DERIVING MARITIME TRANSPORT DEMAND

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ABSTRACT

Triggered by the last crisis of 2007 and the huge amount of ships on order, for which no work exists in 2010 or is expected to exist in the coming 10 years, the question rose, how much inefficiency is actually present in the maritime trade. To research this we looked the many trade models that exist. Unfortunately the most common way to determine transport demand is either through a random function or just taken as fixed. Our model derives transport demand from a macro economic model, which represents the world through 17 country-blocks. The country blocks were chosen in such a way, that they can be easily identified as the important maritime trade areas. The import and export figures calculated with this model are reworked into trade in tons for the three markets of wet bulk, dry bulk and container/general cargo.

Keywords: Macro-economic model, international trade, gaming, world shipping

CRISIS OF 2007

In the summer of 2007 mounting losses in the market of American sub-prime mortgages ignited a chain reaction, which resulted in a world-wide crisis (Koelewijn, Bikker, et al. 2009). After disaster has struck the common view is as follows; Due to the fact that the money market is global, the sub-prime loans of several banks were sold on to banks and pension funds all around the world. A main driver for this is that the USA has no ability of its own to finance its expenditure and borrows readily from other countries. Still without shipping none of this would have happened, so it is not without irony that shipping feels the brunt of the current crisis more deeply than any other crisis.

Globalization started way back in the 15th century with the colonization drift of the western European countries. It was continued by multinationals rather than governments at the start of the 19th century. But its current definition relates mostly to the global integration of our lives, made possible by advances in telecommunication and engineering (Friedman 2007).

Shipping was and still is the key beneficiary of globalization; in the 15th century sailing ships were used to discover seaways to known locations and to discover completely unknown territory. Spices and valuable minerals were shipped from the colonies to the motherland.

Steel ships and the steam engine allowed (sea)trade to become more predictable, shorter and cheaper, which in itself increased the demand for trade.

Even more than the first globalization move, the second one was literally fuelled by shipping, the invention of tankers allowed the oil companies to move their product more easily over longer distances, which allowed looking for oil fields further and further away, giving rise to the huge industry we know today. The invention of the container was another one that pushed international trade up. "Small" quantities could now be transported a lot cheaper than ever before. This resulted in an optimization of production where in some cases the intermediate products are travelling the oceans up to 6 times before reaching the consumer.

The third wave of globalization is mainly carried by the developments in IT and Telecommunication. Even service work (as opposed to manufacturing work) can now be outsourced to countries with low wages and high educations, like India. Shipping has lost its propelling roll by now, but still continues to improve its service and flexibility. Efficiencies achieved in fleet deployment are higher than ever due to the increasing availability of ever more reliable data and continuous communication with the vessels. Still the past boom and following crisis was able to lure us once more into the most costly of all inefficiencies, overcapacity.

SHIPPING HIT HARD

With banks toppling all around us and consumer demand and trust hitting unseen lows, shipping is one of those industries hit particularly hard. The demand for trade would not only drop due to a decrease in consumption, but this would be augmented by the fact that the importer would be unable to arrange bank guarantees for his cargo. The fall in freight rates was shortly stopped by rising oil prices. As 75% of all oil is in the end used for transportation, expensive fuel means higher transport prices. The crisis would also effectively kill the overheating of this market as demand for transport kept dropping. Without oil to keep the freight rates up they plummeted to levels seen only in the last major crisis.

The graph below represents 4 indicators (DRYS 2009, TOL 2009, NASDAQ 2009, OIL 2009) that show how one crisis was moving onto the next one. The dotcom-bubble of 2000 was countered by a lowering of the interest rate by almost all central banks in the western world. As a result money became cheap. This amongst others spiked the housing bulb in the USA until 2005, when the interest was finally raised. By 2007 many homeowners were facing troubles with their repayments and the first banks started to topple, resulting in the crisis described above.
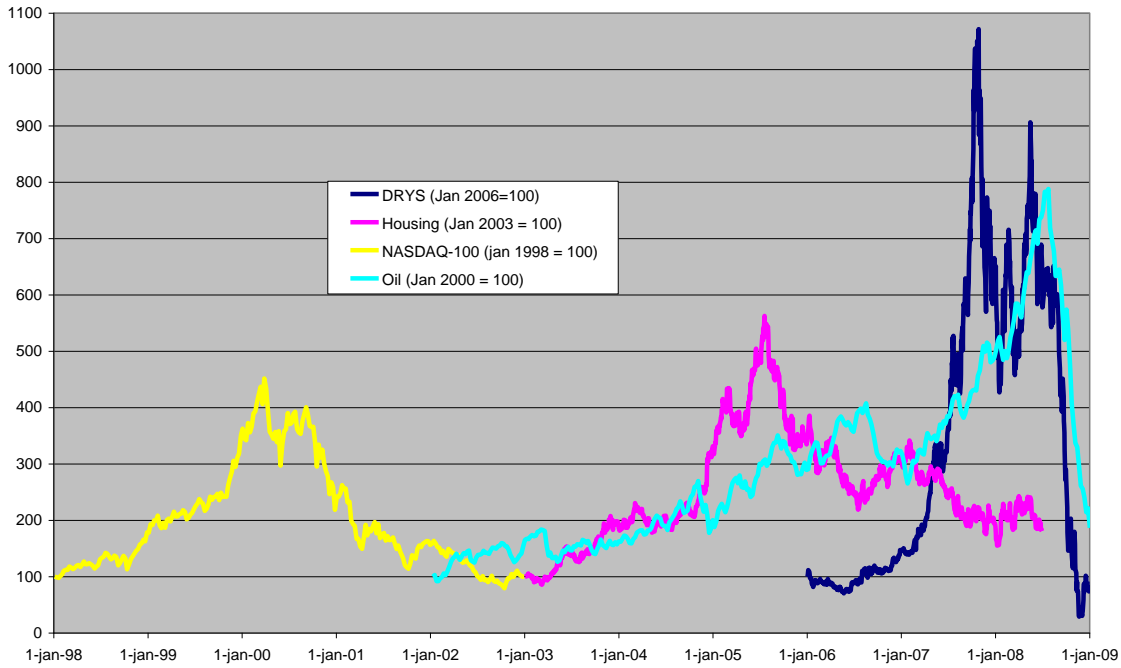
Figure 1 – Various booms in the past 10 years (Source: Author)

Shipbuilding was also having a very good time till the first signs of collapse of the freight rate in 2008. Orders kept coming in and prices were rising to 2 or 3 times of there normal level. Yards closed in the slum at the end of the last century were reopened all over the world. Equipment suppliers soon proved to be the weak link and waiting time for main engines and shafts could be over a year. Owners started ordering ships for near future replacements as the order books filled and thus putting extra pressure on an already overheated market. In the graph below (Composed by author with data from RMT (UNCTAD 1998-2009)) the fraction of the existing fleet on order is shown. While 10-15% is deemed normal, a year ago over 50% of the dwt currently sailing the world was on order.
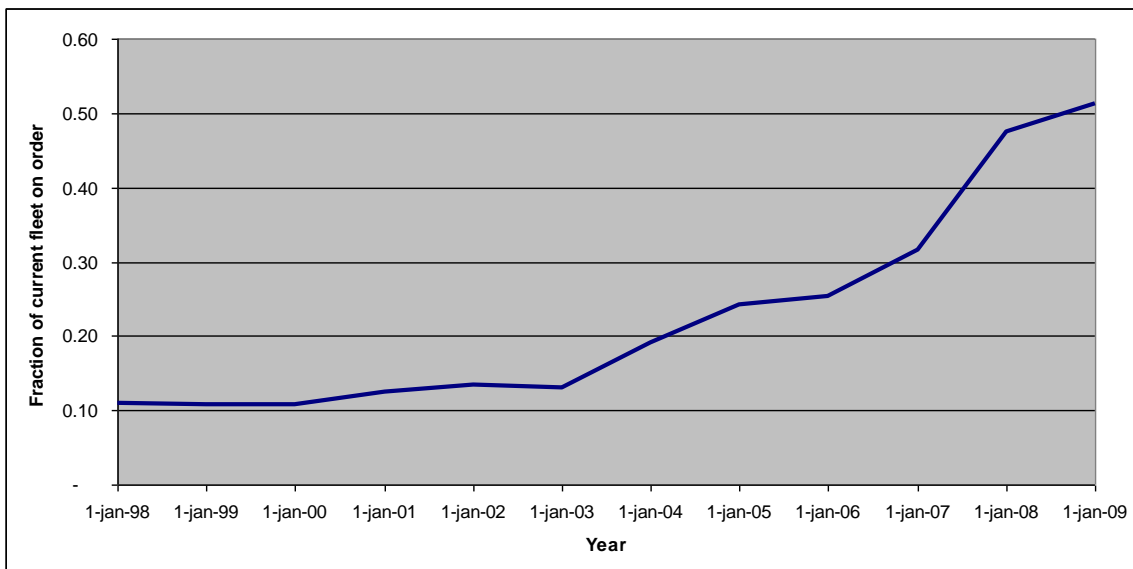

Figure 2 – Fraction of current fleet on order (Source: Author with data from the Review of Maritime Transport)

The current crisis shows great analogy with the boom and bust of the super tankers in the 70s, here overcapacity depressed freight rates for almost 20 years (Stopford 1997). Brand new tankers were demolished sometimes even straight after delivery. The results of the current crisis will most likely also be felt in shipping and shipbuilding for the next 20-25 years. But how much is actually wasted and lost as a result of this overheated market?

DETERMINING THE INEFFICIENCY OF SHIPPING

We can all agree that building a 300 000+ dwt and scrapping it straight after delivery is a huge waste of resources, money and labour from an economic point of view. We can even put a number on it easily, by taking the price that was paid for it and subtracting the scrap money it brought in. It will be less obvious when we look at vessels that did sail for a while. Even harder to estimate would be the lost earnings to the industry as a result of overcapacity keeping freight rates below viable levels.

Would we be able to determine how the world fleet develops based on pure rational investments, management and scrapping, we would be able to determine the loss due to our non rational behaviour. While this will teach us something about our past, it does not necessarily lead the way to a better future. Instead of just determining the optimal and the occurred loss in the past, determining the future optimum would be far more valuable.

It would be naïve to think that we'll ever end up in this optimum or for that matter can predict the future. The direction the optimum takes on the other hand can be a clear signal to investors (and banks) to invest or stop investing in new ships. Using a range of scenarios with different shock applied to the near future, would thus help in determining a proper strategy for shipping companies, investors and banks.

This paper will deal with part of a model to answer that question. The complete model is not focussed at determining the costs associated with this overcapacity, but also to investigate the future for shipbuilding from a cost perspective. The part dealt with within this paper is the selection process of the macroeconomic model to form the shell and the conversion of the bilateral trade output in US dollars into a (realised) demand for transport. The supply side of this model, the fleet of vessels sailing the world has not yet been developed.

Both Beenstock and Vergottis (Beenstock&Vergottis 1993) and Stavros Tsolakis (Tsolakis 2005) extensively discuss all econometric models of the shipping market from 1930 till 2005 and add their own. Still all these models take demand as given (trend or fixed) or assume a random motion. I do not disagree in principle with these approaches. It allows you to run your model requiring less data and it will be easy to adjust the growth at some point in the future to evaluate the effects on trade. However the model in my research is intended to not only look at shipping, but also at shipbuilding. Especially the last part I'd like to investigate further than so far done in these models.

Table 1: Shipping models and their transport demand functions (Source Author compiled from Beenstock and Tsolakis)

Name/Author	Market	Year	Demand Function
Tinbergen en Koopmans	Dry Bulk	1934	Demand is known, freight rate is determined
Norship	Wet and Dry Bulk	1977-1981	Demand is a function of world trade and rates; world trade has a fixed growth rate
Hawdon	Wet Bulk	1978	Demand is known, freight rate is determined
Charemza & Chronicki	Wet and Dry Bulk	1981	Demand is known, freight rate is determined
Dynamo	Wet Bulk	1984	Demand is known, freight rate is determined
Martinet	Wet Bulk	?	Demand for oil to be specified by the user
Beenstock and Vergottis	Wet and Dry Bulk	1993	Demand is inelastic and fixed
Zannetos	Shipping	1966	Random walk
Tsolakis	Wet and Dry Bulk	2005	Demand is known, freight rate is determined

Arguments from both Tsolakis and Beenstock and Vergottis, triggered the idea to look to a different way of modelling demand for shipping. Tsolakis uses dummy variables for political events that influenced trade, but these events don't influence the trade volume or commodity prices, while if it would influence the demand for transport, it's likely other elements are also influenced. Something similar goes for the newbuilding price determination by Beenstock and Vergottis, they allow for certain production costs to influence the price, but the relation between the production costs is unkown as these all are exogenous. In my view a large number of elements at a national or regional level are of influence on the minimum shipbuilding price like the development in average wages, unemployment, interest rates, inflation, exchange rates, technological development, subsidies, etc. The model for this will need to take these elements into account. It will be small step to extend the model and take into account the relations between the various elements that determine bilateral transport demand and investigate local demand and supply equilibriums.

ADOPTING AND EXPANDING A MACRO ECONOMIC MODEL

Selection of the adoption process, top-down or bottom-up?

The first thought was take the econometric shipping model of Beenstock and Vergottis as it still is the most complete one and add a certain demand determining model to it. The model only caters for bulk cargo with an emphasis on the dampening on price shock through the combined fleet. Today this fleet totals 71 vessels compared to 2591 Panamax or larger bulkers and 936 Suezmax or larger tankers (Clarcksons 2009). It is safe to say that this carrier type is not nearly as important as it was 20 years ago. The effort involved in creating a model that would link the various costs of newbuilding and adjusts the newbuilding market to limit the role of asset play, was also not straightforward.

The idea was therefore dropped and the problem would be approached from the other side. Using a multi country model to derive transport demand from (on the major maritime trade routes) and extend it with a model for the supply of transport. As mentioned before the latter has not yet been developed. There are a lot of macroeconomic multi country models around. IMF, Central banks and governments; they all use multi country models to predict their immediate futures.

The focus for us is a transport model, so the representation of the countries should be complete, but not overly complicated. Another demand would be that it needs to be able to represent the maritime nations and their bilateral trade. A third demand would be that although the model itself may assume continuous growth, shock can be applied to the variables and their effects can be investigated. Not one model we found would represent all the countries/areas relevant for maritime trade and not become overly complex.

Ships transport goods all over the world and due to a combination of products available, development and culture, we can distinguish a number of regions that are important sources or destinations of this trade. To model and simulate 193 (UN 2009) countries is also a very impractical approach. The solution chosen was to divide the world into 16 maritime relevant regions based on interviews with several experts. These regions are represented in Table 2 below and more graphically in Figure 3. Selection criteria for the regions, where sources or destinations of a certain good, culture, development, natural resources and various others.

Table 2: 16 Regions and their leading economies (Source: Author)

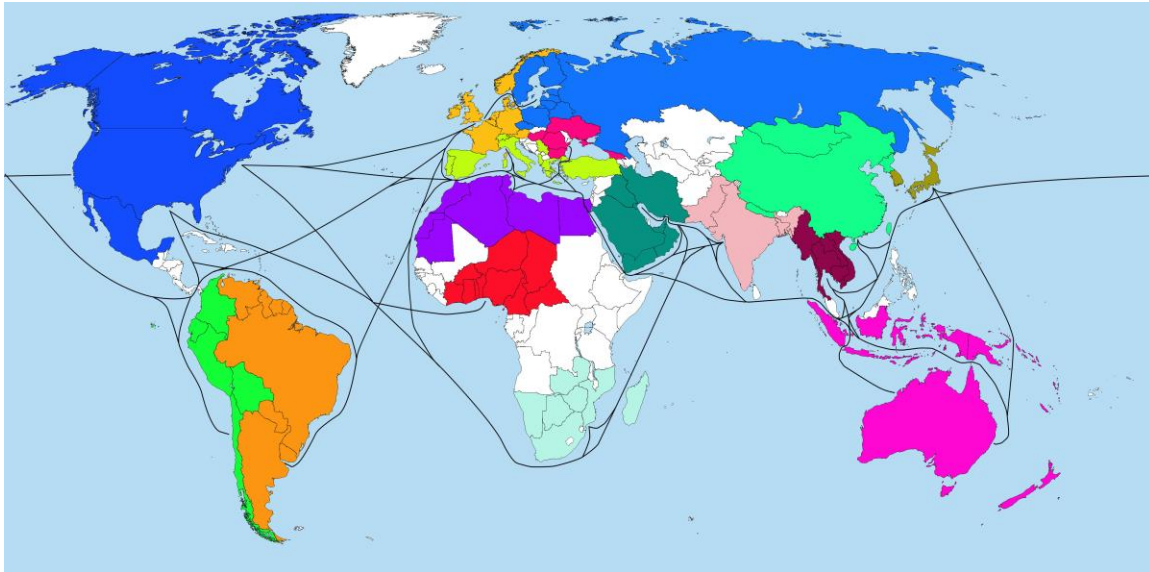| **Region**	Hamburg – le Havre Range	Baltic Area	Black Sea Area	Mediterranean	
Main Country	Germany	Poland	Romania	Italy	
Region	North Africa	West Africa	Southern Africa		
Main Country	Morocco	Nigeria	South Africa		
Region	Middle East	Greater India	Southeast Asia	Greater China	North East Asia
Main Country	Saudi-Arabia	India	Thailand	China	Japan
Region	Oceania				
Main Country	Australia				
Region	North America	West Coast South America	East Coast South America		
Main Country	USA	Chile	Brasil		

Figure 3: Regions represented in colour, including major trade lanes (Source: Author)

The selected main country would usually be the most important economy of that region, although in the case of Russia, it was not chosen to represent any region, as its economy can not be seen representative for any of the regions it is located in. The choice here was made to let the second largest economy be the main country as it better represented the state and development of that area. A similar argument goes for the selection of Saudi Arabia as the main country of the Middle East region. In area the largest country, but in population and economy it is not. Though given its position as mediator for that region, it will represent the "average" of that region better than for example Iran or Iraq. Also data availability played a role in this decision.

Naturally no multi country model would have applied our specific grouping. So we were also looking for a well documented model as well. This way we could apply our own data and only borrow the structure. A model that would meet all our criteria was MEMMOD from the Deutsche Bank (Deutsche Bank 2000). Not only was it well documented it also provided an overview of other by them considered multi country models and the number of equations. This overview is presented below. In counting the equations, each equation was counted individually, the value of "Equations / Country" is therefore a rough estimate of the unique number of equations, as it does not take into account any unique central equations (e.g. for a trade specification) Although the number of equations does not detail which information is modelled, but the need to have a not too extensive model for data availability, made us drop the models with over 100 equations per country.

Table 3: List of multi-country models, compiled by author with data from MEMMOD

Model	Multi-Mod	InterLink	Quest	FRB-Global	EPA	NIGEM	Oxford Model	MEMMOD
Country #	7	23	16	8	9	18	24	9
Equations #	600	4200	1030	1400	1230	1500	4500	690
Equations	86	183	65	175	137	84	188	77

/ Country								

The MEMMOD model has its focus on Germany and was focussed on the effects of growing international economic integration. Due to this integration, policies not only affect the country itself but also it's trading partners. Their chosen model a structural one based on neo-classical theory. Special care was taken to ensure the reflection of homeland policy on trade partners and vice versa. The trade partners are represented "by compact models of their economy" as they state in their description. It allowed to represent both short term and long term behaviour by using parallel equations for the elements where a difference between long and short term can be expected. This focus on trade and the selected variables together with extensive documentation of the model were the most important reasons to adopt this model as the basis of our model. Future research after this PhD can always be focussed on creating/finding a better model, this one at least meets the criteria.

Collecting the data for re-estimation of the model

Once selected the data required to estimate and fill the model can be searched for. Best would be to use as few sources as possible, as this ensures the same systematic errors for all countries. While it soon was clear that one source would not suffice, the following three sources were chosen as the main sources of the data: IMF (IMF 2008), Worldbank (Worldbank 2008) and OECD (OECD 2008). We hoped that would provide all the data needed.

What wasn't mentioned before, but now needs some clarification is the fact that, the regions would represent all countries in that region. To do this, various variables needed to be scaled in order to represent the entire region. There are two types of (data) variables present within the model; levels, which represent a state of the economy and can be added up (e.g. GDP) and rates, which indicate the change of a level. These cannot be added up (e.g. inflation). In order to not need all data for all countries of a region, it was decided to scale up all levels using two reference variables. The ratio between the total of the region and the value of main country would be used to transform the other level variables of the main country to region size. GDP was the first reference selected, Population the second. After some research it was concluded that these two alone would not suffice, but that we needed 5 reference variables in total: GDP, Population, Import, Export and Inflation. All other level variables were either scaled (Social Benefits, Real Capital Stock, Investments, Consumption, Government Spenditure, Labour Force and Money Stock (M2)) or taken from the leading country directly (wage rate, Production Costs, Short Term interest Rate, Unemployment Rate, Exchange rate, Price Deflator, Real Interest Rate, Direct Tax Rate, Indirect Tax Rate).

Due to the facts that for the 5 reference variables we'd need data from all the countries considered and that the statistical time series of many African and South American countries proved incomplete or invalid, our three sources would not suffice. Below is presented a table with an overview of the used sources. Next to the three earlier ones other sources are mentioned. (NB = National Bank, NSA = National Statistical Agency, P = Papers, Est = Deduction of results from other data, that was available e.g. Total Capital from Depreciation

and Investments). Even then for some countries sufficient long data series were lacking and series from other countries in that region have been substituted. The column "secondary countries" indicates which, if any, other countries statistical time series were used to replace missing or incomplete time series of the main country. When it would concern a level variable the data would of course be scaled based on that countries reference variables.

Table 4: Data sources and availability (Source: Author)

Country Block	Main Country	Secondary Countries	Secondary Data Sources	Data Availability
Hamburg – le Havre Range	Germany	Netherlands, France	-	1980 – 2005
Baltic Area	Poland	Sweden	-	1990 – 2005
Black Sea Area	Romania	Hungary	NSA[1,2], NB[3]	1995 – 2005
Mediterranean	Italy	-	-	1981 – 2005
North Africa	Morocco	Algeria	NSA[4,5], Est	1987 – 2005
West Africa	Nigeria	Niger, Ghana, Camaroon	NSA[4]	1995 – 2005
Southern Africa	South Africa	-	P[6] (1983-1993)	1995 – 2005
Middle East	Saudi-Arabia	-	NB[4,7], Est	1996 – 2004
Greater India	India	Pakistan	NB[8], NSA[9], Est	1996 – 2005
Southeast Asia	Thailand	-	NSA[10,11]	1995 – 2005
Greater China	China	-	NSA[12], NB[13], P[14]	1993 – 2005
North East Asia	Japan	-	-	1980 – 2005
Oceania	Australia	-	-	1980 – 2005
North America	USA	-	-	1980 – 2005
West Coast South America	Chile	-	NB[15]	1993 – 2005
East Coast South America	Brasil	Argentina	NB[16], NSA[17], Est	1995 – 2005
Total	-	-	-	1996 – 2004

1: NIS 2008, 2: KSH 2008, 3: BNR 2008, 4: UNSTAT 2008, 5: CAPMAS 2008, 6: Wakeford 2003, 7: SAMA 2008 8: RBI 2008, 9:COI 2001, 10: NESDB 2008, 11: BTEI 2008, 12: NBSC 2008, 13: PBC 2008, 14: Holz 2005, 15: BCC 2008, 16: BCB 2008, 17: INDEC 2008

The data provided for Southern Africa might seem peculiar, why uses a paper providing some data for the period of 1983 till 1993, when in the end the data serie does not run to before 1995? The goal has always been to complete the time series from 1980 till 2005 as much as possible. The equations are regressed with as much data as is available, to get the best results. In the final model it could be that the data was not used as too many other

values were missing. South Africa is not the only one with this problem, but is the most clear case in the table above.

Though major improvements could be made in the data, it was decided to move on as there is only a limited amount of time and to proof our approach, this rough data would give sufficient results as well.

As mentioned all data was used to re-regress all equations, this includes 19 equations per country plus another 5 per country for the trade block in the model. This part links imports, exports and exchange rates of all the regions. In total some 400 regressions were performed. Although available I see it outside of the scope of this paper to discuss all these regressions here.

The initial results from the model

As presented in the table above, there is only continuous data for the period 1996-2004, with the model requiring data of several time steps before and after, the only starting years available are 2000, 2001 and as late as available. The discussion of the results of the model in this paper will focus on the values of import and export, as for the conversion to ton*mile demand for transport these are the interesting values. In the graph below the results for one of the trades, all export from Asia to the Americas are presented for the three different starting positions. While between 200-2005 the bandwidth is relatively narrow, yet the increased growth of the housing boom already push the latest line upwards, above the two predicted trends. By 2020 this maximum is 200% higher than the minimum. It does prove that the prediction of the future depends on the current situation; 2000 was already mentioned as a crisis year and up until 2005 we were seeing a big boom, reflected in the outcomes of 2020.
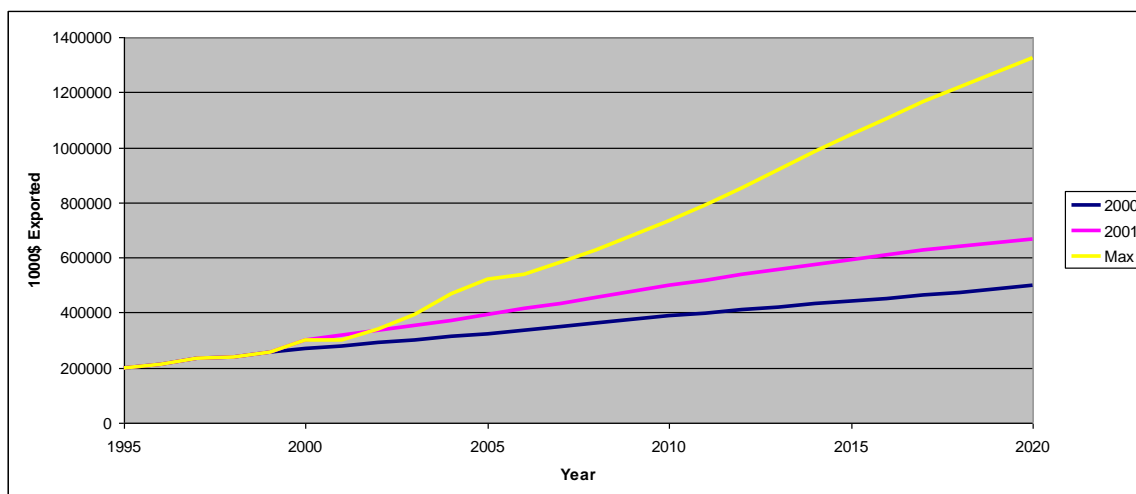

Figure 4: Model predictions of Eastbound Export on the Pacific (Source: Author)

The model used assumes a fixed division of trade between countries, but if we introduce a severe shock to one of the economies, will the results be acceptable? A good shock to test this could be for example a drop in consumption of one of the countries we are exporting to.

In the current crisis consumption in the USA dropped by about 2-3% (BEA 2009). However not only consumption was affected, but a lot of variables at the same time and although some effects spill over into other variables, the starting point was definitely not a shock to consumption only. In order to make the effect of a drop in consumption in one nation visible in our graphs a severe shock of 15% to consumption only was assumed. How will the export from Asia be affected by such a drop in 2010? The result is shown below. The Y-axis shows the results of the new values/divided by the original model estimation. The value 1 represents identical values and a value below 1 indicates a drop in import of that particular country.

Figure 5: Change in import due to a drop of 15% in Consumption in North America in 2010 (Source: Author).

What is wrong in the above graph? It clearly shows a dip compared to the normal version and the year the dip occurs is also the same. Still although we see one line, there are actually 4 present, why is there (almost) no difference between them? The import of the two other regions should not be affected by the drop in Consumption in the North America! The reason they are is that the model assumes the division of trade from a country and into a country will remain the same over time. A shock to one country therefore affects all trade, instead of only the trade to that particular country. This also explains why a shock of 15% can result in a reduction in imports of only 1-2%. It is shared with the other 16 regions.

The graph above has been deducted using export data of the model. While both import of the North America region and the Export to this region should be affected, it is quite likely that the model does not show a very strong reaction in exports as these values are determined by the other regions available, rather than by the affected region directly. An investigation to the effects on import would be needed to see if the reaction is different there.

The figure below shows the same results as above (though without the line for totals). The colours of the lines are kept the same as well. Now the effects of the shock to consumption are clear, imports drop around 9%, which is a lot more realistic than the 2% when using export. As might be expected with these models once the shock is gone, the value will move

back to its original position quickly, many times overshooting that value once or twice. The latter is also the case here. Imports rise quickly and actually overshoot their original value after the shock has occurred.
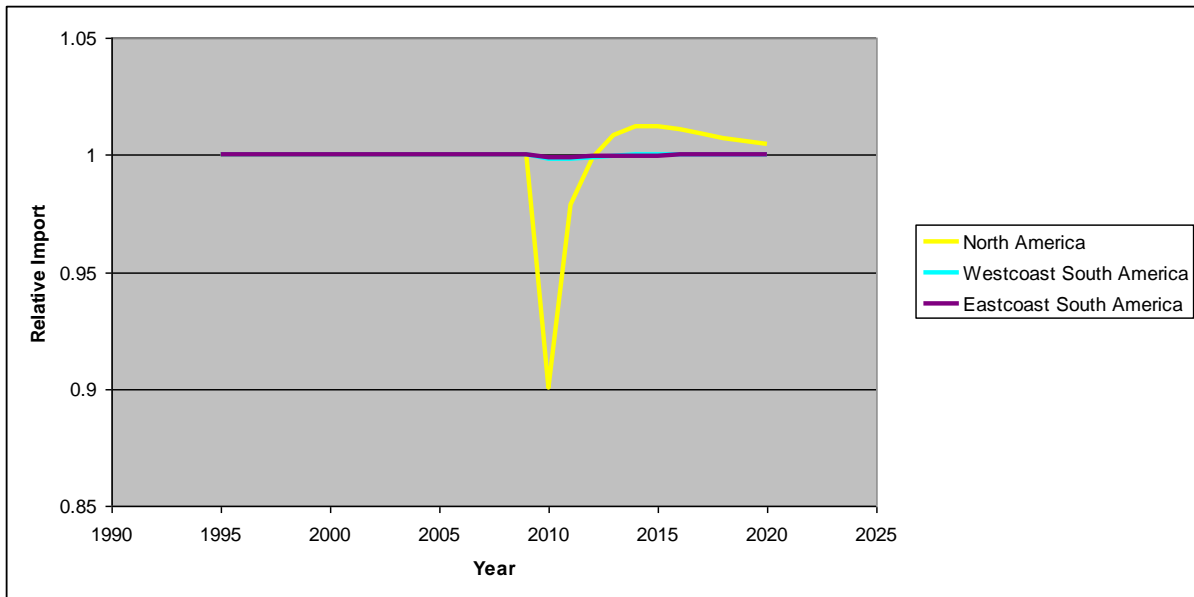

Figure 6: Change in import due to a drop of 15% in Consumption in North America in 2010, results based on model imports (Source: Author).

The other two lines also show a slight reaction to the shock, 0.25% to be exact, but in essence continue almost in a straight line as should be expected. In Figure 5 it was shown that all export reacted to a drop in imports of the North America region. This does result in a drop in a small drop in GDP of all countries as well and through that translates in an even smaller drop in imports of these countries too.

Before this solution was chosen a theorem by Geraci and Prewo (Geraci & Prewo 1977) was also tested to check if variable trade distributions could bring a solution. In their paper they determine how trade between two countries is influenced by 6 factors: GDP of the two countries, import tariff, preference group (like the EU), common language, neighbours and transport cost. As the last one is very hard to determine (on the level they and we are looking at it), they use a combination of distance and unit value to estimate the transport cost. Unfortunately even with rescaling the values to the original imports and exports, strange behaviour keeps occurring once the shock is introduced. The coefficients used were taken directly from the paper and are based on data from 1977. Perhaps a new regression of these values could be attempted, but as the results based on imports already results in realistic behaviour, this has not been pursued further.

TURNING MONEY INTO TRANSPORT DEMAND

The output of the above described model is imports and exports of each of the regions to all regions expressed in dollars. Export includes export to itself as each region consists of multiple countries and there might be a lot of international seaborne trade going on between

them. The demand for shipping is expressed in ton*miles, a legacy of Tinbergen as was explained in the introduction. A proper process is required to convert the dollar trade between two countries into a physical trade between to countries. As there are three types of major trade served by very different vessels, it is important to at least divide the trade amongst these three trades; dry bulk, wet bulk and general cargo. Dry bulk is the trade of all dry materials loaded in bulk and without packaging, the main products are iron ore, grain and coal. Wet bulk is the bulk transportation of liquid products. These can be loaded and unloaded through pumps. The main trades are crude oil, oil products, LNG/LPG and chemical products. The general cargo trade used to be ships loading a large amount of small parcels of goods on board. Nowadays the container trade is the largest of the general cargo trades, though specialised trades such as reefers (cold transportation of fruits) and car carriers still exist as well.

As a preliminary assumption this division is assumed to be constant over time. This assumption has been made for two reasons. Firstly when the export of manufactured products grows, the requirement for raw materials and energy rises as well. The last two are mainly represented in the dry and wet bulk class with the first one mainly present in the general cargo trade. The second reason is that the goal of this PhD is to provide this new functioning framework, the work involved in identifying the factors that influence trade shares of goes outside of that scope.
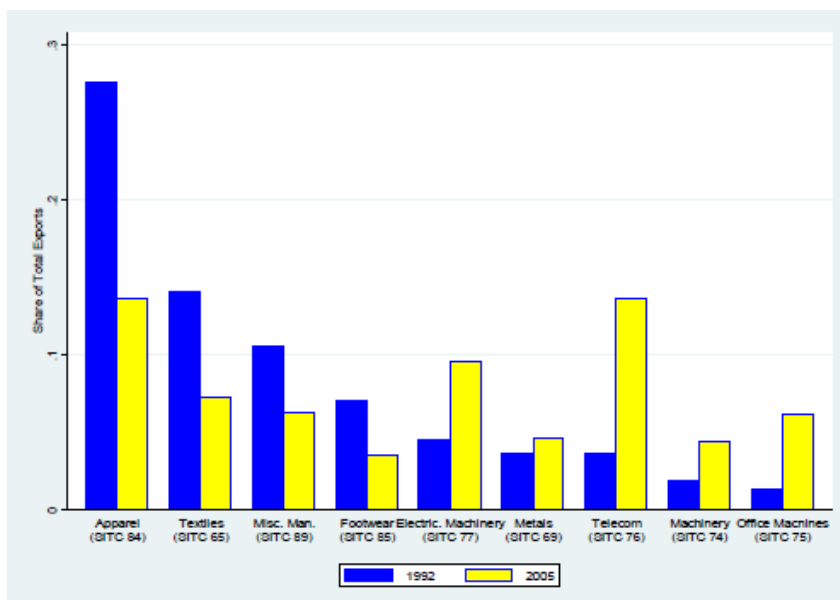

Figures 7: Reallocation of Exports Across SITC One-Digit Industries (Source: Amity and Freund 2008)

In further support research related to the changes of goods shares in the export of china (Amity and Freund 2008) shows a drastic change in the goods exported and produced when looking at the years 1992 and 2005. At the 1-digit SITC (2009) level the fractions of export have moved quite drastically (Figure 7). Fractions are calculated on the basis of constant dollars US. It is also impossible to assign a 1-digit SITC code completely to one of the three trades identified. The WITS (2008) database provides 3-digit SITC code bilateral export data

for almost all countries in the world. This allowed the groups of goods to be assigned to one of the three maritime trades or to be classified as others/money trade. The exact division is left out of this paper and is based on my best knowledge. Several product groups (at the 3-digit) level could be assigned to two different trades and a look at the 4-digit SITC level was taken to see which products were the main contributors and according to that they were assigned.

Amity and Freund also went a level deeper in their export classification and Figure 8 shows the changes between 1992 and 2005 for the most important goods exported from China on the 2-digit SITC code level. This figure clearly illustrates a move to more knowledge intensive products. Where footwear and other textiles are in decline, telecom and electrical machinery are on the rise. Though the data level provided here does not allow us to be completely sure, it appears that the major redistribution took place within the category of general cargo, or more precisely within the container trade. A good indication for the validity of our assumption of "constant fractions" for the bilateral trades.

Figures 8: The Reallocation of Manufacturing Exports Across Major Two-digit Sectors (Source: Amity and Freund 2008)

The process above allowed us to divide the money value of the bilateral exports into the 3 maritime trades and a group of others. Perhaps not clear from the description so far, the WITS data was on country level and for each region the exports of the countries within the region was summed up, as well as for their export partners in the various other regions.

The next step would be to convert the data in dollars to data in tons. The WITS database provided not only data on the dollars, but also on the tons of exported data for each of the groups of goods. Using this data a $/ton value was determined for each of the trades between two regions (272 bilateral combinations). Below the results of this action are represented in two forms. The first graph counts the amount of times a trade had a specific value, rounded off to the nearest 0.5 dollar/ton, the second graph sums up the total volume

of traded with that specific value. The blue line represents wet bulk, the pink line dry bulk and the yellow line general cargo. Both bulk trades have their peaks at the 1 or 1.5, while general cargo does not really have a peak but is stretched out over a larger range. The products falling in the general cargo category are also a lot more diverse than those of the dry and wet bulk trades.
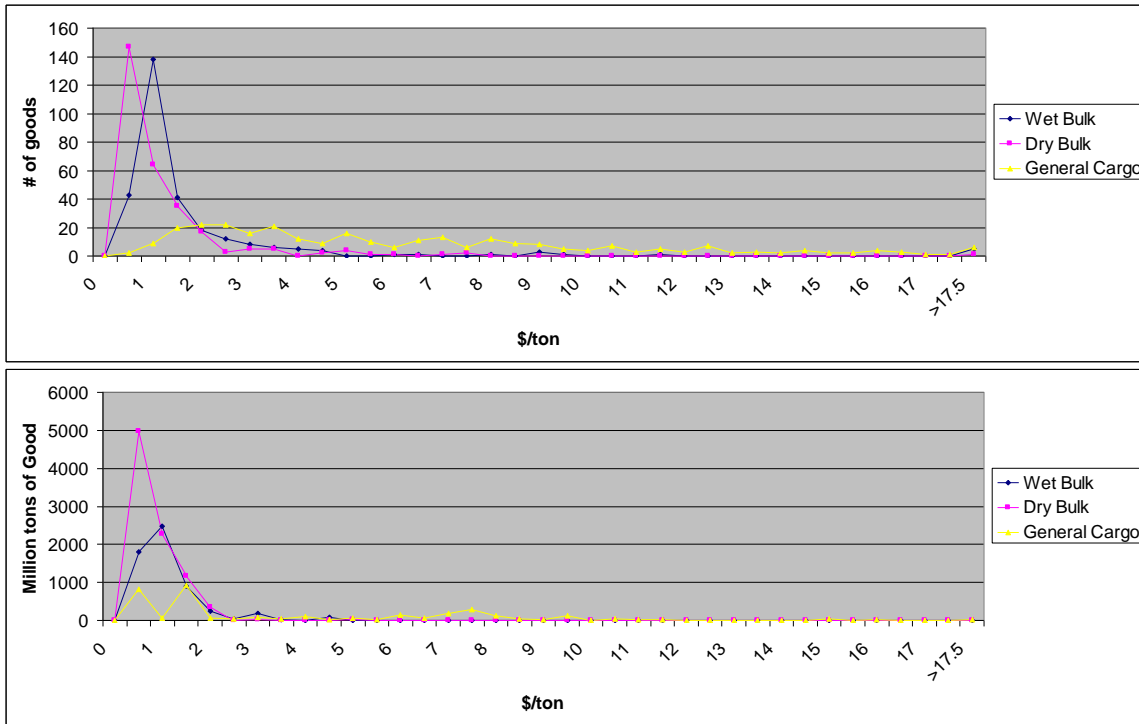

Figure 9a & 9b: Number of countries with given specific value & total volume with specific value (Source Author).

The average value for each of the three trades can be assumed to be the gravity point of the graph. This leads to the following values, rounded to the nearest half presented in Table 4. Intuitively the volume based approach would appear to be the most fair. It allows a weighing of the importance of various bilateral trades. This will therefore be used in the model.

Table 5: Average specific value for each of the trades (Source Author).

	Wet Bulk	Dry Bulk	General Cargo
# basis	2.0	1.0	6.5
Volume Basis	1.0	1.0	4.0

The last steps to come to the transport demand is to use the values above to turn the money stream between two regions into 3 trade streams of goods and multiply it by the distance between the two regions. The choice was made assign one important port (two for North America) to each of the regions and use these as the basis for the distance calculation. A more extensive approach would be to use the trade from all ports of a region to all ports of the other region and based on this define an average distance travelled between the two regions. A major downside of this approach is that if trade changes, the distance between two regions changes. The expected increased accuracy is limited on the other hand.

$$\text{Demand}_{i,ab} = \text{Money}_{ab} * a_{I,ab} / \text{Unit value}_i * \text{distance}_{ab} \qquad (1)$$

$\text{Demand}_{i,ab}$ = Transport demand for trade i, between country a and country b

Money$_{ab}$ = The value of export from country a to country b

a$_{i,ab}$ = the fraction of the value of export from country a to country b of trade i

Unit Value$_i$ = The specific value ($/ton) of trade i

Distance$_{ab}$ = the distance between country a and country b (their main ports)

i = Wet bulk, dry bulk or general cargo

THE ESTIMATION OF TRANSPORT DEMAND

All the work described so far builds a large table, in which bilateral trade in 3 distinct categories is present for the years 1995-2020. A proper representation of all the results is outside the scope of this paper, it would include 3x272 lines. Below three sets of graphs are representing the previous discussed example of trade on the Pacific. The data is based on a run of the model allowing all available data to be used. This is the extremely positive case described (Yellow line) described in chapter 4 (Figure 4). The graphs present the realised transport demand as seen from the America's (which includes the regions of North America, Westcoast South America and Eastcoast South America), for an overview of the countries present within these regions I refer to Table 2 and Figure 3 earlier in this paper. The Asian side (which in this example includes the regions of Greater India, Southeast Asia, Greater China, North East Asia and Oceania) of this example is not shown in detail, as it would require another six graphs. The total trade from these regions is the reverse of the import and export below. The top two graphs are concerned with the import and export of dry bulk over the pacific. As all figures have the same scale (for clarity) it shows that the North American region is a net importer of wet bulk. The dip shown on the import side is the result of the housing crisis that started by the end of 2005. The current larger crisis is not taken up in the data, explaining the swift recovery around 2011. The Eastcoast South America region is a net exporter of wet bulk; this is explained by the presence of Venezuela in this group, together with the upcoming markets of the coast of Brazil. The last region, Westcoast South America, is not a major player in either the import or export market, but based on the model prediction, will become a net importer of wet bulk.
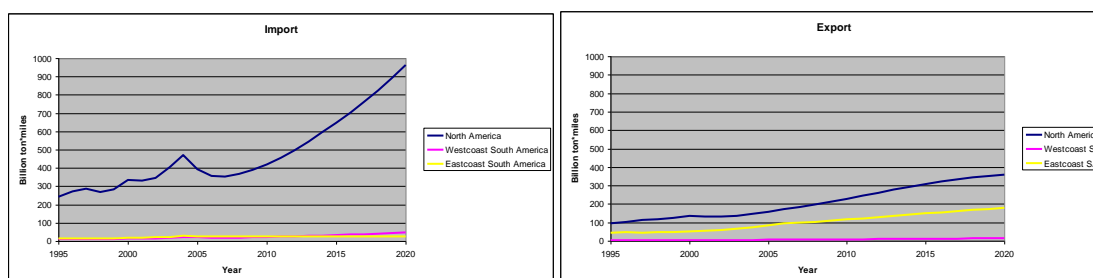

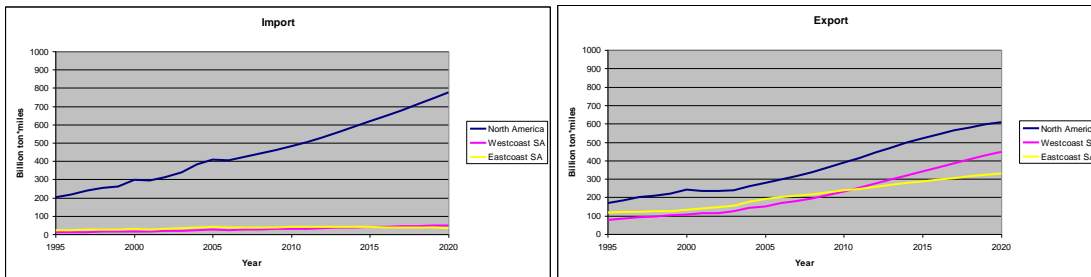Figure 10a-10b: East- and westbound wet bulk trade per importing county (Source: Author)

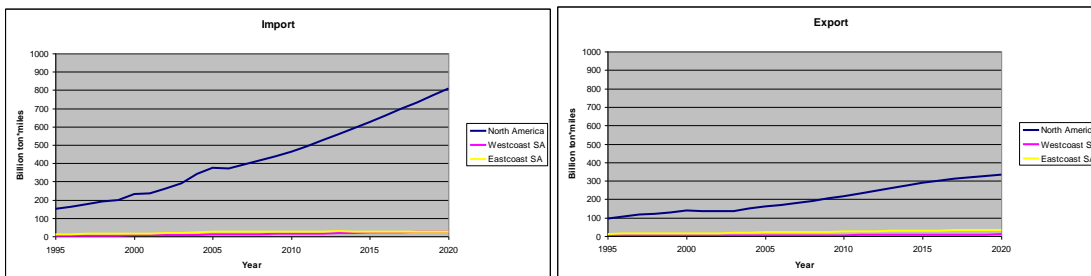Figure 10c-10d: East- and westbound dry bulk trade per importing county (Source: Author)

Figure 10e-10f: East- and westbound general cargo trade per importing county (Source: Author)

The next two graphs (Figure 7c and 7d) show the results for dry bulk. Both while North America is a large importer, it's also a large exporter, though not of the same products. Their substantial export is mainly based on grain and other agricultural products, while there import consists mainly of minerals. The nearly flat area in the export from 2000-2004 is most likely a result of the dotcom crisis that started in 2000. As exports were represented in dollar values and include services and investments, the investments made in this industry dropped considerably. My expectation would be that regular trade would not be affected the same as total exports value, but due to the choice of a fixed division between the four trade types (the three presented here and one miscellaneous), this is now present within this graph. The investigations required to solve this problem are outside the scope of the PhD, but it is important to understand the implications as they are visible here. Both regions in South America are net exporters of dry bulk, mainly minerals such as iron ore, tin, silver, coal etc.

The last two graphs represent the general cargo trade, which includes the container trade. Both regions in South America do not have a major trade in this aspect. Their economies are mainly focussed at the raw materials their countries can provide, rather that at the benefits of production with cheap labour. Wages are substantially higher than developing Asian countries, which limits their competitiveness in this field as well. As would be expected the North America region is a major importer of general cargo a group which includes a lot of luxury items.
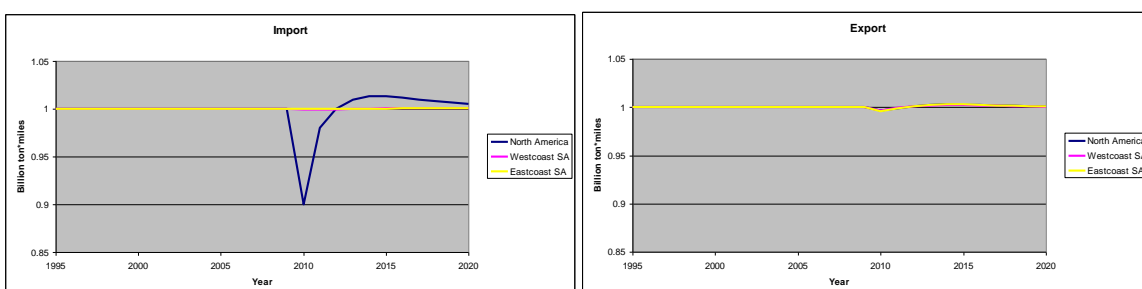

Figure 11a-11b: Changes in Import and Export of wet bulk due to the shock to consumption in North America. (Source: Author)
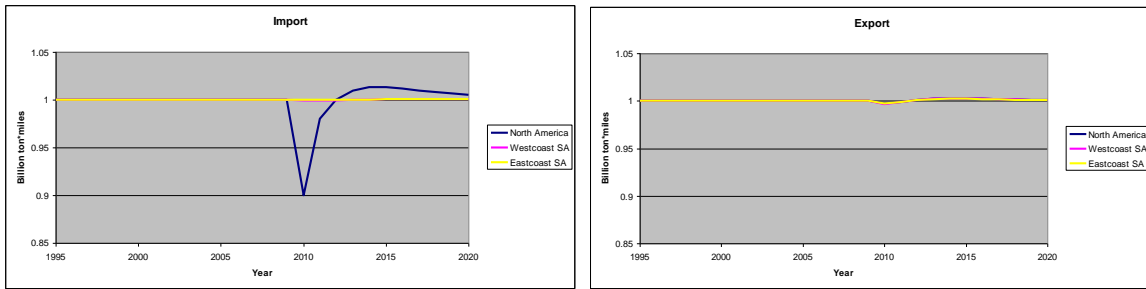
Figure 11c-11d: Changes in Import and Export of dry bulk due to the shock to consumption in North America. (Source: Author)
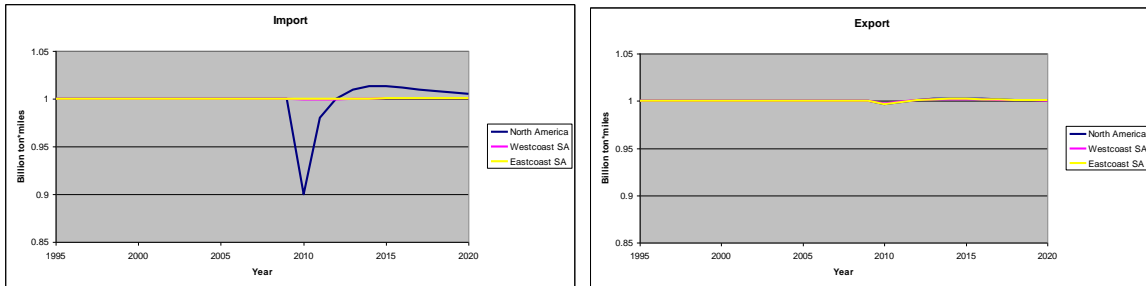

Figure 11e-11f: Changes in Import and Export of general cargo due to the shock to consumption in North America. (Source: Author)

When applying the same shock as before, the 15% decrease of North American consumption in 2010, the differences are presented below. The shape of each of the three graphs seems to be very similar, not only to each other, but also the Figure 6. This is easily explained by our approach. The division between the trades on a certain route is fixed. If import falls by a certain percentage, all imports on all routes will fall by that same percentage. While above it was remarked that the method proposed by Geraci and Prewo provided unrealistic behaviour, a method would make the results more realistic. As in the current crisis general cargo has been hit a lot harder than bulk shipping, as it transports luxury items, rather than necessities.

On the other hand one could argue against this that luxury items also require raw materials and when the trade in these items fall, the trade in raw materials will also follow a similar drop.

FUTURE WORK

An aspect that's already been investigated is the transformation of the yearly data into weekly data. It was mentioned in the beginning of this paper that we are looking for transport demand on a monthly or weekly basis as a concession to both the macroeconomic and freight rate data. This hasn't been taken up any further in this paper in order to be able to properly describe the first stage of the work done. In the next paper (to be presented on the IAME'10 conference), this will be discussed, including the challenges such as seasonality.

The remainder of the PhD will focus on the supply side of the model. As time is limited, the supply side will at first only focus at the dry bulk market. The idea is to look at optimal fleet usage, which at a year level could be quite straight forward, due to a viable assumption of

market clearing. On a week and trade level, this will pose challenges, as ships will be unavailable due to being in service or elsewhere. The approach and outcome of this research should be available by the end of 2010.

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