Potential Freight Volumes of the Kvarken Ferry Link

- Base Report to the Midway Alignment project

Jonas Westin

Robert Sörensson

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1 INTRODUCTION

The Kvarken Ferry Link is a maritime transport connection between Sweden and Finland. This report is a deliverable from the Centre for Regional Science (CERUM) at Umeå University to the Midway Alignment project.\(^1\) The purpose of the report is to analyse the freight demand for the ferry by estimating the maximum potential freight transport in the catchment area of the ferry. The analysis is based on a model analysis of the maximum potential freight volumes in the catchment area of the ferry across the Kvarken strait using input data from the Swedish national freight modelling system Samgods. The results are combined with a scenario analysis where the effect of different forecasts for the Kvarken ferry is studied. The analysis might serve as an input in a subsequent analysis of the market potential and transport demand for the ferry link between Vaasa in Finland and Umeå in Sweden.

The report is organized as follows. In Section 2 we turn to a description of the various data sources that constitute the starting point in the process of estimating freight flows and briefly describe results from previous studies. Section 3 briefly describe results from previous studies of the Kvarken strait. In Section 4, we analyse the maximum potential freight volumes in the catchment area for the ferry link between Umeå and Vaasa using a simulation model for different price scenarios. In Section 5, we estimate the price sensitivity of the Kvarken ferry and analyse the effect of a scenario with a free ferry. In Section 6, we make a forecast of future demand using an approach where three different scenarios with different growth rates and market shares are studied. Section 7 concludes and discusses implications for the design of a new ferry.

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2 DATA ON TRANSPORT FLOWS AND INTERNATIONAL FREIGHT DEMAND

It is important to stress, right at the outset, that no single data source is readily available to fully capture transport flows and freight demand neither within nor between Finland, Norway, and Sweden. Rather, the available data on transport flows and international freight demand is the result of a structured process where the data are estimated from various sources (Edwards et al., 2008; Edwards 2008). This process varies between countries as well as within countries and over time. These processes are usually commissioned by national agencies, institutes and/or consultants in the transport field. The data for transport demand is generally structured in the form of origin-destination-matrices that describes the annual freight demand for different commodities at a base year between different pairwise geographical areas or zones. The matrices are usually measured in tonnes per year. Since both the base year, the methodology, the zonal division and the commodity groups varies between different countries, it is often complicated to directly compare the content of matrices from different countries. Other sources of data are traffic counts, harbour statistics, foreign trade statistics and estimates of transport costs for different transport modes and logistics costs in harbours and terminals (Trafikverket, 2014a). The transport demand in the matrices are in general more uncertain for cross-border and transit transport flows compared to domestic transport flows (Forsgren and Westin, 2014).

\(^1\) The purpose of the Midway Alignment project is to upgrade the existing transport route by designing and developing a new ferry for the Kvarken strait. The project is coordinated by SSPA Sweden AB. In April 2014 SSPA commissioned a short description of freight flow data between the northern parts of Finland, Norway, and Sweden to CERUM.
2.1 Commodity Flow Survey
The Commodity Flow Survey (CFS) produces data on the movement of goods in Sweden with Swedish and foreign recipients and consignors. The survey is commissioned by the Swedish agency Transport Analysis and provides information about the types of commodities shipped, their value, weight, transport modes, sending, and receiving zones.

The sample survey covers the manufacturing, mining, and wholesale sectors. Whereas data for transport of forestry, dairy and sugar and other agricultural related products are obtained from register sources. A sample of slightly more than 12,000 local units are used as a basis for the estimation of commodity flows corresponding to a total of approximately 23,000 local units. A local unit is a single physical location where business transactions take place. Each local unit report on their individual shipments that comprise data on value and weight, commodity type, modes of transport, cargo type, origin and destination, and geographic point of departure or entry from or to Sweden for foreign shipments (SIKA, 2006a; SIKA, 2006b).

The survey design is a three-stage cluster survey stratified by size of the local units in terms of employees and turnover, industrial classification and region where applicable. The first sampling stage is local units, followed by reporting weeks and finally shipments. Smaller units, in terms of employment or turnover, below a given cut-off limit are excluded (Trafikanaly, 2010; Trafikanaly, 2011).

2.2 Swedish National Accounts
Statistics Sweden holds vital supplementary data to the CFS in the form of Swedish National Accounts (NA). To portray the working of the economy with particular emphasis on the process of production and consumption three items from NA are practically useful.

Three items are:
- supply tables
- use tables
- input/output tables

This set of tables answer the question: where do products come from and how are they used? Note that these relations are expressed in value terms whereas the CFS reports on these relations both in weight and value terms. The main part of the supply table is a matrix of products by industry showing which industry supplies which product, whereas the main part of the use table is a matrix of products by industry showing which industry uses which product. The supply- and use tables are an integral part of the process to compile the third type of tables, the input/output table. For analytical purposes a transformation from a pair of supply- and use tables into an input/output table have the advantage of consistency for row and column totals, i.e. they are equal.

However, the supply and use-tables has a matrix dimension of products by industry, i.e. product×industry; so a choice must be made whether the product or industry dimension is the most appropriate for the symmetric input/output table. Irrespective of the choice between a product×product or an industry×industry dimension the symmetric input/output matrix the individual elements are still expressed in value terms.

2.3 Other data sources
Another supplementary data source is the Central Company and Work Place Register (CFAR). The primary components of interest are employment, turnover, industry classifications and location. These items are used to classify companies and their work places. To estimate international transport flows, the Foreign Trade Statistics (FTS) provides essential information about Swedish
trade relations in the form of all export and all import flows. Note, however, that FTS record nation to nation relations expressed in value terms which implies that the data needs to be converted into tonnes. The national trade statistics also need to be disaggregated into the regional level using model based estimations.

To summarize, the available data on transport flows and freight demand is constructed from various sources and is therefore based on model estimations. This implies that the data only provides an estimation (or a best guess) of the transport flows rather than giving the real picture.

3 RESULTS FROM PREVIOUS STUDIES OF THE KVARKEN STRAIT

The freight transport across the Kvarken strait have increased with around 50 percent between 1998-2008. The increase has been stronger than other trade between Sweden and Finland (ÅF Infraplan, 2012). The transport flows peaked in 2006 with close to 290 000 cargo tons and 14 000 cargo units per year. The transport flows decreased during the economic crisis but have during the last three years almost reached the same levels as in the 2006 as shown in Figure 1 (Wasaline, 2014).

![Figure 1: Annual freight volume measured in cargo tons / year. Source: Wasaline, 2014](image)

The effect on freight volumes therefore differs from the effect on passenger volumes where the end of tax-free sale on the ferry led to a large decrease in passengers after 1998 (ÅF Infraplan, 2010). The low level in 2002 was partly an effect of an unsuitable ferry and competing ferry services from Botnia Link (ÅF Infraplan, 2012).

When choosing transport alternative, studies on freight transport has shown that transport price is the most important factor for the choice of transport route given that a certain level of transport quality is reached. The transport quality includes factors such as reliability, consolidation possibilities, punctuality and transport time etc. Other factors such as environmental concerns are generally ranked lower by the cargo holder (Vierth et al., 2012). Studies on the Kvarken link have confirmed that many freight transports chose alternative routes such as the road through Haparanda/Tornio, both because of lower price and because of uncertainty about the time table and the reliability of the ferry. The confidence in the quality of the transport service was also affected by earlier interruptions due to problem with the ice situation (ÅF Infraplan, 2010).

A description of the transport infrastructure on the Norwegian side is found in Sandberg and Solvoll (2013).
4 ANALYSIS OF MAXIMUM POTENTIAL FREIGHT VOLUMES

The following section contains an analysis of the maximum potential freight volumes in the catchment area of the ferry across the Kvarken strait. The analysis is based on cost calculations using the CCM-model\(^2\) (Westin and Forsgren, 2014) and the base matrices in Samgods version 0.8 (Swedish Transport Administration, 2014). The CCM-model is a transport model developed in the SimLab project. In a previous study, Forsgren and Westin (2012) used the Samgods model to analyse the effect from a strengthened connection across the Kvarken strait. The analysis revealed several shortcomings in the Samgods model, mostly related to cross-border and transit traffic. Shortcoming was also identified in the way the ferry link was modelled. The CCM-model was developed to overcome some of these problems. The CCM-model has a special focus on simulating freight transport in the NLC-corridor and to analyse the competitiveness and catchment areas of competing freight transport corridors.

4.1 Catchment Area
The catchment area for the ferry is analysed using the CCM-model (see Westin and Forsgren, 2014). The estimated catchment area for the ferry across the Kvarken strait is shown in Figure 2.

The analysis of the catchment areas is built on a cost-based approach where the generalized transport costs between each pairwise zone in the model are calculated. The multimodal transport network and the zonal divisions are based on the network from the Samgods model (Swedish Transport Administration, 2014). The model calculates the generalized cost of a typical transport on alternative transport routes. The generalized cost include time and distance based costs for road, rail and ferry modes as well as costs for waiting times, loading, unloading and handling costs at terminals and harbors, see Hanssen et al. (2012). An important limitation of the approach is that the model does not consider capacity constraints or time restrictions such as driving time regulations, ferry time tables and opening times in harbors and terminals etc. This implies that the model ignores some of the real world constraints and rigidities that restricts the ability of transport companies to adapt to changes in the transport system. The results should therefore be treated with caution.

\(^2\) Competitive Corridor Model.
The catchment area is defined as the set of pairwise zones where the ferry across the Kvarken strait is the most competitive transport alternative for a typical freight transport. Since the route choice is based on cost-minimization, the catchment area is hence the set of pairwise zones where the transport route with the Kvarken ferry has the lowest generalized cost compared to all alternative transport routes. From the figure we see that for zones in the northern parts of Scandinavia and Finland, the route over Tornio/Haparanda has a lower generalized cost. The ferry route between Stockholm and Turku/Helsinki does in a similar way have a lower generalized cost than the Kvarken ferry in the southern parts of Sweden and Norway. The costs for transport and loading and unloading in the terminals are based on cost estimates in Vierth, Mellin and Karlsson (2014) and Hanssen et al. (2012).

4.2 Potential Freight Volumes in the Catchment Area
To estimate the maximum potential freight volumes in the catchment we use data from the Swedish national freight model system Samgods. Samgods is a multimodal transport model for forecasting and transport planning and is owned and developed by the Swedish Transport Administration. The Samgods model contains data describing the infrastructural network, transportation costs and transport demand in the form of PWC-matrices describing the freight demand between producers and consumers in different geographical areas in the model. The transport demand in the Samgods model is described in a number of PWC-matrices. The PWC-matrices contain estimations of the transport volumes between every pairwise zone in the model divided into several commodity groups. The PWC-matrices are measured in tonnes per year and are estimated using data from the Swedish Commodity Flow Survey and trade statistics (Edwards,
In this analysis we have aggregated the data into 12 commodity groups using the STAN\textsuperscript{3} 12 classification.

The maximum potential freight volume for the ferry between Umeå and Vaasa is calculated by aggregating the transport volumes in the PWC-matrices from Samgods for the each pairwise zone in the calculated catchment area from the CCM-model. The freight volumes in the catchment area are shown in Table 1 below. The catchment area is estimated using the CCM-model for the base scenario and aggregated freight volumes are based on the Samgods PWC-matrices for year 2006. The volumes are divided into eastbound (from Umeå to Vaasa) and westbound (from Vaasa to Umeå) transports.

In total, roughly 720 000 tonnes per year are transported across the Kvarken strait in the catchment area in the Samgods PWC-matrices. Of the total transport flows, 180 000 tonnes per year are transported from Norway and Sweden to Finland and Russia, and 540 000 tonnes per year are transported from Finland and Russia to Sweden and Norway. Figure 3 and 4 shows the share of commodity groups for eastbound and westbound transport flows in the catchment area of the ferry.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{fig3.png}
\caption{Share of commodity groups in eastbound transport flows in the catchment area of the ferry. The total transport volume is 180 000 tonnes per year.}
\end{figure}

\textsuperscript{3} Strategic Transport Analysis Model.
Figure 4: Share of commodity groups in westbound transport flows in the catchment area of the ferry. The total transport volume is 540 000 tonnes per year.

The figures reveal that a large share of the westbound transport flows are pulp wood and round timber that currently do not use the ferry. For eastbound transport flows the commodity groups are more balanced even though paper and pulp has the largest share. To estimate the maximum potential freight volumes that can use the ferry we therefore need to exclude commodity types that is unlikely to use the ferry. Removing timber and wood from the total freight volumes the maximum potential freight volumes for the ferry link is reduced to 326 000 tonnes per year of which 172 000 tonnes per year are eastbound and 150 000 tonnes per year are westbound. The main reduction in transport volumes with or without timber and wood products comes from Russian export of timber products to Sweden. This highlights the importance of marketing and investigating the possibility to attract commodities that does not use the ferry link now.

These figures can be compared to official statistics from the ferry shown in Figure 1. The PWC-matrices are estimated for the base year 2006 estimated on data mostly collected during 2004 and 2005. Comparing the official statistics with the estimated maximum potential for the same period (excluding commodity group 2, pulp wood and round timber) we see that the Kvarken ferry roughly has a theoretical market share of 75% of the estimated maximum potential freight volumes in the catchment area.

Based on the estimated maximal freight potential in the catchment area of the ferry, the analysis indicates that there is a small room for further growth by attracting existing freight flows from other transport alternatives in the catchment area. The freight volumes for the ferry has also been stable around 230 000 to 250 000 tonnes per year after the peak in 2006. Hence, in order for the ferry to increase freight volumes, either the catchment area or the total transport volumes need to increase.
5 PRICE ELASTICITY AND THE EFFECT OF A FREE FERRY

To analyze the price elasticity of demand\(^4\) of the Kvarken ferry we create a scenario where the ferry price is reduced by ten percent and study the effect on the catchment area. By comparing the transport volumes in both scenarios we get a rough estimate of elasticity of demand. The elasticity of demand from a price change of the ferry is -4 which indicates that the maximum potential demand is very sensitive for changes in transport price. The largest increase in freight volumes from a price change is between Sweden and Finland. However, since the model calculations is based on generalized costs and calculates the change in the maximum potential from an increased catchment area, the actual effect on the demand for the Kvarken ferry from a decrease in the transport price may differ. The analysis does however indicate the existence of a strong competition between alternative transport routes. To validate the estimated elasticity, it is therefore important to supplement the model based analysis of the elasticity of the maximum potential demand with empirical studies on micro level data from the ferry. Several such studies have already been conducted, e.g. ÅF Infraplan (2012) and Vectura (2012).

5.1 Catchment Area and Potential Freight Volumes in a Free Reference Scenario

In addition to the elasticity calculation, we have also analyzed the catchment area and potential freight volumes in a reference scenario where the price of using the ferry is zero. Assuming that, everything else equal, there is no monetary cost of using the ferry, the model indicates that the maximum potential freight volumes can be ten times larger than in the base scenario and increase the catchment area to include transport nodes in both southern Sweden and northern Finland. The result indicates that a free Kvarken ferry has the potential to attract part of the freight volumes that today use ferry services between Stockholm and Åbo/Helsinki, see e.g. ÅF Infraplan (2010).

However, this result strongly depends on the assumption that the transport cost on competing routes are fixed. Since a decrease in the price on the Kvarken ferry can lead to increased competition with alternative transport routes, such as competing ferry services in southern part of Sweden, the result from the model is likely to overestimate the real effect. Scheduling and time restrictions can also limit the size of feasible the catchment area.

6 FORECAST OF FUTURE DEMAND

The maximum potential freight volumes estimated in previous section are based on data on the transport demand in 2006. If foreign trade increases in the future, it is likely that the estimated maximum potential will underestimate future transport demand. The high elasticity also indicates that the pricing strategy of the ferry can have a strong impact on the future freight volumes.

The Swedish Transport Administration (Trafikverket) estimates in their current forecast that the demand for freight transport (measured in tonne kilometer) will increase with 50% between 2006 and 2030 corresponding to an annual increase of 1.7%. A large part of this increase is attributed to mining and an increased share of foreign trade. Excluding the effect from mining, the corresponding annual increase is 1.5%. The forecast is related to a high degree of uncertainty and is based on an assumption on high economic growth of especially foreign trade during the period (Trafikverket, 2014b).

\(^4\) The price elasticity of demand is a measure of the relationship between a change in price and a change in demand. The price elasticity of demand is calculated as the change in demand (measured in percent) divided by the change in price (measured in percent). An elasticity of -4 implies that if the price is decreased with 1%, the (maximum potential) demand increases with 4%.
In the forecast for the Swedish National Transport Plan 2014-2025, the Swedish Transport Authority estimate that the foreign trade will increase heavily between 2006 and 2030; they estimate that export (measured in tonnes per year) will increase with 75%, import with 95% and transit traffic with 9%. The largest share of the increase for both export and import are assumed to come from the mining sector and other types of raw materials (Trafikverket, 2013). Unless a new Kvarken ferry manage to also attract these commodity types, the effect on the transport volumes on the ferry will be lower than the totals indicate above. Forecasts for transport volumes in the whole Baltic area estimate an annual increase in transport demand of around 2% (Baltic Transport Outlook, 2011). The model analysis also indicate that a new pricing strategy has a potential to increase the market share of the ferry considerably.

To deal with the uncertain factors we conduct a scenario analysis where we analyze different growth scenarios and estimate the effect on the demand for ferry transport. In the first scenario we assume an annual increase of 1.5% corresponding to the general forecast for freight transport by the Swedish Transport Administration, in the second scenario we base the growth rate on the estimations on growth rates from Baltic Transport Outlook 2030 (2%) and in the third scenario we analyze a situation where the market share of the ferry increases with 4% per year. We also include a no growth scenario as a reference point corresponding to a situation where the freight volumes do not increase. The forecast is hence based on assumptions regarding the growth rate of the transport volumes and the market share of the ferry. The first two scenarios with a 1.5% increase and a 2% increase the market share is assumed to be constant corresponding to a business-as-usual situation where the ferry is operated in a similar way as before. The growth hence comes from an assumed increase in the trade between mainly Sweden and Finland and Sweden and Russia. The third scenario corresponds to an annual increase of 4%. Observe that the last scenario relate to a situation where the ferry operator takes active measures to increase the market share, for example though lower prices for freight transport. The forecast for the different scenarios are shown in Figure 5.

Figure 5: Forecast of the demand for freight transport on the Kvarken ferry based on different growth scenarios.

Compared to the year 2013, the scenarios correspond to an increase of 29%, 40% and 95% to 2030. If the forecast is compared to the base year 2006 used in the previous analysis, the scenarios correspond to an increase of 14%, 24% and 72% to 2030. The difference depends on the choice of base year.
7 SUMMARY AND CONCLUDING REMARKS

Based on the estimated transport demand in the Samgods base matrices, the analysis indicates that the ferry currently has a theoretical market share of around 75% of the estimated maximum potential freight volumes in the catchment area. The relatively high market share suggests that the Kvarken ferry already has attracted a large share of the potential freight volumes in its current catchment area. To increase freight volumes, the ferry therefore needs to either increase the catchment area, for example through lower prices for freight transport, attract other commodity groups or rely on a general growth in the freight volumes across the Kvarken strait, e.g. as a result of a higher growth in the central parts of the catchment are compared to the rest of Sweden and Finland or increased transport through the catchment area. With an annual increase of the demand for freight transport on the Kvarken ferry of 2%, the demand for freight would be 24% higher 2030 compared to 2006. However, the growth of transport demand depends on the assumption that the Kvarken ferry can continue to offer a competitive transport alternative in the future.

Literature on freight transport indicate that the most important factor for transport alternative is transport price given that a certain quality level is met. The quality aspect both include punctuality and reliability (that the cargo is delivered on time and is not damaged) and transport time (Vierth et al., 2012). It is therefore important to design the ferry to keep the price down without reducing the transport quality, especially in terms of reliability and punctuality. The high elasticity of demand also suggests that it is possible from a price perspective to increase the ferry’s market share of freight transport between Sweden and Finland by making the ferry service more competitive relative to other transport routes.

The model shows that the demand is very sensitive to changes in the transport price. This increases the uncertainty of the results but also indicates that the price of using the ferry potentially could be an important factor for future freight volumes. Further analysis of sales data from the ferry and discussions with transport owners and freight operators are therefore important.

Competition between freight transports and passenger cars during peak season is a common problem in transportation. The problem can be seen in many ways. One alternative is to treat the problem as a capacity problem and design the ferry to handle peak load. The downside of this strategy is that it will lead to lower fill rates during the remaining year and that it can increase the cost of the ferry. The problem can also be seen as a question of pricing and prioritization. During peak load, should the ferry operator (and the municipalities) prioritize passenger cars or freight transports? What is the mix the operators wants to achieve? To deal with these conflicting interests over how to allocate the limited capacity, many principles can be used. The allocation principle can be based on pricing where the price of using the ferry is higher during peak season. Another alternative is to allocate the limited space using a first-come-first-serve principle, either using separate quotas for passenger cars and trucks or using a combined quota. An alternative solution to the capacity problem is to design the ferry to allow for double trips in order to temporarily increase capacity during peak season when demand is high.
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