Danish Ministry of Transport

Economic Assessment of a Fixed Link across the Fehmarn Belt

Summary Report

March 2004

COWI

in cooperation with

DANMARKS TRANSPORTFORSKNING

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1 Main conclusions

- A cable stayed bridge with 4 road lanes and 2 railway tracks across the Fehmarn Belt will very likely yield a net benefit for the European countries compared to a situation with continued ferry operation.

- An immersed tunnel with the same capacity will probably yield a net result around zero for the European countries. The reason is that it is more expensive to construct the tunnel than the bridge. Beyond this, benefits and costs of a bridge and a tunnel are essentially the same.

- The elements that influence the results most, are investment end operating costs of the fixed link, traffic volumes and traffic growth after opening of the fixed link.

- The main benefits of a fixed link are time savings for passengers and savings in ferry operation costs as well as saved costs of freight trains - due to reduced travel distance.

- There is a small environmental benefit of a fixed link, primarily caused by reduced air pollution and CO_2 emissions from the ferries.

- The main costs of a fixed link are the investment costs. But also the operating costs of the fixed link and investment costs of necessary railway infrastructure in Denmark and Germany are significant.

- Users from other countries than Denmark and Germany will obtain substantial benefits from a fixed link across the Fehmarn Belt. Approximately one fourth of the benefits in terms of time savings and savings in train freight distance can be allocated to citizens and companies in other countries than Denmark and Germany.

- Therefore, the profitability of a cable stayed bridge is less for Denmark and Germany alone than it would be for all the EU countries together, even though an EU grant of 10% of the investment costs is included as a benefit. It is, however, likely that the investment would still be profitable for Denmark and Germany. An immersed tunnel would probably give a net result slightly below zero for Denmark and Germany alone.

2 Introduction

2.1 Background

According to the Government's policy statement "*the Danish Government will in cooperation with the German Government prepare a decision on establishing a fixed link across the Fehmarn Belt*".

At a meeting between the Danish and the German Ministers of Transport in the spring of 2003, it was decided that a Danish-German working group on the Fehmarn Belt should consider organisational, financial, economic, technical and legal issues related to establishing a fixed link across the Fehmarn Belt.

As part of the preliminary investigations on a fixed link across the Fehmarn Belt in 1999, an economic analysis was carried out. The analysis was undertaken in cooperation with the German Ministry of Transport and it was based on German methodological recommendations.

However, the Danish Ministry of Transport found that there was a need for an analysis of the project based on the latest Danish methodological recommendations. It therefore decided to undertake a new economic analysis.

The Danish Ministry of Transport asked COWI in cooperation with the Danish Transport Research Institute to carry out the new economic analysis. The project was undertaken in the period July 2003 to January 2004.

This publication is the English summary of the Danish main report of the project.

2.2 Purpose

The purpose of the project was to carry out an economic analysis of a fixed link across the Fehmarn Belt. In the analysis, costs and benefits of establishing a fixed link were calculated in accordance with the latest Danish methodological recommendations and data in that area

The analysis comprises two technical solutions:

- A cable stayed bridge with 4 road lanes and 2 railway tracks (4+2)
- An immersed tunnel with 4 road lanes and 2 railway tracks (4+2)

An important aspect of the analysis is to determine to whom costs and benefits can be assigned. The analysis is therefore split as to whether costs and benefits can be assigned to Denmark, Germany or other countries. Based on this distribution the analysis has been carried out with three geographical perspectives:

- All countries
- Denmark and Germany
- Denmark

The three analyses are, for instance, relevant as a background for discussing the size of an EU grant to the fixed link.

The result of an economic analysis may constitute an important element in the decision process on establishing a fixed link, but it is important to underline that the result of the analysis cannot stand alone. First of all, the economic analysis is connected with uncertainty which makes the results sensitive. Secondly, the decision makers also have to take other issues such as distributional effects into consideration. Finally, there are some effects that cannot be quantified in an economic analysis.

3 Methodology

This section gives a short description of the scenarios analysed. Moreover, it presents the traffic model and the economic methodology analysis.

3.1 Scenarios

The economic analysis quantifies costs and benefits of two different types of fixed links across the Fehmarn Belt compared to a reference case. The reference case and the project alternatives are defined as follows.

Reference case
The reference case is defined by an infrastructure situation as it would be in 2015 and forward, if a fixed link across the Fehmarn Belt were not built[1].

The ferries on the Fehmarn Belt are rebuilt to a higher capacity and the frequency of the ferries on Gedser-Rostock and Trelleborg-Rostock is increased by one departure per day. It is assumed that the travel time is the same as the present travel time.

The Danish railway lines Vamdrup-Vojens and Tinglev-Padborg are upgraded to double tracks. The German railway line Neumünster-Bad Oldesloe is electrified and upgraded to double tracks with a maximum speed of 120 km/h.

Moreover, a number of improvements especially of railway infrastructure are made – e.g. upgrading of the railway line Copenhagen-Ringsted - but these are the same in the reference case and the project alternatives.

Project alternative 1: Cable stayed bridge (4+2)
Alternative 1 is defined as a fixed link across the Fehmarn Belt built as a cable stayed bridge with 4 road lanes and 2 railway tracks[2]. The fixed link is assumed to open in 2015.

The ferry supply is fixed at the same level as the summer of 2002 except for the route Rødby-Puttgarden, which would be closed when the fixed link opens. The

[1] The reference case is named *Reference Case B* in FTC, Nov. 2003: *Fehmarn Belt Forecast 2002 - Reference Cases.* November 2003.
[2] Both project alternatives are named *Base Case B* in FTC, Apr. 2003: *Fehmarn Belt Forecasts 2002. Final Report.* April 2003

price of using the fixed link is assumed to be equivalent to the price of using the ferry.

The Danish railway line Ringsted-Rødby is electrified and the railway line Orehoved-Rødby is upgraded to double tracks. In Germany, the railway line Puttgarden-Bad Schwartau is upgraded to double tracks, the railway line Bad Oldesloe-Ahrensburg is upgraded to three tracks and the railway line Ahrensburg-Hamborg-Wandsbek is upgraded to four tracks. Finally, the railway line Lübeck-Puttgarden is electrified[3].

Project alternative 2: Immersed tunnel (4+2)
Alternative 2 is defined as a fixed link across the Fehmarn Belt built as an immersed tunnel with 4 road lanes and 2 railway tracks. The remaining assumptions are the same as to those of Project alternative 1.

Necessary railway investments on land
As it appears, the need for upgrading the railway infrastructure on land is different for the reference case and the project alternatives. In the economic analysis, the railway infrastructure needs are based on those of the traffic model. This implies that the stated upgrading of the railway infrastructure is necessary in order to accommodate the traffic volumes in the reference case and the project alternative, respectively. If the railway investments were not undertaken, the traffic volumes, forming the basis of the economic analyses, could not be accommodated.

3.2 Traffic model

Construction of a fixed link across the Fehmarn Belt as a substitute to ferries will have implications for the traffic. The fixed link will reduce travel time thus making transport in the transport corridor more attractive. Therefore, a fixed link will promote traffic in the corridor and also transfer transport from other routes and between modes.

The level of traffic and the expected changes in traffic constitute a key element in the assessment of the project, because traffic volumes are the basis of the quantification of the economic costs and the benefits of the investment. Traffic volumes are analysed by means of a traffic model which consists of a mathematical modelling of the transport demand.

The model describes the available transport system in terms of road and railway networks as well as airline and ferry routes. The model contains data on travel patterns, transport costs and properties of the routes such as travel speed, user fees etc. The model is hence the tool for calculating expected traffic volumes on modes and travel patterns.

[3] It should be noted the railway investment on land as described in FTC, Nov. 2003 are not fully consist with those in BVU, 2003: *Traffic Study for the Øresund Corridor-Hamburg*. February 2003. The investment costs for Germany are based on the figures form BVU.

The applied traffic model is built specifically to model the traffic consequences of opening a fixed link across the Fehmarn Belt. It is an updated version of the model that was used in the analyses from 1999. The model covers the European continent, but it focuses on Eastern Denmark and Northern Germany[4].

The traffic model results in a traffic volume forecast for 2015 for the reference case and the project scenarios based on the present traffic level. In the forecast of the traffic to 2015, a number of assumptions have been applied. Besides the assumptions on ferry traffic and infrastructure projects described above, the main assumptions are:

- The tolls on the fixed link are the same as the fares on the ferries.
- A fixed link will imply changes in traffic patterns in Northern Europe - partly due to induced traffic partly due to changes in route and mode choices. The assumptions on transfer and growth are based on interviews and a number of assumptions on the development in the economic and demographic factors, e.g. the growth in GDP and population[5].

Moreover, the traffic prognosis is based on a number of assumptions on the future transport policy in the EU. For instance, the speed limits on the road network are assumed to remain unchanged[6].

The modelled traffic volumes are sensitive to the applied assumptions as well as changes in the attitude and preferences of the travellers as these are key input to the model calculations.

3.3 Economic methodology

The purpose of the economic analysis is to assess the economic benefits and costs of a fixed link across the Fehmarn Belt compared with continued ferry operation for society as a whole.

The applied method to quantification of the benefits and costs of a fixed link across the Fehmarn Belt is based on welfare theory. The methodological frame is the manual issued by the Danish Ministry of Transport (2003)[7] which is an implementation of the guide in economic assessments from the Danish Ministry of Finance (1999)[8].

The results of the economic analysis are presented as the net present value and the internal rate of return of the investment. The robustness of the result is as-

[4] See FTC, Nov. 2003.
[5] See FTC, Nov. 2003 (page 51).
[6] See FTC, Nov. 2003 (page 52).
[7] Trafikministeriet (2003): *Manual for samfundsøkonomisk analyse - anvendt metode og praksis på transportområdet.*
[8] Finansministeriet (1999): Vejledning i udarbejdelse af samfundsøkonomiske konsekvensvurderinger.

sessed on the basis of a number of sensitivity and risk analyses. Together with an assessment of the non-quantified effects these analyses form the basis for the overall assessment and conclusion of the project.

Key elements
The following elements are included in the economic analysis:

- *Investment costs*: For the fixed link and for the necessary railway investments on land.
- *Operating costs of the fixed link.*
- *User benefits*: Time savings and changes in vehicle operating costs distributed on benefits for existing users as well as new and transferred users.
- *Environmental costs:* Including air pollution, noise and accidents.
- *Revenue from the fixed link.*
- *Consequences for other operators:* Including railway track managers, railway operators, the Great Belt Bridge and the Øresund bridge.
- *Duties, subsidies and tax distortion.*

The above elements are traditionally the key elements in analyses of transport investments, and they are considered decisive as to whether a fixed link is economically profitable. Besides the above elements, a fixed link may also have other effects such as reduced barrier effect, increased perceived risk, loss of undisturbed nature, inconvenience during construction etc. These effects are not included as it has not been possible to quantify them.

Finally, a possible dynamic effect due to increased employment is not included. This is in accordance with the Danish manual. A separate project is being carried out by the Danish Ministry of Transport on this aspect.

Key figures
The analysis applies Danish unit costs and Danish values to the physical effects. This means that values for passenger and freight traffic of other nationality is assumed to be similar to Danish traffic. The following table summarises the key methodological assumptions.

Table 3.1 Overview of key methodological assumptions

Parameter	Assumption
Overall method	Market price method based on a welfare theoretic foundation
Planning horizon	50 years (a scrap value for the fixed link is included at the end of the period)
Discount rate	6%
Tax distortion factor	20%
Net duty factor	17%
Traffic growth	Growth is included for 2015-2040. For following years traffic is assumed constant. The growth in traffic is based on assessments from the Danish Ministry of Transport.
Distribution of benefits for freight transport between origin and destination country	Assumed 50%/50%
Time values	Danish Unit Cost Catalogue
Real growth in time values	Same as expected growth in GDP. The recommendation of growth in GDP from the Danish Ministry of Finance until 2010. From 2011 1,8% p.a.
Valuation of air pollution	Danish Ministry of Transport
CO_2 price	16 €/ton
Vehicle operating costs	Danish Unit Cost Catalogue
Costs of accidents	Danish Unit Cost Catalogue
Price level	Fixed 2003 prices
Forecast of prices and costs	Average annual inflation
Year of result	2015

Method applied in the 1999 economic analysis

As mentioned earlier, an economic analysis of a fixed link across the Fehmarn Belt was carried out in 1999. The analysis was carried out in cooperation with the German Ministry of Transport and it was based on prevailing German methodology for economic assessment at that time.

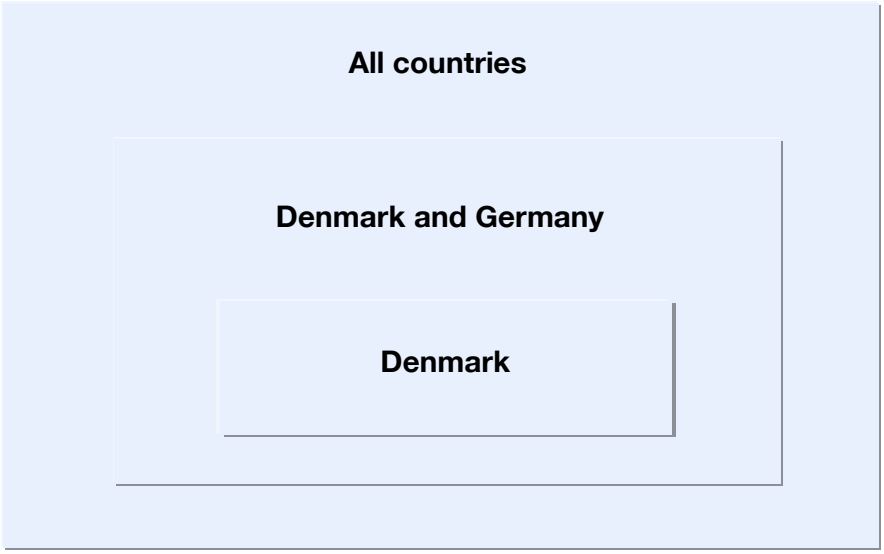
The methodology of the 1999 analysis differs on a number of areas from the present Danish methodology. Among other things the analysis was based on the factor price method, unit costs were the prevailing German values, a discount factor of 3% was applied and growth in traffic was only applied in the years 2015-2025. Moreover, regional employment effects were included in the analysis.

4 Economic results

The results of the analysis are presented with the following geographical perspectives:

1. Analysis covering effects for all countries
2. Analysis covering effects for Denmark and Germany
3. Analysis covering effects for Denmark

Figure 4.1 Geographical perspective of the analysis



First, the results for all countries are presented and then similarities and differences vis-à-vis the other two analyses are discussed.

The results are presented with focus on a cable stayed bridge (4+2) and it is described how an immersed tunnel (4+2) differs, because most benefits are similar for the two solutions. The traffic volumes for the two technical solutions are identical, because the capacity is the same.

4.1 Analysis covering all countries

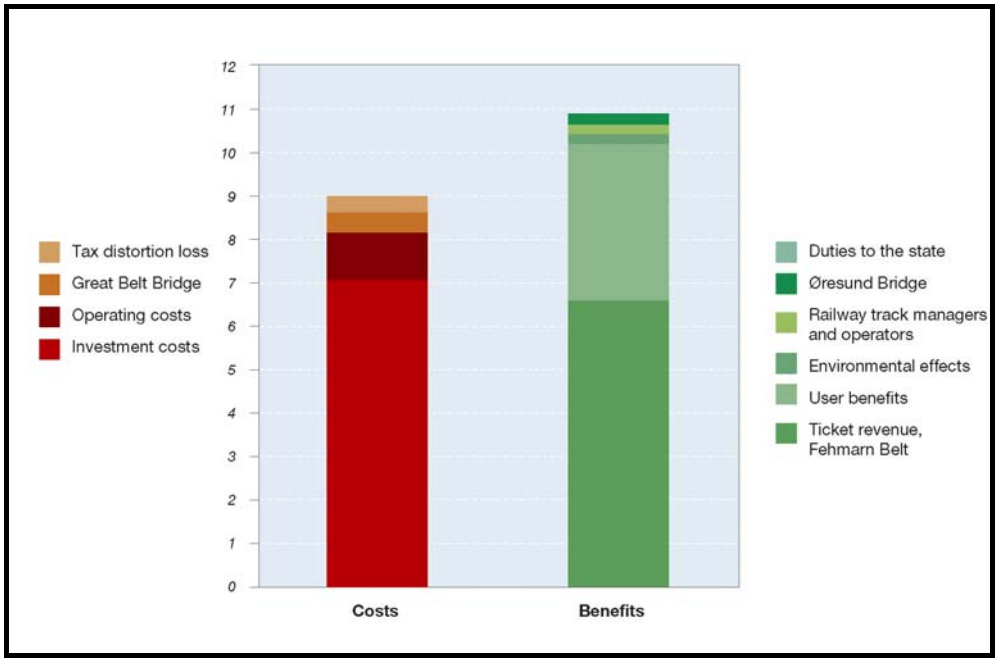
Construction and operation of a cable stayed bridge (4+2) across the Fehmarn Belt results in a total net benefit of approx. 1.9 billion € over a 50 year period[9]. The internal rate of return of the project is 7.0%.

The result is the best estimate. It is based on a number of assumptions on investment and operating costs on the one hand, and effects for society on the other.

On the basis of sensitivity analyses, the results for all countries are found to be relatively robust. Total costs have to increase by 22% in order for costs to exceed benefits.

The results for the best estimate are shown in the figure below.

*Figure 4.2 Economic result for a **cable stayed bridge** (4+2), **all countries**, net present value in billion € in year 2015, 2003 prices*



The total costs imposed by cable stayed bridge (4+2) are shown in the left part of the figure above and benefits are shown in the right part of the figure.

The total costs add up to approx. 9 billion € in net present value in year 2015 in 2003 prices. The figure shows that the largest cost item is naturally the investment in the bridge and necessary railway infrastructure on land followed by the operating costs. Then comes the loss of revenue on the fixed link on the Great

[9] Net present value in year 2015 in fixed 2003 prices.

Belt Bridge, which is primarily caused by the reduced number of freight trains. Finally, there is a small tax distortion effect[10].

The total benefits add up to approx. 10.9 billion € in net present value in year 2015 in 2003 prices. In the analysis covering all countries, an EU grant is not included because it is both paid for and received by the EU thus making the net effect zero.

For the governments, the financial benefits measured in market prices (i.e. ticket revenue, effects for the railway track managers and railway operators as well as the effects on the Great Belt Bridge and the Øresund Bridge) cover in total 80% of the financial costs measured in market prices (i.e. investment costs, operating costs for the fixed link and related investment in railways in Denmark and Germany).

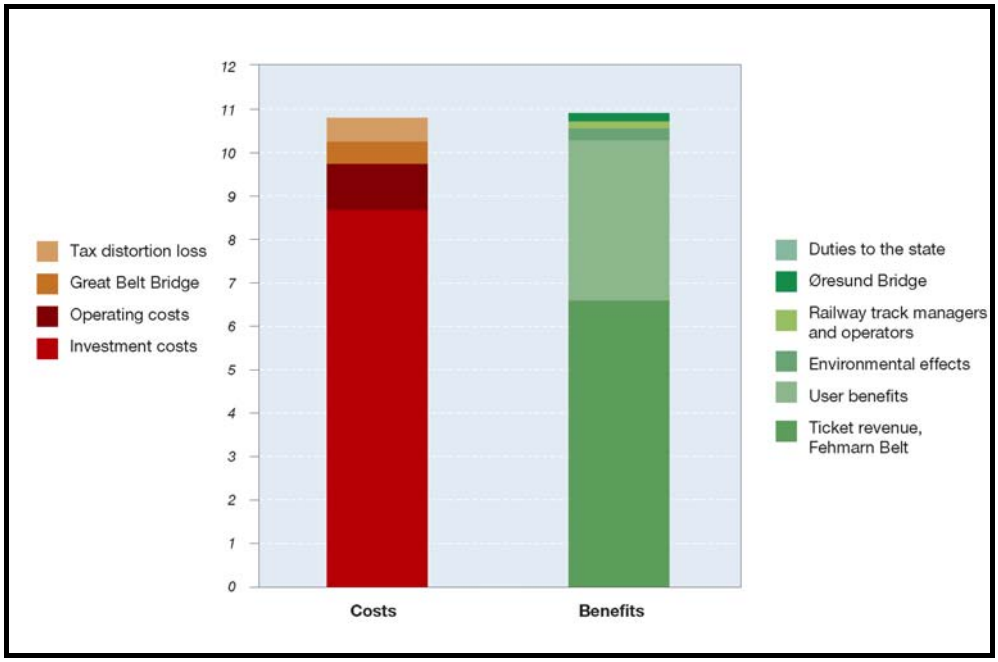
The largest benefit for the fixed link is ticket revenue[11].

Secondly, there is a substantial benefit for the users in terms of time savings but also saving of vehicle operating costs. The remaining benefits are minor. They include a net benefit for the environment, benefits for railway track managers and railway operators, increased revenue for the Øresund Bridge and, finally, a small effect on duties to the state.

Immersed tunnel (4+2)
The results for the immersed tunnel (4+2) show an economic result of approximately zero. The immersed tunnel is more expensive to build than the cable stayed bridge and the increased costs are not compensated for by increased benefits. Costs and benefits are shown in the figure below.

[10] The tax distortion effect is added to all net costs for the state, because they are typically financed by taxes. The reason is that, for instance, income tax increases the salary for the employer and decreases the income for the employee. Therefore, the general expectation is that the supply of manpower is smaller than in the case without income taxes.
[11] The ticket revenue is included as a benefit in the economic analysis. It is assumed that the loss of revenue from ferry operation corresponds to the saved costs of ferry operation. In this case the ticket revenue from a fixed link corresponds to the saved costs of ferry operation for existing passengers. The revenue from new passengers should also be included as a benefit because it is assumed that these passengers alternatively to a fixed link would use a ferry.

*Figure 4.3 Economic results for the **immersed tunnel** (4+2), **all countries**, net present value in billion € in year 2015, 2003 prices*



The total costs are approx. 10.8 billion €, which is about the same as the total benefits of 10.9 billion €. The benefits are exactly the same as the benefits for the cable stayed bridge.

Non-quantified effects

There are a number of effects which cannot be quantified in the analysis, either because they cannot be quantified in physical terms, or because they cannot be monetarised. The most important non-quantified effects are found to be the following:

- A possible above normal profit on the ferries
- A willingness to pay for the bridge experience in itself, an aversion against a tunnel, willingness to pay for a ferry experience
- Inconvenience during construction
- Poorer access to the bridge than the tunnel due to wind conditions
- Value of time for goods
- Effects of road wear and tear from passenger cars
- Effects for travellers on other routes

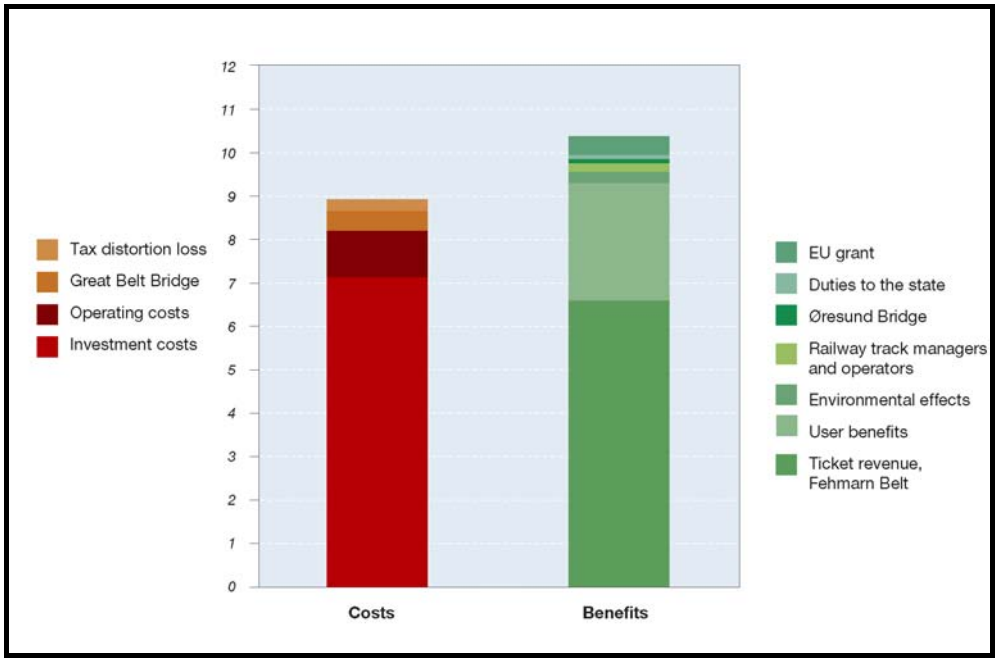
Naturally, it is difficult to assess the impact on the result of the non-quantified effects, because they are not monetarised. Based on a qualitative assessment of the impact of each effect it is nevertheless found that the overall impact of the non-quantified effects is relatively limited. The non-quantified effects should therefore be assigned very high weight in order for the result of the economic analysis to be affected.

The partial analyses have many similarities and few differences compared with the analysis covering all countries.

4.2 Partial analysis for Denmark and Germany

The figures below show the results for the cable stayed bridge (4+2) for Denmark and Germany together.

*Figure 4.4 Economic results for the **cable stayed bridge** (4+2), **Denmark and Germany**, net present value in billion € in year 2015, 2003 prices*



The total benefits decrease from the 10.9 billion € in the analysis covering all countries to 10.4 billion € in net present value in 2015 in 2003 prices for Denmark and Germany.

The total costs are more or less the same: 8.9 billion €, because Denmark and Germany finance the investment and the operation of the fixed link. This implies a net present value of approx. 1.5 billion € and an internal rate of return on 6.9%.

Compared with the analysis covering all countries there are basically two differences:

- The user benefits decrease
- The EU grant is included as a benefit

The total user benefits for all countries amount to approx. 3.6 billion €. Of this, benefits for Danish and German users amount to approx. 2.7 billion €. The remaining approx. 0.9 billion € (26%) are benefits for users from other countries than Denmark and Germany. Even though the distribution of freight traffic on countries is somewhat uncertain, there is no doubt that users from other countries than Denmark and Germany benefit from the fixed link. The benefits are mainly time savings, but also savings in travel distance, especially for railway transport.

The other difference compared to the analysis covering all countries is that an expected EU grant is included as a benefit in the partial analyses. It should be noted that at present a decision on an EU grant has not been taken, and the size of such a grant, if any, is therefore unknown. However, it is thought to be likely that the project would obtain a grant, because the Fehmarn Belt link is considered a key element of the Trans European Network.

Based on the assessment of the Danish Ministry of Transport, the EU grant has been set at 10% of the investment. The average payments of Denmark and Germany to the EU of 2.1% and 25.1%, respectively, have been deducted. This implies that an EU grant of approx. 0.4 billion € is included in the partial analysis where only effects on Denmark and Germany are included.

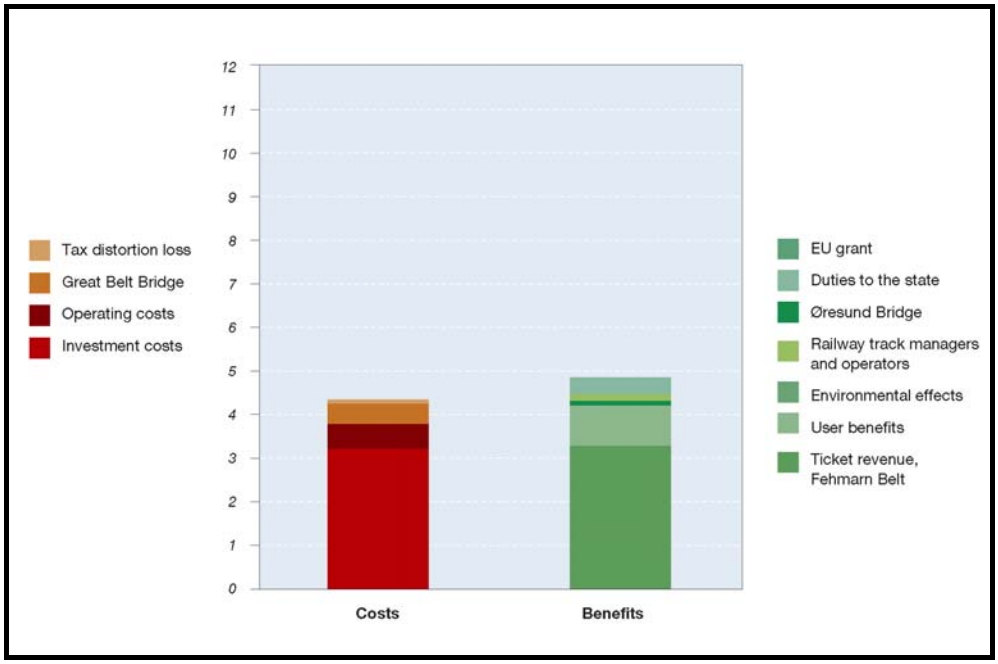
The EU grant is less than the non-included benefits for citizens of other countries. Therefore, the conclusion of the results for Denmark and Germany are a little less positive than the results for all countries – even with the EU grant of 10%. Assuming that the citizens from other countries all come from the EU, this would imply that the EU grant should be larger than 10% based on a fairness assumption in order to compensate Denmark and Germany for building and operating a fixed link.

If the EU grant is 18% then the internal rate of return is the same for the analysis covering all countries as the analysis covering only Denmark and Germany.

4.3 Partial analysis for Denmark

Below, the results for the cable stayed bridge (4+2) are shown for the partial analysis for Denmark.

*Figure 4.5 Economic results of the **cable stayed bridge** (4+2), **Denmark,** net present value in billion € in year 2015, 2003 prices*



The total costs are approx. 4.3 billion € corresponding to half of the costs in the Danish/German analysis. However, the total benefits are 4.9 billion € corresponding to a net present value of 0.6 billion €. The internal rate of return is 6.8%.

If the analysis is compared with the analysis for Denmark and Germany, it is seen that both costs and benefits are approximately halved. This shows that Denmark and Germany share the costs of the fixed link and the ticket revenues. There are, however, differences for the following five elements:

- The loss on the Great Belt Bridge
- The benefits of the Øresund Bridge are not allocated to Germany
- The user benefits are more than halved
- Investments in railway infrastructure on land are bigger in Germany than in Denmark
- More than half of the EU grant is allocated to Denmark due to the reduction from own payments

The loss on the Great Belt Bridge of approx. 0.5 billion € in net present value affects only Denmark. Therefore, the costs are a little higher in the analysis for Denmark relatively. At the same time the user benefits decrease by more than 60% which is due to the fact that user benefits for Germans are higher than user

benefits for Danes. There is some uncertainty related to the distribution of user benefits for freight transport, which implies that this conclusion is less robust.

On the other hand, the investments in railway infrastructure on land are double in Germany compared to those in Denmark. Moreover, the benefit of increased traffic on the Øresund Bridge is allocated to Denmark (and Sweden). And, finally, as the Danish contribution to the EU is much less than the German contribution, only 2.1% is deducted. These effects pull the result in the other direction.

The overall effect on the result of the analysis for Denmark is that the internal rate of return is of the same magnitude as the rate of return for the analysis covering both Denmark and Germany. This result is somewhat lower than the result of the analysis covering all countries.

4.4 Detailed results

The detailed results for the three analyses are presented in the table below.

*Table 4.1 Detailed economic results for the **cable stayed bridge** (4+2), billion €*

NPV in year 2015 in 2003 prices	**All countries**	**Denmark & Germany**	**Denmark**
Investment costs	-7.1	-7.1	-3.2
Operating costs	-1.1	-1.1	-0.5
Financial costs in total	**-8.2**	**-8.2**	**-3.8**
Time saving	2.9	2.2	0.9
Vehicle operating costs	0.7	0.4	0.1
User benefits in total	**3.6**	**2.7**	**1.0**
Ticket revenue, The Fehmarn Belt fixed link	6.7	6.7	3.3
Great Belt Bridge	-0.5	-0.5	-0.5
Øresund Bridge	0.2	0.1	0.1
Railway track manager	0.1	0.2	0.1
Railway operator	0.1	0.0	0.0
Operating consequences in total	**6.5**	**6.5**	**3.1**
EU grant	**0.0**	**0.4**	**0.3**
Duties to the state	**0.0**	**0.1**	**0.0**
Tax distortion, net	**-0.3**	**-0.2**	**-0.1**
Environmental effects	**0.3**	**0.2**	**0.1**
Costs in total	-9.0	-8.9	-4.3
Benefits in total	10.9	10.4	4.9
Net present value (NPV) in total	1.9	1.5	0.6
Internal rate of return	7.0%	6.9%	6.8%

Distribution of user benefits on modes
The time savings and savings in vehicle operating costs for all countries are all together 3.6 billion €. The table below shows how these benefits are distributed on modes.

Table 4.2 Time savings and savings in vehicle operating costs divided on modes, all countries, billion €

NPV in 2015 in 2003 prices	**Road**	**Rail**	**Total**
Passenger	2.5	0.2	2.7
Freight	0.3	0.6	0.9
Total	**2.8**	**0.8**	**3.6**

The table shows that passenger traffic obtains the largest share of the benefits. Approx. 26% of the benefits can be allocated to freight traffic, the majority of which come from railway traffic.

Environmental effects
The environmental effects are primarily caused by the facts that the Fehmarn Belt ferry line is closed and that the total distance driven is increased.

The air pollution avoided from ferries is far higher than the extra air pollution due to increased kilometres driven. Below, the result for each of the environmental effects is shown. The total benefit is approx. 250 million €.

Table 4.3 External effects, all countries, million €

Effect	*NPV in 2015 in 2003 prices*
Air pollution	215
CO_2	43
Noise	0
Accidents	-5
Total	**252**

The air pollution costs distributed on modes are presented in the table below.

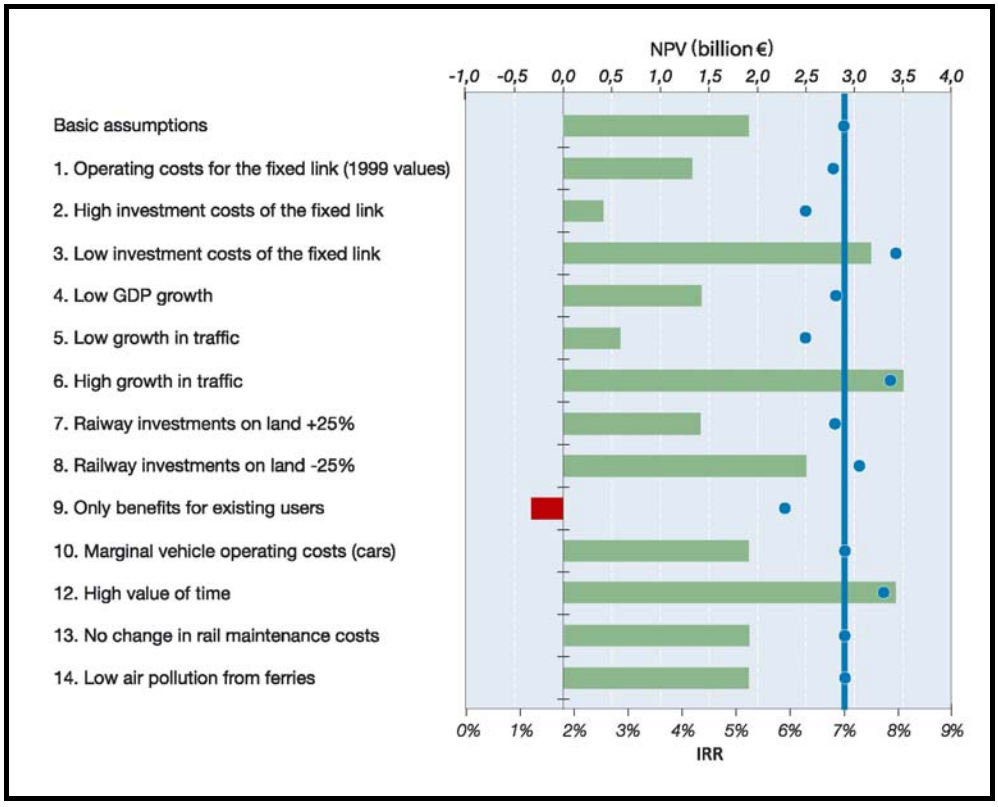
Table 4.4 Air pollution, all countries, million €

Mode	NPV in 2015 in 2003 prices
Passenger car	-10
Bus	0
Train (passenger)	-13
Ferry	215
Truck	12
Train (freight)	5
Combi (rail)	6
Total	**215**

Sensitivity and risk analyses

The following figure presents the sensitivity analysis for the analysis covering all countries.

Figure 4.6 Results of the sensitivity analyses, net present value in year 2015, 2003 prices (columns) and internal rate of return (dots), cable stayed bridge (4+2), all countries



The figure shows that even with relatively strong changes in assumptions, e.g. an increase of investments of 25%, the net present value remains positive.

The only analysis showing a net present value below 0 is the analysis where only benefits from existing passengers on Rødby-Puttgarden, who use the same

means of transport, are included. The analysis can be interpreted as a sensitivity analysis on traffic volumes. The analysis is, however, estimated to give a substantial underestimate of the effects, because a fixed link will naturally attract traffic from other routes.

It can hence be concluded that the positive net present value is relatively robust towards partial changes in assumptions.

Moreover, a Monte Carlo simulation (risk calculation) has been undertaken. In that analysis the three key elements that affect the results the most have been changed. The three elements are growth in traffic, investment costs (including land based railway infrastructure) and operating costs of the fixed link.

The Monte Carlo simulation shows that the risk of the net present value being less than 0 - given certain assumptions on the key elements – is approx. 7% in the analysis covering all countries. The probability that the result is positive is therefore relatively large, when the three key elements in the analysis are changed simultaneously in a Monte Carlo simulation.