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Railway vendor lock-in

The Dutch case

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Abstract

For the concession of the high speed line in the Netherlands, the Dutch state preferred the same concessionaire as for the conventional lines. This thesis questions whether this preference can be economically rationalised by using the framework of path dependence. Within this framework the positive network effects and the economies of scale of the incumbent firm, the NS, and a potential entreat, the NS' contester for the high speed line are analysed. This analysis is based on railway literature, the Dutch state parliamentary proceedings and a game theoretical model. For the high speed line the Dutch states preference can be explained on the larger positive network effects the incumbent firm had over its contesters. However, insufficient economies of scale are present to justify an economic lock-in. This thesis concludes with policy recommendations to avoid future preference for one single concessionaire. These recommendations are to decrease the possibilities of both the NS and the Dutch state to influence each other policy and to increase the difference of the in-vehicle costs between both lines and decrease the waiting cost at high speed line railway stations.

Acknowledgement

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This thesis represents 16 ECTS.

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Chapter 1. Introduction

In the Netherlands the construction of the high speed railway line between Amsterdam and the Belgium border is broadly covered by the national press and heavily discussed by the Dutch parliament. Both the press coverage and parliamentary discussion focussed on two economical relevant aspects; the relationship between the concessionaire of the line, the Nederlandse Spoorwegen (NS) and the Dutch state, and the late start of running the service of the line.

National governments may prefer existing suppliers for the provision of new goods and services, but; generally states do not and should not have a preference for an individual supplier. This is stipulated by European Tendering regulations to ensure a fair chance for all suppliers of goods and services. Furthermore, the European Union has set directives to integrate the railway market into one open European market. Also, the rail market is a unique market. It is known for network effects, economies of scale related to size and density and it requires a high level of coordination during operation.

For the concession of the passenger transportation on the high speed line, the Dutch state had preference for the NS. However, it appears that the Dutch state regrets its preference after the tender of the concession of the high speed line. In a sense, the Dutch state became in a vendor lock-in with the NS. In that light, three hypotheses are developed based on an initial literature review that could provide a suitable explanation for the lock-in. Firstly, the Dutch railway network is a natural monopoly. Entry barriers might be too high for an alternative supplier of the high speed passenger service. Secondly, the lock-in of the Dutch state is the result of the institutional characteristics. According, to Pierson (2000) institutions exhibit self-enforcing processes that prevents once established institutions to be closed. The NS is state owned for the last 72 years. Reducing the impact of the NS to the Dutch political environment might by a slow and difficult process. A third hypothesis is that, the vendor lock-in is the result of the characteristics of the Dutch railway network.

This first hypothesis might be far fetched because apart from the NS multiple other companies had shown interest in the concession. High entry barriers cannot prevent competition as three additional companies showed their interest in the pre-qualification of the European tender. Two of these companies offered a concession bid and although one of these bids was declared invalid by the Dutch state, one company, Arriva, nowadays a subsidy of the Deutsche Bahn, did offer a serious bid. Thus, if the market was a natural monopoly owned by the NS, Arriva would act irrational or have insufficient knowledge about the market when deciding to submit their bid. However, this seems unlikely for such a large company.

Furthermore, the natural monopoly does not explain the Dutch state's preference for the NS. It could only explain why the NS had won the open European tender. The second hypothesis that institutions exhibit self-enforcing processes, might be a valid one. However, it is not a transport economic explanation and is thus considered beyond the scope of this thesis. This means that only the last hypothesis could be a valid transport economic explanation for the vendor lock-in of the Dutch state. In this thesis this hypothesis will be further developed to investigate the lock-in.

The goal of this thesis is to provide an in-depth economic explanation of the Dutch state's preference for the NS as a concessionaire on the high speed line. Furthermore, this thesis wants to provide recommendations on how to improve a state's relationship with its concessionaires and reduce the preferences for one particular concessionaire over another. This makes that, this thesis addresses the following questions: What is the economic theory behind a lock-in? Is the Dutch state locked-in with the NS? Can an economic explanation be provided on how the lock-in did arise? And what can be recommended to avoid a vender lock-in in the future.

The methodology of this thesis is the following: the economic theory will be investigated through a literature review. The applicable literature is found on the internet by using several search engines on the web as google scholar and trough references of relevant papers; The overview of the high speed line in the conventional line, the market conditions, the concession of the high speed line and the late start of service are based on the relevant parliamentary proceedings and reports from the NS and Prorail; and finally, the analysis is made trough the application of economic and game theoretical models.

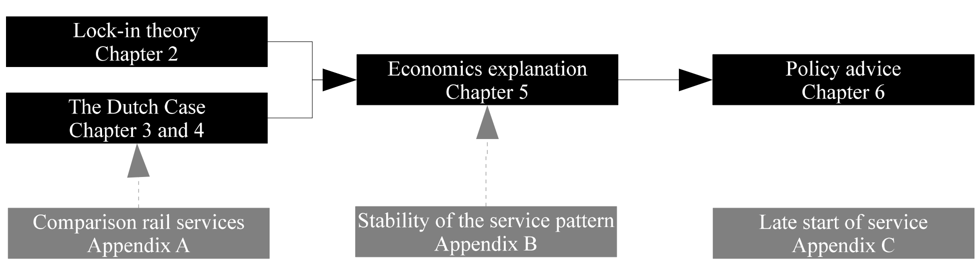

Figure 1, Report structure

The remaining of this thesis is structures as followed: In chapter 2 the theory behind the development of a lock-in is presented. This thesis presents a brief presentation on the Dutch case in chapter 3. In chapter 4 it is shown that the Dutch state is in a vendor lock-in by the NS. Chapter 5 provides an economic explanation based on the theory of path dependence in chapter 2 and trough the application of economic models. Chapter 6 will give recommendations to avoid the lock-in in the future and chapter 7 concludes this thesis. Appendix A adds to the explanation of the Dutch case through a comparison between the conventional and high speed line rail services on the relative passenger share of both lines. Appendix B presents a game theoretical model to explain the stability of service patterns between two head to head competing rail services. These two rail services compete on price and schedule and offer an external difference in travel time. In appendix C, the question is raised if we can rationalize the late start of the service.

Chapter 2. Path dependence

History does matter. In economics, law and physics it is accepted that past actions explain the world we live in today and the range of choices that are made. In other words, the present is path dependent of the actions and decisions made in the past. However, this can result in optimisation of potentially minor, local and insignificant equilibrium, while other more beneficial equilibriums that were reachable are now not any more reachable. As Arrow (2000) states, the study on path dependence raises the question on the structure of the economy and less on the outcome.

How does literature defines the conditions in which a - vendor - lock-in can evolve? Two different theoretical approaches describe path dependence and the potential lock-in it can create. On one side, there is the theoretical work of Liebowitz and Margolis' (1995). They argue that path dependence and the eventual lock-in is the result of a market failure, or more in general, irrational behaviour of economic actors and their lack of knowledge. A fundamental element in their analysis is the assumption that the positive network externality can be internalised. Their view is closely linked to neoclassical microeconomic theory. On the other side, there is Arthur's (1994) and David's (2000) work. In their papers path dependence is the result of chaotic minor events that create self enforcing processes. Self enforcing processes increase the costs to move to another path to a point that these costs outgrow the benefits of this other path. In their view only eternal shocks can change one away from a chosen path. This view is derived from chaos theory. Puffert (2001) builds on this work and defines for multiple basic type of networks the potential positive network externality.

As Liebowitz and Margolis' keep the closest to the assumption of neoclassical microeconomics: they argue that there is only one effective economic equilibrium. Furthermore, they state that this equilibrium is stable under the assumption that economic actors behave rational in the relation to the knowledge that is available to them. In contrary to Liebowitz and Margolis, David and Arthur, but also Puffert, state that path dependence is the result of dynamic processes with potentially multiple Nash equilibria. Furthermore, they argue that path dependence is the result of minor seemingly irrelevant events. What is common on all path dependence literature is the significance of past events, the necessity of increasing returns, the present of coordination problems and that deviations from the chosen path involve costs. The height of these costs are the cause a - vendor - lock-in.

Neoclassical microeconomic view

Liebowitz and Margolis' theoretical work is the extension of earlier work to provide an explanation on the adoption of technologies. A common used example is the layout of a keyboard. Nowadays most people use a QWERTY style keyboard. However, the Dvorak style keyboard is considered to be superior. The fact that this thesis is still written on a QWERTY key board is because of path dependence. A similar analysis was made on the adoption of video cassette recorders, VHS versus Video2000. In their work Liebowitz and Margolis (1995) explain path dependence simply as *"Where we are today is a result of what has happened in the past"*, thereby explaining their idea about path dependence. Liebowitz and Margolis' work consists of two parts. The first part of their work is their taxonomy of path dependence. This taxonomy defines the efficiency of a chosen path. The second part of their work describes the required conditions to create a lock-in.

Taxonomy of path dependence

In Liebowitz and Margolis' taxonomy of path dependence the aspects of rational behaviour and knowledge play an important role. Based on these two aspects they define a taxonomy of three levels of path dependency: the first, second and third degree of path dependence. Each level is the superlative degree of the level below the level prior to it. In their view, rational behaviour will always lead to an efficient outcome despite the results of the chosen path and the efficiency of a path is only determined by the rationality of the economic actor. This taxonomy is summarised in table 1.

	Knowledge	**Behaviour**	**Type of path**
First degree path dependence	Complete	Rational	Efficient
Second degree path dependence	Incomplete	Rational	Efficient
Third degree path dependence	Complete or Incomplete	Irrational	Inefficient

Table 1, Taxonomy of path dependence according to Liebowitz and Margolish (1995)

The first degree of path dependence is the result of a rational past action made under perfect information. The outcome of the action is entirely known and the outcome of all alternatives is entirely known. The made decision is the best option of all other option and therefore the decision made is efficient. An example of such decisions is limited to find in real life. Nearly no decisions are made under perfect information.

If the action is made rational and under imperfect information Liebowitz and Margolis speak about second degree path dependence. The result of these actions can be regrettable as another action might have resulted into a more beneficial outcome. As path dependent decisions might be costly to reverse, the cost to switch to the alternative path could outgrow the benefits. Nonetheless, Liebowitz and Margolis state that given the initial set of information the action was efficient. Multiple economic examples are known to fit this condition, as coordination and Bayesian games and investments under limited information.

The irrational decisions made with or without perfect information, are defined as third degree path dependence. This means that the outcome of the chosen path dependent decision was avoidable. In this case, there exists or existed an alternative decision to achieve a more preferred outcome. However, this decision has not been made and the more efficient outcome has not been realised. In economic terms, at one moment in time the net discounted collective value of an alternative decision was known to be larger than the chosen decision. Nonetheless, this alternative decision has not been chosen. Liebowitz and Margolis relate this third degree of path dependence to a market failure and, according to their view, it is the only form of ineffective path dependence.

Conditions for a lock-in

In order to read the next section, it is worth to mention the concept of inherent value and network value of a product. The inherent value is the product's value which an adopter experience as if it was the only user. The network value is the additional or subtractional value based on the number of users of the product. The adoptive value increases or decreases with the increase in the number of adopters. The sum of the inherent value and the network value is the total value of the product. If the network value increases the total product's value economics define this as a positive network effect. Otherwise it is defined as a negative network effect.

Liebowitz and Margolish state that apart from insufficient knowledge and potentially irrational behaviour, two additional economic conditions are required to generate a lock-in; economics of scale and positive network effects. This is illustrated by the two approaches that Liebowitz and Margolish present to assess this lock-in. In the first case, the individual network value of all adopters depend on the final number of adopters. In the second case, the individual network value depend on the number of prior adopters. Thus, the individual value for all adopters is not equal. The inherent value is in both cases for all adopters equal. Hence, the total value is in both cases only a function of the network value. This distinction is shown in table 2.

	Network value depends on all adopters before and after adoption	**Network value depends on total number of adopters before adoption**
First degree path dependence	No lock-in	Timing problem
Second degree path dependence	Efficient lock-in	Efficient lock-in
Third degree path dependence	Inefficient lock-in	Inefficient lock-in

Table 2, Taxonomy of lock-in according to Liebowitz and Margolish (1995)

First of all Liebowitz and Margolis argue that in order to become locked-in, economies of scale should be present for a product. This is necessary to obtain a non-existent, decreasing, constant average costs in order to create a natural monopoly. Otherwise, an alternative competing product can be successfully developed.

In Liebowitz and Margolis perspective, an inefficient lock-in will not occur in case of first degree path dependence if the network value depends on the total number of adopters. In the first degree path dependence, all adopters know the final number of adopters. So, they know the final network value of their action before they actual make the action. So, under the assumption that these actors behave rational, all actors internalise the network value into their own decision, so no inefficient choice can be made. This makes that information deficits are required in order to become locked in. In this case, all adopters are unaware of the network value of the product. In fact, they valuate the network value as zero. This information deficit lowers the total demand of the product and hence produces a suboptimal, but efficient, equilibrium. Under third degree path dependent behaviour a lock-in can only occur when sufficient information is available for enough actors to make the optimal action. However, these economic actors fail to take advantage of this knowledge and the implied profit opportunities. In other words, these actors fail to internalise the adoptive value. Liebowitz and Margolish also show that it is required that the under-informed adopters are required to believe that the adoptive value is only based on the number of adopters prior adoption instate of going to all adopters.

By the second approach, Liebowitz and Margolis argue that under perfect knowledge a timing problem occurs because all adopters wait until another adopter decides to adopt the product. In first degree path dependence all adopters know that the network value is larger if they wait to adopt the product. This is not defined as a lock-in, but as a timing problem. A second degree path dependence lock-in occurs if all users only known their individual payoffs and do not take into account the network value. This is similar to the first case. Finally, under third degree path dependence a lock-in occurs if an economic actor knows that an alternative yields into an improved payoff. However, this actors fails to turn this knowledge into profit by coordinating the buying process. In other words, this actor fails to internalise the network value.

Conclusion

Liebowitz and Margolish define an inefficient lock-in to be the result of irrational behaviour or in more general terms a market failure. Other lock-ins can occur, but these are efficient in an economic sense because the economic actor behaved rational in accordance to the knowledge it had available. In addition to these behavioural conditions, the product should necessarily exhibit two economic conditions for a lock-in to be created. These are the increasing returns to scale and a positive network effect.

Chaos theory view

Arthur (1989) defined a different view on path dependence compared with Liebowitz and Margolish. Its theory was based on the physical processes called chaos theory. David supports this view and clearly disagrees with Liebowitz and Margolis on the definition of path dependence and lock-in outlined above. Furthermore, David rejects Liebowitz and Margolis view on efficient and inefficient path dependence and the resulting taxonomy of path dependence. Puffert adds an additional comment against Liebowitz and Margolis view. In Puffert's paper, it is argued that not all external network effects can be internalised and thereby Liebowitz and Margolis view only explains the branches of path dependence and not the nodes that connects them. In contrast to the comments above, the role of positive network effects and economies of scale are accepted to explain path dependence by all authors.

Redefining path dependence

David rejects Liebowitz and Margolis work because of their inability to capture the essence of path dependence and David provides in his work an alternative concept of path dependence. David's work provides two definitions one negative and one positive. The negative definition states that *"Processes that are non-ergodic, and thus unable to shake free of their history, are said to yield path dependent outcome"*. The positive definition states that: *"Stochastic process, whose asymptotic distribution evolves as a consequence the process's own history."*

In the negative definition, David remains close to Liebowith and Margolis's work. That is that the presents depends on the actions from the past. However, David adds the type of process that is required, which is a non-ergodic process. A parallel is made between Markov chains and processes that are apparent in economics as special distribution of income and wealth and firm size distributions. If this Markov chain has two or more absorbing subsets this chain is said to be path dependent and the process will converge to a single equilibrium. Based on this parallel David provides a positive definition. The positive definition stresses the importance of chance and minor accidental outcomes in the evolvement of economic equilibriums and remains close to Arthur's captures of increasing return. In his paper, increasing returns were mathematically illustrated by the Polya urn process. A large urn contains two balls. Each ball has one colour, say black and white. In the first round one ball is randomly taken out of the urn. This ball is returned to the urn with an additional ball of the same colour. This process is repeated until the urn is filled. It is known from this process, that it will ultimately converge to an equilibrium with one of the two colours. The actual outcome of the process depends on the outcome of each individual trail and the sequence of the outcomes.

Comments against effective and ineffective paths

David rejects Liebowitz and Margolis taxonomy of path dependence and the impact irrationality and incomplete knowledge. In Davids view, it is the dynamic outcome of random events that result in an inefficient path and therefore the more static definitions of first and second degree path dependence defined by Liebowitz and Margolis are rejected. Also, he does not accept that irrational behaviour results in a ineffective path. David argues that the market in itself will identify the market failure and adjust to it to reverse it if the ineffective chosen path was privately remediable. Also, he states that if these ineffective paths are not privately remediable, these are certainly remediable through public intervention.

Internalising network effects

Puffert argues that not all network effects can be internalised and thereby Liebowitz and Margolis view only explains the branches of path dependence and not the decisions that connects them. Puffert states that the height of the switching costs depend on the transaction costs of internalising the network effects. Furthermore, Puffert states that innovation in this internalisation mechanism results in a move from one path to another. Hence, the quality that the network effect can be internalised makes what path is chosen. However, these network effect might not be internalised because of the state of technology or organisations and the imperfect knowledge of the future. In case, the network effect can be entirely internalised a parato optimal equilibrium or equilibria evolve because of the network effect. However, this is not the case if the equilibrium is socially less optimal and hence a path dependent chose can be made. Furthermore, the parato optimal equilibrium or equilibria is not path dependent, as these paths are objects of choice where all actors coordinate their actions from the start of the process.

Revisiting conditions for a lock-in

From the discussion above, it can be concluded that according to David, Arthur and Puffert that a random or stochastic event over irrational behaviour is the main cause of path dependence and the lock-in it may cause. If the switching costs increase over time, this increase may eventually be able to cause a lock-in if the costs outgrow the benefits. Arthur defines the state of lock-in as path inefficient self sustainable, Nash, local equilibriums from which apart of an external shock cannot be escaped from. David even argues that this equilibrium has to be stable while some portion of actors behave under incomplete information or irrational. So that if a large portion of the actors do incidentally chose an alternative path, the society as a whole still remains at the local equilibrium. In other words the equilibrium has to be evolutionary stable. In that sense, the lock-in is also a coordination problem.

According to David, increasing returns are characterised by four aspects. It is unpredictable, nonergodic, inflexible, and it may be path inefficient. It is unpredictable because the outcome of earlier events are large. Nonergodic is a process in which earlier events cannot be cancelled out. Inflexibility relates to the costs of shifting to another more beneficial path. Arthur provides four equal, but more economic characteristics that generates the increasing return and the lock-in it can create. These are two supply conditions namely large fixed costs and learning effects and two demand conditions, coordination effects and adaptive expectations. A brief explanation of each condition is given in the table 3.

Demand	Coordination effects	The short term sacrifice of self interest for a long term gain that depend on the favour of others.
	Adaptive expectations	The expected future depends on the past.
Supply	Large fixed costs	The existence of large upfront investments.
	Learning effects	The experience gain from conducting repeated activities.

Table 3, Demand and supply conditions for path dependence according to Arthur (1994)

Comparing conditions

Comparing the necessary conditions for a lock-in between the work of Libowitz and Mangolish and the work of David and Arthur, it can be concluded that the economic conditions that can create a lock-in are equal. The condition of large fixed costs are equal to the economies of scale, as the output increases the fixed costs spread over more units of production. Arthur states that as production costs are high, individuals have a strong incentive to keep the first path chosen. Learning effects are defined by Arthur as the knowledge gained in the operation of complex systems. Learning effects result in a cost reduction as the output increases on the long run average costs function. This learning effect is a form of economies of scale, as firms may fall back to aggressive pricing strategies in order to reduce prices below current production costs to increase sales and to lower the long run costs (Himmelweit, 2002). Coordination effect as defined by Arthur, are equal to the positive network effect defined by Liebowitz and Margolis. This is because if the number of adopters increase the payoff for the individual users increases. Finally, Arthur defines adaptive expectations as a source for increasing returns and the lock-in it can create. Also, adaptive expectations are closely related to the network value of Liebowitz and Margolis. Agents want to avoid choosing the wrong path because of the total value it might provide. This includes the past experience of a path, hence projections of the past are incorporated into the decision of the first ones and in that sense changing their preference.

Conclusion

Concluding, Arthur and David state that similar conditions as Liebowitz and Margolis are required to walk a path dependent path, economies of scale and positive network effects. These factors create in both their views self-enforcing processes or increasing returns. Their main point of difference is found in the creation of these at the start or the core origin of a path dependent route taken. In Arthur and David's view, the stating point lays in the outcome of a self enforcing random event and therefore not in the rationality of the economic actor's behaviour. A lock-in is according to Arthur and David, a local equilibrium in which the economy is evolved. This can be a local or global equilibrium that is stable for irrational behaviour with or without complete knowledge. In table 4 the two theories are schematically compared with each other.

View	**Required circumstances**
Microeconomic explanation	Economies of scale, positive network effects and irrational behaviour or Economies of scale, positive network effects and incomplete knowledge
Chaos theory explanation	Economies of scale, positive network effects and stochastic event

Table 4, Circumstances that explain a lock-in

Chapter 3. The Dutch case

Historically, there existed only a limited number of railway routes between Amsterdam and Belgium passing Rotterdam in the Netherlands. There was a direct route and travellers had the possibility to travel indirectly over Utrecht. However, this indirect route was considerably longer and had no direct trains running. In the beginning of 1990's the direct route was getting congested. The construction of the high speed track between the Belgium border and Amsterdam had to relieve this congestion and provided a true alternative route and had to improve the quality of the rail network in general.

Although the high speed line mostly travels over separate tracks, at multiple nodes it connects to the conventional rail network and shares at these locations the tracks with the conventional rail. In Amsterdam and Rotterdam the high speed line links up to lines from the north and north east of the Netherlands. Breda links up to the south east and west. Schematically, these connections and alternative routes can be represented by figure 2. Between Schiphol and Amsterdam the high speed line runs over conventional tracks. Furthermore, the high speed line between Rotterdam and Breda runs largely parallel to a the conventional line.

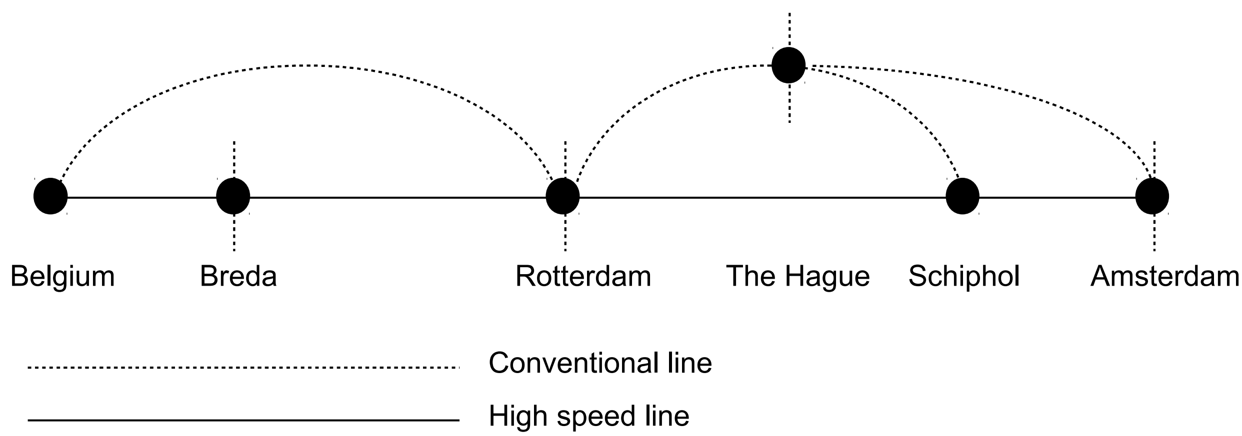

Figure 2, Schematic representation high speed and conventional line

The parliamentary proceedings showed that the capacity of multiple lines is nearing its maximum capacity and had hence limited capacity for future growth. This limited capacity giving rise to extensive construction works. Therefore, the high speed line was also intended to relieve the existing infrastructure by reducing the number of trains using the conventional network. This is shown by the NS's plan to close the Benelux line after the opening of the high speed line. Also, for the intercity lines between Amsterdam and Rotterdam it was intended to change the routing. The frequency of service will be reduced and the remaining trains would take a longer route passing Haarlem instead of Schiphol to travel to Amsterdam.

In appendix A the impact of the high speed line and the rerouting of the conventional lines is made. Calculated is under which circumstances passengers are indifferent to use the high speed line and the conventional line. Under the assumption that trains depart uniformly distributed in time and passengers arrive uniformly distributed at the railway station, it is concluded that the high speed line will highly benefit from the rerouting. Calculations show that the share of passengers of the high speed line will increase from 20% to 50% while the difference in ticket price is increased by 0.80 Euro. Increase in differentiation between the high speed line and the conventional line will thus increase the profitability of the high speed line.

Additional, some of the characteristics of the Netherlands passenger railway market are summed up below. The market is vertically disintegrated between the infrastructure and the passengers service since the beginning of the 1990's. The exploitation of the railway stations is added to the passenger service. The concession of the passenger service was granted through the exclusive long term concession to both the current intercity network and the high speed network. Regional services are available for alternative concessionaires than the NS. The infrastructure is managed by Prorail. No seat reservation is in place for national services and tickets are bought at the station at a ticket vending machine or by using an electronic prepay card. The price of the tickets is regulated for the conventional lines. However, no price regulations on the high speed line was in place. The majority of the daily commuters buy a month or an annual season ticket for a part of the network or the entire network. The users of these season tickets can be divided into two groups. The first group consists of commuters. Season tickets are often offered to them by their employers so they can commute between their homes and offices. The second group are students who are offered a state ticket for second class travelling. (NS Groep NV statutair, 2011)

Finally, both the NS and Prorail are public companies. However, the NS is slightly more detached from the state and is seen as publicly owned company as its shares are managed by the states treasury department. However, this is a recent shift. During the concession of the high speed line, the shares were still managed by the infrastructural department. Prorail is and was more closely connected to the Dutch state as it remains to be management by the infrastructural department.

Chapter 4. Defining the Dutch's lock-in

In chapter 2 an economic definition of a lock-in is presented. This definition is adjusted to include the Dutch state and the NS to fit the analysis of the concession of the high speed line. The new definition becomes the following: “The concessionaire selection for the Dutch rail lines is a stochastic process, whose asymptotic distribution evolves as a consequence of the process's own history and there did exist in the past an alternative arrangement according to which the Dutch state could have a different concessionaire. However, this arrangement is lost due to past actions and the economic characteristics of the high speed line.”

Before the arrangement is investigated that causes the lock-in, the remainder of this chapter will show that the Dutch state is in a vendor lock-in by the NS. In economic terms two indicators are available to show that a person or company is in a lock-in. They include the preference of the economic actor for a certain company and the height of the switching costs to an alternative supplier. In the case of the concession of the high speed line, it will be illustrated that there is a lock-in by discussing the Dutch preferences for the NS and the height of the switching costs after selection of the NS. The remaining of this chapter is based on the Dutch state's parliamentary proceeding (Tweede kamer, 1995-2011).

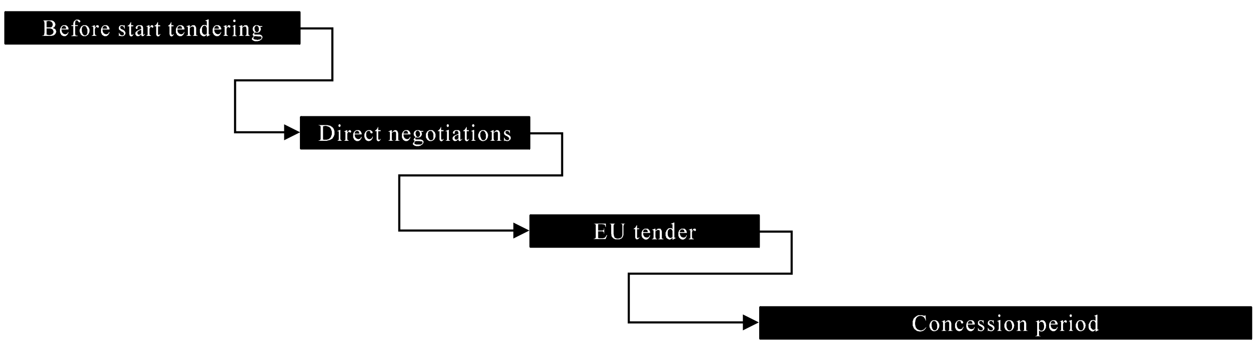

Figure 3, Global tendering and concession program high speed line

Parliamentary preference

In the parliamentary proceeding it was observed that the parliamentary preference was shown from the early start of the project. Also, during the tender procedure of the concession this preference was discovered. In this section this preference is discussed in two distinct project stages. Firstly, the period before the tendering procedure started, and secondly, the tendering phase for the national passenger transport on the high speed line. During the first period the Dutch state decided preliminary on the routing of the high speed line. The tendering process itself consisted out of two phases. Direct negotiation phase in which the NS could prove its added value and an open European tendering phase in case the direct negotiations failed. This phase was closed by a direct negotiation phase with the winner of the open European tender. The different phases are also shown in figure 3. This paragraph discusses the first three steps. This paragraph concludes with a brief summary on the potential reasons for this preference.

Preference before tendering

The preference in the first phase is shown by the cooperation of both parties and the references of the Dutch parliament to the NS as future concessionaire. Both the NS and the Dutch state jointly investigated the impact of the high speed line on the railway network and they determined together the conditions in which the political aims of the line could be realised. By working together, both parties shared the same vision on the expected future. Also, as the NS participated in the investigation, the outcome of it was likely be supported by the NS. Hence, it can assumed that the joint investigation is beneficial for the NS. It is unlikely that the Dutch state did not realise that joint this investigation was beneficial for the NS before the decision to start the joint investigation. Thus, the Dutch state must have preferred NS as concessionaire.

Furthermore, the Dutch state referred to the NS as future concessionaire multiply times. These references are summed up below. The Dutch state informed the parliament that just one company, the NS, was interested in the exploration of the high speed line. However, during the tender phase multiple companies participated in the bid. The parliament made multiple direct references to the NS as future concessionaire. Furthermore, the state requested of a strong concessionaire, implicitly referring to the NS. Also, several parliamentary motions asked for integration of the high speed line into the conventional railway network. This integration would basically result in handing over the concession to the NS without a tendering procedure. And finally, the business case made at the start of the project assumed the NS as concessionaire of the line.

Preference during the direct tender negotiations

During the direct tender negotiation phase the NS had to prove its added value of the integration of the high speed line into the conventional rail network and offer a sufficiently high concession fee. The allowance of a direct negotiation phase by itself shows that the Dutch state preferred the NS. Also, the parliament stated that the NS was most capable to integrate the new line into the conventional railway network. Eventually, NS' bid failed due the height of the concession fee, the offered concession fee was too low for the Dutch state to justify the concession, the limited integration of the new line in the conventional railway network and the explicitly prohibited enclosure both the national and international transport in their bid.

Between the direct tender negations failure and the open European tender the Dutch state showed again its preference for the NS. The parliamentary showed their regret of the failed direct tender negotiations. Also, both the parliament and the government intensively searched for options to restart the direct tender negotiations. Eventually, the NS was provided two additional 'legally risky' options to avoid the open European tender for the national transportation of the concession. The first option was a final chance for the NS to prove its added value for national transportation, while the international transportation would remain to be tendered. As compensation the state required additional reforms within the NS. The second option was the exclusion of the NS for the open European tender. However, the winner of this tender had to fully cooperate with the NS and had to accept the NS as an equal partner. Both these options were not accepted by the NS and again this was regretted by the parliament. The parliamentary proceedings show that this decision of the NS was followed by multiple request of the house of parliament to restart the direct negations.

Also, after the NS rejected this final offer, the Dutch state investigated internally new options to restart direct negotiations with the NS. The Dutch state investigated to tender the concession directly or to an Orange Alliance between the NS, KLM (Dutch airline company) and Schiphol Group (Dutch airport company) or to a new state owned investment agency which would subcontract the works to the NS. In the end time pressure and market power concerns related to the Orange Alliance failed all these options so the state had to start the open European tender.

Preference during the open European tender

The preference of the Dutch state was also shown during the European tender. The selection criteria of the tender appears to favour the NS and the Dutch state allowed for fundamental changes within initial NS' bid. The selection criteria were: the bidder's capabilities on substitution of road and air traffic; integration with conventional rail and air network; their knowledge of the Dutch market; managing the growth in mobility and the height of their concession fee and the contractual changes.

The NS capabilities on the substitution of road and air traffic are closely related to the integration with the conventional railway network. As Seabright (2003) shows railway transportation is a network product in which the extent of the network determines the demand of rails transportation. The NS is the concessionaire of the conventional railway network and has thus the advantage in internalising these network effects. Therefore, the NS could not lose on both the substitution criteria and the integration with the conventional network. Furthermore, although the by the parliament proposed Orange Alliance, a combination between the NS, KLM and Schiphol, could not participate in the tender, an alliance of between the NS and KLM was allowed. As the KLM is the dominant airlines in the Netherlands, the selection criteria air traffic substitution and integration were more favourable for this combination over other participants of the open European tender. Hence, this paper can only conclude that these two selection criteria were intended to favour this alliance.

Although the other companies that were interested in the concession had some experience in the Dutch market, the NS was the only company with superior relevant knowledge of the Dutch market due to its former monopoly position. So using this argument as selection criteria indicates again the preference for the NS by the Dutch state. This experience was solely related to the intercity bus lines and regional train passenger transport. Also, the NS informally communicated to the Dutch state that they were able to pay a larger concession fee than originally required by the Dutch state. As the NS was able to do so, the minimum annual concession fee of 100 million Euro favoured the NS. Indeed, the NS submitted a joint bid together with KLM - the High Speed Alliance, HSA - and won in this combination the open European tender as the other bidders were not able to pass the 100 million target.

Finally, fundamental contractual changes favouring the NS were made during the tender phase allowed by the Dutch state. During the contract negation phase, the Dutch state accepted an lower annual concession fee than originally offered by HSA's. The fee was lowered from 160 million to 148 million Euro's. In return the NS had to increase its invested capital by 100 million. As the concession lasts 15 years, the present value of this reduction of the concession fee can be estimated. The Dutch state used a discount rate of around 4%, resulting that over the 15 years concession period the present value of this reduction is estimated around 133 million Euro's. It is hence surprising that the increase invested capital balances the lowered concession fee. Furthermore, the reduced concession fee, lowers the bankruptcy risk of HSA. Finally, additional cooperation with the Belgian and French railway companies was required. However, the Dutch state would assist in the negotiations with those companies. Overall, it is concluded that this deal was mostly beneficial to HSA.

What arguments were presented for the Dutch state's preference?

In the parliamentary proceedings several arguments for the Dutch state's preference were observed (Tweede kamer, 1995-2011). The arguments are related to two aspects: firstly, to the weak market position of the NS in Europe and, secondly, the NS would provide the highest value of the passengers on the high speed line.

The NS had an international weak position. The European rail market has been opened in the early 1990's. This opening came for the Dutch state and the NS at an inconvenient moment. In the 1980's the NS developed an elaborate program on modernisation of the train network. The program included the high speed line. According to the parliamentary proceedings the effort put into this program, made the NS less prepared for the open European market. Even-more, the NS has been vertically disintegrated into multiple companies. This made that the infrastructure manager had received most of the investments in the last years. This made that the Dutch state was afraid that the NS would be overruled by foreign companies and would decimate in the near future. No reference has been found, but the anxiety for foreign companies might have been enlarged due to the potential loss of employment in the Netherlands and shareholders value. Please note that the Dutch state was and remans the only shareholder of the NS.

Furthermore, it was stated by the Dutch state that competition between the high speed line and the conventional line would lower the value for all the rail passengers. It was argued that the high speed line would be a valuable addition to the existing network and the NS was the company most experienced in the Dutch market. In the early discussions on the tendering process of the high speed line, it was, afterwards falsely stated, that the NS was the only company interested in the operations on the high speed line. Furthermore, the NS was ought to be the only company capable to manage the integration of the high speed line in the conventional network. For this last aspect special attention was given by the parliament on the rebalancing of the passenger flows between the high speed and the conventional network. The Dutch state argued that the competition might become unstable if competition was allowed on the line.

However, if this preference was that strong, why did the Dutch state failed to offer the high speed line to the NS directly? Was the NS not interested? Differences in interest between the infrastructure and finance department could play a role as well as the difference in interest of the political parties. Or the NS could have been aware of the Dutch states objectives and wanted to exploit this knowledge. Or finally, the new position of the NS might have been of influence.

Political parties and governmental departments disputed over the requirements of on rail competition. The liberal party was in favour of competition on the network, while the socialist party was less in favour. Furthermore, the infrastructure department appeared to aim for maximising the welfare effects of the high speed line. While on the contrary, the treasury required a minimum concession fee to make the line financially viable. Also, as manager of the NS's shares the infrastructure department might have additional reasons to prefer the NS. The NS detached from direct governmental control in the early nineties. The Dutch parliament and public servants might not have been used to this new position. Therefore, there exists a chance that the parliament and the public servants misjudged the objectives of the NS. This misjudgement could have been a source for the failure.

Signs of significant switching costs

Significant switching costs signalling the lock-in of the Dutch state to the NS manifested after contract closure, step 4 in figure 3, during the concession period of the high speed line. Till summer 2011 four types of contractual changes in favour of HSA were found and indicate significant regrettable switching costs. HSA was compensated for all the delays in the start of running the service. The Dutch state accepted contractual deviations on the international service and reduced the concession fee based on these deviations. The Dutch state decided not to enforce the contractual quality requirements with respect to the frequency, speed and routing of the service. Lastly, the Dutch state allowed HSA to postpone concession fee payments to the end of the concession period to directly prevent bankruptcy. In the following section these four types of contractual changes are discussed in more detail. This section ends with a reflection on the potential background of these contractual changes. This reflection is also based on the arguments found in the parliamentary proceedings.

Compensation late start

HSA was compensated for the losses caused by the late start. In the parliamentary proceedings is found that, this delay was caused by technical difficulties and the late delivery of the trains. The technical difficulties were the misalignment of the European rail safety system (ERMTS) and the electromagnetic interference between the conventional line and the high speed line. Contractually, Prorail, HSA and the Belgian state agreed to install an early version of new ERMTS. However, this version allowed for margin of interpretation. As a result the European Union developed a new, stricter, version of this rail safety system. It took longer to install this new version of the infrastructure and to equip the trains with it. As purchaser of the trains, HSA had the possibility to influence the alignment of the systems. However, it failed to do so. Nonetheless, HSA was financially compensated for the delay in the start of the service. A further discussion on the causes of late start of service can be found in appendix C.

Compensation deviations international service

HSA was compensated for the contractual deviations from offering the international service. HSA's bid included 16 daily return services to Paris and the service to Brussels from The Hague and Breda. This service was a joint service with the Belgian and French railway companies. HSA was contractually obliged to deliver this service. The Dutch state had to assist HSA in the contract negotiations but did not guarantee successful outcome of the negotiations. During the negotiations the French railway company, the economic rationality behind the frequency of service to Paris was questioned and the French did not accept any frequency larger than 10 per day. The Belgian railway company questioned the rationality behind serving The Hague and Breda. Eventually, the Belgians agreed to serve The Hague and Breda from Brussels by a single line. However, this was as part of a compensation package for a miscalculation made by the Belgian government[1]. The Dutch state accepted both these deviations. At the same time the Dutch state lowered the height of HSA's concession fee as compensation to the failure of the non-obliged Dutch state's assistance.

Not enforcing quality requirements

HSA was not enforced to deliver the offered quality. HSA's bid included requirements on the lines operated on the high speed tracks and the reliability, frequency, speed and seat certainty. Due to the late delivery of the trains the service provided was not in compliance with these requirements. The state could have enforced the contractual penalty because of these deviations, but decided not to do so. Even-more, it was questioned by the parliament if HSA could deliver the service conform these requirements even when the high speed trains are delivered. Up till the summer of 2011, the Dutch state has not been enforcing the quality requirements.

Postponement of concession fee payments

The Dutch state accepted to postpone the concession fee payments of HSA. As mentioned earlier, HSA was experiencing late delivery of trains. The result was that HSA was not able to generate sufficient income. Bankruptcy of HSA seemed unavoidable. Furthermore, the Dutch state and others questioned how realistic the height of HSA's bid was. According to specialists, it would not be possible to generate sufficient income from the high speed line to cover the concession fee offered. This combined let to a memorandum of understanding between HSA and the Dutch state to halt the bankruptcy. Based on this memorandum the Dutch state allowed HSA to postpone the payments of the initial four year to the end of the concession. HSA had to increase these postponed payments with an annual interest rate equal to a 10 year government bond. According to the Dutch state, the net effect of this deal was zero. However, this is only the case if we ignore the risk of bankruptcy of HSA. As mentioned earlier, specialists questioned the possibility to generate sufficient income at all, hence how can HSA repay these postponed payments?

1 The Belgium state reported lower travel times on Belgium grounds then would be actually achievable. This increases the operation costs for HSA and lowers its revenues due to a reduction in competitiveness.

This paper can only conclude that the risk of HSA not repaying these postponed payments is large. So, we expect that HSA will never be able to pay the postponed concession fee at the agreed interest rate. Thus, we conclude the net effect is that this agreement was primarily beneficial for HSA.

Why did the Dutch state accept these contractual changes?

The main reasons for these contractual changes found in the parliamentary proceedings relate to the Dutch state's switching costs if HSA went bankrupt. These costs were manifested through the contractual obligation of HSA to keep the service running for one year after HSA's bankruptcy on the Dutch state's costs and risks. A new concessionaire selected after a bankruptcy of HSA would yield into significant lower concession fees. Also, the tendering costs of the new concession are considered to be significant. Furthermore, the European directive rail package three prevents future monopolistic concessions for national rail passenger's transportation, while the current monopolistic concession was mentioned as one of the reasons for HSA to offer a high concession fee. Finally, the Dutch state included the concession income in their long term financial forecasts.

Conclusions

The Dutch state is in a lock-in with the NS. The preference of the economic actor and the switching costs to an alternative are the key signs for a lock-in. The Dutch state showed great preferences for the NS before contracting the high speed line and it signalled significant switching costs. The found indicators are grouped in the table 5 below.

Signs of Parliamentary Preference	**Signs of large switching costs**
Joint investigation impact high speed line on Dutch railway network	The Dutch state compensated the NS for the late start of the service
Multiple references to NS as future concessionaire	The Dutch state compensated the NS for deviations for their bid on the international service
NS was provided a primary position during the tender process	The Dutch state did not enforce quality requirements
The Dutch parliament regretted the failure of the initial negotiations with NS	The Dutch state accepted postponement of the concession fee payments
The Dutch state investigated possibilities to restart tender negotiations	
Selection criteria favoured the NS (substitution, integration, market knowledge and height of the concession fee)	
Fundamental contract changes were allowed after the NS offered their bid	

Table 5, Indicators of the Dutch state's preference and switching costs

Some reasons for the preference and the acceptance of the contractual changes were also observed in the parliamentary proceedings. The reasons for the preference of the NS were the weak international position of the NS and the higher passengers value. The reasons for the acceptance of these contractual changes were the potential bankruptcy of the NS and all associated costs resulted from this bankruptcy and the new rules on the European playing field, that prohibited a monopolistic rail concession.

Based on this chapter, it is clear that a lock-in is present after the contract closure with the NS. However, was this lock-in already present at the tendering phase? Thus, in order to explain how the Dutch state came in the current vendor lock-in, at least these two economies of scale and positive network effects should be present before the contract closure. If these required market characteristics are found before the contract closure, the lock-in is the result of decisions and actions before this phase. If these are not found, the lock-in is the result of irrational behaviour, incomplete knowledge or a stochastic event at the contract closure and hence the decision on the contractual structure has caused the lock-in. Thus, the question whether the preference is path dependent relates to the market conditions and the characteristics of the NS and its competition between the decision to construct the high speed line and the selection of the NS. This period is conform the parliamentary proceeding between 1996 and 2001.

Chapter 5. Unrevealing the lock-in

In general, the railway market is sensitive for lock-ins. For example, the most known lock-in in the railway market is the rail gauge. Several rail gauges in the world do exist. However, they do not coexist within one network. Rolling stock can be made suitable for both gauges, but this is expensive and time wise it lakes long to adjust the rolling stock during its trip. This makes that the costs of these often outweigh the burden. Furthermore, the market is characterised by positive network effects and economies of scale. With an increase in the network size, the more cities the railway hits, the number of connections increase exponentially. This is beneficial for all users of the network. Also, the fixed infrastructural costs are significant over the variable costs indicating the clear presence of economies of scale. However, these aspects are irrelevant for the assessment of the vendor lock-in of the Dutch state by the NS.

The remaining of this chapter is structured as follows. Based on the discussion above and the comparison of path dependence theories, the assessment of the railway market lock-in in the Netherlands are hypothesised. Afterwards, it is investigated if the high speed line in the Netherlands contains these characteristic required for a lock-in to arise. However, firstly, the general characteristics of the railway market are summarised below.

General characteristics Railway market

Passenger transportation is the displacement of people from one geographic node to another, starting and arriving at given dates under particular quality and safety conditions. Due to the large geographic differentiation of all nodes, the potential number of trips is enormous. Furthermore, most railway networks are meshed. This makes that for most trips the users have some flexibility in their path in the form of equivalent alternatives.

As with all forms of transportation, the demand in railway travel is a derived demand from the demand for mobility. This demand is translated into the demand for a mode of transport to supply the service requested. Each mode has its own characteristics as speed, comfort, reliability and flexibility and the characteristics of the users. Products that are closely related are competitors. Products that are more differentiated are not considered competitors as they serve a unique market section each. Furthermore, demand depends on the chosen mode of transportation by other travellers, the positive network effects. In this context a typical public transportation effect is observed, the Mohring effect. As demand increases, an operator is likely to increase frequency. This increased frequency increases again demand. Furthermore, for railway transport both technical and spatial sources of a network effect are observed by Puffert. Technical sources are related to the width of the track gauge and the electrical power distribution. Spatial sources relate to the number of direct and indirect linkages within the network.

The supply of rail passenger transport is capital intensive in comparison with other modes of transport. Both the tracks, stations as well as the rolling stock are characterised by large acquisition, operation and maintenance costs. This makes that, apart from fuel and maintenance most of the costs in railway service are generally considered fixed. Especially for high speed rail, the tracks and the rolling stock of high speed rail have higher costs over conventional rail. This results that rail passengers transport and in particular high speed rail is known for its economies of scale. Furthermore, the high level of coordination required between the infrastructure and the service indicate large transaction costs between these two. Finally, the externalities in the transport economics are considerable factor in each transport analysis. The same is true for the railway market. However, Infras and Iww (2000) shows that the average external costs for rail passengers transport are respectably lower in the railway market compared to other modes of transport. Within the railway market the external congestion and accident cost are of more importance compared with the environmental costs (Seabright, 2003). For high speed rail the environmental external costs are generally larger than for conventional rail due to its increased energy consumption.

Explanatory aspects for the lock-in

Multiple reports were presented by the Dutch state to show the benefits of the high speed line. A 1992 McKensey&Company report states that the net present value of the annual profits would be too small to cover the investment costs. However, the annual turnover would always cover the exploitation costs. This analysis included the cost reduction of the conventional line due to a reduction of the trail services, a total growth in rail services and increased ticket prices due to the decreased travel times. The exploitation profits were supported by multiple additional researchers (Tweede kamer, 2004). Also, in 1993, ICES (cited in Tweede kamer, 2004) presents that financially the investment in the high speed line would not be beneficial. However, it states that socially the high speed line would be beneficial for the Dutch society. The high speed line decreases the travel time sufficiently to recommend the construction of the high speed line to commence. Reading the ICES recommendation in depth, it remains unclear whether the decrease in travel time is or is not double counted as the McKensey&Company report includes an increase income due to higher tickets prices. Counting again reduced travel times as a positive externality of the high speed line is hence double counting these gains. Nonetheless, it is clear that the Dutch state was convinced on the benefits.

As the decision on the construction of the high speed line appears to be based rationally on the benefits of the high speed line, only the exploitation of the high speed line should shown path dependent characteristics and hence a random, unpredictable, nonergonic and inflexible event should be inherently be present in the railway market.. Otherwise the Dutch state could not have become vendor locked-in by the NS. A self-enforcing process could have been developed based on the decision to construct the high speed line that favoured the NS as concessionaire. In line with the literature on path dependence, this self-enforcing process should be fuelled by positive network effects and economies of scale. This fuel for path dependence should make the NS more effective as concessionaire over its contester. In other words, the total benefit of a combined concession is larger than the benefits of two separate concessions. Combined with the theory on path dependence this can be broken down into several aspects that define the circumstance that require a vendor lock-in by the Dutch state. Firstly, there are aspects that are beneficial to the rail passengers, which are indirectly beneficial for the Dutch state. In line with Seabright (2003) the identified aspects are the integration of services, the reliability of the network and the completeness of the network. Excluded aspects are speed, comfort and flexibility. These are external aspects of the selection of the concessionaire of the high speed line as these were the result of the decision to construct the high speed line. Secondly, there are aspects that would be beneficial to the Dutch state directly. These are strategic advantages as coordination effects and adaptive expectations and a larger concession fee, as a result of economies of economies of scale. Finally, there should be direct aspects beneficial for the NS. The direct and indirect aspects are explained and listed in the table below.

#	Description	Type circumstance
1.	Passengers would benefit significantly more from the integration of the high speed line into the conventional network by NS compared with its contester.	Positive network effect
2.	The NS increases the completeness of the Dutch rail network more in comparison with its contester. The number of direct and indirect linkages increases more by the NS.	Positive network effect
3.	The NS increases the reliability of the Dutch rail network more in comparison with its contester. The number of late arrivals or fall out of trains is smaller by the NS. Also, the stability of the service pattern high larger by the NS.	Positive network effect
4.	The NS has significant larger coordination effects -larger long run benefits over its initial costs- in comparison with its contester. The Dutch state is convinced that a should term investment in the NS is beneficial on the long term.	Positive network effect
5.	The Dutch state preferred the NS because of adaptive expectation. The NS has a better track record in comparison with its contester. In the year prior to the concession decision, the NS showed high reliability scores, services quality.	Positive network effect
6.	The NS benefits more from economies of density in comparison with its contester. The NS is more efficient in serving additional passengers.	Economies of scale
7.	The NS benefits more from economies of size in comparison with its contester. The NS is more capable to manage the enlargement of their rail network compared with its contester.	Economies of scale
8.	The NS benefits more from economies of scope in comparison with its contester. The product mix of the NS decreases the costs of marketing activities and allows for cross subsidising between the high speed line and other business activities.	Economies of scale
9.	The operations on the conventional line makes the NS quicker in learning the operations of the high speed line in comparison with its contester.	Economies of scale

Table 6, Explanatory aspects for a lock-in

Discussion on the network effects

As shown in the table above, the network effects are investigated through the integration of the high speed line into the conventional line, the completeness of the network, the reliability of the network, coordination effects and the adaptive expectations of the Dutch state. The additional network value is likely small on most issues. However, competition between both lines might have significant effect on the reliability of the service.

Limited integration effects

Limited integration effects are expected if the concession of the high speed line will be granted to the NS. The inherent number of passengers travelling with the conventional line and the high speed line will remain the same. However, as individuals now have the opportunity to choose between two lines, the total network value will be the sum of both lines. Thus the total value will be closer to the inherent value. Travel time of the high speed line is smaller than the conventional line. Independent on the ticket price, this will always result in partial substitution of the high speed line into the conventional line. This substitution will decrease the number of passengers on the conventional line. Following the Mohring effect, this decrease in passengers will result in a further decrease in frequency on the conventional line. This again will decrease the number of individuals on the conventional line because of a further substitution to the high speed line. This process is repeated until a new equilibrium is found. This new equilibrium on the conventional line is thus certainly lower than the current number of passengers and closer to the inherent value than the equilibrium before the opening of the high speed line. However, as not all passengers will shift from the conventional line to the high speed line, the network value of this line is not maximised too. However, this effect will occur with the concession of the high speed line to both the NS or its competitor and can thus not be a reason to prefer the NS.

Also, the Dutch state required the NS to position the high speed line as a separate railway product. The high speed line was not allowed to be integrated into the conventional network. This separation was recommended by McKinsey (1992) to allow for price differentiation between the conventional line and the high speed line, ease business operations, international communication and further this separation makes the high speed line accountable for its own operations. It is not difficult to imagine that this enforced separation decreased any integration benefits for the NS.

Furthermore, the ticket system was required to be compatible with the new national digital public transportation system, the 'ov-chipkaart'. In other words, the ticketing system had to be integrated and therefore tickets are interchangeable between both lines. As the tickets are interchangeable, the passengers can as easily travel by the NS as its competitor. This prevents any additional benefits for the NS to attract more passengers over the contester.

This all makes that there exist one possible advantage by the selection of the NS over its contester. The selection of one concessionaire of the high speed line and the conventional network increases the opportunity to produce a joint schedule for through passengers. Without competition the NS prefers passengers with a sufficient willingness to pay to use the high speed line. One method to increase the number of passengers for the high speed line, is to grant an easy step over that limits the transfer time. In case of competition, the NS prefers passengers to use the conventional line over the high speed line. In this case the NS can maximise the transfer time. The competitor can adapt its schedule to this behaviour.

However, it is unlikely to be beneficial for the passengers. Hence the Dutch state can prefer on this argument the NS.

Limited increase of the completeness of the network

The construction of the high speed line and the number of additional interconnections is limited. Also, the rerouting of the conventional line by the NS limits the increase in completeness. Puffert shows that the total network value of a spacial network depends on the direct linkages and the completeness of the network. This completeness is only marginally increased due to the construction of the high speed line. The high speed line made the node Breda move from an indirect link to a direct link with Belgium. Its existing connections between Rotterdam and Dordrecht remain direct connections. On all other nodes no new connections where achieved. Also, the changes proposed by the NS in the conventional line would remove some direct linkages. Passengers travelling from Dordrecht, Roosendaal and further into Zeeland will loose their direct link to Leiden and Schiphol. Hence, for these passengers the total value of the network is slightly increased. The rerouting of the conventional line would increase the frequency of trains to Haarlem, but because Haarlem is already connected through a direct line to Rotterdam and Amsterdam, this does not effect the number of direct linkages. This makes that it is concluded that the high speed line is mainly supplementary to the conventional line. Potentially, the NS would have rerouted the conventional line in case the concession was won by its competitor. However, this is unlikely, because it would damage its own operations.

Increase in reliability

The reliability of a rail connection enhances the value of the connection to the passengers. If the NS would offer a larger network reliability compared to its contester, the network value offered by the NS is larger. It is shown that reliability of the railroad network depends on the mechanical reliability and the factors under management control as network operations, equipment distribution, train dispatching and control systems, terminal operations and power availability (Kraft, 1998). However, the reliability of the network is also dependent on the stability of the service pattern of those operating the network (van Reeven, 2006).

The mechanical reliability of the connection Amsterdam-Belgium will likely grow as a result of the opening of the high speed line. Multi-pathing is a mean to improve the reliability (Kraft, 1998). The high speed line can act as a valid alternative in case of a mechanical failure on the conventional line and visa versa. Nonetheless, this would not largely depend on the selection of the NS. The high speed line remains dependent on the availability of the conventional tracks around stations. This is especially the case for the tracks around Rotterdam and Amsterdam. Furthermore, mechanical failures in the network often happen at railroad switches and civil structures (Prorail, 2008). These locations are mostly located in urban areas around the stations of Rotterdam and Amsterdam. Thus, in case of a mechanical failure, it is likely that it will effect both the conventional and the high speed line. Also, Prorail is responsible for the mechanical reliability of the network. Thus there remains only the mechanical reliability of the rolling stock in which the NS could be preferred over its competitor. However, there are no signs that the mechanical reliability of NS's rolling stock would be larger than the mechanical reliability. Contractually, the concessionaire of the high speed line was forced to deliver a high lever reliability of its service and in case of delays the concessionaire has to repay proportionally to the delay a part of the ticket price (Tweede kamer, 2008).

Hence, the mechanical reliability will likely not differ between both the NS and its competitor, nonetheless, the stability of the service pattern will likely decrease due to competition between the conventional and high speed line. The stability of the service patterns is initially investigated by van Reeven and Janssen (2006). A game theoretical model shows that on route competition will results in an unstable service pattern if the passengers are insufficiently sensitive to quality of non-scheduling service characteristics. This model is adjusted to fit on rail competition with difference of in vehicle time in appendix B. The model determines under which conditions passengers are indifferent between the high speed and the conventional lines. Under this condition the demand of each line is determined relative to each other. Based on the profit function of the concessionaires, high speed and conventional, equilibrium prices are determined and the condition is set under which a stable service pattern emerges. It appears that waiting cost have to be at least three times smaller than the difference in travel time. This condition is compared with the current differences in travel time between both lines. Due to the relative minor travel time gains and the larger cost of waiting time over in vehicle time , the outcome of the model shows that unstable service patterns are likely to emerge in case of competition. In this appendix also a brief overview of head to head competition abroad is investigated.

Limited coordination effects

The coordination effects are limited by the selection of the NS. It is unlikely that without any significant additional network value on the long run, increase in completeness of the network and increase in reliability, the benefits on the long run would validate any costs up front. However, as shareholder of the NS the Dutch state could experience some coordination effects. The NS had and still has ambitions to expand its services abroad. In 2010, the NS had subsidiaries and joint ventures in Ireland, Great Britain, Germany and Czech Republic. In the annual report of 2010 no information is provided on the profitability of the foreign subsidiaries, but the profit of the joint ventures is known. This makes that at least 6.2%, 18 million Euro, of the NS's profit is earned abroad. In the parliamentary proceeding its was argued that a firm position on the home market could increase the profitability of the NS abroad. Nonetheless, these are hard to quantify and to relate to the NS' concession of the high speed line. Hence, limited coordination effects for the Dutch state might be available by the selection of the NS. Thus it is concluded that insufficient information is known to make a clear distinction and it hence can be a reason to prefer the NS.

Limited adaptive expectations

The adaptive effects of the high speed line are limited with the selection of the NS. First of all, the NS had no experience of the explanation of high speed services. Arriva was that company with experience on high speed rail in Germany, but the Dutch state did not show preference for this company. Secondly, the NS had experience on the Dutch conventional rail line. However, it performed relatively poor in the last decade before the concession. During this decade the relative market share of passenger transport service decreased from 10% to 8% (Europese Commissie, 2001). In other words, although the NS privatised, it failed to attracts additional passengers. Also, the reliability of the passengers service lowered in this decade (Tweede kamer, 1999 and Treinreiziger.nl, 2010). The reliability of trains arriving within 5 minutes of their scheduled arrival time dropped from 94.2% in 1992 to 88.2% in 2001. Finally, the passengers satisfaction hit its lowest value measured ever in 2001 (Treinreiziger.nl, 2011).

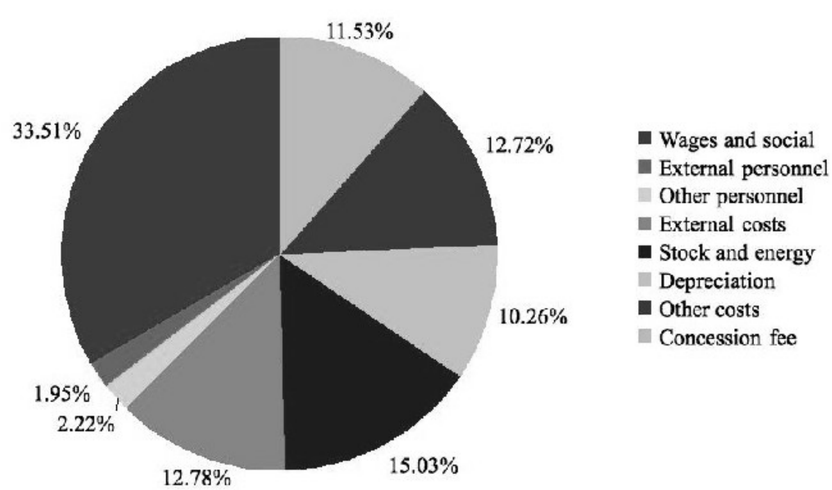

Figure 4, Cost decomposition NS 2011 (NS Groep NV statutair, 2011)

Discussion on the economies of scale

In this section it will be showed that the new high speed line does not benefit from economies of scale if its operations are executed by the NS. The long run average costs of the total railway output will not decrease. In general, rail transport is characterised by strong economies of scale in the form of economies of density and some economies of network size. However, in the Netherlands it is expected to be limited. This is because of the vertical disintegration, the requirement of new rolling stock and the introduction of a new train safety system. Also, the cost structure of the NS and its contester is similar. Some economies of scope might be expected. However, in relation to the overall costs these are expected to be limited. Furthermore, variable costs make a significant portion of the total costs of the NS as shown by figure 4.

No economies of density

The NS as concessionaire on the high speed line would experience no benefits from economies of densities. Economies of density in railway studies refer to the decrease of the long run average costs while increasing the traffic volume and keeping the network size constant. Harris (1977), shows that the fixed costs in railway traffic are large and that significant traffic is required to overcome the high fixed costs. Also, Resor and Smith (1993) found similar results. However, they also state that with the increase in density the marginal maintenance costs will rise. More recently, Braeutigam (1999) and Cantos (2001) show that economies of density are present in Europe. The last author empirically determined the economies of density at 1.90 for the NS.

In the section above it is argued that the demand of passenger transportation will decrease for the conventional line and hence the economies of density in total will decrease. Also, the requirement that the high speed line should be a separate railway product to the high speed line, prevents large economies of densities of the NS on the high speed line over the contester. This makes that the NS can only match arrival and departure times for easy stop overs of trough passengers to the high speed line and thus make it more difficult to attract additional passengers. If the NS would not be the concessionaire of the high speed line, it could attempt to misalign these arrival and departure times to maximise the number of trough passengers. However, the contester can react to such strategies to cancel out the effects. Hence, the NS can benefits from some of economies of density, but the effect is limited.

No economies of size

The NS would not gain for economies of size. The vertical disintegrated of rail operations reduces some economies of size, the high speed line rolling stock is not comparable with the conventional stock and limited empirical evidence is found.

The Dutch state vertically disintegrated the rail operations. The result of this vertical disintegration is that the economies of size for the concessionaires of passenger transport decreased. This is because most of the economies of size are gained through the maintenance and design of the tracks (Seabright, 2003), through the so called engineering benefits. Because of the disintegration in the 1990's, Prorail gained the management over the entire network including the high speed line and hence gains most of the economies of size.

A second argument is that the rolling stock from the conventional network is incompatible with the high speed line as well is the train safety system in the conventional trains is different compared with the high speed line. This makes that the conventional rolling stock cannot be employed on the high speed line. The reversal can be possible. However, as the high speed line's rolling stock is more expensive and purpose build, it is unlikely that this equipment would be bought to be employed on regular tracks. If one company might experience economics of size it should be the contester of the NS. This contester could employ its rolling stock more efficient by employing the high speed rolling stock in both their home country and in the Netherlands. However, it is expected that this benefit is limited as the high speed line is equipped with the unique train safety system. Also, the maintenance costs of the rolling stock was likely similar due to the employment of specialist high speed stock. This makes that the only benefits for the NS that can be envisioned are a better utilisation of staff and the avoidance of duplication of cleaning services. However, the NS contracts the cleaning works to a third company (NS Groep NV statutair, 2011), so, it is concluded that these benefits are limited.

The limited benefits of economics of size is supported by empirical research of European rail networks from Braeutigam (1999) and Cantos (2001). Both show that the economies of size in Europe are virtually non existed. However, in Breautigam analysis not all of these networks were really comparable and Cantos found no efficiency on a European scale that the railway networks of The Netherlands and Denmark did benefit from its size. However, it is believed that this finding is not relevant for the high speed rail as Cantos' paper was published before the opening of the high speed line. Furthermore, Mizutani (1999) showed that public owned railway companies have likely higher fixed costs. Hence, the economies of size are no evidence that the NS would gain a natural monopoly.

No economies of scope

The NS would not benefit more from economies of scope compared with its contester. Economies of scope are an important aspect in any analysis. Diversification can allow for some cross subsidising between the offered products and some fixed costs can be shared. The NS would only limitedly benefit from economies of scope as - mentioned earlier - rolling stock is unlikely to be shared between the high speed line and the conventional line. Marketing sharing benefits are also limited because of the clear distinction between the high speed and the conventional line. Also, no marketing activities as employed especially to use rail. According to the annual report the marketing activities of the NS were limited to the promotion of on station services (NS Groep NV statutair, 2011). Also, no by products can be identified that could suggest any economies of scope. In the procurement of energy some benefits might occur, however the competitor of the NS would likely also benefit of it. Cross subsidising is more difficult to assess. However, the Dutch state enforces the NS to provide every quarter a financial update of the concession excluded from any other business activities (Tweede kamer, 1995-2011, nr. 284). Accountancy wise, this will decrease the opportunity of any subsidising the high speed line with the conventional line.

Similar learning benefits

The NS and its contester share similar learning effects on the high speed line. The conventional line uses different rolling stock at a different current than the high speed line. The technology of high speed rail was new in the Netherlands and the applied train safety system was unique. The NS did not own this equipment before the concession. Also, its contester did not own the specific rolling stock. However, it might be able to adjust its existing stock to fit the Dutch conditions. This makes that the NS and any contester of the NS for the concession of the high speed line would experience similar learning costs. Even the contester might have an advantage as it could have been experienced with high speed travel on its home market. The NS on the other hand had more experience with the infraprovider, Prorail. However, these benefits are likely small. This is again due to the deployment of technologies that are new to the world, as supported by the severe delays of the opening of the high speed line.

Conclusion

Concluding, path dependence cannot explain the vendor lock-in of the Dutch state by the NS. Some clear positive network effects are found for the high speed line if the NS would be the concessionaire of the high speed line over a contester. However, no evidence for additional economies of scale for the NS are found. The NS could benefit from economies of scale with regards to economies of density, size and scope. However, insufficient evidence is found that this is actually the case. This means that there is insufficient evidence to explain a natural monopoly for the NS and hence the lock-in. It is does explain the preference the Dutch state had for the NS. Hence, in order to avoid the lock-in for future concessions the structure of the high speed line concessions should be altered. In more detail, the aspects that provide some explanation on the lock-in should be altered in such a way that the Dutch state has no preference for one concessionaire. In table 7, an overview is presented of all aspects that could explained the vendor lock-in of the Dutch state. In the next chapter some potential directives are given to avoid future lock-in.

#	Description	Level of evidence
1.	Passengers would benefit significantly more from the integration of the high speed line into the conventional network by NS compared with its contester.	Some evidence
2.	The NS increases the completeness of the Dutch rail network more in comparison with its contester. The number of direct and indirect linkages increases more by the NS.	No evidence
3.	The NS increases the reliability of the Dutch rail network more in comparison with its contester. The number of late arrivals or fall out of trains is smaller by the NS. Also, the stability of the service pattern high larger by the NS.	Strong evidence
4.	The NS has significant larger coordination effects -larger long run benefits over its initial costs- in comparison with its contester. The Dutch state is convinced that a should term investment in the NS is beneficial on the long term.	Some evidence
5.	The Dutch state preferred the NS because of adaptive expectation. The NS has a better track record in comparison with its contester. In the year prior to the concession decision, the NS showed high reliability scores, services quality.	No evidence
6.	The NS benefits more from economies of density in comparison with its contester. The NS is more efficient in serving additional passengers.	No evidence
7.	The NS benefits more from economies of size in comparison with its contester. The NS is more capable to manage the enlargement of their rail network compared with its contester.	No evidence
8.	The NS benefits more from economies of scope in comparison with its contester. The product mix of the NS decreases the costs of marketing activities and allows for cross subsidising between the high speed line and other business activities.	No evidence
9.	The operations on the conventional line makes the NS quicker in learning the operations of the high speed line in comparison with its contester.	No evidence

Table 7, Evidence for the lock-in

Chapter 6. Avoiding a lock-in

Based on the analysis in chapter 5 several measures are identified that can avoid the preference of the Dutch for the NS. The goal of these measures is to create a level playing field for all contesters for a concession. The measures focus on the integration of the high speed line into the conventional line, the stability of the service pattern and the long run benefits that Dutch state has by owning the NS. Appendix B showed that the service pattern became unstable because of the freedom to determine a moments of departure, the freedom to set the price of a ticket, the relative high waiting costs and increase differentiation of in vehicle costs between both lines. Based on these finding several measures are identified in this thesis that improve the service pattern. These measures are listed in table 8 and are discussed in more detail on the remaining of this chapter. Table 8 also shows the link with the found evidence in the previous chapter. This chapter closes with the preferably measures to avoid the lock-in.

#	Measure	Relation with found evidence
1.	Predefine service pattern	The integration of the high speed line into the conventional network (#1) and the stability service pattern (#3) is removed as a dimension of competition.
2.	Predefine ticket prices	Prices are removed as a dimension of competition to increase the stability of the service pattern (#3).
3.	Predefine in vehicle time of both rail lines	The exogenous difference in vehicle time is increase to guarantee the stability of the service pattern (#3).
4.	Taxation and compensation of unstable service pattern	Unwanted behaviour is levied to guarantee the stability of the service pattern (#3).
5.	Decrease waiting costs and increase difference of in vehicle cost	Increase the exogenous difference in vehicle costs and decreased waiting costs for passenger to guarantee the stability of the service pattern (#3).
6.	Reduce the state's and the NS's influence on each other policy	Long run success of the NS is removed as primary beneficial aspect of the Dutch state (#4).

Table 8, Measures to avoid the lock-in

Predefine service patterns

The Dutch state could predefine the service patterns for its concessionaires. The concessionaire offers a price to provide this service. As the Dutch state defines the service, a stable service pattern will certainly be realised. However, is this a preferred solution? First of as the service pattern is defined, concessionaire have less opportunity to compete. The reliability and the costs of service are the remaining dimensions. Also, the Dutch state has to be able to predict their required service pattern in advance over a long run. Contractual devisions are always possible to improve the service pattern to the demand. However, these changes inherent transactions costs. This makes that only if the transaction costs are lower than the benefits, the schedule in adopted. Hence, the railway network is less flexible to adapt to changes and thus some welfare losses are expected.

An option to limit these welfare losses the Dutch state can maximising the difference in departure time between the conventional and high speed line. This is a less restricted method to increase the stability of the service pattern. Furthermore, it improve the integration of the high speed line into the conventional network is by maximising the transfer time. Concessionaires remain the freedom to change their schedule, only they are restricted to the schedule of their competitor.

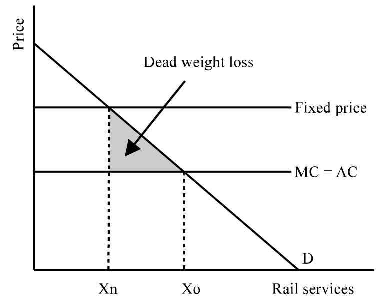

Figure 5, Dead weight loss

Predefine ticket prices

Predefining the ticket prices by the Dutch state removes one dimension of competition. If the Dutch state set the ticket price as a sufficient high level that the differentiation between both lines is enough a stable service pattern can emerge. However, this also will result into some welfare losses as ticket prices will be set above equilibrium prices to guarantee stability. In figure 5 is shown that depended on the elasticity of demand the welfare loss could range for large to non existed. In cases of inelastic demand this measure is recommended. However, in transport economics this is unlikely to be the case. Intermodal competition result in elastic travel demands for each mode of transportation (Blauwens, 2008). Furthermore, past experiences of predefined ticket prices have not proven to be efficient to reduce competition. In the United States a public cartel set ticket price of air travel prior its deregulation in 1978. The result of this regulation was that airliners spent the additional income to enlarge competition on the quality component of air travel in order to attract more passengers. For example electric pianos were installed in airplanes for people leisure, flight attendant wore paper miniskirts and french cuisine was served. Even-more the frequency of air travel increased beyond sustainable levels (Katz, 1998).

Predefine in vehicle time

Instead of stabilising competition of both lines through the price dimension, the Dutch state could also differentiate both lines by predefining the in vehicle time of the conventional line and the high speed line. This can be done by increasing the travel time or the decreasing the comfort level of the conventional line. If the in vehicle time is set sufficiently slow, the quality difference between the high speed line and the conventional line fits the equilibrium condition of the game theoretical model. However, also this measure will result in a welfare loss. The passengers that remain to travel with the conventional line experience loss as the in vehicle time is increased or the comfort level is decreased. Also, the passenger of that would have travelled by the conventional line and now switch to the high speed line will experience a loss due to the higher ticket prices. Again insufficient information is available to determine the size of this loss. In line with the predefining the ticket prices competition can move to other quality dimensions. However, as prices are not set above equilibrium levels, this is less likely to move beyond sustainable levels.

Taxation and compensation of unstable service patterns

As shown in appendix B one of the potential reasons that a stable service pattern emerges in Japan is the high costs of delays for the passenger service provider. A similar increase in costs can to stabilise the service pattern through internalisation of the externalities of the unstable service pattern. Currently, the NS compensates its passengers experience a delay of 30 minutes or more (NS, 2011b). High speed line passengers are compensated by a delay of more than 15 minutes (NSHighspeed, 2011b). Passengers are compensated by filling up a form. The threshold value for compensation is € 2.20. The Dutch state can enforce its concessionaires to compensate passengers earlier, for example with a delay of as less as 5 minutes. The height of this compensation should not reflect the value of time of the passengers or the value of the ticket, but the cost of the unstable service pattern. Furthermore, he Dutch state can enhance the long term stability of the service pattern through an taxation of changing the service patterns. This to internalise the externalities of the change. Similar to the predefined service patterns by the Dutch state welfare losses are expected. The service pattern will not directly change as a result of a change in passenger preference, because the benefits of this change for the concessionaire might be too low to balance the tax. This tax can hence be seen as an increased in the transaction costs as mentioned in "predefining the service pattern". However, the difference with this measures is that the incentive to change the pattern is entirely up to the concessionaire. Furthermore, the Dutch state can introduce a progressive tax with the number of changes in the service pattern to allow for some flexibility. Also, with this option there remains a chance that competition moves to other dimensions. However, in line with the reasoning above, as prices are not set above equilibrium levels, accesses are less likely to result in unstable competition. Nonetheless, taxation and earlier compensation has not been included in the game theoretical model and can therefore not be recommended.

Decrease waiting costs and increase difference of in vehicle cost

The main arguments that no stable service pattern will emerge is that the waiting costs is significantly larger than three times the difference of the in vehicle costs. Increasing the difference of each both lines together with a decrease in waiting costs can result in a stable service pattern. Several measures can assure this. These measures are decreasing the waiting cost in the railway stations by increasing its amenities or increasing the in vehicle costs by decreasing amenities of the rolling stock. Decreasing the amenities of the rolling stock can be achieved by decreasing the quality of the catering, furnishing and communication possibilities (Herrmann, 2000) and comfort level (Wardman, 2001). However, it is not expected that these decreases in comfort are accepted by the passengers and these will likely reduce the total number of rail passengers. Furthermore, decreasing the quality will likely result in a welfare loss. On the other hand increases in quality of the high speed line, might be accepted. Increasing a rail station's amenities by improving the customers satisfaction can be achieved by improving the provision of good quality affordable refreshments, the behaviour of staff, the quality of the information system, the basic facilities of the platforms and safety and security (Geetika, 2010). All aspects are given in decreasing importance. The costs and benefits of decreasing the waiting costs is difficult to judge and is beyond the scope of this thesis. However, it might help to push service patterns into the stable zone.

Reduce the state's and the NS's influence on each other's policy

During the decision to construct the high speed line, the NS participated in joint committees with the Dutch state on the routing and the concession of the high speed line. Furthermore, the Dutch state's infrastructural department was directly responsible for the NS at this time. Reducing the influence of each other on each other result in less dependence. A first step has already been taken by transferring the responsibility of the NS from infrastructural department to the treasury. For this thesis insufficient information is available to determine if this transfer of responsibility is sufficient. As a share owner the Dutch state can still interfere with the NS internal management. However, it is definitely a step in the right direction.

Conclusion

Several measures are investigated to avoid the lock-in in the future. The total welfare effect of these measures are not assessed in this thesis due to the lack of data. However, the taxation of unstable service patterns and earlier compensation of passengers in case of delays might be suitable solutions. However, its impact would result in a stable service pattern according the developed model. This makes that the recommended option to increase the difference of in vehicle costs and decrease the waiting costs is the recommended policy. Predefining service patterns, ticket fees or the increased duration of the in vehicle time might also be valid however are considered second best. Furthermore, it is recommended that the Dutch state's and the NS's influence on each other policy should be reduced.

Chapter 7. Conclusion

In this thesis four questions were addressed: What is a lock-in? Is the Dutch state locked-in with the NS? Can an economic explanation be provided on how did the lock-in arise? And how to avoid a lock-in in the future?

Chapter 2 contained a literature review to define a lock-in in general. Two similar but on one crucial point different theories were described. On one side the microeconomic oriented theory of Liebowitz and Margolish was discussed while on the other side the chaos theory of David and Arthur. Both theory explain a lock-in as the result of path dependence which is created through self-enforcing processes resulting from a combination of economies of scale and positive network effects. The result of this self-enforcing process is that the switching costs to move from one branch to another eventually become too large to outweigh the benefits. If the switching costs outweigh the benefits, economic literature defines this as a lockin. the case the The difference of both theories lays in the cause of path dependence. Liebowitz and Margolish state that insufficient knowledge and irrational behaviour is the main cause while Arther and David state that the cause is a random event, chance.

In chapter 3 and 4 the Dutch case is presented. In these chapters it is shown that the Dutch state rationally decided to construct a high speed line between Amsterdam and the Belgium border and is in a lock-in by the NS. The Dutch state also shown preference for the NS during the pretender phase and the tender phase itself. During the pretender phase it involved the NS in the decision making process through a joint investigation and the state referred to the NS as concessionaire before the tender phase, provided for the NS favourable selection criteria. During the tender phase the state regretted the failure of the direct tender negotiations and searched for options to restart the negotiations. Furthermore it allowed for fundamental changes after the NS provided their bid. The path dependence aspects of the decision to select the NS were shown through the high switching costs. The state compensated the NS for the late start of service, for contractual devisions from their bid. Also, the state accepted quality devisions by the NS and postponement of the concession fee payments. Furthermore, in appendix A it is shown that elongation of the conventional line has a strong positive effect on the number of passengers for the high speed line.

In the subsequent chapter 5 the economic explanation on the lock-in is explored. Multiple aspects are defined that could gave rise to positive network effects and economies of scale that might explain the lock-in. These aspects are one by one investigated. It is concluded that too limited evidence is found to state that the NS had sufficient economies of scale advantages over its contesters to generate a lock-in.

Both companies would have similar economies of density because of the routing of the line, economies of size because of the separation between infrastructure ownership and passengers service, and scope because of the limited size of marketing activities of the NS. Also due to the nature of the high speed line, it is a new the Netherlands and for the NS, no learning benefits are found. Nonetheless, evidence is found that the selection of the NS would result into network benefits. Most striking are the stability of the service patterns. A game theoretical model developed in appendix B showed that insufficient difference between the high speed line and the conventional line were present for a stable competition to arise. However, this were not the only evidence found that the NS would provide high value. The NS could integrated the high speed better into the conventional network and the selection of the NS could yield into coordination benefits for the Dutch state. Namely, the share of the NS are owned by the Dutch state.

The absence of economies of scale makes that the Dutch state's lock-in is not path dependence. In other words, the effects are reversible and the preference of the Dutch state for the NS is hence not economically rational. Chapter 6 provides some policy advices to avoid a lock-in in the future. Six policy advices were extracted form the analysis in chapter 5. Five of these target the integration of the high speed line into the existing network and the stabilisation of the service patterns. These policies are the removal of ticket price and or schedule as a dimension of competition, the increase of the difference of passengers in vehicle costs and decrease waiting costs and the taxation and passenger compensation of unstable service patterns. One policy advice proposes to decrease to possibilities of both the NS and the Dutch state to influence each other's policy. The recommended policies are to increase the difference of the in-vehicle costs between both lines and decrease the waiting cost at the high speed line railway stations and to decrease the possibilities of both the NS and the Dutch state to influence each other's policy.

Finally, in Appendix C the late start of service of the high speed line was investigated. In this analysis it is concluded that the late start of service was not primarily the result of technical difficulties but also because of the contractual misalignment of the stakeholders involved. A cause of this misalignment might have been the number of structural changes in the 1990's.

Limitations and directions for further research

The main limitation of this research is the lack of empirical data available on the costs and benefits of high speed rail travel by the NS and its competitors. Empirical data on the cost of high speed travel and its economies of scale in relation with conventional rail travel would have strengthen the case that rail transportation is not a natural monopoly. Furthermore, statistical data on the network effects in high speed rail, both positive and negative would have strengthen the case that network effects are presents and that the difficulties to internalise these is the cause for the lock-in by the Dutch state.

A second limitation is that the modelling of passengers share in appendix A is based on generally accepted values from the transport economic literature. However, it is difficult to judge wether these values are also applicable for the Netherlands. Is waiting time on the central station in Amsterdam truly valued twice as costly as the in-vehicle time; Is the costs of the in-vehicle time of the high speed line equal to the in-vehicle time of the conventional line; Is the travel motive distribution equal to the distribution in the Netherlands etcetera. Testing against these assumptions would provide a more reliable estimation of the expected demand distribution of both lines. It also helps to support the conclusion that no stable competition would arise in appendix B and it can provide a more depth recommendation on how much the waiting cost have actually to be decreased for the individual railway station and/or the difference of in vehicle costs have the be enlarged. It is not difficult to imagine that the waiting time in a railway station with numerous services as Amsterdam is relatively more pleasant to wait compared with a railway station under construction as Rotterdam. Similarly the quality of the rolling stock likely influence the in vehicle costs.

A final limitation is that the behaviour of the Dutch state is analysed based on the parliamentary proceedings only. Other human sources as past decision makers have not been interviewed. These sources could have provided valuable additional background information.

As a result of these limitation additional statistical evidence on the cost structure of the high speed line and the conventional line is recommended. Also, additional information on the value of waiting and in vehicle time of different type of railway stations and the high speed and conventional trains are valuable. Finally, it is recommended to interview decision makers on their vision on the selection procedure of the NS.

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Appendix A. Comparing current and future service

In this appendix, a comparison is made between the existing (2011) and future (2012) service between Rotterdam and Amsterdam. The aim of the comparison is to determine the growth of the expected passengers share of the high speed line over the conventional line between the current and future service.

Model

To compare both the high speed line and the conventional line a simple linear model is used. This model describes the consumer preference for transportation between two railway stations on three dimensions; waiting costs, in vehicle costs and ticket fee. Passengers incur costs for waiting time twice the height of the in vehicle time. Various researchers pointed out that the cost of waiting time is larger than the time in the vehicle while traveling. However, the relative costs of waiting time compared is disputed (Wardman, 2001). Wardman provides non-lineair multipliers to convert in vehicle time costs to waiting time costs. These factors are relative to the length of the trip and the duration of the waiting time and range from 1.80 for 2 minutes of waiting time of a 200 mile trip to 3.61 for 20 minutes of waiting time of a 2 mile trip. In this analysis follows a commonly accepted rule of thumb. This is that the waiting time is double to the in vehicle time. This thesis can envision that this factor is also affected by the comfort and level of amenities of the train station. Furthermore, the price changed for the trip is a costs to the passengers. Finally, the maximum willingness to pay is included in the equation. It is assumed that this maximum willingness to pay is sufficiently large for rail transport to exist. Due to the presence of the rail connection between Amsterdam and Rotterdam it is undoubtedly that such demand exists. Consequently, the utility for a passenger with one of the lines is:

A1. $U_i = V - p_i - 2tT_i^w - tT_i^t$ where:

V	is the maximum willingness to pay,
p_i	the ticket fee,
t	the in vehicle time costs,
T_i^w	the waiting time
T_i^t	the in vehicle time.

Subscript i stands for the high speed line and conventional line respectively. The in vehicle time costs for the indifferent passenger can be calculated by equating the utility functions of the conventional line (1) and the high speed line (2). The result is shown in the following equation:

A2. $T_1^w - T_2^w = \frac{1}{2}\left(\frac{p_2 - p_1}{t} - T_1^t + T_2^t\right)$

where $p_2 - p_1$ represents the price difference, $T_1^t - T_2^t$ the difference of in vehicle time and $T_1^w - T_2^w$ the difference in waiting time. This equations also shows that the price difference is equal to zero if the in vehicle costs are zero or if the difference of in vehicle time is double to the difference in waiting time.

Input

In our analysis the impact of the high speed train on the travel times and the costs of travelling is estimated for the track between Amsterdam and Rotterdam. This is estimated trough the average travel times during the day for both the conventional line and the high speed time in both the existing and future situation. This estimation is made for the regular travel hours, roughly between 6AM and 12PM. Firstly, the frequency and in vehicle travel times are determined based on figures provided by the NS. Secondly, the total travel time and the travel costs are determined. This is based on the travel time and waiting time. Apart from the model restrictions, the following assumptions are made:

1. Passengers arrive to the train station uniformly distributed over time. Thus, the average waiting time per person is half of the time between two leaving trains.
2. The in vehicle costs is 9.90 Euro commuters, 9.70 Euro leisure and 23.50 Euro business (Wardman, 2001). Values are converted from pounds by average 2001 values (X-rates, 2011) and inflation corrected by the consumer price index for the dutch central bureau of statistics (Statline, 2011a)
3. The distribution of travel motives equals the average distribution of motives in the Netherlands. This is 22% commuters, 71% leisure and 7% business (Statline, 2011b).
4. Waiting time costs double to the in vehicle time.
5. Reliability of both line are equal.
6. Quality of both lines are equal. Discomfort, fatigue and boredom are related to the distance and time travelled but start only after significant travel time. The distance covered is equal for both lines and the difference of in vehicle time is always less than 45 minutes.
7. Difference in ticket price between the high speed line and the conventional line is 2.70 Euro in 2011 and 3.50 Euro in 2012 (NSHispeed, 2011)

8. Conventional trains and high speed trains are uniformly distributed and the departure of a high speed train is exactly in the middle of two regular services.

Ad.1 A portion of the passengers will plan their trip in advance, however, they will take enough time to cover for unexpected events that delay there trip. This means that passenger will always experience some waiting time. However, as, the frequency of the trains between Amsterdam and Rotterdam is high, it is believed that the assumption that the average waiting time is equal to half of the frequency remains valid.
Ad.2 The distance between Amsterdam and Rotterdam is 82 kilometres over conventional tracks and 69 kilometres over the high speed track. Wardman provides figures for 25, 50 and 100 miles. 82 kilometres equals 50 miles, 69 kilometres equals 43 miles. For both figures the 50 miles value is the closest.
Ad.3 Combining 1 and 2 makes an average costs of in vehicle time of 10.65 euro per hour.
Ad8. Van Reeven (2006) showed that *"Every operator minimises consumers waiting costs for its own departures, and, given uniform demand, locates departures at equal distance apart."* The assumption in this analysis does not completely fit this finding. However, the assumptions in the analysis are not equal too. Production facilities are not equal for the high speed line and the conventional line and travel times are not equal. Extension of this game theoretical model could improve this assumption but is considered beyond the scope of this appendix.

The NS provides recommended travel options between Amsterdam and Rotterdam via their website (NS, 2011). The options provided depend on the preferred time of departure. Twice an hour the high speed line is recommended. For other departure times the conventional line is recommended. The september 2011 are summarised in the table A1.

Type of train	Route	Frequency	In vehicle time	Comments
High speed	Amsterdam-Schiphol-Rotterdam	2 x per hour	40 minutes	
Intercity train	Amsterdam-Schiphol-The Hague-Rotterdam	1 x per hour	60 minutes	'Benelux line'
Intercity train	Amsterdam-Schiphol-The Hague-Rotterdam	2 x per hour	63 minutes	
Intercity train	Amsterdam-Utrecht-Rotterdam	incidentally	66 minutes	Interchange at Utrecht, 5 minutes
Intercity train	Amsterdam-Schiphol-The Hague-Rotterdam	1 x per hour	74 minutes	During the night 12PM to 5AM
Express train	Amsterdam-Haarlem-The Hague-Rotterdam	2 x per hour	70 minutes	
Express train	Amsterdam-Schiphol-The Hague-Rotterdam	2 x per hour	69 minutes	Interchange at Leiden, 2 minutes

Table A1, Recommended connections Amsterdam-Rotterdam in 2011

In 2012 the frequencies and type of trains between Amsterdam and Rotterdam will be adjusted in favour of the high speed line. The exact implications for the passengers are difficult to determine, because only the frequencies, change of in vehicle time and change of waiting time is given.

Type of train	Route	Frequency	In vehicle time	Comments
High speed	Amsterdam-Schiphol-Rotterdam	4 x per hour	36 minutes	During rush hour increased frequency
Intercity train	Amsterdam-Haarlem-The Hague-Rotterdam	4 x per hour	70 minutes	
Intercity train	Amsterdam-Utrecht-Rotterdam	incidentally	66 minutes	Interchange at Utrecht, 5 minutes
Intercity train	Amsterdam-Schiphol-The Hague-Rotterdam	1 x per hour	74 minutes	During the night 12 to 5AM
Local train	Amsterdam-Schiphol-The Hague-Rotterdam	4 x per hour	79 minutes	Interchange at Leiden, 10 minutes

Table A2, Possible connections Amsterdam-Rotterdam in 2011

In 2011, the average in vehicle time between Amsterdam-Rotterdam is 67 minutes with 4 minutes waiting time for the conventional line. In 2012 the average in vehicle time will increase to 75 minutes and 10 minutes waiting time. This is due to the decrease in frequency. Hence, the average travel time for the conventional line will increase by 14 minutes. In 2011, the service on the high speed line takes 40 minutes in vehicle time with 15 minutes of waiting time. In 2012 the in vehicle time is decreased due to the introduction of new rolling stock. The predicted in vehicle time becomes 36 minutes. The waiting time also reduces because of the increase in frequency. All above is summarised in table A3.

	In vehicle time	Waiting time	Average travel time
Conventional line (2011)	67 minutes	4 minutes	71 minutes
HSL (2011)	40 minutes	15 minutes	55 minutes
Conventional line (2012)	70 minutes	10 minutes	80 minutes
HSL (2012)	36 minutes	7 minutes	43 minutes

Table A3, Travel times Amsterdam-Rotterdam in 2011 and 2012

Analysis

For different values of in vehicle time costs the relation between the expected waiting time difference and the ticket fee difference are calculated and plotted. A positive time differences means that the expected waiting time of the high speed line is larger than the expected waiting time of the conventional line. In other words, the high speed line departs earlier than the conventional line. The price difference is only shown for the cases that the ticket fee of the high speed line is larger than the conventional line. The different lines represent the price difference that make the passengers indifferent between the conventional line and the high speed line at different in vehicle time values.

These plots are made for the 2011 time table and the 2012 time table. These plots show that in 2011 passengers will never take the high speed line if they have to wait 13.5 minutes longer for the high speed line than the conventional line. The demand for the high speed line depends on the positioning of the high speed line in comparison to the conventional line. The area below the indifference curves represents the demand for high speed line. The area above the indifference curves respectively represents the demand for the conventional line. Hence, if a high speed train will always depart within 13.5 minutes of each conventional line and the price difference between these two lines is zero, the percentage of passengers taking the high speed line would be 100%. Exact demands cannot be predicted without knowing the actual time differences between two departures.

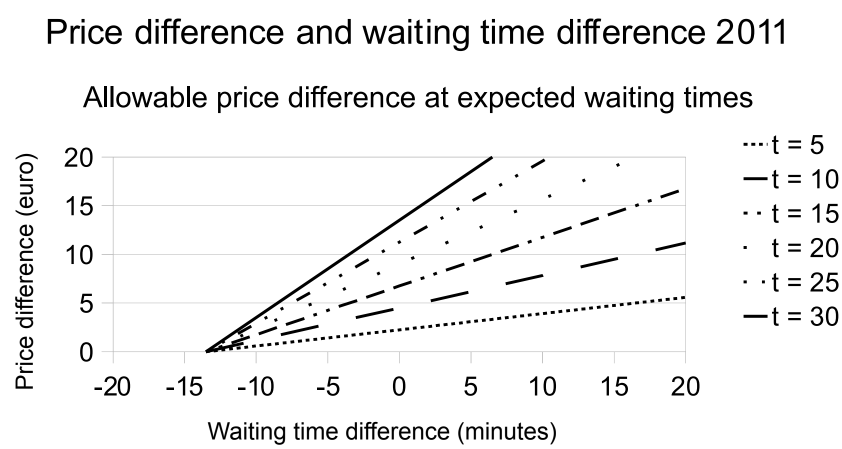

Figure A1, Price diffidence and waiting time difference in 2011

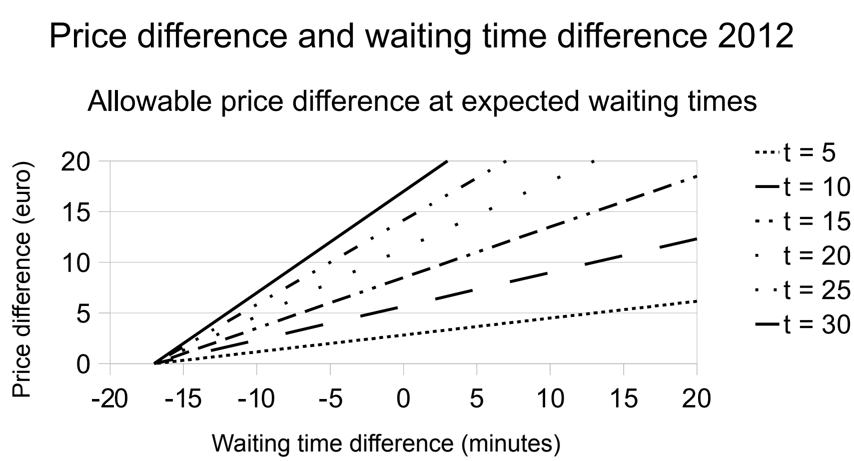

Figure A2, Price diffidence and waiting time difference in 2012

These two graphs A1 and A2 show the allowable difference in waiting time between a high speed train and a conventional train at different ticket prices and value of in vehicle time can be determined for different travel motives. Negative waiting time difference indicates the additional time someone is willing to wait for the high speed train. The maximum allowable time differences in respect with the different travel motives are shown in the tables A4 and A5.

Travel motive	**In vehicle time valuation**	**Allowable waiting time difference (ticket price difference 2.70 Euro)**
Leisure	9.70 Euro	-5.15 minutes
Commuter	9.90 Euro	-5.32 minutes
Business	23.50 Euro	-10.05 minutes
All	10.65 Euro	-5.89 minutes

Table A4, Allowable waiting time difference in 2011

Travel motive	**In vehicle time valuation**	**Allowable waiting time difference (ticket price difference 2.70 Euro)**	**Allowable waiting time difference (ticket price difference 3.50 Euro)**
Leisure	9.70 Euro	-8.65 minutes	-6.17 minutes
Commuter	9.90 Euro	-8.83 minutes	-6.40 minutes
Business	23.50 Euro	-13.55 minutes	-12.53 minutes
All	10.65 Euro	-9.40 minutes	-7.15 minutes

Table A5, Allowable waiting time difference in 2012

Based on the assumption that trains depart uniformly in time and the high speed train departures right between two conventional trains, the share of passengers preferring the high speed train can be determined. Here we can consider two base cases. Firstly, the allowable time difference between the high speed train and the conventional line is larger than the actual time difference. In this case, passenger will not take the first conventional train but wait till the next high speed train. Secondly, the allowable time between the high speed train and the conventional line is smaller or equal to the actual time difference. In this case a passenger will take the first conventional train. In 2011 the time difference between two conventional trains is 4 minutes. Thus, the difference in departure between a high speed train and a conventional train is 2 minutes. This is smaller than the allowable time difference of 5.89 minutes. In this situation the first case apply. The average passenger will not take the first train, but waits and takes the first high speed train. The result is, that the high speed train collects for 6 minutes worth of average passengers. As the frequency of the high speed train is twice an hour, the high speed line collects in one hour around 12 minutes worth of average passengers. Thus, around 20% of the passengers are expected to travel by the high speed train. In 2012, time difference between a high speed line and a conventional line is 7.50 minutes. In this situation the second case applies. The average passenger will take the first available train. As frequencies of both lines are equal, 50% of the passengers are expected to travel by the high speed train. Graphically, this share can be shown by the figures A3.

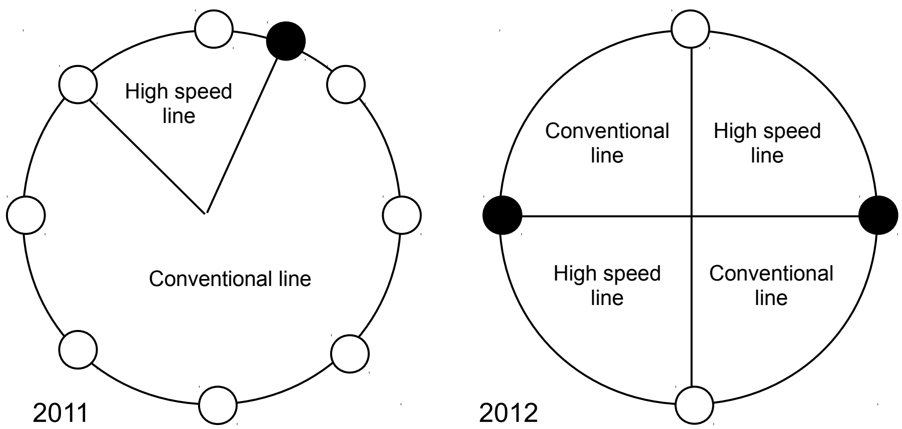

Figure A3, Predicted relative share conventional line and high speed line, figurative

Travel motive	**Allowable waiting time difference (2011)**	**Relative share for the high speed line (2011)**	**Allowable waiting time difference (2012)**	**Relative share for the high speed line (2012)**
Leisure	-5.15 minutes	20%	-6.17 minutes	50%
Commuter	-5.32 minutes	20%	-6.40 minutes	50%
Business	-10.05 minutes	33%	-12.53 minutes	100%
All	-5.89 minutes	20%	-7.15 minutes	50%

Table A6, Predicted relative share high speed line

Similarly, the share of passengers can be determine based on the 2012 figures and for each individual travel motive and its corresponding value of in vehicle time. These shares are shown in the table A6.

Conclusion

The passengers share of the high speed line between Amsterdam and Rotterdam is expected to grow from 20% to 50%. This growth is partially based on a doubling in the service frequency of the high speed line and a reduction of the service frequency of the conventional line. The growth of the passenger share on the high speed line is limited, because of the increase in ticket price difference by 0.80 Euro. Furthermore, relaxing the assumption on the distribution of departures, can change the expected market share. These figures can be extended for other sections of the high speed line, were a similar changes in service frequency, ticket prices and travel time improvements are seen.

Appendix B. Stability of rail service patterns

In the appendix the stability of the service pattern is investigated. The aim is to determine if competition between the high speed line and the conventional line would result into an unstable service pattern. Also, a short review is presented on the stability of on-route competition abroad.

Introduction

As shown in appendix A, the actual demand of the high speed line and the conventional line depends on the time of departure of one line over the other. A stable service pattern is a regular schedule that does not include strategies to collect more passengers by delaying or speeding up the published service. In rail transportation, speeding up the service is an unlikely method as time tables are strict. However, delays are common and an unreliable service is often due to specific managerial decisions as Kraft (1998) pointed out. Thus, delaying the service in comparison with the published service, can be a strategy to collect more passengers. Delays should be smaller than 15 minutes in order to prevent the repaying of ticket prices (Tweede kamer, 2008).

Description of the model

In contrast to van Reeven's model this model will include the in vehicle time to assess the stability of the service pattern and it will not include a quality component. In the Netherlands, the distances between stops and the total length of the high speed network is too limited for passengers to experience differences in fatigue, boredom etc. Hence aspects mentioned by van Reeven as competition on friendliness, courtesy of personnel, vehicle type, interior design, advertising image, meals/snacks, lounges are of less importance of non existent in the Netherlands at all. For example in comparison with France, the average distance of the high speed line between two station in the Netherlands is around 50 kilometres. While in France the average distance between stations is almost the double being around 90 kilometres. Also, the total length of the high speed network is significantly larger in France compared to the Netherlands; around 1800 kilometres versus 125 kilometres of which only 85 kilometres consist of purpose built tracks (Prorail, 2011 and Reseau Ferre de France, 2011).

The stability of the service pattern is analysed trough a similar horizontal product differentiation model as van Reeven and Janssen (2006) used. A situation in which two operators are in competition for a fixed origin-destination pair are described by the model. Both operators are assumed to use different production technologies. The costs of the production technology is assumed endogenous of the demand and equal for both companies. This assumption is supported by Mizutani (1999). Based on empirical research in

Japan, it was concluded that the marginal costs of public and private companies are comparable. Fixed costs is significantly larger for public companies. Equally to van Reeven, the consumer's preference is assumed to be linear distributed on a a two dimensional space representing the preferred time of arrival and the preferred in vehicle time. This space is normalised from 0 to 1 in both dimension. For simplicity both operators operate only one service per time period. Consumers will experience a costs for a deviation from their preferred arrival time. Waiting time at departure and arrival location will cause a disutility. Consumers will also experience a costs for in vehicle time. Equally, the in vehicle time and the waiting is assumed to be in this analysis to be linear. However, it should be noted that the height of the value of in vehicle and waiting time depends among others on the purpose of the trip, travel distances, the mode of transportation, the income of the passenger (Wardman 2001) and various quality aspects of the service (Seabright 2003). Also, the prices charged, the deviations from the preferred departure time and the in vehicle time, can be traded off against each other. This makes that the utility for a passenger for both lines can be represented trough the following formula:

B1. $u_i(1) = V - p_1 - w(1 - x_i) - vT_1$

B2. $u_i(2) = V - p_2 - w(x_2 - x_i) - vT_2$ if $0 \leqslant x_i \leqslant x_2$

B3. $u_i(2) = V - p_2 - w(1 + x_2 - x_i) - vT_2$ if $x_2 \leqslant x_i \leqslant 1$

V	the maximum willingness to pay,
p_n	the ticket fee,
w	the waiting time costs,
T_n	the in vehicle time
v	the in vehicle time costs.
n	represents respectively the conventional (1) and the high speed line (2)

Due to the nature of the high speed line, the in vehicle time of the high speed line is smaller than the in vehicle time of the conventional line and is exogenous of the model. Both operators use different production technologies. This difference is represented trough a different production costs. It is assumed that the production costs only has a fixed component in relation to the time of departure. This is because rail transportation is characterised by large fixed costs as the costs for rolling stock and the fixed concession fee. Variable costs related to the wearing of the tracks are left out as no variable price is paid to the infraprovider as indicated in the parliamentary proceedings. This means that the variable component can be taken out of the profit equation. Consequently, the profit function of both the high speed line and the conventional line can be represented trough the following equation:

B4. $\pi_n = p_n D_n - C_n$ where

π_i	the profit
p_n	the ticket fee,
D_n	the demand,
C_n	the fixed costs,
n	represents respectively the conventional (1) and the high speed line (2)

In line with van Reeven, the decisions of the rail concessionaires are represented trough a two-stage game. In the first stage both operators simultaneously determine their schedule and in the second stage the prices are determined. Prices are much easier to adjust that the travel schedules and require less time. These two stages are subgames of the overall game. Service patterns will only be stable if, in the overall game, the is a subgame perfect Nash equilibrium. Dynamic games are solved by backward induction and at stage 1, operators anticipate their optimal strategies for stage 2. These games are solved in reverse order. First the equilibrium prices are determined and after that the optimal schedule is determined including the effect of the prices.

Operator's demand can be calculated by equating the utility function of both the high speed line and the conventional line. This to calculate the indifferent passengers who get the same utility for the high speed line and the conventional line. This is:

B5. $\underline{T_2 - T_1} = \frac{p_2 - p_1 - w(1 - x_2)}{v}$ where $0 \leqslant x_i \leqslant x_2$

B6. $\overline{T_2 - T_1} = \frac{p_2 - p_1 + w x_2}{v}$ where $x_2 \leqslant x_i \leqslant 1$

It should be noted that equation 5. is smaller than equation 6. The difference of in vehicle time can be represented as the passengers preferred in vehicle time difference. As stated earlier this preferred difference of in vehicle time will be represented between 0 and 1. This makes that this equation can be graphically represented. This is shown in figure B1, where the area below the indifference curve represents the demand for the conventional line and the area above the indifference curve the demand for the high speed line.

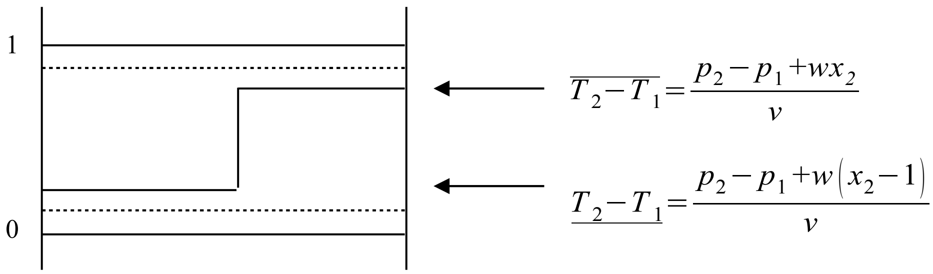

Figure B1, Representation of indifferent consumer

Analysis

As the area below the indifference curve equals the demand for the conventional line and the area above the demand for the high speed line. The demand of each line can be represented trough the following equations:

B7. $$D_1 = x_2 \frac{p_2 - p_1 + w(x_2 - 1)}{v} + (1 - x_2) \frac{p_2 - p_1 + w x_2}{v} = \frac{p_2 - p_1}{v}$$

B8. $$D_2 = x_2 \left(1 - \frac{p_2 - p_1 + w(x_2 - 1)}{v}\right) + (1 - x_2)\left(1 - \frac{p_2 - p_1 + w x_2}{v}\right) = \frac{v - p_2 + p_1}{v}$$

The demand of the high speed train (2) will rise if the ticket price of the conventional train rises, the ticket price of the high speed train lowers or the in vehicle costs lower. Visa versa, the same hold for the conventional train, apart a lower in vehicle costs will rise the demand for the conventional train too. Again equally to van Reeven the total demand does not depend on the moment of arrival of the departure. Hence, an operator has no incentive to change its location in reaction to the location of the competitor. These demands can be substituted into equation B4 for both concessionaires to calculate the resulting profits. These profits will be:

B9. $\pi_1 = p_1 D_1 - C_1 = p_1 \frac{p_2 - p_1}{v} - C_1$

B10. $\pi_2 = p_2 D_2 - C_2 = p_2 \frac{v - p_2 + p_1}{v} - C_2$

The next step is to maximise these profit in respect to ticket price. This is done by taking the derivative of the profit function in respect the ticket price. Equalling, this derivative to zero to calculate best response in respect to the ticket price. Also it has to be checked that the second derivative is smaller than zero to verify that it is a local maximum. This is shown by the following equations:

B11. $\frac{\partial \pi_1}{\partial p_1} = \frac{p_2 - 2\mathrm{p}_1}{v} = 0 \rightarrow p_1 = \frac{p_2}{2} \ , \frac{\partial \pi_1^2}{\partial p_1^2} = \frac{-2}{v}$

B12. $\frac{\partial \pi_2}{\partial p_2} = \frac{v - 2\mathrm{p}_2 + p_1}{v} = 0 \rightarrow p_2 = \frac{v - p_1}{2} \ , \frac{\partial \pi_2^2}{\partial p_2^2} = \frac{-2}{v}$

In both cases the found best responses are a local maximum as long as the in vehicle time costs are large than zero. As shown by Wardman (2001), in vehicle costs are for all passengers considerable large than zero. Substituting these best response curves into each other will yield into equilibrium ticket prices. This is shown be the next equations:

B13. $p_1 = \left(\frac{v - p_1}{2} \right) \frac{1}{2} \rightarrow p_1^x = \frac{1}{3} v$

B14. $p_2 = \left(v - \frac{p_2}{2} \right) \frac{1}{2} \rightarrow p_2^x = \frac{2}{3} v$

Equilibrium ticket prices for the high speed line will be twice as large as the equilibrium ticket price of the conventional line. Furthermore, the equilibrium ticket prices can be substituted back into the indifference curves.

B15. $\underline{T_2-T_1}=\left(\frac{2}{3}v-\frac{1}{3}v+w\left(x_2-1\right)\right)\frac{1}{v}=\frac{v-3\mathrm{w}\left(1-x_2\right)}{3\mathrm{v}}$ if $0\leqslant x_i\leqslant x_2$

B16. $\overline{T_2-T_1}=\left(\frac{2}{3}v-\frac{1}{3}v+wx_2\right)\frac{1}{v}=\frac{v+3wx_2}{3\mathrm{v}}$ if $x_2\leqslant x_i\leqslant 1$

By substituting these ticket prices into the profit function the equilibrium profits are found and by substituting these into the indifference curves the boundary conditions for this profit to emerge.

B17. $\pi_1^x,\pi_2^x=\frac{1}{9}v-C_1,\frac{4}{9}v-C_2$

if $v\geqslant 3\mathrm{w}\left(1-x_2\right)$ for $0\leqslant x_2\leqslant\frac{1}{2}$ and $v\geqslant 1.5\mathrm{w}\mathrm{x}_2$ for $\frac{1}{2}\leqslant x_2\leqslant 1$

These conditions are fulfilled for any $x_2\in[0,1]$ if $v\geqslant 3\mathrm{w}$, meaning that the difference of in vehicle cost should be significantly larger than the waiting costs, for a stable service pattern to emerge. Hence, sufficient differentiation is required. At this point we can go back to the Dutch case to consider the impact on the competition between the high speed and the conventional line. In table A3 the 2011 and 2012 values are provided on the travel time and waiting time. The difference between these in vehicle time and the range of waiting time are shown in the table B1. It is observed that the average waiting time in relation with the difference of in vehicle time in 2011 is relative small. In 2012 the difference increases. However, it remains unlikely that a stable service pattern will emerge as passengers valuate waiting time as significantly larger than in vehicle time (Wardman, 2001).

Year	**Difference in vehicle time**	**Average waiting time conventional line**	**Average waiting time high speed line**
2011	27 minutes	4 minutes	15 minutes
2012	34 minutes	7 minutes	10 minutes

Table B1, Difference in vehicle time and waiting time

Stability of service patterns abroad

On-route competition in railways is limited around the world. This makes that the judgement on the stability of the service patterns are difficult to assess. Countries were on-route competition is experienced are Germany, Great Britain and Japan. In Germany, there is insufficient evidence for a stable service pattern. Also, in England on route competition is too limited to make a proper judgement. Preston (2009) shows that completion had only emerged on niche routes which the incumbent operator has neglected. In Japan there no direct on a national level. On a regional level competition does exists. This competition is on route competition between Japan's former national rail service and regional private rail companies. This competition appears to be stable.

German contains insufficient evidence that stable service patterns do exist in railway competition. Multiple regional concessions are run by other companies than the main German railway company, Deutsche Bahn (Seguret, 2009). However, these concessions do not compete on a similar level, as the local lines do not serve interregional passengers. Also, some companies did attempt to compete directly. However, most of them failed to successfully operate their rail service, some stopped their operations after a short period. Only in the eastern part of Germany competing companies still operate. Seguret (2009) concludes that most of these operate on niche routes and at limited frequencies and thus cannot be distinguished as full competitors. Only on the route Leipzig Berlin Rostock competition is seen. The competitor, InterConnex, offers at significant lower ticket prices at an higher frequency of service and just slightly slower travel times. However, this line experienced a lot of schedule reorganisations to remain in operations. This could denote an unstable service pattern and certainly not a stable pattern.

In Japan local trains compete on route for local passengers. This competition appears to be stable. This stability appears to be the results of the high focus on punctuality and the vertical integration of passenger service, infrastructure and train stations. Delays larger than 5 minutes are compensated and the conductor apologises for the delay (Onishi, 2005). Furthermore, the vertical integration allowed Japanese railways to diversify on non schedule dimensions, to internalise on positive network effects (Seabright, 2003) and to minimise on route competition (Terada, 2001). An example of non service related product differentiations in the form of the ekiben. The ekiben is a railway boxed meal sold in trains and train stations. A large variety of ekiben are known in Japan and various lines and station are known for their special tasty ekiben (Noguchi, 1994). Positive network effects are captured by Japanese rail operators through their entrance of non rail businesses as the development of housing and retail near train stations (Seabright, 2003). Also, due to the vertical integration train stations are not shared, hence, passengers had to make an early decision on the preferred train service. Even more, till the year 2000 existing operators could block the construction for new railway stations near existing ones (Terada, 2001).

Conclusion

A game theoretic model showed that an unstable service pattern is likely to occur if the high speed line and the conventional line will compete. Foreign empirical evidence is lacking to prove of the existence of such unstable service patterns. However, this evidence is lacking not because stable service patterns do occur, but because apart some niche lines no direct competition between two lines do occur or rail lines found other ways to differentiate. Again this could be a signal that unstable service patterns do occur and that these are such short lived that no evidence can be extracted from them. The German and Japanese case provide in that sense some evidence.

Appendix C. Late start of service

In this appendix the late start of service is discussed. It is stated that in contrast to popular believe the misalignment of the multiple stakeholders' objectives was the main cause of delay in the start of the service over the reported technical difficulties. This misalignment can be observed particularly by the fact that most of the parties had no contractual incentives to deliver on time. In the following of this section, four occurrences of this stakeholder objective misalignment are presented. These are the compensation payments the Belgian railway company had to pay to compensate HSA, the start time of payments to the infraprovider, Prorail, the supply of the locomotives and the supply of the trains. Each of these four cases is presented in more detail below. The observed incentive for HSA not to speed up the start of service and; the compensation payments; can be found in chapter 3 and will not be discussed again here.

Belgium compensation payments

The compensation payments of Belgium were no incentive to speed up construction of the line. The Belgian state made a miscalculation on the estimated travel time between Antwerp and Brussels. Also, the construction works on the Belgian side were delayed. As a compensation for this delay the Belgian railway company had to pay a percentage of the revenue from the international high speed service on the new tracks till 2012. We cannot assess if the agreed fee fully covered the loss in income of HSA. However, we do know that this compensation reduced the profitability on the Belgian side. Also, the international service running over regular tracks remained in service. If the profit from the high speed line reduced by the compensation payments to HSA was smaller than the profit from the conventional line, we can even conclude that the Belgian railway company had an incentive to delay. However, no signals are found that this might have been the case.

Income infraprovider

The infraprovider Prorail received its payments independently from the usage of the high speed line. As shown earlier, the Dutch state decided to vertically and horizontally disintegrate the new high speed line from the conventional railway network. Furthermore, the construction of the high speed line was split in two, the substructure and superstructure of the line. The Dutch state was responsible for the construction of the substructure and Prorail for the superstructure. Prorail again subcontracted all of these works to infraspeed. Prorail and infraspeed started to receive its payments from 2006 onwards. The result was that these parties received their payments even when the lines were actually not used. Of course the Infraspeed and Prorail made costs during this period as a result of the construction of the line and the integration with the train safety system. However, it is likely that their costs would have been larger if the high speed line was in operation. Hence, their profits were likely larger when the line was not in service. This provided them thus an incentive not to speed up the start of operation on the line.

Supply of trains

The Dutch state required that the suppliers of the trains could not bid for the concession of the line. The concessionaire was responsible for the running and had to order the trains at a third party. The main reason for this decision was to achieve an equal playing field. This makes that the final negotiations on the supply of the trains could only start after the contract closure with the concessionaire. In a sense, this increased the time pressure to construct the trains and hence enlarges the possibility for a delay in start of service. Of course, this does not show that the incentives between HSA and its supplier were not aligned. However, the incentive not to speed up the production of the trains lays embedded in the fact that no joint venture was allowed. In this case the supplier of the trains had no financial incentives to the success of the line and hence could follow more its own agenda.

However, this requirement above does not completely explain the delay for the high speed line in the Netherlands. With a solid contract between HSA and its supplier, their preferences should be aligned. However, an additional argument can be found in the contractual misalignment in the contract between HSA and its supplier, AnsaldoBreda. Agreed was that AnsaldoBreda delivered the trains 9 month after the opening of the high speed line. Therefore, the delay of the opening of the tracks allowed them to deliver the trains even later. Even-more, AnsaldoBreda experienced technical difficulties with the delivery of trains to another client. This made that a delay in the opening of the high speed line eased their work. The main direct reason of this delay was again the technical difficulties with the train safety system.

Supply of locomotives

The supplier of the locomotives had an effort based contract. As it became apparent that the supply of the trains was significantly delayed, the Dutch state searched for a temporary solution. The chosen solution was to equip Bombardier locomotives with the new train safety system. The Angel train was selected to supply these locomotives. The contract made with this company was an effort based one. The state paid their supplier based on their hours spent instead of the result, the delivery of the locomotives. Thus, the more hours spent, the more income would be generated. Also, Bombardier and Angel train knew that their works were of temporary status, as works would end after the delivery of the trains by AnsaldoBreda. In this papers view, this provided two incentives: firstly, not to speed up the deliverance of the locomotives and secondly, to increase the technical difficulties to construct the trains by AnsaldoBreda. This last incentive would result in an increase of the time needed to deliver the trains and hence increase the use of the temporary locomotives. The fact that a newer version of the train safety system was implemented is an observed signal that Bombardier and Angel train increased the technical difficulties for AnsaldoBreda.

Reasons for the misalignment and conclusions

Reasons for the misalignment were not directly found in the parliamentary proceedings. However, the whole process of ordering the trains, locomotives and the construction of the high speed line was new for the Dutch state. More-so, the NS was just privatised and it was in a process of vertically disintegration. It is concluded that the sum of all these changes was too much to successfully align all interests.