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Economy-wide benefits

Dynamic and Strategic Effects of a Fehmarn Belt Fixed Link

Report prepared for the Ministry of Transport, Denmark
and the Federal Ministry of Transport, Building and Housing, Germany
by Copenhagen Economics Aps and Prognos AG, June 2004

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Preface

This report has been prepared by a team of experts consisting of Claus Kastberg Nielsen, Jesper Jensen and Martin Hvidt Thelle from Copenhagen Economics Aps in Denmark (with the latter as a project leader) and Olaf Arndt, Monika Waluga and Kai Gramke from Prognos AG in Germany.

The work of the experts has been subject to external quality assurance by Dr. Johannes Bröcker from Christian-Albrechts University, Germany and by Dr. Torben Holvad from Transport Studies Unit, University of Oxford. We are thankful for their comments and we have integrated these in the report. We are also thankful for suggestions and comments from Dr. Michael Gasiorek from University of Sussex, UK.

The work of the expert team has been carried out in close contact with a steering committee headed by Mr. Jørn Holdt from the Danish Ministry of Transport. The German Federal Ministry of Transport, Building and Housing and the Danish Ministry of Transport jointly financed the project with the financial support from TEN.

The views expressed in this report are those of the authors and they are not necessarily shared by the steering committee.

Model documentation and other details of the study are reported in a Technical Report available from the author.

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June 2004

Please note that we use the common German-Danish text standard to use commas "," as decimal separators and period "." as thousands separator. Thus 1/10 is written as 0,10 and one thousand is written as 1.000.
Throughout the report we use an exchange rate of 7,44 Danish kroner to 1 euro.

Summary

Building a fixed link across the Fehmarn Belt[1] can benefit economic growth and increase welfare in many ways. Current users of the ferries can benefit from a faster and more flexible transport service. A faster and more flexible transport connection can also attract new users and increase the frequency of existing users. The improvements in transport services can furthermore foster regional integration leading households to commute more, to shop more across borders and they may even want to migrate across the border. Finally, firms can benefit from better accessibility to foreign markets leading to higher sales, and it may induce them to reorganise their business and regroup some of the activities in the geography. Lower transport costs imply more trade and more production.

We have chosen to look more closely at one of these issues, namely the economy-wide benefits from increased trade and relocation in the transport using sectors of the economy (i.e. goods transport). The motivation for this choice is two-fold: Firstly, the dynamic and strategic effects from trade and delocalisation of firms are believed to be among the economically most significant ones. Secondly, analytical tools for a sound and robust analysis of these issues have been developed over the last few years. Together this enables us to analyse important benefits from large transport infrastructure investments that hitherto have been neglected – not because they are irrelevant or insignificant – but because the tools for measuring the impact of these benefits simply weren't available.

This report focuses on the dynamic effects in goods transport. The dynamic and strategic effects are the wider economic effects in terms of increased productivity and more competitive markets that are not included in a traditional cost-benefit analysis of a transport infrastructure investment (e.g. time savings and environmental impact). A cost-benefit analysis is a standard framework, which is intended to aid decision-making in the public sector. A pure cost-benefit analysis involves the enumeration and valuation in monetary terms of all the costs and benefits, to whomever they accrue, over the life of the project being evaluated. In this analysis the additional benefits associated with the dynamic effects are assessed.

The idea can be illustrated by a simple equation postulating that the total economic benefits from an infrastructure investment is the sum of the benefits accounted for in a cost-benefit analysis and the benefits occurring from the dynamic and strategic effects:

Benefits measured by cost-benefit techniques

+

Dynamic and strategic effects

=

Total economic benefits

[1] The Fehmarn Belt fixed link between Germany and Denmark is currently considered to replace the ferry service between Puttgarden (D) and Rødby (DK) by 2015. The link is planned to be part of the trans-European network (TEN) and the Van Miert Report from 2003 includes it as a priority for future infrastructure investments in Europe.

According to a recent cost-benefit analysis for the Danish Ministry of Transport by Cowi (2004) the construction and operation of a cable stayed bridge across Fehmarn Belt results in a total net benefit of approximately 1,9 billion euros (14,4 billion Danish kroner) over a 50 year period.

A fixed link across Fehmarn Belt will have many dynamic and strategic effects, of which only some have been quantified. The welfare gains that have been quantified have a present value of 0,4 billion euros (3 billion Danish kroner) calculated on the basis of 50 years[2]. The welfare gains are due to increased competition, increased production and lower costs. One source of welfare gains is that a fixed link implies a reduction in transport costs for supplies that use the fixed link. In turn this implies that the costs of supplying goods abroad decreases. For example, the costs of supplying machinery produced in Denmark and sold in Germany decrease. The lower costs imply more trade and higher production. This is one source of welfare gains.

The largest growth effects in relative terms are found close to the fixed link. The regions of Lübeck and Kiel in Germany get a share of the dynamic effects from the Fehmarn Belt that is about 4 times as high as their regional shares of German GDP[3]. And the region of Lolland-Falster in Denmark gets a share of the Fehmarn Belt effects that exceeds its share of Danish GDP by more than a factor of 4. These regions are in relative terms the most affected regions in Europe from the fixed link across the Fehmarn Belt.

In addition to the quantifiable effects, the following five effects are identified as having regional economic effects related to a fixed link across Fehmarn Belt:

- Effects in the construction phase
- Tourism
- Commuting
- Migration
- Shopping

The dynamic and strategic benefits materialise because of increased trade, increased competition and increased productivity. The benefits accrue to the final consumers and companies through lower prices and a more varied supply of goods and services. It is important to mention that the direct gains in the cost-benefit analysis, Cowi (2004) include benefits for all users of the link (irrespective of nation), whereas in our spatial computable general equilibrium model of the dynamic and strategic effects we report the main results related to the three regions: Germany, Denmark and the other Nordic countries (Sweden, Norway and Finland).

In order to obtain a more complete picture of the total benefits of the project, we argue that the above benefits should be added to the direct benefits accounted for in a traditional cost-benefit analysis (CBA). We use a methodology designed to avoid double counting of the benefits. We

[2] The estimation of the dynamic and strategic effects is of course subject to uncertainty. The effect of increased competition and increased productivity can be estimated at between approximately 0,3 and 0,6 billion euros (between 2 and 4 billion Danish kroner). The values are present value in 2015 by the use of a discount rate of 6% and at the 2003 price level. Appendix E of the Technical Report document how we calculate the present value.

[3] The factor of the relative gain for a region in e.g. Germany is calculated as follows: first we calculate the region's gain from the Fehmarn Belt fixed link from Bröcker (1999). We then divide this gain by the total gain from the fixed link for all German regions. This gives us the region's share of the total national gain from the fixed link. Next we calculate regional shares of GDP. This is simply done by dividing the regional GDP by total German GDP. Finally, we divide the regional share of the Fehmarn Belt fixed link gains by the regional share of GDP: for example if a region gets a share of 0,8 percent of the fixed link effect and only has a share of 0,2 percent of regional GDP, then our ratio of relative gain is a factor of 4 (calculated as 0,8 divided by 0,2).

derive a so-called *total benefit multiplier,* which is calculated consistently within the model as the ratio of the total economy-wide benefits[4] over the direct benefits.

The dynamic effects are estimated from a computable general equilibrium model (CGE-model) built by Copenhagen Economics[5]. The model is constructed along the lines of a model built by professors Venables and Gasiorek[6] for the UK standing advisory committee on trunk road assessment (SACTRA). The same kind of CGE-model is used for evaluating the dynamic effects of infrastructure investments for the European Commission's regional funds[7]. We also compare our model results with recent research in Germany and the Netherlands[8]. Especially research by Dr. Johannes Bröcker underlines the importance of including the general equilibrium effects in analyses of larger transport infrastructure investments[9].

How do the dynamic and strategic effects arise?

Copenhagen Economics has grouped the dynamic and strategic effects in two:

1. More trade leading to **increased competition** and **lower prices**
2. Business dynamics via location of new firms leading to **increased productivity** and **lower costs**

The first effect (*increased competition)* covers the gains that arise as a consequence of Nordic firms obtaining improved access to compete against firms in Germany (and the rest of the continent) and vice versa. Firms will find that it is easier to sell goods on the other country's home market, and thus dominant positions on the home markets are gradually reduced. This is a socio-economic gain and it is analysed in the report, under the heading *pro-competitive* effect.

One reason why imperfect competition exists is that the firms produce differentiated products (e.g. the consumer regards Danish and German beers as different varieties) and the consumer sees it as an added value to have several choices of product varieties (e.g. beer brands and types[10]). This means that each firm has a small amount of market power, which it can use to increase prices to above marginal costs[11].

The second effect is called "*increased productivity"* and concerns for example cost savings achieved by relocating and reorganising the firms as a consequence of the improved connection between the Nordic countries and the continent[12].

These effects occur when economies of scale exist in the production. That is to say, larger companies can produce at a lower unit cost than smaller companies. Production can be

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[4] We use the terms "economy-wide effects" and "dynamic and strategic effects" synonymously. We estimate values of the so-called short-run total benefit multiplier of 1,25 and a long-run total benefit multiplier of 1,52, as shown in Chapter 2.

[5] The report is based on analyses using a general equilibrium model of Germany and the Nordic countries. The model ("*the Copenhagen Economics New Economic Geography model*" – called the CENEG-model) incorporates the effects of decreasing transport costs in a situation with economies of scale and imperfect competition.

[6] See Venables & Gasiorek (1998).

[7] See Venables & Gasiorek (1996).

[8] See both Oosterhaven & Kaap (2003) and Oosterhaven & Elhorst (2003).

[9] See Bröcker (1999).

[10] There is an article by Goldberg & Knetter (1999) in which they explicitly examine market power in certain markets, and for certain products – one of which is beer. However beer might not be the best example regarding the ongoing debate on the special Danish legislation for deposit on beer bottles. This "technical/political" barrier is of a much higher magnitude than the marginal transport cost.

[11] In economic terms we are dealing with a model with monopolistic competition as in modern trade theory à la Dixit-Stiglitz and as in models of the 'new economic geography' strand of literature.

[12] Increased productivity can also come from other sources than cost savings. For example business travel can play a major role in knowledge diffusion, which can have a positive (as well as negative) effect on the rate of growth, see for example Baldwin *et al* (2003) chapter 17.

reorganised in larger units and thereby cover a larger geographical area from the same location. If there are economies of scale in expanding production from the present level (which there is in some, but not all sectors) the traffic investment will mean lower production costs, and in turn a socio-economic gain in the form of increased productivity (i.e. you can produce the same amount of goods at a lower total cost).

Why are the dynamic and strategic effects additional?

The dynamic and strategic effects are additional to the standard cost benefit analysis[13]. The most apparent reason is that the specific cost benefit analysis, Cowi (2004) and the traffic forecast, FTC (2003) do not consider changes in trade volumes as a result of the fixed link[14]. On the contrary, our analysis estimates *how much* trade between Germany and the Nordic countries will change due to the reduction in trade costs that the fixed link represents.

Furthermore, the dynamic and strategic effects should be viewed as an addition to the CBA benefits, because they represent real term improvements for companies and consumers and because they can be evaluated on a solid theoretical and empirical basis.

The theoretical explanation for adding these benefits is that in a standard cost-benefit analysis of traffic investments, it is assumed that the market price is a correct measure of the socio-economic marginal costs, and that this reflects the full welfare-economic advantages of the traffic project in question. If this assumption is correct, the cost-benefit analysis will wholly explain the total socio-economic advantages and disadvantages.

However, there are many reasons why this may not be the case in the real world, and this analysis focuses on one of these reasons – i.e. the existence of imperfect competition within the sectors using the transport link[15]. Thus, the analysis quantifies the inferred socio-economic effects of an improved traffic connection between Germany and Denmark that are not included in the traditional cost-benefit analysis. These effects are called the "strategic and dynamic" effects of the Fehmarn Belt fixed link.

Further analyses can reveal additional dynamic and strategic effects

First of all we consider the potentially large savings in overall logistics costs seem unaccounted for in the studies to date. In order to initiate studies of this we carried out simulations of additional transport cost reductions using professional transport management software[16]. The results show that the indirect cost savings from better transport planning with a fixed link is in the same order of magnitude as the direct cost savings (reduced transport time). In other words, just looking at the saved salary for the driver (plus fuel costs and depreciation when driving across the link) only shows about half of the actual savings that (large) firms will gain from the fixed link. This is certainly the case where timely delivery and short lead times are essential (i.e. in modern just-in-time (JIT) approaches to production). More studies are certainly needed to understand these issues better, before such benefits can actually be added as social economic gains. We also stress the important role of threshold effects, whereby companies will only initiate restructuring if the cost savings are sufficiently large.

Second and finally, additional business travel may imply additional benefits. For example, more visits by German engineers to Danish clients may improve the profitability of engineering

[13] We use an internally consistent methodology, see appendix B of the Technical report.

[14] However, it is not generally the case that cost-benefit analyses ignore the increase in traffic flows as a result of transport improvements.

[15] While there is only one way to be perfect, there are many ways to be imperfect. We consider the impact of transport costs and increasing returns to scale at the plant level. Together these create an economic trade-off between market proximity and production concentration that makes location choices non-trivial – also known as the "folk theorem of spatial economics", according to Scotchmer & Thisse (1992).

[16] *Route-planner* developed by Transvision, see www.transvision.dk.

consulting firms in Germany and improve knowledge diffusion in Denmark. Better knowledge diffusion may in turn induce higher economic growth. Again, detailed studies are warranted to quantify this effect. Also, complementary regional policies aimed at business networks may be important to realize these gains. Currently, only five daily flights connect Copenhagen to Berlin[17] with a short 50 minutes airtime. A fixed link with direct train connections could increase the frequency of rail transport and possibly reduce the travel costs.

Regional impacts
Growth effects from a fixed link across Fehmarn Belt will spread as far North as Örebro in Sweden (700 km North of the new link, and 200 km directly West of Stockholm) and as far South as to the region of Hessen in Germany (600 km South of the new link). The growth effects in Denmark will appear in the Eastern part of the country (Zealand and Lolland-Falster).

The largest growth effects in relative terms are found close to the fixed link. The regions of Lübeck and Kiel in Germany get a share of the dynamic effects from the Fehmarn Belt that is about 4 times as high as their regional shares of German GDP[18]. And the region of Lolland-Falster (Storstrøms Amt) in Denmark gets a share of the Fehmarn Belt effects that exceeds its share of Danish GDP by more than a factor of 4. These regions are in relative terms the most affected regions in Europe from the fixed link across the Fehmarn Belt.

Within Germany the regional impacts of the Fehmarn Belt fixed link are primarily found in the regions of Schleswig-Holstein and Hamburg. These two regions each represent about 3-4 percent of total German GDP, but they are each likely to gain a share of the German dynamic effects from the fixed link of respectively 9 and 11 percent. The region of Mecklenburg-Vorpommern is also likely to be positively affected by the fixed link in absolute terms, but to a lesser extent than Hamburg and Schleswig-Holstein.

The regional distribution of the dynamic and strategic effects within Denmark shows that the Eastern part of the country (the regions of Zealand and Lolland-Falster) is the most affected regions. Other regions in Denmark (Funen and Jutland) remain virtually unaffected by the fixed link. One explanation of this is that the transport connections in these regions will not be altered as a result of the fixed link since they will continue to use the Jutland-corridor.

Within Sweden, Norway and Finland the gains from the dynamic and strategic effects are most prominent in Southern Sweden[19]. However, the size of the relative gain is smaller than in the regions in Denmark and Germany.

The regions in Northern Germany, the Eastern part of Denmark and Southern Sweden gain from the fixed link. Other regions are unaffected from the fixed link. They are neither worse nor better off after the fixed link than before.

Structure of the report

Chapter 1 introduces the dynamic and strategic effects from large infrastructure projects. We also give a brief introduction to the methodology and introduce key concepts. In **Chapter 2** the

[17] With Scandinavian Airlines from Kastrup Airport to Tegel Airport. As of May 2004 the low cost airline EasyJet has opened a route from Copenhagen to Berlin.

[18] The factor of the relative gain for a region in e.g. Germany is calculated as follows: first we calculate the region's gain from the Fehmarn Belt fixed link from Bröcker (1999). We then divide this gain by the total gain from the fixed link for all German regions. This gives us the region's share of the total national gain from the fixed link. Next we calculate regional shares of GDP. This is simply done by dividing the regional GDP by total German GDP. Finally, we divide the regional share of the Fehmarn Belt fixed link gains by the regional share of GDP: for example if a region gets a share of 0,8 percent of the fixed link effect and only has a share of 0,2 percent of regional GDP, then our ratio of relative gain is a factor of 4 (calculated as 0,8 divided by 0,2).

[19] The region "Southern Sweden" consist of the Swedish NUTS-3 regions (län): Malmöhus, Kristianstad, Blekinge, Halland and Kronoberg.

selected effects come under close scrutiny. We quantify the effects using two different economic models: one at a national scale and one at a regional scale. In **Chapter 3** we provide our analysis of the so-called logistics effects. Finally, in **Chapter 4** the dynamic effects that have materialised from other major infrastructure investments are compared with the expected dynamic effects from a Fehmarn Belt link. We compare the results with the Great Belt link in Denmark, the Øresund link between Denmark and Sweden and the Eurotunnel between England and France.

Chapter 1 Economy-wide benefits of infrastructure investments

1.1. Purpose of the study

This report is the result of the Danish Ministry of Transport's call for tender with the following title: *Analysis of dynamic and strategic effects of a Fehmarn Belt fixed link*. The main purpose of the requested study as described in the terms of reference is to analyse: *"The expected impact on employment, competition, location choice of businesses and economic growth…"* of a Fehmarn Belt fixed link. The study shall focus on "…*the dynamic effects associated with tying the Øresund, Hamburg and Berlin regions closer together".*

1.2. What do we mean by dynamic and strategic effects?

We use the terms "dynamic and strategic effects" and "economy-wide effects" synonymously. By dynamic and strategic effects we understand the economic effects in terms of increased productivity and more competitive markets that are not included in traditional cost-benefit analysis of a transport infrastructure investment (e.g. time savings and environmental impact). The idea can be illustrated by a simple equation postulating that the total economic benefits from an infrastructure investment is the sum of the benefits accounted for in a cost-benefit analysis and the benefits occurring from the dynamic and strategic effects:

Benefits measured by cost-benefit techniques

+

Dynamic and strategic effects

=

Total economic benefits

1.3. Selection of effects for quantification

Below we list a number of effects that are usually not treated in a traditional cost-benefit analysis (CBA). These effects can loosely be labelled as dynamic and strategic effects:

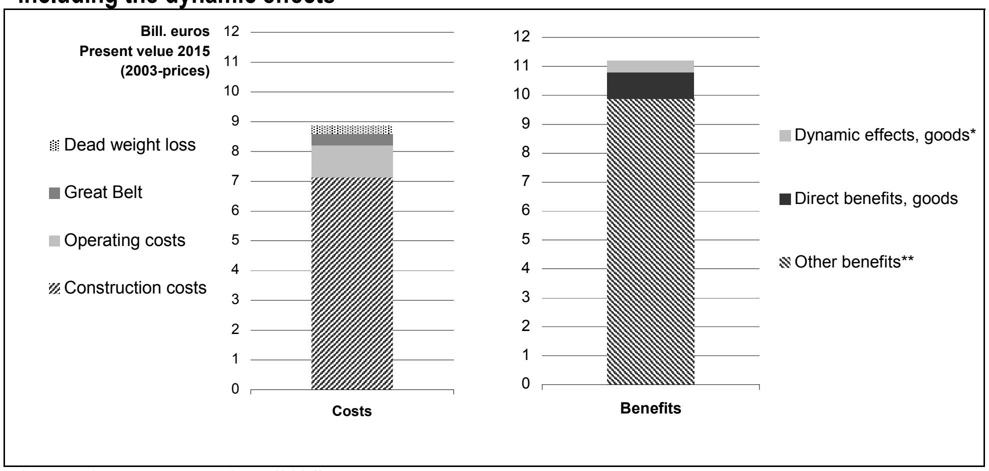
- Economic gains from further integration of the goods markets

- Logistics effects
- Tourism
- Commuting
- Migration
- Shopping
- Effects in the construction phase

Out of these seven effects we only quantify the effects of the first two. The other five effects are not discussed further in this analysis.

The focus of this report is to model the economic gains from further integration of the goods markets that is introduced by a fixed link across the Fehmarn Belt. We therefore apply sophisticated modelling tools to a more narrow part of the total benefits. We look at the wider economic effects of the transport cost reductions in goods transport (for both rail and road transport). In other words we look at the two upper boxes in the right side of Figure 1.1 and we use our efforts on estimating the size of the light grey box in the figure (the top).

Figure 1.1: Costs and Benefits for a cable stayed bridge (4+2)[20] across Fehmarn Belt including the dynamic effects



Source: Own results and Cowi (2004).

Note: Benefits for all countries are included. *) Dynamic effects only include Germany, Denmark and other Nordic countries. **) Other benefits include benefits from both goods and passenger transport, e.g. toll revenues, rail operator's revenue, environmental effects and increased use of the Øresund link. These benefits and the direct goods benefits (i.e. transport cost savings) are reported in Cowi (2004). The left-hand side of the figure shows the costs as reported in Cowi (2004). These include the constructions costs, the costs of operating the fixed link, the loss of toll revenue on the alternative route via the Great Belt link, and finally the dead weight loss.

The estimation of the economy-wide effects of increased integration of the goods market is based on the direct cost estimates for goods transport in the cost-benefit analysis, Cowi(2004). This part of the analysis is found in Chapter 2.

Our analysis also point to additional cost savings because of the so-called logistics effects. These are additional cost reductions that are not included in the model in Chapter 2. We quantify the importance of some of these logistics effects in Chapter 3. First we turn to the methodological foundations for our model-based analysis in Chapter 2.

[20] 4+2 means a fixed link with 4 road lanes and 2 railway tracks.

1.4. Analytical framework

In this section we briefly introduce the analytical framework for the quantification of the dynamic and strategic effects[21]. We also define the key element in the study: *The total benefit multiplier*. This multiplier is the ratio between the total benefits in the general equilibrium model and the direct benefits measured in a partial cost-benefit analysis (CBA) with perfect competition. Therefore our analysis departs from standard CBA and from standard perfect competition theory.

Cost-benefit analysis is a standard framework, which is intended to aid decision-making in the public sector. A pure cost-benefit analysis involves the enumeration and valuation in monetary terms of all the costs and benefits, to whomever they accrue, over the life of the project being evaluated. There are well-established appraisal techniques for assessing the costs and benefits of transport changes. Economists have repeatedly demonstrated that, in a *perfectly* competitive economy, a fully specified cost-benefit analysis would capture all the economic impacts of a change to the transport system.

However, markets are not perfectly competitive. Where some degree of monopoly power is prevalent in the market, firms will – as usual - charge prices to maximise profit, but these prices will be higher than under perfect competition. In a similar manner, if markets before the construction of the infrastructure project are small, it may not be possible to reap economies of scale and prices will again be larger than need be. Under these circumstances, and provided prices in the transport sector reflect marginal social cost, an infrastructure project that opens the small local market to wider competition may bring prices down, stimulate employment, spur economically advantageous relocations and, in turn, generate economic growth and potentially significant gains in social welfare. In this case the traditional cost-benefit analysis may in many cases underestimate the total benefits of the infrastructure project[22].

In order to measure the additional benefits associated with such dynamic effects it is important to use an internally consistent analytical framework that enables the analyst – within the same framework - to calculate both traditional CBA-based measures of (costs and) benefits as well as the broader measure of benefits including the dynamic gains. If this is the case, the risk of double counting, that is including some effects both in the CBA-measure and in the dynamic measure, will be significantly reduced.

We use such an internally consistent analytical framework for this study. The same framework has previously been used to evaluate the dynamic effects of large infrastructure project for SACTRA[23] in the UK, see Venables & Gasiorek (1998). The analytical framework is based on general equilibrium theory and it incorporates all major linkages between the transport sector and other sectors. It also allows for imperfect competition in some or all sectors. The degree of competition in each sector is taken from an OECD-study of price-cost margins by production sector[24].

[21] A more detailed description of the methodology is given in appendix B of the Technical Report. The model we use is described in detail in appendix D of the technical report.

[22] Often having prices equalling social marginal cost is not the case in the transport sector, due to externalities. However, this problem is not serious in a Danish appraisal context where at least local air pollution and noise are taken into account in the transport CBA.

[23] Standing Advisory Committee on Trunk Road Assessment.

[24] The degree of competition are measured by price-cost margins (i.e. the ratio of price over marginal costs) – the lower the price-cost margin the more competitive. See Martins *et al* (1996). This represents an extension of the model by Venables & Gasiorek, which assume uniform price-cost margins across sectors.

Chapter 2 Trade, productivity and relocation

In the last decade, the use of spatial computable general equilibrium (SCGE) models for assessing the economic impacts of transport projects has become one of the key items on the research agenda for project appraisal, worldwide. These models are particularly suitable for analysing the dynamic and strategic effects of transport projects through linkages between the transport sector and the wider economy (i.e. the permanent indirect effects on the transport using sectors). Potentially, according to the literature, these impacts can turn out to be up to 40 percent in magnitude of the direct benefits[25] measured in traditional cost-benefit analyses in terms of transport cost reductions and time savings. However, there is no general indication that indirect effects are always of this magnitude - this has to be proven on a case-by-case basis[26]. There can be cases where the total benefit multiplier (TBM) is lower than 1, also noted in SACTRA (1999).

After applying a state-of-the art SCGE model to the appraisal of the Fehmarn Belt fixed link transport investment, we find a central estimate of such dynamic and strategic effects (in the short run) in the order of 25 percent of the direct benefits for goods transport measured in traditional cost benefit analyses (in other words we find short run TBM = 1,25 in the Fehmarn Belt case). Multipliers in the long run – allowing for entry and exit – are higher, at around 1,50. These extra economic gains relate to the direct benefits for goods transport only[27].

At the same time we strongly underline that the exact specification of the spatial equilibrium model can lead to different results in terms of assessment of impacts. Our systematic sensitivity analysis shows that the total benefit multiplier in the Fehmarn Belt case can be up to 1,78 (long-run) or as low as 1,18 (short run).

2.1. Introduction to the model

The model applied is a general equilibrium model equivalent to the DREAM model used by Statistics Denmark and the MobiDK-model in the Danish Ministry of Economics and Business Affairs. The model has been adjusted to the present situation of the Fehmarn Belt, as in Venables and Gasiorek (1998) and the analysis of large-scale traffic investments as in SACTRA (1999) and Bröcker (1998a). The model is documented in annex D in the technical report.

General equilibrium models are increasingly used as part of the decision making process in political decisions of significant socio-economic interest. For example, this type of model has been used to assess the climate policy of Denmark, see Finansministeriet (2003), and the type of model has also been used to illustrate the long-term consequences of immigration in Denmark.

[25] This is the same as saying that the total benefit multiplier (TBM) is in the order of 1,40.
[26] We refer to appendix A for a literature survey of the link between infrastructure investments and the economy.
[27] The eventual extra benefits of transport cost reductions for passenger transport are discussed in chapter 3.

This is the first application of this type of model within the transport sector in Denmark. This type of model has been used in analyses of infrastructure investments in Germany[28], the Netherlands, the UK and by the EU Commission. Also, CGE-modelling has been adopted in various EC funded research projects, e.g. TRENEN II STRAN and IASON. The Danish Transport Research Institute (DTF), among others, also recognise that this type of model can be used to analyse the wider economic consequences of traffic investments[29].

2.2. Key results from the model

The Fehmarn Belt fixed link will integrate the markets of Germany and Denmark more closely. The same applies to the German market and the markets in other Nordic countries (Sweden, Norway and Finland via the Danish-German link). However, these markets are already closely integrated[30] via existing links (ferries from Denmark to Germany and from Sweden to Germany, but also by road and rail connections via the Danish-German border) and the Fehmarn link is therefore an improvement to an already integrated market for manufactured and intermediate goods.

The dynamic and strategic impacts of the new transport link will therefore be moderate compared to the overall economy for several reasons. Firstly, the link only affects part of the total trade volume (other trade links remain unchanged). Secondly, the toll for crossing the fixed link will remain at the level of the current ferry service (and therefore the major transport benefit is timesaving and increased flexibility). As shown in the technical annex D transport costs are reduced by around 2 percent because of the fixed link[31]. Furthermore, when taking in to account that transport costs only represent a small fraction of the total cost of supplying product in the foreign market also adds to explaining why the welfare gains are small in relative terms[32]. Thirdly, important sectors of the economy are not modelled in our analysis of the new link[33] and we underline that the benefits quantified here only covers the *dynamic and strategic effects related to goods transport*, and that these benefits are additional to the benefits accounted for in the cost-benefit analysis.

For the above reasons it is not surprising that the welfare gains modelled in this analysis are small measured in percentage change of the total welfare. However, small shares of very large numbers also matter. In monetary terms the dynamic and strategic effects represent gains of approximately 400 million euros or approximately 5 percent of the total costs of the investment[34].

The relative welfare improvements of the Fehmarn Belt fixed link that we estimate here are in the same order of magnitude as found in other studies of transport infrastructure investments

[28] For example Bröcker (1998) includes an evaluation of the motorway from Dresden to Prague.

[29] DTF (Danmarks Transportforskning) is a research institute under the Danish Ministry of Transport. See the report by Fosgerau, Mogens and Tine Lund Jensen. (2003), *Economic Appraisal Methodology – controversial issues and Danish choices*, Ministry of Transport Denmark and a working paper by Munk, Knud Jørgen (2001), *The construction and use of CGE models for transport policy analysis Discussion paper,* Danmarks Transportforskning.

[30] For example Germany is the most important trading partner for Denmark. This applies to both the import and the export. The share of German suppliers in Danish imports remained stable at 22 percent in the course of the last decade.

[31] The technical annex also show large variations in how much transport costs are reduced according to the type of goods and the distance travelled.

[32] Results in the technical annex A document that the total cost of supply (i.e. production costs + transport costs) generally only decreases by 0,03%. Certain products with high transport costs and low productions costs (like e.g. wood products and paper products) experience higher reductions in percentage terms (up to 0,5% of total cost of supply for transports between Denmark and Germany).

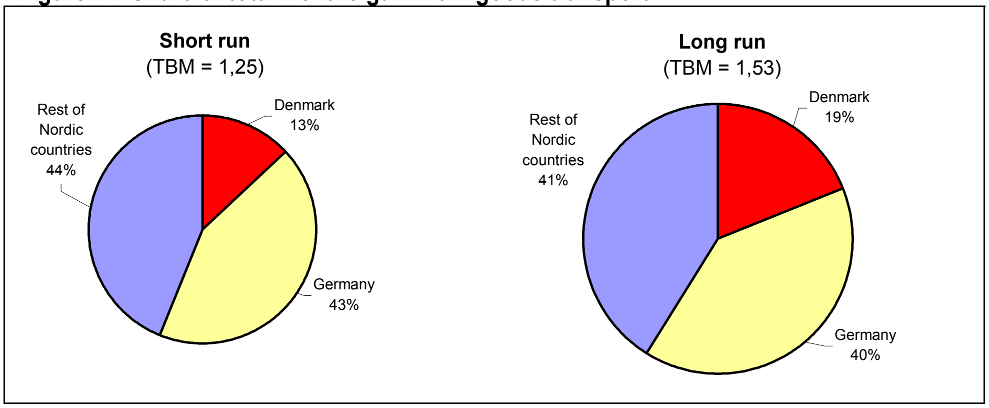
[33] Most services, which account for more than 70 percent of GDP, are not traded across borders.

[34] This is the total present value of the dynamic and strategic effects over 50 years discounted back to year 2015 and reported at the 2003-price level for Denmark, Germany, Sweden, Norway and Finland.

where a similar methodology and model have been applied, see Venables and Gasiorek (1996) in their evaluation of EU-financed infrastructure projects in Spain and Portugal.

We distinguish between short run and long run effects. In the short run (1 to 5 years after the opening) the transport cost reduction lead to more trade, but the number of firms will remain unchanged. In the long run (after approximately 10 years) new firms have entered in sectors with high profits and exited from sectors with low profits. When new firms enter a sector they add a new variant of the product in the sector. This leads to the dynamic effects in the long run.

Figure 2.1 Share of total welfare gain from goods transport



Source: Copenhagen Economics results from the CENEG-model

Note: The total welfare gains are measured in terms of changes in equivalent variation from base case B, FTC (2003).

Denmark will obtain 13 percent of the total welfare gain in the short run and 19 percent in the long run. Around 40 percent of the welfare gain will go to the German economy in both short and long run. The same is the case for the three other Nordic countries (Sweden, Finland and Norway) taken together[35].

Short-run effects

The fixed link implies a reduction in transport costs for supplies that use the fixed link. In turn this implies that the costs of supplying goods abroad decreases. For example, the costs of supplying machinery produced in Denmark and sold in Germany decrease. The lower costs imply more trade and higher production. This is one source of welfare gains.

In sectors where production takes place with increasing returns to scale, this yields profits to firms as they produce more without incurring more fixed costs of production. This is a second source of welfare gains.

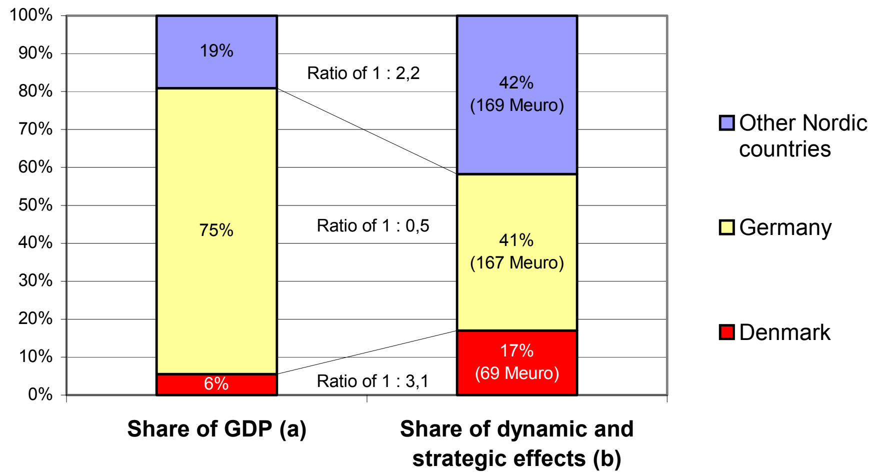
The higher production in increasing returns sectors also benefits consumers as these sectors generally provide a sub-optimal level of output. This is a third source of welfare gains.

In relative terms, Denmark and the other Nordic countries gain most, cf. Figure 2.2. In the case of Denmark, this is due to the openness of the Danish economy. The Danish economy relies more on exports and imports and thus gains more from reductions in transport costs. This is the main explanation why Denmark obtains 17,0 percent of the dynamic and strategic effects (when short and long run results are combined) while the country only represents 5,6 percent of the total GDP in the five economies in the analysis. The ratio of these two shares is 3,1,

[35] The analysis only covers the Nordic countries and Germany. A fixed link will also affect other countries, e.g. Poland, but we consider these effects negligible.

which is the highest of the three regions in the analysis. Therefore, in relative terms, Denmark has the highest gain in welfare from the dynamic and strategic effects.

Figure 2.2 Welfare gains from dynamic and strategic effects of a Fehmarn Belt link



Source: Copenhagen Economics results from the CENEG-model

Notes: a) Calculated as the share of total GDP in the three regions in the analysis. Other Nordic countries include Sweden, Finland and Norway. b) Calculated as the share of welfare gains measured in terms of changes in equivalent variation from without case. Both short and long run effects are included. This is explained in the Technical annex. M euros = million euros.

The other Nordic countries gain 42 percent of the dynamic and strategic effects while they only represent 19 percent of GDP. This gives a ratio of 2,2. Therefore in relative terms the other Nordic countries are also winners. The gain to the Nordic countries is partly due to the openness of the economies and partly due to the relative big reduction in transport costs on trade links with Germany.

The positive effect of the Fehmarn Belt fixed link on Germany's total economy is relatively small, but this is mainly due to the size of the German economy. As shown in the following sections, the North-German regions gain just as much as the Nordic countries in relative terms.

Long-run effects

The higher profits in the short-run attract more firms. This increases competition, and the markets will have a wider variety of products. Denmark gains relatively more from this: It not only gains from the direct reductions in transport costs on its own imports and exports, it also gains from being supplied with more varieties in other sectors.

We now turn to the explanation of the nature of these results. We distinguish between two effects. The first effect *increased productivity* concerns e.g. cost savings achieved by relocating and reorganising the firms as a consequence of the improved connection between the Nordic countries and the continent. These effects occur when economies of scale exist in the production. That is, larger companies can produce at a lower unit cost than smaller companies. At the same time there is the possibility that economies of scale could lead towards market concentration (though depending on the minimum efficient scale, MES).

The second effect is called *increased competition* and covers the gains that arise as a consequence of the Nordic countries obtaining improved access to compete against businesses in Germany (and the rest of the continent) and vice versa. Firms will find that it becomes easier to sell goods on the other country's home markets, and thus dominant positions on the home markets gradually disappear. This is a socio-economic gain and it is analysed in the report, under the heading the *pro-competitive* effect[36].

2.3. Pro-competitive effects

Imperfect competition implies that prices exceed marginal costs. The transport link improves the intensity of competition between firms on the two sides of the transport link. Firms located at one end of the transport link find it easier to sell in the home region of firms located at the other end of the transport link, such that market power on local markets is eroded. This suggests that reductions in transport costs may reduce market power and price mark-ups. Reduced prices tend to expand firms' sales in all regions, that is, their home region and their export region, and this pro-competitive effect of transport cost reductions becomes a source of an output expansion and a welfare gain.

One reason why imperfect competition exists is that the firms produce different products (e.g. the consumer regards Danish and German beers as different varieties) and the consumer sees it as an added value to have several choices of product varieties (e.g. beer brands and types). This means that each firm has a small amount of market power, which it can use to increase prices to above marginal costs[37].

The socio-economic value in the short run is obtained by summing the change in consumer surplus and in profits. This can be substantially greater than the simple CBA calculation. The ratio between the welfare gain and the CBA-gain is a multiplier. Thus, a multiplier of 1,25 implies that the true welfare gain of a project is 25 percent larger than the economic gain calculated by standard cost-benefit analysis.

Table 2.1 shows the short run effects from scenarios with a fixed link. The middle row of Table 2.1 corresponds to the central case in the cost benefit analysis by Cowi (2004). In this scenario the transport costs are reduced corresponding to the reduction predicted in the traffic forecast by FTC (2003).

The economic gain from such a reduction in transport cost implies an increase in total production value of 32,5 million euros (~240 million DKK) annually when measured as in the standard cost-benefit analysis. Counting the dynamic and strategic effects in the CENEG-model with imperfect competition and increasing returns to scale the total welfare gain in the short run, from the same transport cost reduction, amounts to 40,5 million euros (~300 million DKK) annually. Thus, the TBM equals 1,25 derived as the total welfare gain divided by the CBA-gain.

The other two rows of Table 2.1 serves to show a key property of this kind of spatial and dynamic general equilibrium models, namely the fact that the total benefit multipliers are very insensitive to the size of the transport cost reduction.

The reduction in the first row is half the reduction of the central case, and can be assumed to set a lower bound to the size of the reduction. The reduction in the bottom row is 1½ times the reduction in the central case and is assumed to represent an upper bound for the realistic transport cost reductions. This upper bound can be interpreted as the reduction in transport costs if we value the reduction in overall logistics costs (i.e. timesaving that could lead to lower warehouse and inventory costs, as well as reduced risk of delays). However, half the transport reduction (or 1½ times the reduction) is chosen arbitrarily with the sole purpose of demonstrating, that the TBM-value we derive is not just a result of a carefully chosen size of

[36] The attentive reader will already have noted that if you assume in advance that the markets have perfect competition (as is the case in the traditional cost-benefit analysis), the pro-competitive effect will equal zero.
[37] In terms of economics, it is a model with monopolistic competition as in modern trade theory à la Dixit-Stiglitz.

the transport cost reduction. Thus, neither the upper, nor the lower row of Table 2.1 should be taken as other rough estimates of likely span on the size of the transport cost reduction, and the key point is that even if we are not 100 percent sure about the size of the transport cost reduction we can still make use of the TBM-values derived from the CENEG-model. For further sensitivity analyses we refer to Section 2.6.

Table 2.1 Short run socio-economic effects of the Fehmarn Belt fixed link

	Short run		
Size of the transport cost reduction	**ΔCBA** MEURO	**ΔWS** MEURO	**TBM = ΔWS/ΔCBA**
Small transport cost reduction (half of FTC)	18,0	22,4	1,247
Central case (FTC)	32,5	40,5	1,245
Large transport cost reduction (1½ times FTC)	47,1	58,6	1,245

Source: Copenhagen Economics, CENEG-model

Note: Annual effects. CBA: Direct gain to transport users; WS: Total welfare gain in short run; TBM: Total benefit multiplier. MEURO = million euros.

The total benefit multiplier (TBM) from this table can in principle be used in combination with any other CBA analysis, since it gives an internally consistent estimate – avoiding double counting – of the size of the dynamic and strategic effects relative to the conventional CBA.

As is apparent from the results, the multiplier is rather independent of the level of transport cost reductions. This result is in line with the original work by Venables and Gasiorek (1998). Moreover the value of the estimates is comparable to the results in Venables and Gasiorek (1998). We should also mention that Newbury (1998) considers the TBM to be lower than Venables and Gasiorek (1998).

2.4. Relocation and productivity gains

With economies of scale in production, an improvement of the traffic connection can result in changes in firm location, the structure of their stocks, and their transportation and distribution systems. Production can be reorganised in larger units and thereby cover a larger geographical area from the same location. If there are economies of scale in expanding production from the present level (which there will be in some trade sectors, but not in all of them) the infrastructure investment will mean lower production costs, and in turn a socio-economic gain in the form of increased productivity (i.e. you can produce the same amount of goods at a lower total cost).

Increased productivity can also occur because of the so-called *cluster-effects* where manufacturers, specialised subcontractors and associated research institutes can obtain advantages by being located in the same geographical area. A fixed link can increase both the probability that new clusters occur and increase the advantages of the existing clusters in the regions around the fixed link. With respect to this, it is important that the bridge connects the four high-level tech agglomerations: Berlin, Hamburg, the Øresund Region and Stockholm. However, the clustering argument is not essential to our argument or to the aggregate results in terms of welfare gains.

Table 2.2 shows the long run effects from transport cost reduction scenarios as in Table 2.1. The gain calculated by a standard cost-benefit analysis is the same as in the short run. However, the welfare gains in the long run increase to 49,4 million euros annually in the central case (up from 40,5 million euros in the short run). As a result the total benefit multiplier increases to a level of 1,52.

Table 2.2 Long run socio-economic effects of the Fehmarn Belt fixed link

	Long run		
Size of the transport cost reduction	**ΔCBA** MEURO	**ΔWL** MEURO	**TBM = ΔWL/ΔCBA**
Small transport cost reduction (half of FTC)	18,0	27,4	1,523
Central case (FTC)	32,5	49,4	1,521
Large transport cost reduction (1½ times FTC)	47,1	71,6	1,521

Source: Copenhagen Economics, CENEG-model

Note: Annual effects. CBA: Direct gain to transport users; WL: Total welfare gain in long run; TBM: Total benefit multiplier. MEURO = million euros.

The long run multiplier is independent of the level of transport cost reductions. This result is also found in the short run as well as in other studies, Venables and Gasiorek (1998).

2.5. Modelling the transport costs

The reductions of transport costs due to the Fehmarn Belt fixed link is deducted from the latest forecast by FTC (2003). The saved transport costs correspond to the direct gain as analysed in the model (ΔCBA). We consider only the direct gain related to the trade between the three regions in our model (Denmark, Germany and other Nordic countries). Evidently, gains also accrue to trade between the Nordic countries and other countries on the European continent. In the overall results presented in the summary, we include the gains for all users of the link (irrespective of nationality). In the detailed results we focus on the main results related to the three regions in the model (accounting for approximately 75 percent of the gains).

For lorries the direct gain is a combination of a time-component and a distance-component. For rail transport we calculate the gain on basis of saved ton-kilometres. The savings in physical units are evaluated using unit prices as in Cowi (2004)[38].

For the overall transport cost reduction to be used as an input to the model simulations, we use a weighted average of the reductions from rail and from road. The weights will be the respective modal shares taken from the forecast model "Case B", FTC (2003) – in this way we take into account the cost effect of changes in modal shares. Other logistics effects are discussed in Chapter 3.

As stated in the introduction to this chapter the reductions in overall transport costs between the three regions are moderate in relative terms. International transport costs between Germany and the Nordic countries are reduced, on average, by 1,63 percent compared to the base case. This is an aggregation of detailed information about transport modes, route choice and the sensitivity to transport cost changes for different commodity groups.

Furthermore we model the production of the goods. We thereby take into account the marginal cost of production and we relate the transport cost to the overall cost of selling a product in a foreign market. The transport cost reductions are relatively small compared to the marginal production cost[39].

Most of the direct benefits accrue to transporters using rail or combined transport. Reductions for the other Nordic countries, especially South-western Sweden and Eastern Denmark, are generally higher than for other regions because of the geographical location of the link.

[38] Modelling of the transport cost reductions is shown in appendix D. Transport costs are also discussed in Chapter 3 regarding the logistics effects.

[39] In appendix D we show more details about the level of reduction by sector and by trade link for both of the transport costs and total costs of supply (production + transport costs).

2.6. Sensitivity analysis

The above results are produced with the use of a given set of data and parameter estimates. After collecting a base data set containing the information needed (industry numbers, national data, transport data), the model is calibrated to fit this data exactly. This is the standard technique employed to fit computable equilibrium models to data, but it is important to stress that this method is not statistically based, and is not capable of testing the model against data. Instead, the structure of the model is assumed to be correct, and the calibration technique merely fits numbers to this model. As a consequence, there are no standard errors or confidence intervals around any of the results obtained.

The estimation of the dynamic and strategic effects is of course subject to uncertainty. Based on the assumptions mentioned above, these effects (equivalent to the two effects mentioned above: increased competition and increased productivity) can be estimated at between approximately 0,3 and 0,6 billion euros (between 2 and 4 billion Danish kroner)[40]. The variance in this estimate occurs by calculating a large number of model calculations (so-called Monte-Carlo simulations), which together give a picture of the model's sensitivity to variation in the two most critical assumptions[41].

The sensitivity analysis shows that in only 5 percent of the model runs, the dynamic effects are below 0,3 billion euros (2 billion Danish kroner). Therefore it is highly unlikely that the two assumptions in question will result in gains below this amount. Inversely, it is very unlikely that the dynamic and strategic effects will be higher than 0,6 billion euros (4 billion Danish kroner) upon variations in the two parameters mentioned. To sum up: 90 percent of the results can be found within the range of 0,3 and 0,6 billion euros (between 2 and 4 billion Danish kroner).

The calculations of the dynamic and strategic effects have been made consistently with the calculations of the direct benefits of the cost-benefit analysis. Therefore, the uncertainties relating to the cost-benefit analysis (e.g. the assumptions about increases in traffic) will also influence the size of the dynamic and strategic effects[42].

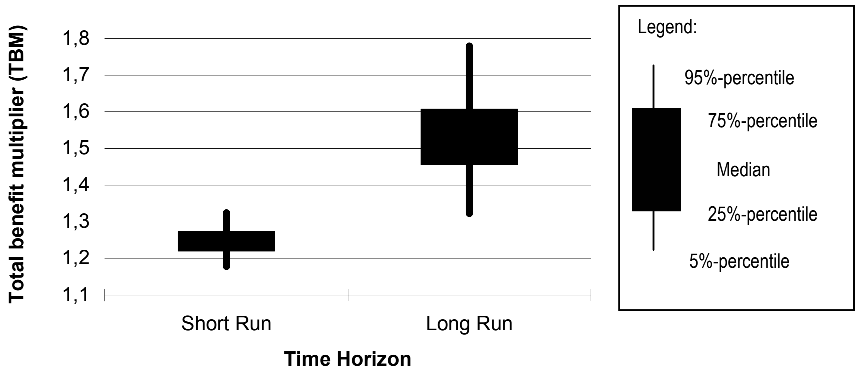
One response to this is to conduct sensitivity analyses, running the model with different parameter values or behavioural assumptions in order to see how sensitive the results are to these changes in assumptions, and how results from the model compare with results obtained from other methods. This might be particularly important in the present context, where estimates of changes in traffic flow produced by this method could be compared to those derived from other methods.

[40] The values are present value in 2015 by the use of a discount rate of 6% and at the 2003 price level.

[41] We carry out sensitivity analyses for the values of the so-called Armington elasticity and the so-called Dixit-Stiglitz elasticity (these are elasticities that capture the consumers "love-of-variety" for products from different countries respectively from different firms). Assumptions about these two parameters are the crucial sources of uncertainty in the model results, but other non-included variables may have minor influence on the sensitivity of the results.

[42] If direct benefits are reduced by, say 20%, dynamic effects are simultaneously reduced by 20%.

Figure 2.3 Results of systematic sensitivity analysis



Source: Copenhagen Economics, CENEG-model

Whereas the multiplier is not very sensitive to the size of the transport cost reduction (see section 2.2 to 2.4) the multiplier is quite sensitive to other assumptions. The sensitivity analysis is performed by calculating a large number of model calculations (so-called Monte-Carlo simulations). These give a picture of the model's sensitivity to variation in the two most critical assumptions[43].

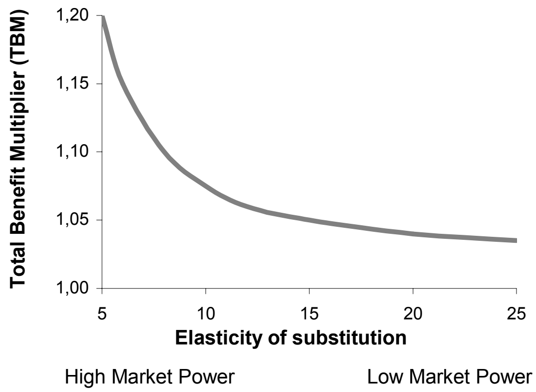
The sensitivity analysis shows that in only 5 percent of the model runs, the short run multiplier is below 1,18. That is to say, it is highly unlikely that the two assumptions in question will result in values below this. Inversely, it is very unlikely that the short run multiplier will be higher than 1,32 upon variations in the two parameters mentioned. To sum up, you can say that 90 percent of the results for the short run multiplier can be found within the range of 1,18 and 1,32.

The variations in the long-run multiplier as a result of the exact same simulations are larger than for the short run multiplier. This is not surprising since the Dixit-Stiglitz elasticity and the Armington elasticity are the key drivers of the dynamic and long run results in the model. To sum up the sensitivity analysis for the long run multiplier we conclude that 90 percent of the results for the long run multiplier can be found within the range of 1,32 and 1,78.

Figure 2.4 shows a similar relation between the elasticity of substitution (σ) and the TBM, but in the Bröcker model. A similar relationship is found in the CENEG-model. For low values of the elasticity of substitution, the different varieties are not easily substituted and thus there is less competition between each of the monopolistic competitive firms, and each firm obtain some degree of market power that enables them to charge prices above marginal costs. When firms pose some degree of market power, there are greater socio-economic returns from an output expansion in that sector, because monopolistic positions will be eroded. Therefore, the TBM is high when firms have high levels of market power (i.e. for low values of the elasticity of substitution).

[43] We carry out sensitivity analyses for the values of the so-called Armington elasticity and the so-called Dixit-Stiglitz elasticity (these are elasticities that capture the consumers "love-of-variety" for products from different countries respectively from different firms). Assumptions about these two parameters are the crucial sources of uncertainty in the model results, but other non-included variables may have minor influence on the sensitivity of the results.

Figure 2.4 The relation between the elasticity of substitution and the TBM



Source: Bröcker (1998b)

2.7. The regional welfare gains

The regional distribution of the welfare gains has been studied carefully in the so-called *CGEurope* model built by Dr. Johannes Bröcker[44]. We use the *CGEurope* model to answer the question: *How far into Germany and how far into the Nordic countries are the growth effects of a Fehmarn Belt fixed link likely to spread?* The short answer is that growth effects will spread as far North as Örebro in Sweden (700 km North of the new link, and 200 km directly west of Stockholm) and as far South as to the region of Hessen in Germany (600 km south of the new link). The growth effects in Denmark will appear in the Eastern part of the country (Zealand and Lolland-Falster).

The largest growth effects in relative terms are found close to the fixed link. The regions of Lübeck and Kiel in Germany get a share of the dynamic effects from the Fehmarn Belt that is about 4 times as high as their regional shares of German GDP[45]. And the region of Lolland-Falster in Denmark gets a share of the Fehmarn Belt effects that exceeds its share of Danish GDP by more than a factor of 4. These regions are in relative terms the most affected regions in Europe from the fixed link across the Fehmarn Belt. The largest regional growth effect (Lolland-Falster, Denmark) is around 0,15% of regional GDP. The growth effects in other regions are much smaller.

The regional model

The regional model is the same type of model as used in the previous sections[46], which means that trade flows between regions and the money flows between the production sector and households are all included in the model. The model is very detailed with respect to the number of regions[47], since it covers all of Europe divided into more than 800 regions.

In general, economic geography models of this kind show higher growth effects in regions close to the new link. However, it is not only the mere distance to the link that matters. Alternative transport corridors matter too. Therefore, regions for which the new link constitutes a major improvement of their accessibility will gain more than regions that are de facto not

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[44] The main results from the model are reported in Bröcker (1998), Bröcker (1999) and Bröcker (2003).

[45] The factor of the relative gain for a region in e.g. Germany is calculated as follows: first we calculate the region's gain from the Fehmarn Belt fixed link from Bröcker (1999). We then divide this gain by the total gain from the fixed link for all German regions. This gives us the region's share of the total national gain from the fixed link. Next we calculate regional shares of GDP. This is simply done by dividing the regional GDP by total German GDP. Finally, we divide the regional share of the Fehmarn Belt fixed link gains by the regional share of GDP: for example if a region gets a share of 0,8 percent of the fixed link effect and only has a share of 0,2 percent of regional GDP, then our ratio of relative gain is a factor of 4 (calculated as 0,8 divided by 0,2).

[46] Namely a so-called spatial computable general equilibrium (SCGE) model.

[47] See also the technical appendix D for at short introduction to the model.

facing new transport alternatives because of the link. As shown in the model, Norwegian exporters at the southern tip of the country will continue to use the ferries across the North Sea to Denmark and the motorways through Jutland to Germany. Therefore, such regions are unaffected by the new link, since they will not change transport behaviour. Another feature of the model is that regions that trade heavily with regions on "the other side" of the new link will gain more than regions trading only a little with regions on "the other side" of the new link.

The *CGEurope* model captures these effects. We, furthermore, emphasize that the results build on a rather detailed representation of the road network, where individual road links are divided into road-classes depending on the average speed of the links. Existing ferries are also included in the network[48]. The level of detail in terms of regions and the transport network comes at a cost, thus the model does not describe sector differences between regions. Each region is represented as having one production sector assumed to include all economic activity in the region and corresponding to the size of regional GDP.

Regional results
Germany accounts for 41 percent of the dynamic and strategic effects according to Figure 2.2. Within Germany the regional impacts of the Fehmarn Belt fixed link are primarily found in the regions of Schleswig-Holstein and Hamburg. These two regions each represent about 3-4 percent of total German GDP, but they are each likely to gain a share of the German dynamic effects from the fixed link of respectively 9 and 11 percent. In other words these two regions located geographically close to the fixed link will gain a relatively large share of the total dynamic effects for Germany. The region of Mecklenburg-Vorpommern is also likely to be positively affected by the fixed link in absolute terms, but to lesser extent than Hamburg and Schleswig-Holstein. Other regions in Germany are not substantially affected by the fixed link. However, small relative gains can be found as South as the region of Hessen[49].

Denmark represents 17 percent of the total dynamic and strategic effects as shown in Figure 2.2. The regional distribution of the dynamic and strategic effects within Denmark shows that the Eastern part of the country (the regions of Zealand and Lolland-Falster) is the most affected regions. Other regions in Denmark (Funen and Jutland) remain virtually unaffected by the fixed link. One explanation of this, is that these regions will not be better off after the fixed link since they will continue to use the Jutland-corridor[50].

Sweden, Norway and Finland account for 42 percent of the dynamic and strategic effects. Within these countries the gains from the dynamic and strategic effects are most prominent in southern Sweden[51]. However, the size of the relative gain is smaller than the regions in Denmark and Germany. Southern Sweden gets about 16 percent of the total welfare gain in the Nordic region from the fixed link, with twice the region's share of national GDP (Southern Sweden represents approximately 8 percent of GDP in the three Nordic countries Sweden, Norway and Finland).

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[48] The model indirectly assumes that all trade of goods is transported by road. Rail transport and short sea shipping is not included as specific transport modes. This is not a major problem regarding rail transport since rail transport will be subject to transport cost reductions similar to those for road. The cost of short sea shipping will not be affected directly from the fixed link, but in the model it is assumed that short sea shipping costs will decrease as much as road transport costs – which overestimates the reduction. However, only a small share of the trade value is transported by ship and therefore the assumptions made will lead only to a small overestimation of the true regional effects, for example in Finland, where the use of shipping is more prominent than in other regions.

[49] For further regional details we refer to Bröcker (1999).

[50] In this analysis we look at the Fehmarn Belt fixed link in isolation and do not include the positive effect on the regions in Funen and Jutland from other infrastructure investments such as the Great Belt link or the recently constructed motorways in Northern Jutland.

[51] The region "Southern Sweden" consist of the Swedish NUTS-3 regions (län): Malmöhus, Kristianstad, Blekinge, Halland and Kronoberg.

The second largest city in Sweden, Gothenburg, and the regions stretching towards Stockholm via Linköping will also gain in both absolute terms and relative to rest of the regions in the Nordic countries. The positive welfare effects will reach as far North as Örebro about 700 km North of the fixed link. Norway's capital, Oslo, and the regions in the southeast corner of Norway also incur welfare gains from the fixed link (for example Moss, Skien and Tønsberg).

Northern Sweden and Northern parts of Norway as well as Finland gain in absolute terms, but their share of the gains from the Fehmarn Belt fixed link will be lower than their share of GDP, and the effects on these regions are so small that they can be considered as virtually unaffected.

The regions on the Southern tip of Norway are also virtually unaffected by the fixed link. These regions will not find any incentives to change transport corridors as a result of the fixed link, and they will continue to use the ferries across the North Sea and the land corridor to Germany via Jutland.

Summary of regional results

Before summarising the regional results it is helpful to revisit the sources of dynamic and strategic effects. The pro-competitive effect, as outlined in chapter 1, is the overruling source for the total dynamic and strategic effects. However, at the regional level two other effects become important too. One is the substitution effect and the other is the income effect. Below we summarise these effects:

- Substitution effect: The fixed link means that the cost of exports is decreasing in some regions, thus firms can export more (or charge higher prices for their exports) leading to a gain for firms in that region. Profits will therefore shift towards regions that experience the highest decrease in transport costs.
- Income-effect: As firms expand their activity (because the above effect) they buy more products and services, including products and services from other regions. Regions that are not directly affected by the new link can therefore benefit through these indirect and induced effects.
- Pro-competitive effect: Increased exposure to competition decreases the price-cost margin leading to welfare gains. Competition will lower profit rates for companies and lower prices for the consumers. Economic theory tells us that there is a true welfare economic gain from increased competition, because the value to consumers of lower prices more than offset the loss in terms of profits to the producers.

To summarise the regional effects we can say that the regions in Northern Germany, the Eastern part of Denmark and Southern Sweden gain from the fixed link through all three effects mentioned above, especially Hamburg, Schleswig-Holstein, Zealand, Lolland-Falster and Southern Sweden.

Other regions are – on the balance – unaffected from the fixed link. They are neither worse nor better off after the fixed link than before. This is the result of two counter-veiling effects. On the one hand the substitution effect decreases their competitiveness because their accessibility is decreasing relative to the above mentioned regions. On the other hand the income-effect and the pro-competitive effect also work in these regions. Our results show that in general these two effects balance out, leaving the remaining regions virtually unaffected by the fixed link.

Chapter 3 Logistics effects

In this chapter we reconsider the cost savings envisaged by the buyer of the goods transport service. In the modelling exercise in Chapter 2, as well as in the cost benefit analysis by Cowi (2004), only the direct transport cost savings from the fixed link are considered. The included direct transport cost savings consist of fewer kilometres (and thereby less fuel, less vehicle depreciation and so on) and less travel minutes (and thereby less salary for drivers etc). These are important sources of the total benefits from the fixed link, but they measure only the narrow costs related to the company carrying out the transport. See Skjött-Larsen (2003) and Hansen (2003). The main argument in this section is that other cost elements of total transport costs will be affected by a fixed link - elements that have a value to the transport buyer – but are not yet accounted for in quantitative terms. We label these effects "logistics effects".

3.1. The sources of the logistics effects

The experiences from two large infrastructure projects, the Great Belt link and the Øresund Bridge, point towards at least four types of possible logistics effects:

1. **Increased catchment area**. Particularly the Great Belt link resulted in companies perceiving a greater catchment area and reporting increased revenues. The primary reason for the increased catchment area is reported to be the reduced transportation times.
2. **Changes in regularity**. The increased regularity arising from the avoidance of ferries has made it possible to create logistics systems such as the inter-modal railway-transport system. As regards road transportation, the effects have primarily taken place in the form of increased flexibility.
3. **Changes in shipment frequency**. The increased demands from customers as well as the possibility to cross the bridge 24 hours a day, has resulted in more frequent shipments and consequently in reduced stock keeping costs for companies.
4. **Relocation of warehouses and production facilities**. Better accessibility and the increase in catchment area can make it profitable to reorganize warehousing or production structures in order to exploit economies of scale. The improved infrastructure is often mentioned as a key decision variable together with other long-term strategic considerations.

We attempt quantifying some of these effects. With a fixed link across Fehmarn Belt instead of a ferry service, firms (and/or consumers) trading goods across the Fehmarn Belt will experience the improvements shown in box 3.1.

Box 3.1 Logistics improvements for goods transport by road (lorry)

A fixed link has the following advantages over ferry service
• Time savings faster door-to-door delivery because of less waiting time and faster crossing of the Belt. • Increased flexibility leading to improved transport planning because of continuous departures instead of discrete departures. • Reduced risk of delays with the ferry a delay of 5 min. in the approach to the ferry can imply a delay in 30 min. if you "just miss" the ferry.

Apart from time savings these improvements *are not* taken into account in the traffic-forecasting model (FTC, April 2003) with regard to the overall trade volume (in the so-called traffic generation model) and are thus *not included* in the direct benefits accounted for in the cost-benefit analysis. This is understandable given the methodological difficulties in measuring these effects consistently. In appendix B of the technical report we discuss these methods and we introduce new methods in infrastructure evaluation that captures some of these aspects. Results from these studies are reported below.

3.2. Simulation of the effects of better transport planning

We have used specialised logistics software to simulate and optimise transport flows of a representative firm with production with and without the fixed link. The simulations relate to road transport only. Transport planning models of this kind minimises the overall transport costs of delivering a certain amount of goods to a number of clients. The software is developed for the planning of transports for large companies, which optimise their entire logistics system including the planning of a fleet of lorries. The optimisation therefore includes the cost elements mentioned in box 3.1 above. The model we apply has a representation of the road network in Europe and optimise the route planning for a given trade volume and a given network.

If the increased flexibility, the timesaving, and the reduced risk of delays are important to the representative firm this will show up in the optimisation software. Box 3.2 shows the results of a real case simulation where the ferry is replaced by a fixed link. The simulation only covers the reduction in transport costs (i.e. it does not include reductions in inventory costs or warehouse costs – these are to be added to the calculation). Two simulations have been made: One with transport from a Danish manufacturer located in Eastern Denmark (Ballerup) exporting to Germany (several locations) and one simulation where the exact same manufacturer is moved to Linköping in Sweden.

Based on these assumptions the results show a reduction in the costs of transporting the requested goods of 8,9% for the Danish case, and 5,6% for the Swedish case. We assume that these cost reductions are quite symmetric, meaning that the same level of reductions would appear for a firm located in Northern Germany exporting to either Denmark or Sweden. Time savings are the principal component of the cost reductions and the hourly rate is set to match real costs for the transport buyer.

One of the reasons for the difference between the Danish and Swedish cases follows from longer travel time/distance in Sweden compared to Denmark. The longer distance in Sweden implies that the absolute costs are higher and hence the same absolute reduction in transport cost would give smaller percentage reduction in Sweden compared to the Danish case.

Box 3.2 Results of a virtual bridge simulation (using transport planning software)

Facts about the case
Origin=Ballerup or Linköping
Destination=app. 25 addresses spread over most of Germany
Total time for RP ferry crossing (incl. waiting, loading/unloading and margin)=85 minutes
Travel speed on link=autobahn
The fixed link and the ferry service will use same trace (18.6 km).
Number of vehicles per day=27
Number of deliveries=241
Assumed cost structure, hour-rate/km-rate=400kr/3kr

RESULTS BALLERUP SCENARIO
Results, Without Case (WC):
Km=32.402
Minutes=29.964
Total costs (kr)=296.964

Results, Fixed Link Case (FL):
Km=31.672
Minutes=26.346
Total costs (kr)=270.658

Reduction, WC -> FL:
Km=730 (2,3%)
Minutes=3.618 (12,1%)
Total costs (kr)=26.306 (8,9%)

RESULTS LINKÖPING SCENARIO
Results, Without Case (WC):
Km=57.076
Minutes=50.505
Total costs (kr)=507.928

Results Linköping, Fixed Link Case (FL):
Km=56.561
Minutes=46.503
Total costs (kr)=479.703

Reduction, WC -> FL:
Km=515 (0,9%)
Minutes=4.002 (7,9%)
Total costs (kr)=28.225 (5,6%)

Source: Transvision, fleet planner; www.transvision.dk

We have decomposed the above reductions in total transport costs in order to isolate cost reductions that are due to “better transport planning”. For this purpose we design three scenarios.

Table 3.1 Definition of scenarios

	Scenario definition	
	Network used	**Optimisation as in**
Scenario 1	With out case	With out case
Scenario 2	Fixed link	With out case
Scenario 3	Fixed link	Fixed link

In *the first scenario* the transport network includes the current ferry service and the transports are planned according to this network. In *the second scenario* we change the transport network to include a fixed link over Fehmarn Belt, but we do not change the routing or planning of the transports. In scenario 2 we keep the planning from scenario 1 and estimate the savings in time and kilometres from operating the exact same vehicle runs as in scenario 1, the only difference being a faster, but slightly longer, transport across the Fehmarn Belt for those using this route in the initial situation. Finally in *the third scenario* we optimise the transports again taking into account that a fixed link will be constructed. All scenarios are equal in all respects.

The total cost reduction for the Danish case (Ballerup) is 8,9 percent. Of this 7,8 percentage points are due to direct cost reductions (by comparing scenario 1 and 2 which give the effect of the fixed link without changing the planning). The planning effect is 1,1 percentage points (by comparing scenario 2 and 3, which give the isolated effect of re-optimising the transport planning given that the fixed link is constructed. Comparing size of total reduction (including the planning effect) with the size of the direct effect we get a ratio of 1,14. This could be called a *logistics multiplier*, signifying that on top of the traditional cost reductions another 14 percent should be added to include the above mentioned logistics effects. The results are summarised in Table 3.2 below.

Table 3.2 Decomposition of total cost savings and "the planning effect" for the Danish case/example (Ballerup)

	Reductions (pct.)		
	Distance	Time	Costs
Direct cost savings *Scenario 1-> Scenario 2*	0,8%	11,2%	**7,8%**
Planning effect *Scenario 2-> Scenario 3*	1,5%	0,9%	**1,1%**
Total reduction *Scenario 1-> Scenario 3*	2,3%	12,1%	**8,9%**

Source: Transvision, fleet planner; www.transvision.dk

We have only simulated the potential savings for one specific firm believed to be representative. However, a number of assumptions could change the above results. The chosen case has a certain mix of distribution versus full-load transport[52]. We would expect a greater saving on a full-load than on distribution deliveries. However, there are more possibilities for synergy on distribution deliveries than for whole deliveries, but on the other hand there are more stops in the destination region. Total trip length will therefore be longer in a pure distribution scenario, and the time saving element of the bridge will therefore be relatively smaller.

Also the exact location of origin and destination for the trade flows can matter to the results. Of course transport from a manufacturer in Rødby to a customer in Puttgarden will imply a large percentage reduction, whereas a customer in Munich would not see the same percentage reduction in transport costs. We have chosen the above scenarios as an average for the potential savings on the links from Eastern Denmark to Germany and from the other Nordic countries to Germany.

On the whole, we believe that there will only be a small variation in the potential for savings in other simulations. Therefore, our cost reduction scenarios are not very sensitive to the exact assumption about the structure of the transport flows. Thus, the results can be used as an overall estimate of the cost reductions.

3.3. Logistics effects from the Great Belt link and the Øresund Bridge

Hansen (2003) has carried out in depth analyses of project appraisal techniques related to large-scale infrastructure projects. In particular, Hansen (2003) identifies a range of typical strategic effects of such projects as well as some methodological tools and challenges related to measuring both the strategic and the logistical effects on companies

By analyzing the consequences of two large infrastructure projects in Denmark, the Great Belt link and the Øresund Bridge, Hansen (2003) identifies several strategic and logistical effects that could be taken into account when assessing the feasibility of such projects.

The impacts of the Great Belt link were assessed by reviewing studies of the impact of the Great Belt link, carried out after the completion of the bridge as well as by interviewing large companies that carried out structural changes around the time when the bridge was completed.

The research indicates that the bridge has given rise to several logistics effects. In particular, some sectors have increased their catchment area as well as their revenues. The primary

[52] Distribution means that the same truck make many stops in the destination region, whereas full-load transport just makes one stop in the destination region – for example at a transport hub.

reasons given for these benefits are the decreased transportation times, the increased flexibility and the increased supply security.

At the same time, the bridge has made customers demand increased speed and precision when sending their goods with the land transporters and freight forwarders. This has resulted in more frequent, but smaller shipments of goods.

The bridge has also given rise to more structural changes. Some large companies report to have undergone logistics changes; specifically, they have reduced their overall stock levels and the number of warehouses.

Another result of the bridge is the development of a new inter-modal transport concept between Eastern and Western Denmark, the “combi-shuttler”. In short, the bridge has made it possible to operate a train shuttle service for freight, which is far more reliable than was possible with the ferries. At the same time, the bridge saves the transshipment costs in two ferry harbors and allows the trains to carry more goods wagons.

The impact of the Øresund Bridge was assessed based on a study of 47 companies located in the Danish and the Swedish parts of the Øresund region. The study was carried out within a few years of the opening of the bridge, wherefore some effects may not have materialized at the time of the study.

Companies report that the bridge plays an important role for land transports of goods in the local region between Eastern parts of Zealand and Southern parts of Skåne, but that it has not significantly altered transport patterns for remoter destinations.

As regards rail transports, the impact of the Øresund Bridge has been far greater, as the fixed connection between Denmark and Sweden has meant a ferry-free railway between Sweden/Norway and Central Europe. This has given rise to combined transport solutions similar to the “combi-shuttle” over the Great Belt link.

In order to further elaborate on the effects on railway transports, the case of IKEA is reviewed in greater detail. Previous to the opening of the bridge, IKEA transported all goods from Sweden to Germany and Central Europe by road. With the opening of the bridge, IKEA changed to railway transports by starting the railway company IKEA Rail. Even though the company has been closed, in 2003 about 18 percent of IKEA’s goods are carried by railway transport. IKEA plans to increase this share to 40 percent in the years to come.

IKEA quotes the anticipated increase in shipment volume as well as the increasing traffic levels on the highways in Central Europe as the primary reasons for the logistics change. They point out, however, that this solution would not have been feasible without the bridge, as two extra transshipments in the ferry ports would have increased costs and the dependence on ferries would increase vulnerability. The bridge allows IKEA the kind of regularity that is vital for the planning of internal operations.

The train transport takes place in the form of a combined transport solution, where goods are delivered to the station from the factories in Sweden, and freighted by train to a central warehouse in Germany, from where it is then distributed to the outlets by road. IKEA is however considering eliminating the warehousing by changing to direct deliveries from the factories to the individual outlets. This logistics change is however not expected until IKEA has gained more experience with the operation of the system.

Chapter 4 Other major links

In this chapter we compare the Fehmarn Belt fixed link with three major infrastructure investments in other European regions. This summary will provide real examples of dynamic and strategic effects that have actually taken place.

Comparable major transport infrastructure projects are the Great Belt fixed link and the Øresund fixed link in Denmark and respectively Sweden as well as the Channel Tunnel between France and UK.

Table 4.1 Main facts of other infrastructure investments

Infrastructure investments	**Fehmarn Belt fixed link**	**Øresund link**	**Great Belt link**	**Channel Tunnel**
Description	19 km link with a four lane motorway and 2 railway tracks.	16 km long, motorway and railway tunnel and bridge	18 km link consisting of two bridges and one tunnel, motorway and railway	42 km railway system between two terminals with two tunnels
Country	Denmark and Germany	Denmark, Sweden	Denmark	UK, France
Costs	Total infrastructure costs estimated to € 4,0 bill. (2004-prices)	Total infrastructure costs about € 2.7 bill. (2002-prices), owner State of Denmark and Sweden	Total costs amounted to € 4,0 bill. (2002-prices), covered by loans taken up in international capital markets	Private investment, supported by public authorities, total infrastructure costs € 15 bill.
Employment impact during construction period	44.000 – 66.000 man-years (estimated)	60.000 man-years (1995-2000)	66.000 man years (1988-1998)	80.000-100.000 man years (1987-1993)
Inauguration	Planned 2015	2000	Railway 1997 Motorway 1998	1994

Prognos AG 2003 according to Sund & Bælt Holding A/S, Fehmarn-Belt-Komitee, Erfahrungen von Regionen mit festen Querungen, 2001

4.1. The Øresund fixed link

Description: In 2000 the Øresund fixed link, a 16 km long motorway and railway bridge and tunnel, was opened between Malmø in Sweden and Copenhagen in Denmark. The cross-border link is both a local/regional connection between two large cities and a strategic link between Denmark and Sweden. The new transport infrastructure is part of the Trans-European Network (TEN) and was supported by the TEN-programme.[53]

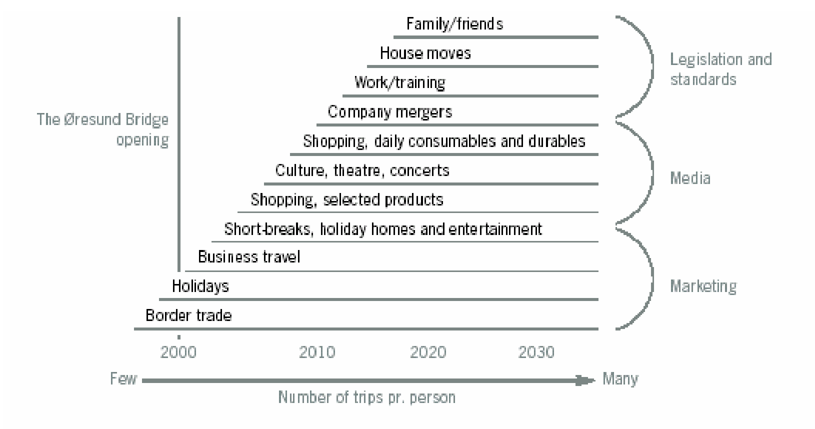
[53] Cp. The Øresund Fixed Link: Evaluation issues and development of new methodology, p.1-2

Traffic effects: Since inauguration in 2000 about 10 million vehicles and 43 million travellers have crossed the fixed link, however the ferries are still working.[54] The ferry line between Ellsinore and Helsingborg is a favourable alternative for crossing the Øresund, which reduces the traffic volume and market share of the fixed link.

In 2003 the average annual daily traffic was more than 10.000 vehicles and traffic increased by 10 percent compared to 2002. During the first four month of 2004 the average increase in traffic was 19 percent. The traffic across the Øresund-link is now in line with the expected at this stage of the integration process. The integration process has gained some speed recently, but the level of interaction between the two sub-regions has not yet reached its full potential[55].

Over the coming 15 years, Øresundsbro Konsortiet expects barriers to be reduced thus giving rise to increased traffic[56]. Regional integration is a long-term process, which proceeds on a step-by-step basis through increased trade, the integration of the business sectors on both sides of Øresund, more commuters and, finally, increased migration across the border will take place. As depicted in Figure 4.1 the regional integration process involves a number of steps over a long time period.

Figure 4.1 The process of regional integration



Source: Øresundsbro Konsortiet

Employment effects: During the period of construction (1995 to 2000) the fixed link has caused an employment impact of 60.000 man-years. Employment effects are found both in the Swedish part (especially for construction of the bridge) as well the Danish part (especially for tunnel-constructions) of the Øresund-Region.

Dynamic effects: Economic effects of the new fixed link occurred in different ways. The fixed link improved the accessibility and transport capacity in the Øresund-region for employees and enterprises by developing a new cross-border network. Commuting between both cities takes around 40 minutes, which constitutes a significant reduction of travel time for commuters. Furthermore the fixed link has in some cases, as explained earlier, may it possible to harvest advantages in the logistics systems by turning two separate distribution systems into one common distribution system for the entire region. A new market for regional distribution across the bridge with smaller lorries has emerged. Employees, firms and institutions also benefit from the increased accesibility. On the labour market the fixed link improved opportunities especially for Swedish unemployed to find new jobs in Denmark. One of the main effects of the fixed link

[54] 27 mill. travelers passed by motorway and 13 mill. railway-travelers.
[55] Cp. OECD, The Oeresund Region, 2002, p.17-18 and p. 39
[56] Øresundsbro Konsortiet (2003), *Facts worth knowing about the Øresund Bridge.*

relates to the region international ranking: With the fixed link the Øresund region has become the largest agglomeration in Scandinavia, and the region has climbed up in the European hierarchy of metropolitan areas. There are many examples of increased integration and improved attractiveness of the region: the ports of Copenhagen and Malmø have merged into one single functional unit – the Copenhagen-Malmø-Port (cmp); the biotechnology industry has formed a common organisation for their important cluster – the Medicon Valley Academy and the Medicon Valley name is used on both sides of the region. Furthermore, multinational companies have concentrated their Nordic headquarters in the region (e.g. Toyota, Daimler-Chrysler, Orange, Novo Nordisk and others).

Summary: The Øresund region is now regarded by many as the best practice case for economic implementation of cross-border regions. Since the opening of the fixed link, growth has accelerated in the region. The fixed link has developed a new transport corridor with faster and shorter access and the economic interactions between Denmark and Sweden are on the rise. For the future an increase of commuting across the fixed link is anticipated in a mid-term view.

4.2. The Great Belt fixed link

Description: In 1998 the Great Belt fixed link, a combined tunnel and bridge-system, was opened. The fixed link between the islands of Funen and Zealand in Central Denmark is the most important traffic connection between the Eastern part and the Western part of Denmark. The link replaced three ferry routes on the Great Belt.

Traffic effects: Concerning passenger traffic, commercial travellers and holidaymakers are the most frequent users of the fixed-link; commuter traffic is less important for the total traffic volume. In contrast to the Øresund fixed link the Great Belt fixed link does not have as large an importance for local and regional exchange of goods and persons (e.g. commuting). In 2003 about one million lorries crossed the Great Belt fixed link. A significant part (40 %) of the lorry traffic represents new traffic, which is generated by improved infrastructure facilities for east-west journeys in Denmark.[57] Car traffic across the Great Belt is currently 2,5 times higher than before inauguration. The traffic volume definitely is higher than forecasted. The increase of total traffic volume is caused by the trend of general traffic growth, diversion of traffic volume from other ferry services and the effect of generating new traffic. In addition, the Great Belt fixed link has benefited from closing several nationwide ferry services and flights.

Employment effects: Between 1987 and 1998 the construction of the Great Belt link generated a total employment impact of 66.000 man-years both in Denmark and abroad, whereas about 75 % of the direct and indirect employment effects were domestic impacts. Approximately 2.500 employees lost their jobs by suspending ferry-lines on the Great Belt and by transpositions of railway traffics and cargo handling.[58] The ferry companies realised that parallel ferry services in competition with the fixed link is uneconomic and stopped their services.

Dynamic effects: At the local and regional level, no significant employment impacts by the fixed link have been identified. The dynamic effects in terms of productivity and settlement effects appeared in many of the economic centres of Denmark. No significant overall effects occurred in the municipalities around the fixed link.

Summary: The main economic advantage of the fixed link is time savings for travel and transport over the Great Belt. The fixed link saves approximately 1½ hours compared to the former ferry service, which is regarded as the main reason for passengers to choose the fixed

57 Cp. Torben Holvad and Steen Leleur, On the Linkage between Transport and the Economy, 2002
58 http://www.trm.dk/sw542.asp

link (in a survey[59] 70 percent of all passengers stated that the time savings was the primary reason for choosing the fixed link over the alternative routes across the Kattegat.) Along the motorway-connection Kolding/Vejle-Copenhagen several industry companies, which have high share of distribution, benefit mostly from the fixed-link by shortening of delivery times and opportunities for just-in-time production.

4.3. The Euro Tunnel

Description: The Channel Tunnel is the major link between the UK (Folkestone) and France (Calais), which closed an import gap in the European Transportation Network (TEN). The Channel Tunnel transport system, opened in late 1994 following a seven-year construction period and several years of project preparation. The tunnel is a 50 km long railway-system with shuttle-trains and also used by the Eurostar.[60]

Traffic effects: Since completion in 1994 the Channel Tunnel is still competing against the ferry service between Dover and Calais. Despite this parallel transportation services the Tunnel gains a high share of the passenger travel segment. In the passenger car segment the tunnel achieved a market share of 54 percent of the traffic volume in 1999, in contrast to a 38 percent market share in the lorry segment. The Eurostar achieved the highest market share of travels between London and Paris (61 percent of the total rail and flight traffic volume between the two Capitals). Until 1999 the traffic and passenger volume of the Channel Tunnel increased continuously but consolidated onwards from there and has been below the anticipated level of the planning period.[61]

Employment effects: Regional labour markets in France and UK has been affected by the construction and operation of the tunnel. During the construction period between 30.000 and 60.000 man-years occurred in construction industry from the investment. Especially the French region Nord-Pas de Calais benefited from employment initiatives. About 90 percent of the French employment impacts occurred in Northern France. Some jobs in the ferry industries have been lost, especially on the British part of the Tunnel.[62]

Dynamic effects: In France the channel tunnel has originated about 4.500 direct jobs. The employment effects result in new jobs for operating the tunnel (1.800 jobs), suppliers and new settlements of enterprises in the neighbouring industrial parks. Additionally there were also positive employment effects on the British side. About 1.200 employees work at the terminal in Folkestone or collaborate as suppliers to the tunnel (approx 1.500). Furthermore, promoted settlements of enterprises amount to approximately 1.800 new jobs in the region of Kent. At present about 10.000 direct and indirect jobs are depending on the Channel Tunnel in Great Britain and France, without considering overall trade and productivity effects for both nations.

Summary: The inauguration of the Channel Tunnel reduced significantly the duration for crossing the Channel (time-save: 60-90 min.) and established a modern European high-speed link, especially for railway traffic. In the future (2007 et seq.) a rise of traffic volume is expected by completion of the new high-speed Channel Tunnel Rail Link between East Kent and London. The employment effects of the Channel Tunnel have reached a relatively high level, partially because of both cyclical trends and different stimulating measures (measures of labour market policy and business development) close to the terminal locations.

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[59] Trafikministeriet, København Bundesministerium für Verkehr, Bau- und Wohnungswesen, Fehmarn Belt Forecast 2002 Final Report April 2003, p. 133-137

[60] Shuttle-train: combined passenger and goods traffic, Eurostar: high-speed train between London and Paris/Brussels.

[61] UK Department for Transportation, Local Government and Regions, Eurotunnel and http://www3.eurotunnel.com/rcs/etun/pb_english/en_wp_corp/en_fld_corp_about/en_fld_corp_figs/index.jsp

[62] Fehmarn-Belt-Komitee, Erfahrungen von Regionen mit festen Querungen, 2001, p. 14

4.4. Summary of comparison

All three infrastructure investments have complex socio-economic impacts. Fixed links with European relevance like the Channel Tunnel or the Øresund link have generated positive impacts on regional economies and labour markets. Negative consequences emerge in the area of the ferry industry, where strong reductions of jobs are considered. The temporary employment impacts of the construction period largely show effects on regional labour markets. Significant benefits in case of reduction of production costs and transportation costs are generated by new infrastructure especially for transport sectors and industrial branches with high export rates. These effects are difficult to compare across studies.

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