Helsinki-Tallinn Transport Link

Comparative Impact Analysis Sub-Report
# Table of contents

Forewords ........................................................................................................................................ 4

1. Ferry Traffic Solution O+ ........................................................................................................ 5
   1.1. Past Development .............................................................................................................. 5
   1.2. Recent Traffic Patterns .................................................................................................... 5
       1.2.1. Vessel Traffic .......................................................................................................... 5
   1.3. Other Routes between Finland and Estonia ................................................................. 9
   1.4. O+ Option .......................................................................................................................... 9
       1.4.1. General ...................................................................................................................... 9
       1.4.2. Traffic Investments in Ports .................................................................................... 10
       1.4.3. O+ Current Facilities .............................................................................................. 10
       1.4.4. O+ Cargo to Vuosaari and Muuga ......................................................................... 12
       1.4.5. O+ All Ferry Traffic to Vuosaari and Muuga .......................................................... 12
       1.4.6. O+ Other Ports ......................................................................................................... 13
       1.4.7. O+ Modern Technologies ......................................................................................... 13
   1.5. O+ summary and conclusions ....................................................................................... 13

2. Volume Estimations .................................................................................................................... 15
   2.1. Passenger Volume Estimations ....................................................................................... 15
   2.2. Cargo Volume Estimations ............................................................................................... 18

3. Cost – benefit analysis ................................................................................................................ 21
   3.1. Investment and Maintenance ......................................................................................... 21
   3.2. Consumer Surplus, Passenger Transport ...................................................................... 21
   3.3. Producers Surplus, Passenger Transport ...................................................................... 22
   3.4. Cargo Transport .............................................................................................................. 23
   3.5. Externalities .................................................................................................................... 23
   3.6. Sensitivity Analysis ......................................................................................................... 25

4. Wider Economic Impact analysis ............................................................................................ 27
4.1. Framework and Methods.................................................................................................. 27
4.2. Assumptions of Economic and Demographic Developments ........................................... 28
4.3. Agglomeration Impacts .................................................................................................. 29
  4.3.1. Labour Market Impacts ......................................................................................... 31
4.4. Competition Impacts ................................................................................................... 32
4.5. Summary of Wider Impact Analysis ............................................................................ 33
4.6. Sensitivity Analysis ...................................................................................................... 34
4.7. Economic Land Use Impacts ...................................................................................... 34
4.8. Effects of Construction on Employment ......................................................................... 35
4.9. Visions on the Cross-Border Integration and Structural Changes .................................... 36
5. References....................................................................................................................... 38

Appendixes:
Appendix 1. Finest Link Scenario 0+
Appendix 2. Finest Link Passenger Volume Estimation
Appendix 3. Finest Link Cargo Volume Estimation
Appendix 4. Wider Economic Impacts – background and methods
Forewords

This is a Comparative Impact Analysis sub-report of the FinEst Link feasibility study, published in www.finestlink.fi.

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1. **Ferry Traffic Solution 0+**

The purpose of this section is to give an overview of history, current situation and future expectations of ferry traffic between Estonia and Finland.

1.1. **Past Development**

The ship traffic between Estonia and Finland ceased in 1939 because of the Second World War. It was re-started in 1965 by Estonian Shipping Company (ESCO) with one passenger vessel. Traffic increased during years and a larger vessel (Georg Ots) was introduced in 1978. Georg Otse was a ferry capable to transport cars and cargo.

ESCO established a new ferry company Tallink in 1989 together with a Finnish Company Palkkiyhtymä. Tallink started ferry traffic with one vessel (m/s Tallink) in 1990. Traffic has developed, and several ships were introduced over the years. Fast crafts used in summer seasons became popular in the 1990’s.¹

1.2. **Recent Traffic Patterns**

1.2.1. **Vessel Traffic**

Currently, there are three ferry companies providing services on the Helsinki-Tallinn sea route all year around carrying both cargo and passengers: Eckerö Line, Tallink Silja, Viking Line. St. Peter Line Ltd. visits Tallinn occasionally while the main route is to St- Petersburg, Russia. There are also additional fast ferry services during summer season.

The daily traffic is based on passenger-car ferry concept, where passengers and cargo are transported in the same vessels. Cruises and related entertainment as well as shopping are also a vital part of the business concept.

Schedules of ferries ro-ro (roll-on, roll-off) ships:

Eckero Line    2-3 departures per day (summer); 1 ferry
Tallink Silja  4-7 departures per day (summer); 3 ferries
              2 departures per day; one ro-ro ship
Viking Line    2 departures per day (summer); 1 ferry

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Table 1 Examples of vessels (source: Internet pages of individual companies; accessed 3.4.2017).

**Eckerö Line**  
M/s Finlandia  
Built: 2001  
Length: 175 m  
Width: 27.6 m  
Ice Class: 1A  
Speed: 27 knots  
Passengers: 2 080  
Lane meters: approx. 1 900 m

**Tallink Silja**  
M/s Megastar  
Built: 2017  
Passengers: 2 800  
Length: 212.2 m  
Width: 30.6 m  
Speed: 27 knots  
Cars: 646  
Lane meters: approx. 3653 m

**Viking Line**  
M/s XPRS  
Built: 2008  
Passengers: 2 500  
Length: 185 m  
Width: 27.7 m  
Speed: 25 knots  
Cars: 230  
Lane meters: 1000 m

There are currently two shipping lines providing fast craft services between Helsinki and Tallinn. Linda Line was established in 1997. The company is operating two fast ferries during summer season (typically 30.3 – 1.10). These fast crafts are transporting passengers only. Viking Line was operating Viking FSTR vessel between 10.4.–22.10.2017. This vessel transported passenger cars and buses.

Schedules of fast crafts:  
Linda Line  3-6 departures per day (summer); 2 vessels  
Viking Line  2-3 departures per day (summer); 1 vessel
Table 2 Examples of Fast Crafts (source: Internet pages of individual companies; accessed 3.4.2017).

**Linda Line**
Length: 52.6 m  
Width: 13 m  
Power: 9280 kW  
Speed: 37 knots  
Passengers: 383

**Viking Line: Viking FSTR**
Length: 91 m  
Width: 26 m  
Speed: 30 knots  
Passengers: 836  
Cars: 120  
Lane meters: approx. 990 m

There has been a continuous traffic growth in port visits during the last ten years as it can be seen in Figure 1. Number of ship arrivals is considerably bigger during summer months (Figure 2).

![Port Visits per year](image)

*Figure 1 Port visits on Helsinki - Tallinn route (Source: Port of Helsinki Ltd.)*
Current passenger capacity of vessels is presented in the table below (situation spring 2017). Some passenger ferries, normally used in traffic between Finland and Sweden, have been used to add capacity during busy summer months by making one trip to Estonia while normally in Helsinki waiting for the evening departure to Stockholm.

Capacity is approx. 17 million passengers per year (two way). According to traffic estimations, requirement for scenario 0+ is 14.1 million passengers per year (two way) or 10.6 million passengers per year with the tunnel (Fixed Link). It can be concluded that ferry capacity is adequate to meet future demands. Capacity can be increased by acquiring bigger and/or additional vessels. However, this does not take into account scheduling according to demand. This might reflect negatively to the capacity on weekdays as well as morning and afternoon departures.

Table 3 Passenger (PAX) Transport Capacity (one way).
1.3. **Other Routes between Finland and Estonia**

DFDS Seaways is operating a vessel between Hanko (Finland) and Paldiski (Estonia) with a ro-ro passenger Ro-Pax (Ro-Pax – Roll-on, Roll-off and passengers) ferry Sailor. Sailor has 119 cabin beds. This route is mainly for cargo but some passengers are also transported.

![Figure 3 Sailor at Paldiski (Port of Paldiski)](http://www.portofpaldiski.ee/img/gallery/vessels/vessel9.jpg)

Previously there has been a ferry line from Kotka (Finland) to Sillamäe (Estonia) operated by Narva Line during 2006 to 2007. There have been plans to commence ro-pax traffic from Turku to Saarenmaa but this has not been realised.

1.4. **0+ Option**

1.4.1. **General**

The 0+ option is developed to evaluate how ferry traffic between Estonia and Finland is developing, in case the Fixed Link will not be built. This evaluation is based on traffic estimates and scenarios made during this project and interviews with stakeholders.

It is likely that ship capacity can be increased if the demand is growing. However, ship traffic is limited by number of vessels in traffic. Traffic congestion in the cities is also an issue to be considered. Current vessel sailing time of two hours is unlikely to shorten in the future. Minimum turnaround time is approx. 40 minutes. Commuting traffic tends to favour certain schedules and this will limit capacity usage.

Train ferry traffic has been ceased generally in the market and therefore is not considered in this study. Train ferry transport is not competitive due to higher costs which relates to inefficient utilisation of ships space and carrying capacity.

The Basic 0+ option is based on current port terminals. However, three other alternatives have been recognised:

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1.4.2. Traffic Investments in Ports

There are several traffic investments planned in connection with the Helsinki Western Harbour improving the transportation system and thus reducing congestion. These investments will be realised regardless of the possible Fixed Link. There may also be other investments. These investments and their benefits have not been estimated.

Traffic investments in Helsinki
- Tyynenmerenkatu 14 M€ 2017-2026
- West Harbour Traffic improvements 5 M€ 2017-2026

These investments will be done regardless of the possible Fixed Link.

Additional:
- West Harbour Terminal 1 renovation or rebuilding planned.
- Mitigation measures if city boulevards proposed in the new City Plan will be established.

Traffic investments in Tallinn
- Masterplan 2030 competition on August 2017 was won by Zaha Hadid Architects.
- Discussion to move ferry traffic from the Old City Harbour to Muuga; in order to ease congestion issues.
- Reiđi road improvement plan (28,5 M€) is expected to help with congestion.
- Plans to take tramline or light rail to the Old City Harbour in near future.

1.4.3. 0+ Current Facilities

In scenario 0+ capacity for one-way passenger transport is approx. 8.5 million passengers per year (approx. 17 million passengers per year two-way) while 4.2 million passengers were transported during 2015. There are significant seasonal changes in traffic, concentrating in summer months. Weekends are more popular than weekdays and there are also daily differences with the popularity of certain departures.

The estimated requirement for scenario 0+ is 14.1 million passengers per year (two-way). For scenario Fixed Link the estimated requirement is 10.6 million passengers per year. It can be concluded that the ferry capacity is adequate to meet future demands. Capacity can be increased by acquiring bigger and/or additional vessels.

Port of Helsinki has built a new passenger terminal to West Harbour with considerable investments to infrastructure and traffic arrangements. This terminal will serve ferry traffic to Tallinn (Eckerö Line and Tallink).

Jätkäsaari area is developing fast from a port area to a residential area. West Harbour (Eckerö Line, Tallink and St. Peter Line) in Jätkäsaari, South Harbour (Linda Line) and Katajanokka (Viking Line) are
all located in the city centre. There are some traffic bottlenecks due to the location. The ferry terminal in Tallinn is located in the city centre. Increasing passenger and cargo traffic is expected to challenge traffic in the city centre. Digitalisation and mobility solutions will enable more efficient traffic management.

Figure 5 Ports and connections between Estonia and Finland
1.4.4. 0+ Cargo to Vuosaari and Muuga

There is currently one ferry transporting cargo between Vuosaari, Helsinki to Muuga, Tallinn. Technically it is possible to re-locate all cargo transport activities to Vuosaari or Muuga. It is likely that both Helsinki and Tallinn port terminals will continue to develop as a cargo and ro-pax terminals with even some private car transport as well. Cargo traffic would benefit from better road and rail connection in above mentioned cargo ports.

However, presently passenger and cargo transportation on ferries are interdependent. Ferry companies use pricing to guide cargo transport from weekend to weekdays in order to utilize ferry capacity efficiently.

The possible impact of relocating all cargo traffic to Vuosaari could be that ship types, schedules and frequencies are changed. There might be less traffic during weekdays which could reduce service level. It is possible that competition will be reduced, because there might be less cargo operators than there are ferry operators currently. Both passenger ferries and cargo ships could have pressures to raise prices due to the lost ability to adjust capacity utilisation between passengers and cargo.

It is likely that current additional cargo traffic between Vuosaari and Muuga will continue and even increase. Required investments are relatively minor, assuming that the current berth can be utilised.

1.4.5. 0+ All Ferry Traffic to Vuosaari and Muuga

Moving all passenger ferry traffic from city centres to Vuosaari or Muuga would require a complete new terminal with some land reclaiming. This option would release current ferry terminals for other
land use. Building a new terminal requires investments, but the city would also gain major benefits to develop urban waterfront without any ferry related road traffic. There is currently a master planning process in Tallinn to develop the waterfront area. In Helsinki there are already detailed plans for the West Harbor port area.

Functionally the Vuosaari and Muuga option should be advantageous for trucks due to enhanced road and rail connections. A more detailed analysis would be needed to evaluate road, yard and berth capacity at Vuosaari.

The option for re-locating all ferry traffic to Vuosaari is considered challenging at the moment, due to limited space at Vuosaari. Such a re-location operation would need major reclaiming work.

1.4.6. 0+ Other Ports

There is currently a ferry operating between Hanko (Finland) and Paldiski (Estonia) with limited passenger capacity. There used to be a ferry line between Kotka (Finland) and Sillamäe (Estonia) but traffic was ceased after one year. There are still possibilities to consider other Finnish and Estonian ports for transporting passengers and cargo if and when volumes increase.

1.4.7. 0+ Modern Technologies

Development of technology might impact positively on ferry traffic in the future.

Ships are becoming more environmental friendly. Vessels with conventional diesel engines are forced to reduce emissions by international conventions. This is also increasing the number of LNG powered vessels. Electric or Hybrid powered ships have been introduced for shorter routes. Two ferries operating completely on battery power between Helsingør (Denmark) and Helsingborg (Sweden), approximately 4 km voyage, carry more than 7.4 million passengers and 1.9 million vehicles annually. There has been some pressure on the limiting of the vessel speeds in the Estonian coast due to environmental reasons. This could increase voyage time.

Autonomous or remote-controlled vessels are expected to be in operation within 10 years. However, it is likely that they are more beneficial on longer routes. Automated mooring is already in use at the Western Harbour for shortening ship turnaround time and enhancing cost efficiency. Modern technologies will be beneficial for ferry operations but will not lead to operational changes.

Developing smart mobility services by utilizing open data for traffic planning and control, such as real-time traffic light control, will improve traffic management related to the ferry traffic. New mobile applications are also developed for improving accessibility and procedures related to ferry traffic.

1.5. 0+ summary and conclusions

Estimated ferry traffic can be managed using current and new facilities and vessels. Additional vessel capacity can be increased in order to meet the increasing demand. However, vessel departure and sailing times might not be optimal for the demand (especially for commuting traffic). The traffic in the city centres will be impacted as a result of ferry traffic using the present harbours. Mitigation measures are possible but the increasing traffic volumes in both Tallinn and Helsinki city areas create a significant problem. Visions of dealing with the problem have been presented (e.g. an underground
road connection in Helsinki). In addition, cargo traffic could be increased by using Vuosaari and Muuga terminals. Planned investments are expected to be implemented in spite of the possible Fixed Link.
2. **Volume Estimations**

2.1. **Passenger Volume Estimations**

**Objectives and approach**

An important part of the project is to describe transparently the baseline data and methodologies to estimate the passenger volumes in all alternatives:

- **0 (zero) scenario**: Refers to present situation, which will be described for reference purposes to understand changes in travel patterns.
- **0+ (zero+) alternative**: Describes the future situation without the fixed link (the tunnel) and answers the question how passenger traffic could be developed if the tunnel will not be built. The 0+ -alternative is presented as the alternative in the comparative impact analysis.
- **FL (Fixed Link) alternative**: Refers to situation where the tunnel is built and answers the question how passenger traffic and travel behaviour could develop if the tunnel is built and operated as planned.

The main goal has been to assess the probable magnitude and quality of passenger traffic (base scenario) for the CBA (Standard Cost-Benefit Analysis). The base scenario was also applied to estimate the temporal trip distributions for e.g. the train operation concept outlining.

Additionally, the focus has been in the formulation of a model that can be used to perform the sensitivity analysis of the effects of different assumptions or uncertainties in the operating environment or baseline data on travel behaviour in alternative scenario situations. The methodology relies on the relevant references, case studies and research information described in separate appendix 2.

**Current situation**

Approximately 9 million trips were made in the Helsinki-Tallinn corridor in 2016. For the moment the share of ferry of all trips is significant (97 %). Only 0.3 million trips are made by air. The growth of passenger traffic over the sea has been very rapid – the number of passengers has grown by over 50 % in the last 10 years.

Significant asymmetries in the present flows can be observed. Currently the Finns make most of the trips (63 %). The share of Estonians of passenger flows is 16 %. Other nationalities represent 21 % of all traffic.

Travel patterns vary greatly comparing Finns to Estonians. So far leisure and shopping purposes are dominant for Finns. There is no single dominant trip purpose for the Estonians, the leisure trips being most frequent at the moment. The monetary flow of tourism is several times larger from Helsinki-Uusimaa to Tallinn-Harju than to the other direction. It has been evaluated that the volume of tourism from Finland to Tallinn is already approaching the saturation level.³

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More than 1.3 million private cars are being transported on ferries. This means that the need to transport private cars on ferries is linked to 15% of all trips at the moment. There is no detailed information about the characteristics of private car transport needs.

**Baseline data and references**

The assumptions of demographic and economic developments and their growth rates are described in the chapter “Wider economic impacts”. The land use projections for Uusimaa and Harju regions are based on a positive scenario of the growth potential of the regions. The population and the number of jobs in Helsinki and Tallinn regions are expected to grow 40% from year 2016 to 2050 (+1% p.a.). Based on those growth rates it is assumed there will be 2 million inhabitants and 1.05 million jobs in the Helsinki region and 0.6 million inhabitants and 0.4 million jobs in the city of Tallinn in 2050.

Derived travel demand has been analysed through different trip types and frequencies of travelling. The most relevant trip types for the passenger traffic forecast are related to travel needs and reasons that occur daily or several times a week: commuting and trips to a place of study. Business and other work-related trips are reviewed as weekly recurring trips. Occasional trips link up to leisure, shopping and visiting. Long distance trips and transit trips (e.g. from Rail Baltica) are considered as intermittent trips as well.

The statistics of commuting via Øresund Bridge between Denmark and Sweden and in the Helsinki Metropolitan Area are the most important references to estimate commuting potential in the Fixed Link scenario. Besides, the corresponding fares and available modes regarding to shares of commuting have been evaluated to produce a valid and a credible estimate.

The detailed description of relevant references and assumptions regarding to different trip types are described in the separate Annex.

**Passenger volumes in the scenario 0+**

The average annual growth of ferry passenger demand has been 4% in the past 10 years. Port of Helsinki has estimated the annual growth of 2% in the future. Passenger growth in scenario 0+ is based on the following annual growth rates:

- 2016 – 2030 +2% / year
- 2030 – 2050 +1% / year

Based on that it is assumed there will be 14.1 million ferry passengers in total in the scenario 0+. 

16
Passenger volumes in the Fixed Link scenario

The calculations are based on the assumption that 15,000 people are commuting four times a week across the Gulf of Finland in 2050. In the forecast there are 10,000 commuters from Tallinn to Helsinki and 5,000 commuters from Helsinki to Tallinn.

In the base scenario the number of annual new train passengers is 11.6 million trips including 3.5 million trips as a total shift from ferries to trains. Therefore, the number of ferry trips is assumed to decrease to 10.8 million annual trips in 2050 compared to the 0+ situation without the tunnel.

The detailed volumes of train and ferry passengers in the Fixed Link base scenario are presented in the separate Annex.
2.2. Cargo Volume Estimations

Objectives and approach

The objective was to produce estimations on cargo potential for year 2050 for maritime and Fixed Link rail transports between Helsinki and Tallinn in alternative scenario situations. Additionally a set of sensitive analyses of the effects of different prices on the transport volumes were performed for illustrating the alternative market situations.

The analyses are performed using FRISBEE freight model, which calculates the theoretical potential for the Fixed Link and Rail Baltica. The model is based on system modelling – when making changes the model calculates the whole transportation system based on new data on costs, transport time etc. The model contains information of transport networks (Finland, Europe, Russia and connections to other continents), transport demand (13 commodities/types of goods SITC2, Eurostat, Comtrade), transport freight by mode (rail, road and maritime transports), by type of goods, terminal and port prices, transport time (taking into account the speed limits, congestions etc. as an average on yearly basis concerning all modes), reliability of transports, risk of damage, loading and handling times in terminals and ports, number and frequency of shipping lines in different ports etc. For different types of goods the factors have different weights affecting the route and mode selection. As an example, for valuable consumer goods the speed and the level of service have more effect than the transport price in route and mode selection.

The data and assumptions

The transport demand 2050 between Finland and all European countries is based on state specific economic forecasts.⁴

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⁴ ETLA, Research Institute of Finnish Economy, moderate forecast
Volume estimations were made in scenario 0+ (existing transport system between Helsinki and Tallinn and Rail Baltica in operation, forecast year 2050) and in scenario Fixed Link (Helsinki–Tallinn tunnel in operation and Rail Baltica in operation, forecast year 2050).

Assumptions were: a) Location of the cargo terminal is near Helsinki airport in the city of Vantaa (the possibility of cargo terminal location in Muuga/Ulemiste was also considered), b) the tunnel price 450 euros per truck per one direction, 12–13 tons cargo per truck per trailer, 600–700 tons cargo per train and 8 tons cargo per TEU, c) average speed of cargo train would be 120 km/h, d) average loading/unloading time of cargo trains is ½ hour and e) annual growth of GDP due to tunnel in Helsinki region 0.1% and in Tallinn region 0.2%.

The volume estimations in base scenario

In the non-tunnel scenario 0+ the maritime cargo between Helsinki and Tallinn would be appr. 6.9 million tons per year of which the potential for Rail Baltica would be 1.8 million tons per year. In comparison, in 2016 approximately 3.8 million tons of goods were transported between Helsinki and Tallinn (2 million tons from Helsinki to Tallinn and 1.8 million tons from Tallinn to Helsinki).

In the base scenario Fixed Link the annual transport potential of the Helsinki–Tallinn tunnel including all types of goods would be appr. 4.2 million tons (from Tallinn to Helsinki 1.7 million tons and from Helsinki to Tallinn 2.5 million tons) and maritime cargo transport potential 4.2 tons, resulting to 8.4 million annual tons of maritime and tunnel cargo all together between these two cities in 2050. The analysis of cargo volumes is based on the assumption that Rail Baltica, the on-going railway infrastructure project from Tallinn via Riga and Kaunas towards Poland, becomes fully functional.

According to the study especially long distance transports between Finland and Central and Eastern Europe via Rail Baltica would use the Helsinki-Tallinn tunnel (more than 80 % of the transport potential for the tunnel). Transport potential for the tunnel consists of the predicted growth of transport demand and shifts from the maritime transports between Helsinki and Tallinn and between Finnish ports and Northern German and Polish ports.

The price of the tunnel transport has a significant impact on the transport potential (Figure 4).
Figure 9 Effects of different tunnel prices to potential cargo volumes 2050
3. Cost – benefit analysis

The elements of cost-benefit analysis are described in this chapter. The analysis includes all effects that can be appraised by means of a valid methodology and clear valuation criteria. The wider economic impacts of transport investment are not included in the standard cost-benefit analysis. However, the primary impacts of transport investment estimated in the cost-benefit analysis have been used to determine the wider economic impacts in the overall assessment of the Fixed Link.

The cost-benefit analysis is used to determine the economic feasibility of the investment. The analysis is carried out following and applying the general guidelines presented in the EU Guide to Cost Benefit Analysis of Investment Projects (2014). The national guidelines are consistent with the EU Guidelines. The cost-benefit analysis is thus based on a well-documented and internationally accepted theoretical approaches and practices of transport cost-benefit analysis.

The cost-benefit analysis studies the difference between the Fixed Link in contrast to the reference scenario (0+-alternative). The benefits and costs of the investment are discounted for the appraisal period to present value. The base year for the cost-benefit calculation is the starting year of construction. Socio-economic discount rate in the calculation is according to Finnish guidelines 3.5 %.

Railway infrastructure project life cycle is 30 years after the operation of the tunnel has started. The increasing number of passengers, freight and benefits during the 30 years’ time is taken into account in the calculation.

3.1. Investment and Maintenance

The investment cost includes also owner’s costs. Risk analysis and cost margins (low/high) have been examined in the sensitivity analysis. There are assumed to be no significant investment savings due to the Fixed Link. This means that the investments in the 0+-alternative would also be made in the case of the Fixed Link alternative.

Construction of the Fixed Link is assumed to start 2025, construction time is assumed to be 15 years and the Fixed Link opened 2040. Project reference period is 30 years after the opening of the tunnel, i.e. 45 years (years 2025–2069). The residual value of the investment at the end of the reference period is 47 % of the original investment cost, if the life cycle of the tunnels is assumed to be 100 years.

3.2. Consumer Surplus, Passenger Transport

Expected time savings represent the most important element of the cost-benefit analysis and the travel time with the Fixed Link is an important starting point for the evaluation. The average time saving for a passenger changing mode from ferry to Fixed Link train is 2 h 10 min (components of savings are: travel time 120–40=80 min, waiting time 30–10=20 min and access times 50–20=30 min).

The improvement in supply conditions generates new traffic as the generalized travel costs between particular origins and destinations are reduced. The user benefit of new generated traffic can be approximated by a function known as the rule of a half, which uses the traffic volumes and generalized costs in different scenarios. The rule of half is the standard method in estimating the benefits of new and generated traffic. In essence, the rule of a half is a linear approximation to the consumer surplus measure of benefits. When changes are large, the linear approximation becomes inaccurate. However in this case, when we do not know the shape of the demand curve, the rule of half is the best available method for estimating the benefits. It should be noted that it can well be that the rule of half overestimates the benefits in this case.
Passenger volume estimations for the Fixed Link are based on rapid growth land use scenario. The rapid growth of land use in Helsinki and Tallinn can be seen as one result of the Fixed Link. According to the rule of half, every new passenger that starts to e.g. commute across the Gulf of Finland using the Fixed Link gets a benefit of 1 h 5 min.

Time savings are monetarized using unit values for different customer segments (commuters, business travelers and leisure trips). Convenience factors take into account the effects in waiting times and changing from one transport mode to another. The unit values of time for Finnish travelers are from the Finnish guidelines for assessment. The base year for the values is 2013 and the values are assumed to increase 1.125 % / a. The unit values are as follows:

- Business trips 23.7 € / h
- Trips to work 10.7 € / h
- Other trips 6.8 € / h.

The unit values for Estonian travelers are assumed to be 30 % of the Finnish values in year 2016 due to a difference in income levels. The Estonian values are assumed to increase faster than the Finnish ones, following the growth assumptions of the economies. Additionally, the Estonian unit values of time for commuters equal to the Finnish values.

In year 2050 the monetarized time benefits are given as time savings of the existing users, convenience factors of the existing users and benefits of new generated traffic.

### 3.3. Producers Surplus, Passenger Transport

Producer surplus of transport operators takes into account the operating costs and revenues from transport services. Both the operators of the Fixed Link and ferries are considered.

The fares of passenger train tickets are:

- 18 € / trip for single trips
- 15 € / trip for frequent travelers
- 12 € / trip for the users of 30-day card (480 €)
- 70 € / car for transferring a private car in a shuttle.

In the cost-benefit calculation the tunnel operations have zero percent tax rate VAT. In this way, the assumption for VAT is the same for ferries and tunnel.

The passenger rail fare revenues are a result from number of passengers and the unit cost of passenger train tickets.

The operators of the ferries lose some of their revenues from transport services in the case of Fixed Link. It is assumed that there are 3 daily ferries less between Tallinn and Helsinki due to the tunnel, which has an effect on operating costs. Also the number of passenger is smaller, which affects fare revenues.

It is not possible to estimate all the effects of the Fixed Link to the ferry operators. This is because the ferries are used both by freight transport and passengers and the ferry companies also provide other services (restaurants, shopping etc.) on board.
3.4. Cargo Transport

The benefits of cargo transport originate from reduced operating costs between Helsinki and Tallinn. The benefits are not separated to users and producers benefits. The unit costs of cargo transport operation (including terminal costs) across the Gulf of Finland are assumed to be:

- Ferries: 15.6 € / ton, which represents the cost for the operator to transport cargo between Helsinki and Tallinn
- Fixed link truck shuttles: 12.3 € / ton and cargo trains: 5.8 € / ton
  - The average cost using the fixed link is 10.3 € / ton.

The benefit for the existing demand is 15.6 – 10.3 = 5.3 € / ton and according to the rule of half for the new demand 2.7 € / ton. Also the fare revenues from the new demand have effect on benefits.

3.5. Externalities

Emissions

Environmental impacts are external effects of the investment and the operation of trains and ferries. External effects are calculated using selected unit values for CO₂, NOₓ and particles.

The tunnel uses a lot of electricity, which has a negative environmental impact. The impact depends on how the electricity is produced. In this calculation, the average properties of Finnish electricity production for the energy of the tunnel are used.

Correspondingly, the number of ferries decreases due to the tunnel. It is assumed that there are about 3 daily ferries less between Tallinn and Helsinki. This has a positive environmental impact. There is also less truck traffic on the streets of Helsinki and Tallinn due to the new location of terminals.

The environmental impact as a whole is small.

Accidents

There are no such accidents on railway traffic or sea traffic that should be taken into account in the cost-benefit analysis. Therefore, it is assumed that the fixed link has no significant effect on traffic safety or the number of accidents.

Calculation

The economic indicators presented as a result of the cost-benefit analysis are Economic Rate of Return (ERR), Net Present Value (NPV) and the Benefit/Cost (B/C) Ratio.

- Economic Net Present Value (ENPV): The difference between the discounted total social benefits and costs
- Economic Rate of Return (ERR): The rate that produces a zero value for the ENPV
- Benefit/Cost Ratio: The ratio between discounted economic benefits and costs.
The investment cost used in the cost-benefit analysis is 12 206 M€, which is the discounted net present value of the actual investment cost 16 000 M€.

Table 4 Calculation table of standard cost-benefit analysis.
Most important benefits originate from the new users that start to travel between Tallinn and Helsinki. They are the source of fare revenues for train operator and they also get user benefits since the generalized cost of travel is reduced.

### 3.6. Sensitivity Analysis

A sensitivity analysis of the economic profitability has been carried out to identify under which circumstances the investment becomes profitable. Travel times together with fares have an effect on traffic volumes, which is the key component in cost-benefit analysis.

The analysis is carried out using disaggregated variables (i.e. demand and prices separately) to better identify possible critical variables. The sensitivity analyses are as follows:

- Investment cost: low (-14 \%) and high estimate (+25 \%)
- Life cycle of the tunnel structures from 100 years down to 50 years.
- Infrastructure project life cycle from 30 years up to 60 years.
- Socio-economic discount rate from 3.5\% up to 5\%.
- Calculations base year to the opening year of the tunnel according to Finnish guidelines.
- Uncertainty of maintenance and operating costs: these costs have been doubled. The doubling of the train operating costs is based on Finnish unit values for train operations.
- Travel time of fixed link up 5 minutes, as the timetables are only drafts.
- The fares revenues from the travelers may be lower due to e.g. competition: 30-day card revenues from 480 euros down to 240 euros.
- Number of new daily commuters up 25% (e.g. share of commuters from Tallinn to Helsinki from 4% up to 5%).
- Number of new daily commuters down 25% (e.g. share of commuters from Tallinn to Helsinki down from 4% down to 3%).
- Unit values of time savings for the Estonian travelers to be the same as Finnish travelers in all trip purposes. In the base case calculation only the unit values of time for Estonian commuters equal the Finnish values.
- The growth of GDP in Finland and Estonia is 30 percentage units higher than in base scenario.

The infrastructure project life cycle from 30 years up to 60 years, smaller investment costs and larger unit values of time and faster economic growth have the biggest positive impacts on the profitability. Correspondingly, investment cost with high margin, increasing the socio-economic discount rate and doubling the maintenance and operating costs have the biggest negative impacts.

Next figure gives the benefit-cost ratios for the sensitivity analyses. There are also two calculations, where all the positives factors and all negative factors are together.

<table>
<thead>
<tr>
<th>B/C RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
</tr>
<tr>
<td>BASE CASE</td>
</tr>
<tr>
<td>Investment cost, low margin (-14%)</td>
</tr>
<tr>
<td>Investment cost, high margin (+25%)</td>
</tr>
<tr>
<td>Tunnel life cycle down to 50y</td>
</tr>
<tr>
<td>Project life cycle up to 60y</td>
</tr>
<tr>
<td>Discount rate up to 5%</td>
</tr>
<tr>
<td>Opening year as base year</td>
</tr>
<tr>
<td>Maintenance &amp; oper. costs up 100%</td>
</tr>
<tr>
<td>Tunnel travel up +5min</td>
</tr>
<tr>
<td>Fare revenues from commuting -35%</td>
</tr>
<tr>
<td>Daily commuting up 25%</td>
</tr>
<tr>
<td>Daily commuting down 25%</td>
</tr>
<tr>
<td>Estonian values of time same as Finnish</td>
</tr>
<tr>
<td>Finnish and Estonian GDP +30% in 2050</td>
</tr>
<tr>
<td>All positives</td>
</tr>
<tr>
<td>All negatives</td>
</tr>
</tbody>
</table>

*Figure 11 Benefit/Cost Ratios for the sensitivity analyses (wider economic impacts not included).*
4. **Wider Economic Impact analysis**

This section summarizes the analysis of the wider economic impacts. The analysis results estimations of the monetary values of main components of the wider economic impacts such as agglomeration, labour market and competition impacts. In addition, it includes a description on the effects on land use, and an estimation of the influence of the construction of the tunnel and the railway on the employment in the construction and other sectors. Finally, the section deals with the development potential and future visions of the cross-border integration of the metropolitan regions concerned.

Wider economic impacts\(^5\) (WEI) of transport projects refer to impacts beyond the direct user and producer benefits. Accessibility improvements due to an investment can affect the productivity of businesses directly or materialise through the labour market, the product market or the land and property market. Lower transport costs lead to lower production costs and better productivity. Productivity increases along with the growth of the size or density of a city or improved transport links between urban centres. Enhanced accessibility leads to larger labour market areas and affects employment rates and the incomes of the working-age population. Transport investments improve the accessibility of areas and promote land development. These changes are closely related with direct user and producer benefits but they can also generate wider impacts.\(^6\)

4.1. **Framework and Methods**

Wider economic impacts arise because the benefit of a change in the transport system to society differs from the benefit perceived by an individual transport user. The sum of user benefits therefore does not represent the total gain to society. The mechanisms through which transport investments can create wider impacts and their relationship with user benefits from the perspective of passenger transport are illustrated in the figure below (Figure 10).

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\(^5\) A literature review of the effects of transport investments to the regional economics is in appendix

\(^6\) Venables 2016; Laakso & Kostiainen & Metsäraanta 2016
In the general evaluation instructions of transport projects it is noticed that major transport investments may cause wider impacts which will not be included in the direct user or producer benefits. The report mentions the productivity gains for firms, concentration gains, competition effects, and enhancement or densifying of labour market areas. According to the instructions it is important to analyse wider impacts if they are expected to be significant. It is pointed out that estimated wider impacts must not be included in the standard cost-benefit calculation, but they should be presented separately. If significant wider impacts can be expected they should be analysed using appropriate methods. While the Finnish or EU’s evaluation instructions do not contain methodological advice for evaluation of the wider impacts, the methods presented in the Transport Analysis Guidance of UK have been applied. A more detailed description of the application of the UK guidance is in the appendix 4. However, the Fixed Link project is rather exceptional, the time horizon is very long, and there are a lot of uncertainties concerning the future economic environment, as well as strategies and policies of regions and cities and the behaviour of the potential users of the link. For this reason, alternative assumptions have been made concerning the key parameters applied in the model.

The framework of the user costs and benefits and wider impacts is based on socio-economic cost-benefit analysis. The aim is to assess all benefits and costs of a project to all actors in the society. The basic principle in the WEI framework and in the Transport Analysis Guidance is that only those impacts are counted which contribute to value added in the production sector (firms), or to the welfare of households in addition to direct user or producer costs and benefits. Consequently, the shifts of economic activity between regions, between industrial sectors, or between the public sector and households or firms, are not included in WEI as benefits or costs. For example, population growth due to internal migration or job growth due to location changes of firms should not be included as benefits, even when this kind of shifts may be interesting from local point of view. In addition, the changes in income transfers from the public sector to households or change in tax income of the state or municipalities cannot be counted as net benefits because they are pure shifts of money between different sectors.

4.2. Assumptions of Economic and Demographic Developments

The impact area of the Fixed Link is defined to cover:

- Finland (divided to Helsinki Region, other parts of Southern Finland, and rest of Finland)
- Estonia (divided to Tallinn region, Pärnu region and rest of Estonia)
- Riga region in Latvia.

The inclusion of Riga region and the separation of Pärnu region are based on the expected realization of the Rail Baltica. The study is based on several assumptions concerning the economic and demographic developments in the impact areas from year 2016 to 2050. The assumptions are based on research on the long run economic prospects and projections in Estonia and Finland. The assumptions are based on a positive scenario of the growth potential of Nordic and Baltic countries and their major urban regions. In addition, in the sensitivity analysis alternative versions of some assumptions have been applied.

---

7 Finnish Transport Agency 2011
8 Department for Transport 2014
9 OECD 2014; VATT 2015; Helsinki-Uusimaa Regional Council 2017
10 A summary of the interviews is in the appendix.
The growth assumptions are used to create a basic long run scenario for production, jobs and population in the impact area. When the values are used in calculations same values and same assumption on the economic structures are applied in alternatives, 0+ and Fixed Link. The potential impulse effect of Fixed Link to the structural changes of the economies in the impact area has been dealt with in the end of this section.

Assumptions about the growth rates from 2016 to 2050 at national and regional level:

**National level: growth rates 2016-50**
- GDP (real)
  - Estonia: 3 % p.a.
  - Finland: 2 % p.a.

**Regional level (Tallinn region, Helsinki region): growth rates 2016-50**
- Population
  - Tallinn: 1 % p.a.
  - Helsinki: 1 % p.a.
  - Riga: 1 % p.a.
- Jobs
  - Tallinn: 1 % p.a.
  - Helsinki: 1 % p.a.
  - Riga: 1 % p.a.
- GDP (real)
  - Tallinn: 4 % p.a.
  - Helsinki: 2,5 % p.a.
  - Riga: 2,5 % p.a.

For the years after 2050 all growth rates have been cut by 50 %, following the weakening growth rates in the OECD’s (2014) scenarios.

### 4.3. Agglomeration Impacts

Changes in the location of businesses resulting from changes in accessibility can lead to creation of larger and more compact business clusters because better transport links bring urban concentrations and their business centres closer to each other. This enables agglomeration benefits, which are created as trade, communication and other forms of interaction between businesses and their employees increase thanks to proximity. Studies show that agglomeration benefits have a positive impact on the productivity of businesses, although the impacts vary widely between sectors.

Productivity impacts are based on better possibilities to exploit scale effects in business, creation of localisation benefits (concentration of firms of the same sector near each other), and urbanisation benefits (diversity and big size of urban areas). Agglomeration benefits can be interpreted as externalities of transport investments, which create wider impacts but are not included in transport user benefits.\(^{11}\)

\(^{11}\) Venables 2016
The Fixed Link would tie Helsinki and Tallinn regions and whole countries closer to each other. Effective Density is an indicator used to measure accessibility as a function of transport distance and economic size of regions. This study applies the following formula for calculating effective density.\(^{12}\)

\[
ED_i = \sum_j \frac{A_i}{d_{ij}}^B,
\]

where: \(i,j = \) region; \(A_i = \) number of jobs in the region; \(d_{ij} = \) transport distance or generalised transport cost between the regions; \(B = \) coefficient that determines the rate at which the impact of distance decays. The larger the \(B\)-coefficient, the more sharply the impact is diluted as distance grows.

The study of agglomeration impacts is based on estimated effective densities within the impact area (Finland, Estonia, Riga) at regional level (NUTS 4) for alternatives Alternative 0+ (ferry connection) and Fixed Link (rail connection). The \(B\)-coefficient applied in this study is 2.5. Two alternatives for the productivity elasticity w.r.t effective density are applied in the study: 0.05 (base) and 0.025 (low). Parameter values are based on the research literature presented in the appendix. Annual GDP levels estimates at rough regional level are based on Eurostat statistics for 2014 and assumptions for GDP growth presented above.

The calculation of the agglomeration impact is based on equations of UK Department for Transport (DfT) (2014), Appendix 4. The results represent total overall impact of agglomeration without a division to different factors (scale, localisation and urbanisation effect). It is also supposed to include the indirect multiplicative effects of firm level growth impulses caused by the project.

The wider impact benefits have been calculated for 30 years starting from year 2040 when the link is assumed to be ready. According to the results the estimated discounted value for 30 years of the total productivity impact of Fixed Link will be about 1 800 – 3 600 M€ depending on the assumption concerning the agglomeration elasticity. The most significant impact will be in Tallinn region, 800 - 1 700 M€ (44 % of total impact) and slightly smaller in Helsinki region, 500 – 1 100 M€ (29 %). Significant impacts will also be allocated to rest of Finland, 360 - 710 M€, rest of Estonia, 80 - 150 M€ and Riga, 30 - 50 M€.

<table>
<thead>
<tr>
<th>Impact</th>
<th>Alternative</th>
<th>Helsinki region</th>
<th>Rest of Finland</th>
<th>Tallinn region</th>
<th>Rest of Estonia</th>
<th>Riga region</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP, M€ p.a. at 2050 level</td>
<td>High</td>
<td>62</td>
<td>41</td>
<td>99</td>
<td>9</td>
<td>3</td>
<td>214</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>31</td>
<td>20</td>
<td>50</td>
<td>4</td>
<td>2</td>
<td>107</td>
</tr>
<tr>
<td>GDP, M€, discounted, 30 years, 3,5%</td>
<td>High</td>
<td>1069</td>
<td>712</td>
<td>1653</td>
<td>153</td>
<td>54</td>
<td>3642</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>535</td>
<td>356</td>
<td>826</td>
<td>77</td>
<td>27</td>
<td>1821</td>
</tr>
</tbody>
</table>

* discounting factor 3,5 %

\(^{12}\) Graham 2007; Venables 2016
4.3.1. Labour Market Impacts

Transport investments can also create wider economic impacts in the labour market. As travel time and therefore travel costs decrease, the labour force achievable to businesses increases and, on the other hand, the area of potential jobs accessible to the labour force grows wider. The change in achievable labour force leads to an expansion of the labour market. This leads to an increase in labour supply and output, as the travel time saved can be used more on production.

The expansion of the labour market and shorter commuting times also lead to a better alignment between labour demand and supply as well as workers’ competence and employers’ needs in that respect, which increases productivity.

The calculation of the labour market impacts is based on equations of DfT (2014), Appendix 4.

**Labour supply impact:** Travel costs affect peoples’ willingness and opportunities to work instead of being unemployment or not active in the labour market. The change in labour supply estimation is based on the change in the generalised cost of commuting relative to expected after tax net earnings. Other factors affecting the number of labour supply increase are the elasticity of labour supply with respect to net wage and the number of commuters between relevant region pairs within the impact area of the Fixed Link. The contribution to the production of a new worker in the labour market is the additional value of the worker measured in gross wage including all taxes and social fees. The lower productivity level of new workers is considered by a productivity level coefficient (compared with the average). Only the tax income to the society generated by the increased labour supply is included in the calculation to avoid double counting with direct user benefits.

The assumed parameters for labour supply impact equation are as follows:

- Elasticity of labour supply: 0.3\(^{13}\)
- Tax / labour cost ratio: 0.6\(^{14}\)
- Productivity ratio, new workers / average: 0.69\(^{15}\)

According to the estimations the discounted value for 30 years of the GDP growth caused by increased participation to labour market will be about 1 000 million euros of which two thirds to the Helsinki region and one third to the Tallinn region.

**Table 6 Estimated labour supply impacts in the regions of the impact area.**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Helsinki region</th>
<th>Rest of Finland</th>
<th>Tallinn region</th>
<th>Rest of Estonia</th>
<th>Riga region</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP, M€ p.a. at 2050 level</td>
<td>33</td>
<td>0</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>51</td>
</tr>
<tr>
<td>GDP, M€, discounted, 30 years, 3,5%</td>
<td>649</td>
<td>0</td>
<td>334</td>
<td>0</td>
<td>0</td>
<td>983</td>
</tr>
</tbody>
</table>

\(^{13}\) Based on research in Finland, Laakso & Metsäranta 2017
\(^{14}\) Laakso & Metsäranta 2017
\(^{15}\) DfT 2014
**Work shifts impact:** Impacts of labour force shifts to changed jobs which may be more (or less) productive, are appraised in two steps. In the first step the effect of the transport investment on the location of work is modelled. Then these results are used to estimate the change in productivity multiplying the change of job by the average productivity of each region (GDP/worker). The result is the change in total output resulting from the shift to jobs with location specific productivity for each year. Also in this case only the tax income contribution to the society is included as the benefit.

According to DfT Guidance the location modelling should be based on a Land Use Transport Interaction -model. In this study it is expected that the fast link would create new work due to productivity gains especially in Helsinki and Tallinn regions while the role of job shifts between regions would be smaller. In the Helsinki region the location analysis of the new and shifted jobs is based on the land use model developed for the MAL 2019 project\(^\text{16}\). In the model the change of jobs in the region is projected to year 2050 at detailed geographical level based on two factors: (1) land use restrictions set by municipalities in master level and detailed land use plans, and (2) the accessibility of each location. According to the model there will be a shift of service jobs towards the best accessible locations (inner city, major rail node zones and the Aviapolis zone near the Helsinki Airport) at the cost of less accessible locations. In Tallinn it is expected, based on land use plans and expert views, that most of new and shifted jobs will locate in the Ülemiste area and in the inner city (Kesklinn).

According to the estimations the discounted value for 30 years of the total labour market impact will be about 1 100 – 2 200 million euros, depending on the assumptions. The GDP impact will end up to the employers in the location region of the job. Consequently, while the majority of the existing and new jobs are in Helsinki, most of the of the work shift labour market effect, 800 – 1 700 M€ (74 %) will end up to the Helsinki region while the impact in the rest of Finland is negative due to the anticipated work shifts. The impact in the Tallinn region are 300 – 600 M€ (29 %) and in the rest of Estonia slightly negative.

### Table 7 Estimated work shift impacts in the regions of the impact area\(^\text{17}\).

<table>
<thead>
<tr>
<th>Impact</th>
<th>Alternative</th>
<th>Helsinki region</th>
<th>Rest of Finland</th>
<th>Tallinn region</th>
<th>Rest of Estonia</th>
<th>Riga region</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Work shift, GDP, M€ p.a., at 2050 level</strong></td>
<td>High</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td><strong>Work shift, GDP, M€, discounted, 30 years, 3.5%</strong></td>
<td>High</td>
<td>1 677</td>
<td>-67</td>
<td>602</td>
<td>-20</td>
<td>0</td>
<td>2 192</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>839</td>
<td>-33</td>
<td>301</td>
<td>-10</td>
<td>0</td>
<td>1 096</td>
</tr>
</tbody>
</table>

### 4.4. Competition Impacts

One of the potential impacts of transport investments is increasing competition between businesses and the resulting efficiency gains due to improved accessibility. The most significant impacts of transport investments are indirect impacts resulting from the decreased time for work-related travel

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\(^{16}\) See: https://www.hsl.fi/sites/default/files/uploads/2017-06-20_mal_yleiskalvosarja_englanti_pdf_0.pdf

\(^{17}\) Note: total impact is based on a cumulative sum of annual effects.
and lower delivery costs, as lower costs and faster transport enable lower prices and higher output. These factors produce wider impacts both in terms of competition between businesses and the structure of the economy.\textsuperscript{18}

In the DfT Guidance the evaluation of the competition impacts is based on the model where economic benefit is given as a function of savings from work-related travel, reliability gains resulting from more predictable travel times and an “uprate factor” for imperfect competition. The uprate factor depends on the gap in the marginal cost of the product or service and the elasticity of demand.\textsuperscript{19}

Based on this model, the impact can be assumed to contribute to the user benefits resulting from work-related travel. The impact is calculated as a 10\% increase on the user benefits derived from work-related travel, based on an earlier study.\textsuperscript{20}

The estimated impact of increased competition is significantly smaller that of agglomeration or labour markets. Total discounted value for 30 years is estimated as 110 M€ of which 46 \% to the Helsinki region, 23 \% to rest of Finland, 22 \% to Tallinn region, 4 \% to rest of Estonia, and 6 \% to Riga region.

Table 8 Estimated competition impacts in the regions of the impact area.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|c|}
\hline
Impact & Helsinki region & Rest of Finland & Tallinn region & Rest of Estonia & Riga region & Total \\
\hline
GDP, M€ p.a. at 2050 level & 2.6 & 1.3 & 1.2 & 0.2 & 0.3 & 5.7 \\
\hline
GDP, M€, discounted* 30 years & 51 & 25 & 24 & 4 & 7 & 110 \\
\hline
\end{tabular}
\end{table}

4.5. Summary of Wider Impact Analysis

According to estimations the discounted value of wider impacts measured in monetary value is 4 000 – 6 900 M€, depending on the assumptions. The biggest component is agglomeration effect, 52 \% in the base alternative, and second biggest work relocation effect, 32 \% in the (base).

Half (50 \%) of all the wider impacts is allocated to the Helsinki region while the share of Tallinn region is 38 \%. The share of the rest of Finland is 10 \%, rest of Estonia 2 \%, and Riga region 1 \%, respectively.

Table 9 Summary of the wider economic impacts by impact factor.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|}
\hline
Impact factor & M€ p.a. Year 2050 & M€ 30 years discounted \\
& Low & Base & Low & Base \\
\hline
Agglomeration impact & 107 & 214 & 1 821 & 3 642 \\
\hline
Labour supply & 51 & 51 & 983 & 983 \\
\hline
Work relocation* & 6 & 11 & 1 096 & 2 192 \\
\hline
Competition & 6 & 6 & 110 & 110 \\
\hline
Total & 169 & 281 & 4 010 & 6 928 \\
\hline
\end{tabular}
\end{table}

\textsuperscript{18} e.g. DfT 2005
\textsuperscript{19} Venables 1999
\textsuperscript{20} DfT 2005
Table 10 Summary of the wider economic impacts by region.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Helsinki region</th>
<th>Rest of Finland</th>
<th>Tallinn region</th>
<th>Rest of Estonia</th>
<th>Riga region</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total impact, M€, 30 years discounted</td>
<td>Base</td>
<td>3 446</td>
<td>670</td>
<td>2 613</td>
<td>138</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>2 073</td>
<td>348</td>
<td>1 485</td>
<td>71</td>
<td>34</td>
</tr>
</tbody>
</table>

4.6. Sensitivity Analysis

Five different combinations of assumptions were tested in the sensitivity analysis, including discounting factor (3.5 / 5 %), agglomeration elasticity (0.05 / 0.025), work shift assumption (base / low) and GDP growth rate in all regions (base / 30 higher than base in 2050 / 15 % lower than base in 2050).

According to the results the discounted value of total wider impacts varies from 4 000 to 7 300 million euros. The results indicate that the assumptions concerning the agglomeration elasticity as well as the number of new and shifted work are crucial to the results.

Table 11 Total wider impacts (discounted) in the sensitivity analysis

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Discounting factor</th>
<th>Agglom. elasticity</th>
<th>Work shift assumption</th>
<th>GDP growth</th>
<th>M€ 30 years discounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base scenario</td>
<td>3.50 %</td>
<td>0.05</td>
<td>base</td>
<td>base</td>
<td>6 928</td>
</tr>
<tr>
<td>Low scenario</td>
<td>3.50 %</td>
<td>0.025</td>
<td>low</td>
<td>base</td>
<td>4 010</td>
</tr>
<tr>
<td>Higher discounting factor</td>
<td>5 %</td>
<td>0.05</td>
<td>base</td>
<td>base</td>
<td>6 292</td>
</tr>
<tr>
<td>Higher GDP growth</td>
<td>3.50 %</td>
<td>0.05</td>
<td>base</td>
<td>+30 % in 2050</td>
<td>7 305</td>
</tr>
<tr>
<td>Lower GDP growth</td>
<td>3.50 %</td>
<td>0.05</td>
<td>base</td>
<td>-15% in 2050</td>
<td>6 720</td>
</tr>
</tbody>
</table>

4.7. Economic Land Use Impacts

Changes in the transport system affect land use. Households and businesses are willing to pay more for the location in the improved traffic zone. For firms improved accessibility means increased productivity. As a result, the price of land will rise in the developed traffic zone and the spatial centers in its area of influence will expand and intensify. Finally, the attractiveness of the whole urban area for business and households may increase. If the effect is strong enough this will lead to an increase in the number of jobs and population.

There is a close link between the change in the accessibility of a transport project and the change in the market price of a real estate. According to research, the change in the capital value of a property located in the affected area of the change is equal to the discounted present value of user benefits resulting from the change in accessibility. For this reason, the project evaluation guidelines state that user benefits and changes in property values should not be included in the same calculation to avoid double counting.
Estimated impact on property values may still be interesting because they provide an alternative view to the impacts of the Fixed Link, even when they will be realized because of user benefits calculated in cost-benefit analysis.

An analysis of the accessibility change at detailed geographical level due to FinEstLink has been carried out. In Helsinki the impact is mainly based on commuting from Tallinn region and on business trips to potential business locations. According to the results the accessibility change decreases fast with respect to distance from the stations and after 400 meters the impact is relatively low. Consequently, the price effect will be focused on business property around the stations about within the radius of 400 m.

According to estimations (Fixed Link v.s. Alternative 0+) the impact on the market value (euros/floor space) of built property will be in Helsinki 3-5 % in the station zones of city centre and Pasila and about 10 % in the Airport zone. In Tallinn the impact will be 5-15 % in a wide zone around the Ülemiste station and airport, and in the central city.

4.8. Effects of Construction on Employment

Major transport investments generate large production, employment and tax revenue impacts of construction, which are based on both direct effects and significant indirect effects affecting the construction chain of production for industry and services. The construction has an influence on the business and employment in the surrounding areas. For this reason, economic impacts are interesting from regional point of view.

However, according to evaluation instructions the economic impacts of the construction must not be included in the cost-benefit analysis or WEI calculation for the following reason:

The socio-economic cost-benefit analysis of a transport project is based on comparing the impact of a project with another option (in this case Alternative 0+). In a comparison option, no investments are made, or they are relatively small, whereby the public resources corresponding to the investment are available for other public or private consumption. From national point of view this result similar kind of direct and indirect effects than the investment in the transport project. It is generally assumed that these alternatives are of the same order of magnitude as the project alternatives, but their allocation to different industries or regions may differ significantly.

The cost estimate\(^\text{21}\) of planning and construction of the Fixed Link (without rail technology and utility equipment and material management costs) are about 13 400 M€. The estimated\(^\text{22}\) direct employment impact of the investment during the construction phase (15 years) is 82 000 person-year (5 500 p.a.) and total impact (including indirect and multiplicative effects) is 159 000 person-years (10 600 p.a.).

\(^{21}\) Based on infrastructure investment cost estimation, mean value (Executive summary WP3 01/2018).
\(^{22}\) Based on coefficients derived from input-output statistics of Statistics Finland from year 2014: industries 42 Civil engineering (construction of roads and railways, utility projects and other civil engineering projects) and 71 Architectural and engineering activities.
4.9. **Visions on the Cross-Border Integration and Structural Changes**

According to research literature\(^23\) accessibility – based on functional and efficient transport infrastructure and services – has a close link to the location choices of firms and households, and economic growth. Investments in infrastructure have an impact on the integration of functional regions at national and international level. However, the infrastructure is not alone sufficient for deepening integration, especially concerning cross-border integration. The development of economic, socio-cultural and political structures need to become part of the process. At political level an overarching vision for the future of the cross-border region and good governance conditions are needed, too.\(^24\)

To a certain degree the differences in economic structure, innovation capabilities and cost structure create the foundation for cross-border growth, the potentials to reap benefits from unexploited complementarities and synergies. Simultaneously, as some of the differences create the main driving force for cross-border growth, they also form barriers hindering successful integration.\(^25\)

Numerous studies have been carried out on the economic impact of new high-speed rail connections. Heavy investments in transport often involve political expectations of major developmental impacts. However, based on the literature, these are rarely realized. In developed countries where the transport infrastructure network has already well developed, additional investments do not in automatically lead to economic growth.\(^26\) In the successful cases the investment has been supplemented with supporting measures to exploit the benefits of the investment, like developing the land use of station zones and investing in connecting transport services. Another important success factor is the strategic cooperation at several levels between the regions connected.

One of the successful cross border transport investments has been the Oresund bridge between Copenhagen and Malmö, opened in year 2000. The bridge connected the manufacturing and port city Malmo having severe structural problems in the 1990s and Copenhagen region with fast growing service sector with shortage of labour. The poor connections between the regions had become a bottleneck for the development of cross-border labour markets, the connections to Kastrup Airport and cooperation between the universities and research institutions of the regions, among others. The investment was linked with a strong vision of the integration with multiregional strategic cooperation, including major urban development in both sides common regional transport system and active cooperation between the research and development institutions. Consequently, Malmo region has experienced a deep structural change of the economy and growth of population and production since the year 2000.\(^27\)

Selected specialists in Tallinn region and Helsinki region were interviewed during this study concerning the views of the regional developments, cross-border integration, and visions and strategies of the cooperation with the view of the impact of Fixed Link on those themes.

A general view is that economic and social integration between Helsinki and Tallinn regions has already proceeded a long way, fuelled by transport connections based on regular ferry service with 2

\(^23\) See the literature review in the appendix.
\(^24\) Banister & Berechman 2000
\(^25\) Lundquist & Tripl, 2009
\(^26\) Banister & Berechman 2001
\(^27\) Andersson et al. 2013
hours crossing time. Another important factor is the complementarity of the economic structures as well as social, cultural and linguistical proximity.

Salary and price level differences are remarkable but in the long run they will diminish and become a less important factor as the driver of economic relations and cross-border work. Economic integration has been supported by direct investments from Finland to Estonia. The growing trend is increasing activity and investments of Estonian firms in Finland. Further integration is expected to take place even with the present transport system: the mobility of people, goods and cargo is growing continuously. However, some of specialists expect the growth to slow down in medium term because of some sort of saturation.

All specialists agree that if Fixed Link will be realised it will speed up the integration as well as the shrinking of the salary and price level gap.

To exhaust maximally the benefits of the fixed link a common development strategy is needed both at regional and national level. A concrete suggestion is a Regional Development Strategy at national level, followed by TwinCity strategy and action plan on city level. The model of the strategic cooperation in the Öresund region should be accompanied so some extent. Another step required would be concrete measures which benefit citizen, firms, universities and administration in both countries.
5. References


