	100%	100%	100%

Table: Development of the railways' market share of different commodity groups 1987– 1997

Commodity group	*The railways' market share, 1987*	*The railways' market share, 1997*	*Total market, billions ton-kilometres, 1997*	*Development of total market index 1987-1997*
Bulk freight	22%	20%	24	112

Basic market	33%	31%	34	107
Product market	26%	17%	22	157
Total	28%	24%	80	121

Traffic products for different markets

The freight transport system can be divided into the following main products with regard to market and production system.

- Wagonload traffic
- Unit trains
- Intermodal traffic
- High speed freight trains
- Express freight

The products cover different market segments and differ as regards production system and vehicle, which means that they have different cost structures and quality characteristics.

Wagonload traffic

Wagonload traffic is the oldest product and the foundation of the railways' freight traffic system. Principally, it meets the basic market's need to transport raw materials and semi-manufactured goods. It comprises the transportation of whole wagons that are loaded and unloaded by the customers at industrial sidings or loading platforms. Wagonload traffic may be either single wagons or groups of wagons. The wagons are often shunted twice or more during their journey. Where the freight's consignor and/or consignee has no rail connection of their own, the transportation by rail is often combined with road haulage at one or both ends.

Unit trains

Unit trains are freight trains that form a part of logistics systems where the railways function as conveyor belts for industry for the transportation of bulk freight and basic commodities. Each system train is operated for a specific customer with dedicated wagons and according to their own timetable. Unit trains use basically the same techniques as wagonload traffic, but unit trains allow the railway's advantages of scale to be exploited to the full. The largest and oldest unit train system is the Northern ore line. Typical loads are iron ore, raw timber, steel, wood chips, peat, oil, and paper.

Intermodal traffic

Intermodal traffic is the transportation, mainly of product market freight, on single load carriers, principally containers, swap-bodies, and road trailers between specially designed terminals on special railway wagons. The wagons travel directly between the intermodal terminals or as groups of wagons in direct wagonload trains. Feeder traffic is by road. There are intermodal terminals in 13 locations in Sweden today, some of them in ports. Container traffic to ports and trailer traffic to ferry berths is extensive.

High speed freight trains

Express freight trains generally transport mail and parcels in the service market. High speed freight trains generally transport mail and parcels overnight with late departures and early arrivals so that collection and sorting can be done at the terminals before departure and sorting and distribution upon arrival. Some trains make scheduled stops along the way for loading and unloading. Modified passenger train equipment is often used and the trains' maximum speed is 160 km/h.

Express freight

Express freight meets the transportation needs of the service market and consists of parcels and small consignments up to a pallet in size that are transported on regular passenger trains. Normal passenger trains have express freight cars or wagons with express freight compartments. On express trains, the freight is normally carried in a small freight compartment in the tractive power unit. Consignments are transported on day trains for same day delivery or overnight on night trains. Operating together with passenger traffic gives a high frequency of service, which is a fundamental prerequisite in order to be able to deliver quickly.

Swedish Rail sold its express freight operations in 2000, which means in practice that most of the express freight traffic by rail has been discontinued in Sweden. A greater supply of fast, frequent day trains should mean a certain potential for development, but in actual fact there is a conflict between short stops at stations and loading and unloading of express freight.

Intermodal traffic

Of the total amount of freight transported in Sweden, not including ore and oil, 64% goes directly from consignor to consignee without transhipping, which means that 36% are transhipments or intermodal. Shipping has the highest proportion of intermodal transportation, 82%, while road haulage has the smallest proportion, 12%. 45% of the railways' transportation is intermodal. The differences are largely due to the different transport modes' geographical accessibility, see the table below.

Not including ore, 55% of all rail freight was transported to/from industrial sidings in 2000, and a further 15% to/from ports, i.e. a total of some 70%. 15% was transported via terminals or hauled by road to loading docks and another 15% was intermodal. A total of 30% of all rail freight was thus a combination of road and rail, see the table below.

Table: Freight transported, not including ore, in tons. Direct transportation and transhipments, i.e. intermodal traffic. Approximate figures for 2000. Source: Jakob Wajsman, Green Cargo

Mode of transport	*Direct*	*Intermodal*
Truck	88%	12%
Rail	55%	45%
Shipping	18%	82%
Total	64%	36%

Table: Freight transported, tons. Not including ore. By loading/unloading location. Approximate figures for 2000. Source: Jakob Wajsman, Green Cargo

Loading/unloading	*Share*
Wagonload via industrial siding	55%
Wagonload via port	15%
Road-hauled wagonload	15%
Intermodal traffic	15%
Total	100%

Measured in ton-kilometres, wagonload traffic accounts for 40% of all freight transported by rail. Unit trains account for 28% and intermodal traffic (road-rail) for 12%. The northern ore line, which is also a unit train, accounts for 20%. The northern ore line is also a major operator outside of Green Cargo. The other private operators account for approximately 2% of the transportation effort, and Green Cargo thus account for 78%. The proportions of the different rail traffic products are shown below.

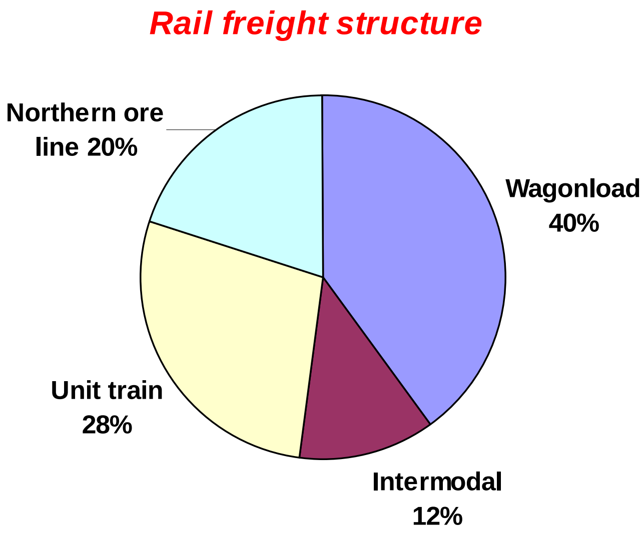


Figure: Freight transport products

Railways' accessibility

Swedish industry is still largely located in places where there is a railway, even if it is not always used. At a rough estimate, 85% of jobs in the manufacturing industry are in places where there is a railway. It is primarily passenger traffic that has been discontinued, while at the same time trade and industry has concentrated production to fewer and larger facilities.

Even if the freight is transported to and from places in the rail network, there are not always industrial sidings or local terminals with freight train connections available. In 1997, the National Rail Administration conducted a survey of transport managers at companies with more than 100 employees. 35% of the companies had industrial sidings, 72% of the freight customers had industrial sidings or direct access to the railway, a further 22% were located within 50 km of the railway, and only 5% were located further than 50 km from the railway. On the other hand, it was almost only those companies that had industrial sidings that used the railway to any great extent. 43% of these used the railways, while over 90% of the companies in all groups made use of road haulage, as the table below shows.

A special study of domestic long-haul direct trucking showed that 32% of the transportation assignments had both their departure and destination points in places in the rail network, while 65-74% had either their departure or destination point in places in the rail network. Another analysis showed that only 7% of road haulage assignments were carried out completely outside the rail network with neither departure nor destination point in places in the rail network, see the table below.

As stated above, industries and their freight transportation are still located close to the rail network to a surprisingly great extent, but the railway has considerable potential if industries' transportation needs can be met. Freight transportation by rail was once considerable, but traffic has ceased and the local infrastructure in the form of industrial sidings no longer exists. The railways function primarily as a mode of transport in their own right – a degree of cooperation with road haulage does exist but not to any great extent.

Table: Access to railway and railways' market share Source: Banverket 1999:"Profiling the railway 1999…", a survey of companies with more than 100 employees.

	Proportion of freight customers	*Access to railway*	*Proportion using railway*	*Proportion using road*
Industrial sidings	35%	72% = close to line	43%	92%
Railway local	37%		11%	95%
Railway within 50 km	22%	28% = far from line	7%	96%
Over 50 km to railway	5%		0%	100%
Total	100%	100%	21%	94%

Table: Access to railway at departure or destination point, all long-haul transportation, by level of refinement. Access to railway means place with railway, but there does not need to be any industrial sidings or feeder traffic. 1988 database analysed by Jakob Wajsman, Green Cargo.

Accessibility	*Bulk freight*	*Unprocess d*	*Refined*	*Highly refined*	*Total*
Dep. point	72%	37%	64%	77%	65%
Dest. point	59%	67%	73%	80%	74%
Both ends	45%	25%	13%	28%	32%