Modelling the Demand for Sea Transport on the Baltic Sea

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Introduction

The countries surrounding the Baltic Sea are very dependent on international trade. The export share of the gross national product range from Poland's 28% to Estonia's 80%[1]. The major part of the trade is goods rather than services. In the case of Sweden 90-95% of the goods transport is somewhere on the way from origin to destination transported by ships. Figure 1 below show the size of the transport flows by ship between Sweden and the other Baltic Sea States. As the transport flows are a consequence of the international trade it is important to understand the determinants of trade when analysing the transport demand between countries.

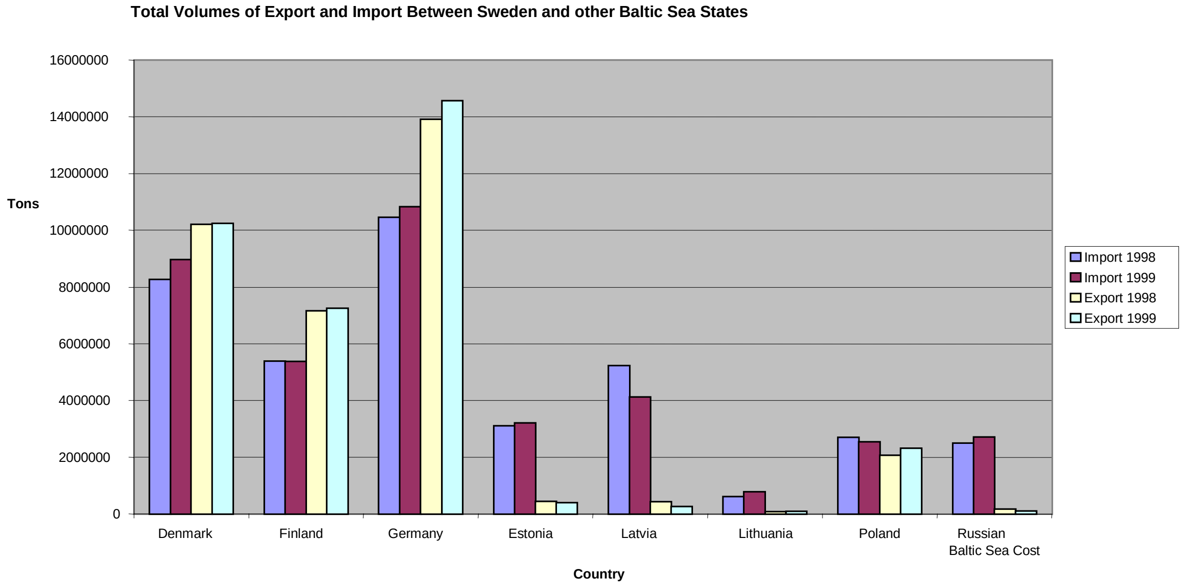

Figure 1. Distribution of sea transport volumes between Sweden and other Baltic Sea States. Data source: The Swedish Statistical Bureau (SCB), processed by the author.

The purpose of this paper is to develop a model where the demand for transport between countries is derived from the demand for international trade, and to estimate the effects of transport cost changes. These effects can be summarised by two elasticity measures. The first is an own-elasticity of import transport, from *i* to *j*, with respect to transport cost changes on this relation. The second is a cross-elasticity of import transport demand from alternative import sources[2], *h* to *j*, with respect to transport cost changes on the relation *i* to *j*.

The model is applied on an extended Baltic Sea Region. The reason for this extension is to study the competition surface between sea and land transports. Therefore are the countries France, Italy, the Netherlands, Belgium/Luxembourg, Spain, Austria, Portugal and Greece included besides the Baltic Sea states. In this paper a preliminary version of the model is tested on the commodity group paper pulp.

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[1] Source: The NEBI Yearbook 2000.
[2] In the paper import source country is used with the same conception as exporting country.

The Model

It is common that transport planning processes employ models for transport generation, distribution, modal split and assignment. Commonly these models are used independently of the others. Supply-demand feed-back to the transport system is modelled sequentially rather than simultaneously. However, one can reasonable hypothesise that the transport decision for the individual shipments is a joint decision of; if to transport or not, between what locations, the use of transport mode and what particular route to traverse. If this hypothesis is true, the correct type of modelling should reflect this joint nature of the transport decision.

In the transport demand modelling literature models can be found which combine two or more of the above components of the transport decision[3]. Usually, these models are applied on passenger travel and in the literature, models that combine the components trip generation and its distribution in the trip-making decision have been developed and applied. However, no applications of the model type, which combine generation and distribution, on transport of goods have been found. The model of this paper combines generation and distribution of international goods transport. Specifically, it can be used for analysis of international transport generation, its distribution or both.

International transport of goods – a demand derived from the demand for import[4]
In the literature of international trade economics, several driving forces for international trade have been discussed and used for analysis of why countries trade with each other[5]. Some examples of driving forces are comparative advantages, specific resources, increasing returns to scale, differentiated products, the wealth of countries etc. These types of factors are assumed to affect the costs and quality of production in each country. Hence, they also affect export prices when the goods is sold abroad.

It is assumed in the model of this paper that import demand in country j is affected by sets of variables reflecting the factors, or country characteristics affecting trade, of the type mentioned above. In E1 below, does X_j denote a variable vector of trade affecting characteristics in the importing country and Y_i trade affecting characteristics of the exporting country and the functions $g(X_j)$ and $y(Y_i)$, are assumed to mirror the factors underlying the driving forces for international trade. By using this assumption the prices of internationally traded goods must not explicitly be included in the modelling. However, the components should not be regarded as price proxies, but rather as composite factors, which affect the demand for import. In the model do these two components together with generalised transport cost, GC, determine the demand for import in country j, which in the general case is given by E1:

$$I_j = f(g(X_j),\ y(Y_a),...y(Y_h),...y(Y_i),...y(Y_n), GC_i, GC_{h\neq i}) \qquad \text{E1}$$

where:
I_j = total import demand in country j.
X_j = a variable vector showing trade affecting characteristics of the importing country.
Y_i = a variable vector showing trade affecting characteristics of the exporting country.
GC = generalised transport costs.

The component $y(Y_h)$ in E1 denotes a function of trade affecting characteristics of exporting countries other than i and, $GC_{h\neq i}$, the generalised transport costs for import from these countries. They are included to regard the fact that import in country j can be taken not only from one country, but many.

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3 See, for instance, Sonesson (1998) for an overview of this literature.
4 The foundations of the modelling presented here very much follow the approach of modelling the demand for long-distance passenger travel in Sonesson (1998). However, changes are made and the basic ideas are translated into an environment of international transport of goods.
5 See, for instance, Krugman & Obstfeld (1999) for an overview or Fujita et al (1999) regarding spatial issues of international trade and economics.

Assume that there are n countries in the world and that it is possible for country j to import from each of them. The import demand is assumed to generate the demand for transports from this set of countries. The transport demand from one of them, say country i, is a result of the total import demand in country j. By distributing the import demand over the n-1 possible exporting countries, the transport demand from each exporting country to country j is given. This lend us a transport demand function, which in the general case, can be formulated according to E2 below:

$$t_{ij} = f(g(X_j), y(Y_i), y(Y_h), GC_{ij}, GC_{hj}) \qquad \text{E2}$$

where: $h \neq i, j$, and,
t_{ij} = transports of goods from country i to country j.

$y(Y_h)$ is included to comprise the effects of alternative import source countries on the transport demand from country i to country j and GC_{hj} the demand effect of the generalised transport costs from each of the n-2 alternative import source countries. It is possible that t_{ij} is also affected by the domestic GC of the importing country, i.e. GC_{jj}. Including GC_{jj} implies that the goods is produced in country j and not necessarily imported, however, it can still be. Accordingly is the domestic production of the goods a substitute to import of it. However, in the estimated model in this paper that was not included.

An interpretation of $y(Y_i)$ in E2 is that the market for import of a specific category of goods is characterised by monopolistic competition, where import from different countries is not entirely homogenous. The heterogeneity is in E2 given by $y(Y_i)$, which is the only part of the transport demand function that can vary between exporting countries. Examples on characteristics underlying the heterogeneity of exporting countries are product quality (perhaps in combination with price), language barriers, legal barriers etc. This and the function $g(X_j)$ is discussed further below.

In the literature of international trade economics it is common to assume that the cost for import of a specific type of goods is equal to the exporting country's price of it. It was assumed above that in the model of this paper *can* the price in combination with other characteristics of the exporting country be included in $y(Y_i)$. Hence, assuming that companies in the exporting country sell their goods Free-On-Board (F.O.B.), i.e. the buyers or importers bear all transport costs, result in the GC being a separate cost decision variable for importers. And in the model, everything else remaining the same, a rational importer must choose the source for import, which causes the lowest GC. This because buying the goods elsewhere would give a lower net value to the imported goods.

E2 is derived from individual import demand functions for each importing country and category of goods. To put the general transport demand model in E2 to practise one can, now, ask what explicit functional[6] form of the model should be used and whether to use time series versus cross-section data? Beginning with the latter there is one major, practical problem with time-series. Without long series for each importing country and commodity it is not possible to estimate a demand model statistically. Therefore is cross-section analysis usually necessary for empirical purposes. The next question is then, what further assumptions must be made to formulate a transport demand model usable for statistical cross-section analysis? One way to proceed is to use the unique values of GC on each transport relation and assume a common functional form and a common set of parameters for all transport relations of the modelled region. That is the way of progress in the modelling of this paper. In the beginning of this section of the paper it was set out that model should comprise generation as well distribution of transports. This can achieved by multiplying an unconstrained gravity model with a singly constrained gravity model. That is done in the model of E3 below:

$$t_{ij} = C * g(X_j) * (S_j \sum_{h=1}^{k} GC_{hj}^{\gamma} * y(Y_h))^{\beta} * \frac{GC_{ij}^{\gamma} * y(Y_i)}{S_j * \sum_{h=1}^{k} GC_{hj}^{\gamma} * y(Y_h)} \qquad \text{E3}$$

[6] There are many theoretical issues of this matter that are left without attention in this paper.

where $h \neq j$ and $k = m-1$, and variables and parameters added:
C = a constant.
γ = a parameter.
m = the number of countries in the modelled region , $m \leq n$.
S_j = the quotient between country j's import over n and the sum of import over m.
β = a parameter.

The first part to the right of the equality sign in E3 is a component generating import demand. It has the same form as a gravity model based on the unconstrained gravity model hypothesis.

It is possible that the number of countries that country j import from world-wide is larger than the number of countries in the modelled region. The variable S_j is used to capture the import demand effects from the countries not in included in the modelled region. By multiplying $\sum_{h=1}^{k} GC_{hj}^{\gamma} * y(Y_h)$ with S_j, it is assumed that import from countries of the world not included in the modelled region, affect import demand in country j in the same way as the countries of the modelled region. The parameter β is an elasticity with respect to total import demand in country j. It is of particular interest when one calculate own-demand and cross-elasticities, which will be shown below.

The second part to the right of the equality sign in E3, the quotient, distribute the total demand relative to the attractive force of importing from exporting country i, $GC_{ij}^{\gamma} * y(Y_i)$, and the sum of this force for all countries. The distribution component has the same form as a gravity model based on the singly constrained gravity model hypothesis. However, the restrictions on the amount of transports to or from a specific country, given by a singly constrained gravity model, is not carried out in the model of this paper. This is due to the first component to the right of the equality sign of E3, i.e. the component of the model generating import demand.

Data and Model Estimated

The figures of table 1 should be interpreted with caution. They do not tell where the paper pulp was produced. Production can take place in importing countries as well as in exporting countries. Besides that is paper pulp an intermediate product used in the production of paper. This industry "consume" the paper pulp. The consumption in each country must be equal to its net import plus the production within the importing country, which is not exported. Of course, domestic production can be a substitute to import. In the case of Germany, having a net import of paper pulp, there must be a paper manufacturing industry, which consume the paper pulp. Though, the figures in table 1 do not tell anything about the size of this industry in each country.

The mentioned variables can be included in the functions $g(X_j)$ and $y(Y_i)$. And, indeed, they are important for the understanding of trade and transport of paper pulp. However, if the purpose of the modelling is to get an understanding of the general characteristics of the international transport system, it can be enough to show the relative attractive force of an exporting country. An application with dummy variables for $y(Y_i)$, where the attractive force of each exporting country is freely determined within the model, would probably result in more accurate estimates of the parameters determining the general characteristics of the transport system. On the other hand, if the purpose of the modelling is to get an understanding or an explanation of the levels of the attractive forces of exporting countries, then an application with an explicit function of $y(Y_i)$ is necessary. For long-run forecasting purposes it can be necessary to somehow balance these two aims. Of course it is interesting to get a better understanding of the general characteristics of the international transport system. But, on the other hand, economic and institutional factors that affect $y(Y_i)$ can change over time and accordingly the presumptions for international trade and transport.

In table 1 below, transport of paper pulp between the countries in the modelled region, according to EUROSTAT, are presented.

Exp. from (country *i*)	Import in (country *j*)																	
	Swe	Fin	Russ	Est	Lat	Lith	Pol	Ger	Den	Fra	Ita	Neth	B/L	Spa	Aus	Port	Gre	Σ
Swe		33	0.07	2	0.3	0.1	32	822	43	292	264	273	112	49	145	14	2	2083
Fin	73		12	0.6	0.004	0.06	11	723	0.01	104	100	45	19	12	10	45	1	1155
Russ	0	7		-	-	-	-	40	0	20	49	23	9	14	3	2	38	205
Est	0	0.9	-		-	-	-	0.05	0	1	0	0	0	0	0	0	0	2
Lat	0	0	-	-		-	-	0	0	0	0	0	0	0	0	0	0	0
Lith	0	0	-	-	-		-	0.02	0	0	0	0	0	0	0	0	0	0
Pol	0.8	0	-	-	-	-		49	0.05	0.03	0.1	0.04	0.02	0.002	3	0	0	52
Germ	114	7	7	0.6	0.02	0.08	10		65	505	626	709	140	105	683	4	4	2979
Den	161	4	0	0	0	0.001	1	122		0.5	20	4	0	0	3	0	0	315
Fra	0.2	0.7	14	0	0	0	3	181	2		266	82	61	604	4	3	2	1222
Ita	12	0	0	0	0	0	0.01	4	0	5		0	3	0.6	8	0.001	0.3	32
Neth	33	1	0	0	0	0	0.7	654	1	228	27		272	6	27	3	0	1252
B/L	11	0.006	0	0	0	0	0.001	101	0.3	416	54	375	3	4	39	0.2	0	1003
Spa	12	6	0	0	0	0	0	143	0	67	159	35	16		38	10	0.004	486
Aus	0.4	0	2	0	0	0	4	80	0	9	169	6		0.8		0	0.7	270
Por	69	8	0	0	0	0	8	226	2	107	50	328	37	156	36		0.6	1027
Gre	0	0	0	0	0.1	0	0	0.4	0	0	2	0	0	0	0	0		2
Σ	485	67	35	3	0	0	69	3145	113	1754	1786	1880	672	950	999	81	48	

Table 1. Transport of paper pulp in the modelled region during 1998 (EUROSTAT, thousand tonnes).

The estimated model contains a dummy variable approach. This variable is denoted D_i and D_h in E4 below. D[7] represents the characteristics of each exporting country in the modelled region, that country j can import from. The interpretation of D is that it gives a measure of all characteristics of the exporting country, affecting other countries' import from it. This *relative* to a normative country, which is assigned the value one. Hence, D captures factors such as the quality and price of paper pulp from different countries, barriers to trade[8], the industrial structure and the supply of production resources. Regarding the latter two the sizes of paper pulp and paper manufacturing industries together with wood resources must be regarded the most important.

$$t_{ij} = C * ((GDP_i / P_i)^{\alpha_1}) * (P_i^{\alpha_2}) * (S_j * \sum_{h=1}^{k} GC_{hj}^{\gamma} * D_h)^{\beta} * \frac{GC_{ij}^{\gamma} * D_i}{S_j * \sum_{h=1}^{k} GC_{hj}^{\gamma} * D_h} + \varepsilon_{ij} \qquad \text{E4}$$

List of variables and parameters added:
GDP_i = the importing country's gross national product.
P_i = the number of population in the importing country.
α_1 and α_2 = parameters.
D_i = a dummy variable which replaces $y(Y_i)$ above.
ε_{ij} = a stochastic error term.

[7] Omitting subscripts for the ease of presentation.
[8] These barriers can be more or less severe due to circumstances regarding legal system, language, cultural understanding, political stability, trust, communication infrastructure, ease in signing trade contracts etc. These factors are discussed further in, for instance, Johansson & Conradsson (1998).

Estimating E4 for paper pulp the function $((GDP/P_i)^{\alpha_1})*(P_i^{\alpha_2})$ was used for $g(X_j)$. GDP/P_i denote per capita gross national product, P_i is population and α_1, α_2 are parameters. The function can be interpreted as per capita import demand is a function of per capita gross national product with an separate elasticity on population size, α_2. A α_2-value of 1 is equivalent to a per capita import demand as a function of per capita gross national product only. Other values of α_2 are difficult to fully motivate theoretically. However, the model fit was improved by the use of P_i and α_2 in the model. The obtained value, shown in table 2 below, imply that per capita import demand of paper pulp grows with per capita gross national product, though the growth is less in countries with larger populations. The explanation of the obtained value is, perhaps, that the larger a country's population is, the greater is the chance that it has its own paper pulp industry and this would decrease its demand for import of it.

The use of $((GNP/P)^{\alpha_1})*(P^{\alpha_2})$ implies that factors such as the sizes of paper manufacturing industries of importing countries are assumed to not affect import. The sense behind the use of this function is that paper pulp is a production factor in the production of paper and paper is consumption commodity. The demand for paper increases with the number of people in a country and their average wealth. Each country has its own paper manufacturing industry and the size of it correspond to the wealth of the country per head of population and the number of people of the country. Perhaps is this description of factors of the importing countries affecting the trade to simplistic. However, due to limited access to data it was used for this preliminary estimation of the model[9].

In a sum up, the model given by E4 three variable categories can be distinguished. Firstly, there are generalised transport costs, GC_{ij} and GC_{hj}. The next is D_i and, thirdly, X_j reflecting characteristics of importing countries, which are assumed to affect the demand of import from other countries. Further, the function $g(X_j)$ and especially D_i must be regarded as composite factors reflecting many characteristics of importing and exporting countries, respectively, on the transport making decision.

The transport data used is from EUROSTAT. Data for calculation of generalised transport costs[10] and on variables included in X_j are from EUROSTAT, Statistics Sweden (SCB), The Swedish Maritime Administration, The Swedish Institute for Transport and Communication Analysis (SIKA), The Swedish Maritime Forum and The World Factbook (the Internet version, 2000).

As discussed above the functional form of E4 was chosen because it comprises generation as well as distribution of transports. To its advantage it also appears that it is capable to simultaneously estimate own-elasticities, E6, as well as cross-elasticities, E7 below. Denoting GC-elasticities $\eta(t)_{GC}$ and using the definition:

$$\eta(t)_{GC} \equiv \frac{\delta t}{\delta GC} * \frac{GC}{t} \qquad \text{E5}$$

it can be shown that the following elasticities are obtained[11] from E4:

$$\eta(t_{ij})_{GC_{ij}} = (\beta - 1) * \frac{D_i * \gamma * GC_{ij}^{\gamma}}{\sum_{h=1}^{k} GC_{hj}^{\gamma} * D_h} + \gamma \leq 0 \qquad \text{E6}$$

$$\eta(t_{hj})_{GC_{ij}} = (\beta - 1) * \frac{D_i * \gamma * GC_{ij}^{\gamma}}{\sum_{h=1}^{k} GC_{hj}^{\gamma} * D_h} \geq 0 \qquad \text{E7}$$

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[9] This matter is discussed further in the discussion section below.
[10] The reader is welcome to contact the author for information on how this was done.
[11] The reader interested in further explanation of how the elasticities are derived is welcome to contact the author.

$$\eta(Dest_j)_{GC_{ij}} = \beta * \frac{D_i * \gamma * GC_{ij}^{\gamma}}{\sum_{h=1}^{k} GC_{hj}^{\gamma} * D_h} \leq 0 \qquad \text{E8}$$

In E8 $Dest_j$ denotes total transports of paper pulp to country j.

The signs of E6-E8 show requirements on the elasticities and imply the following structural properties (for the individual transport maker this is the same as behavioural properties) of the transport making decision:

- transport from country i to country j can not increase when the generalised transport cost between the two increases (E6)
- transport to country j from alternative import source countries can not decrease when generalised transport cost from i to j increases (E7)
- total import transport to country j ($Dest_j$) can not increase when GC_{ij} increases.

From this follows that $0 \leq \beta \leq 1$ and $\gamma \leq 0$ must hold. Other values of β and γ can give elasticity values, which are not in concordance with micro economic price theory[12] and would not be very sensible. Two values of β are especially interesting. Firstly, if $\beta=1$, then cross-elasticities are zero. Accordingly, the only effect of changes in GC_{ij} is a changed level of transport from i to j, nothing is substituted to other import sources. On the other hand, if $\beta=0$, then a change in GC_{ij} do not affect total import transport to country j. In this case there are only distributive effects over the set of import source countries.

Estimation results

The example provided give some preliminary results of the capabilities/qualities of the modelling approach of this paper. The estimation method used was non-linear least-square regression and the results are shown in table 2 below.

Since the dummies 2-17 in table 2 show each country's value relative to country 1 - Sweden[13], they should all have values larger than zero.

With the purpose to illuminate how the elasticity measures given above can be used six example elasticities are calculated. The examples are based on Denmark and Germany as exporting countries and Sweden as the importing country. The calculated GC for transports of paper pulp from Denmark to Sweden is 210 SEK/ton and for transports from Germany to Sweden 212 SEK/ton. The sum $\sum_{h=1}^{k} GC_{hj}^{\gamma} * D_h$ is approximately equal to $5.31*10^{-4}$. Using E6-E8 and these cost numbers give six elasticities with the following values:

$$\eta(t_{Denm-Swed})_{GC_{Denm-Swed}} = ((0.034*(-1.7)*210^{-1.7}*(0.0929-1))/(5.31*10^{-4}))-(1.7/210) \approx -1.7$$

$$\eta(t_{h-Swed})_{GC_{Denm-Swed}} = (0.034*(-1.7)*210^{-1.7}*(0.0929-1))/(5.31*10^{-4}) \approx 0.01$$

$$\eta(Dest_{Swed})_{GC_{Denm-Swed}} = (0.0929*0.034*(-1.7)*210^{-1.7})/(5.31*10^{-4}) \approx -0.001$$

$$\eta(t_{Germ-Swed})_{GC_{Germ-Swed}} = ((2.27*(-1.7)*212^{-1.7}*(0.0929-1))/(5.31*10^{-4}))-(1.7/212) \approx -1$$

$$\eta(t_{h-Swed})_{GC_{Germ-Swed}} = (2.27*(-1.7)*212^{-1.7}*(0.0929-1))/(5.31*10^{-4}) \approx 0.7$$

$$\eta(Dest_{Swed})_{GC_{Germ-Swed}} = (0.0929*2.27*(-1.7)*212^{-1.7})/(5.31*10^{-4}) \approx -0.07$$

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12 See Sonesson (1998) for further discussion on this matter.

13 Sweden's value is set to one.

Usable Observations 252	Degrees of Freedom 231
Centered R**2: 0.774308	R Bar **2: 0.754768
Uncentered R**2: 0.801142	T x R**2: 201.888
Mean of Dependent Variable: 47953.41667	
Std Error of Dependent Variable: 130801.18066	
Standard Error of Estimate: 64773.94670	
Sum of Squared Residuals: 9.69198e+011	
Durbin-Watson Statistic: 2.025430	

Variable	Coefficient	Std Error	t-Statistica	Significance
CONSTANT	3.0918e-010	3.7104e-009	0.08333	0.93359185
ALPHA1	3.9938	1.2475	3.20159	0.00136669
ALPHA2	0.9143	0.1390	6.57670	0.00000000
GAMMA	-1.7038	0.3783	-4.50329	0.00000669
BETA	0.0929	0.2644	0.35120	0.72543688
$DUMMY2_{Finland}$	0.8940	0.0946	9.45210	0.00000000
$DUMMY3_{Russia}$	0.0928	0.0359	2.58044	0.00986741
$DUMMY4_{Estonia}$	0.0205	0.0196	1.04346	0.29673384
$DUMMY5_{Latvia}$	0.0193	0.0186	1.03676	0.29984573
$DUMMY6_{Lithuania}$	0.0174	0.0168	1.03392	0.30117311
$DUMMY7_{Poland}$	0.0270	9.0054e-003	2.99764	0.00272077
$DUMMY8_{Germany}$	2.2741	0.4325	5.25866	0.00000015
$DUMMY9_{Denmark}$	0.0338	0.0138	2.44649	0.01442550
$DUMMY10_{France}$	0.3285	0.1163	2.82547	0.00472120
$DUMMY11_{Italy}$	0.0338	0.0281	1.20520	0.22812660
$DUMMY12_{Netherl.}$	0.3666	0.0725	5.05980	0.00000042
$DUMMY13_{Belg./Luxemb}$	0.1707	0.0742	2.30086	0.02139976
$DUMMY14_{Spain}$	0.2699	0.0648	4.16251	0.00003148
$DUMMY15_{Austria}$	0.0718	0.0320	2.24761	0.02460109
$DUMMY16_{Portugal}$	0.4293	0.0924	4.64714	0.00000337
$DUMMY17_{Greece}$	8.3778e-003	0.0160	0.52444	0.59997237

Table 2. Model estimation results[14] - paper pulp.

Discussion

This paper presented a model capable of making simultaneous estimates of international transport generation and its distribution. It can be used in situations when it might be desirable to examine certain kinds of changes within the system. Changes regarding transport costs and characteristics of exporting and importing countries, or regions if that is the desired spatial level of modelling, can be taken into consideration when the model is applied on real world data.

The preliminary empirical application, provided in this paper, supported the underlying structural/behavioural hypothesis, which the requirements on the signs of E6-E8 imply. Mostly due to limited access to data the attention was focused on only a few variables. Consideration of augmenting the model with additional factors would lend more complexity and more realism to the analysis but, perhaps, on the expense of understanding the basic concepts being expounded[15].

However, some additional factors are worth to mention. For instance, does the estimated model rely on the assumption that a common functional form and a common set of parameters for each importing

[14] Further information on statistical tests performed on the estimation, i.e.on the assumptions of ε_{ij}, can be provided by the author on request.
15 i.e. the affects on international transport demand of changes in *GC* and $y(Y_i)$.

country can be used for estimation of its consequent transport demand, i.e. the function does not comprise differences in preferences[16] of each importing country's population. If these differences are large, the model could be improved by relaxing these model assumptions. There is a future research task to check for such differences and if it is found desirable, augment the model with them.

The estimation indicate that there is a strong exponential relation between overall import demand of paper pulp and gross national product per capita in the importing country. Probably do this variable contribute much to the explanation of import levels for paper pulp. However, in the real world there can be rich countries with small paper manufacturing industries. These countries would rather import paper instead of paper pulp. A model variable, which measures the size of per capita paper manufacturing industries in modelled countries, would catch such differences. The sizes of paper pulp in each country are also of particular interest when to augment the model with additional factors.

The estimated model parameters give elasticity values, which indicate that the overall demand for transport of paper pulp is barely affected, by the level of *GC*. Perhaps these costs do not affect the demand at all, as the estimated parameter value of β can not be significantly separated from zero. If so, these costs only affect the distribution of import source countries.

The values of the example elasticities above show that Swedish import from Denmark must grow *relatively* more if $GC_{Denm\text{-}Swed}$ is reduced compared to the effect on import from Germany when $GC_{Germ\text{-}Swed}$ is reduced. Also relatively more is transferred to other import source countries if $GC_{Germ\text{-}Swed}$ increase compared to if $GC_{Denm\text{-}Swed}$ change as much. The third effect, the effect on total transport, is stronger in the case of Germany. Hence total paper pulp transports to Sweden must decrease relatively more if $GC_{Germ\text{-}Swed}$ increase compared to if $GC_{Denm\text{-}Swed}$ increase as much.

According to table 2 is the attractive force of *D* for Germany considerably larger than the same force for Denmark. Besides that is $GC_{Germ\text{-}Swed}$ larger than $GC_{Denm\text{-}Swed}$. One can ask what are the effects on the elasticities from differences in *D* and *GC*? To study these effects and their generality, the elasticities are differentiated[17] with respect to D_i and GC_{ij}:

$$\frac{d\eta(t_{ij})_{GC_{ij}}}{dD_i} \geq 0 \qquad \text{E9}$$

$$\frac{d\eta(t_{hj})_{GC_{ij}}}{dD_i} \geq 0 \qquad \text{E10}$$

$$\frac{d\eta(Dest_j)_{GC_{ij}}}{dD_i} \leq 0 \qquad \text{E11}$$

Using $0 \leq \beta \leq 1$ and $\gamma \leq 0$ it can be shown that E9-E11 must have the signs shown above. These signs show the direction of moment on the elasticity values in a linear perspective. As $\eta(t_{ij})_{GC_{ij}}$, according to the elasticity requirements stated above, is less than zero, must a larger value of D_i cause a movement towards zero. In the case of $\eta(t_{hj})_{GC_{ij}}$ is, according to the requirements, the elasticity larger than zero. This together with E10 implies the larger the value of D_i, the larger must $\eta(t_{hj})_{GC_{ij}}$ be. The sign of $\eta(Dest_j)_{GC_{ij}}$, given the requirements, is negative. Therefore E11 must cause an opposite effect on this elasticity compared to the effect seen on $\eta(t_{ij})_{GC_{ij}}$.

[16] Paper pulp is an intermediate product in the production of paper and due to different structures and levels of this demand can the demand for paper pulp vary between countries. These structures and levels are affected by preferences.
[17] The explicit functions given by taking these differentials can, on request be provided by the author.

Using the same procedure as for E9-E11 it can be shown that the effects from changes in GC_{ij} on the elasticities are in the opposite direction, i.e.:

$$\frac{d\eta(t_{ij})_{GC_{ij}}}{dGC_{ij}} \leq 0 \qquad \text{E12}$$

$$\frac{d\eta(t_{hj})_{GC_{ij}}}{dGC_{ij}} \leq 0 \qquad \text{E13}$$

$$\frac{d\eta(Dest_j)_{GC_{ij}}}{dGC_{ij}} \geq 0 \qquad \text{E14}$$

A conclusion given by E9-E14 is that differences in the example elasticities are a result of Germany being a more attractive import source country. However, the differences are slightly reduced by the higher level of *GC* for transport from Germany to Sweden.

In the introduction it was mentioned that international trade is of great importance for the economies of the countries surrounding the Baltic Sea. Transport infrastructure improvements decreases the generalised costs for transport. One question from the debate is what impact on the economies of the countries of former Soviet Union will such infrastructure improvements have? In the case of paper pulp the estimated value of β indicate that the total amount, in tonnes, of transported paper pulp in the region will not be much affected. Besides that, the estimation show that these countries are not very attractive as import sources. Therefore will not measurements, which decrease *GC* for transport to or from these countries, affect them much and just about all change will be substitution from other import source countries. The last effect is, of course, negative for those economies'. Instead given that *GC* do not change, more important is to develop countries of the former Soviet Union to become more attractive trading partners.

On the other hand, if the results had given a β–value closer to one, then such measurements would give stronger effects on these countries. The substitution effect would also be much less in this case. This would be to the advantage for the more attractive export countries of today.

The model tested on a wider range of commodity groups will give an answer on the question of the generality of the results given by this study. However, this and also the stability of the results from the estimation of the demand for international transports of paper pulp are tasks for further research.

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