Title of paper
Deindustrialisation and its consequences on Seaborne Trade

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Abstract

Transport systems solutions are being intensively employed for the satisfaction of an ever growing in both quality and sophistication demand, while pressures for greater efficiency and sustainability follow suit. Systems dynamics in the transport industry are hence meant to balance elements of market, society and environment altogether. The traditional segmentation of transport modes within strictly defined markets has been replaced by competition among the modes over same market segments, while societal and environmental aspects are increasingly equally addressed in transport policies.

Demand decoupling for transport follows hence a “Systems to Systems” reasoning, where all aforementioned aspects interact. Evidently, these complex systems portray the extent of evolution resulting from an impressive trade growth, with the latter being stimulated by structural changes occurring in the global economies. From an international trade point of view, transport systems respond to and link the deindustrialisation process of the developed world and the industrialisation process of the developing. The slow process of structural change may however conceal its inevitable impact on the transport industry.

This paper builds upon the literature of deindustrialisation as experienced in Europe and investigates its impact on trade. In particular, it principally concentrates on the consequences of deindustrialisation on seaborne trade and attempts to derive scenarios of possible reformations of future transport systems, viewed from a modal split perspective. It employs simple regression and time series techniques with the purpose of visualising the variables leading to the structural changes. Finally, the paper concludes with a proposal of how this research question could be properly addressed with more sophisticated techniques at a more advanced level.

Structural changes, Deindustrialisation process, Growth, Deep Sea Shipping

INTRODUCTION

Global economic history highlights rapid and fundamental changes where concepts such as structural change attract most attention. Although they are by no means a new phenomenon it is their striking speed of occurrence and spread of appearance that has made them observable and has intensified the desire of multidisciplinary researchers for further investigation.

Structural changes could however be confused with the effects that they cause creating misunderstandings of what actually consists a structural change. In this paper the changes we identify as being structural are the ones that lead to the reallocation of resources (labor and capital) among sectors of the economy in response to changing economic circumstances, including trading conditions, or changes in policy[1].

Deindustrialisation assists in the identification of structural changes in this paper. It is being viewed as the process of evolution and the foundation whose main branches allow us to trace out the mechanisms of change. By that we refer to the main causes leading to deindustrialisation identified broadly as being changes in productivity growth and consumption patterns but also trends in outsourcing and investment[2].

The reasoning of this paper follows an expression of the above to the case of the European Union and is hence driven by the reallocation of resources from the manufacturing to the services sector in response to primarily changing consumption patterns and productivity levels of the two aforementioned sectors complemented by a series of policies supporting trade liberalization and adaptation to the emergence of new global players, finally leading the EU towards a knowledge driven economy.

The focus is on the future role of seaborne trade and in particular deep sea shipping (DSS). It is believed that the current growth of DSS should not be viewed as structural but merely as an extended byproduct of the process of change. Future choices on firstly a policy level, for example the final outcome of the negotiations for the EU free trade agreements, plans for new trading routes[3] , secondly on a market level like the strategic choices of multinationals on their Foreign Direct Investment (FDI) activities and thirdly on a global level the unsettled US deficit with China and many more, all create a rather unstable environment for the maritime sector.

This paper should be viewed as the first steps of research in progress. It consists of three parts. In the first part it tries to identify the structural changes and the variables that best express them within a European context. In the second part it presents two primary "naïve" modeling applications which serve as a starting point of future more sophisticated models. The third and last part is a brief presentation of a possible superior approach. The ultimate goal of the modeling part would be to provide for long term forecasts of the growth of seaborne trade.

[1] Deardorff's Glossary of International Economics

[2] We refer to a paper of the International Monetary Fund (IMF)

[3] New free trade agreements under negotiation with India, Korea and ASEAN aiming at expanding trade opportunities and the Northern East –West freight corridor (N.E.W.)

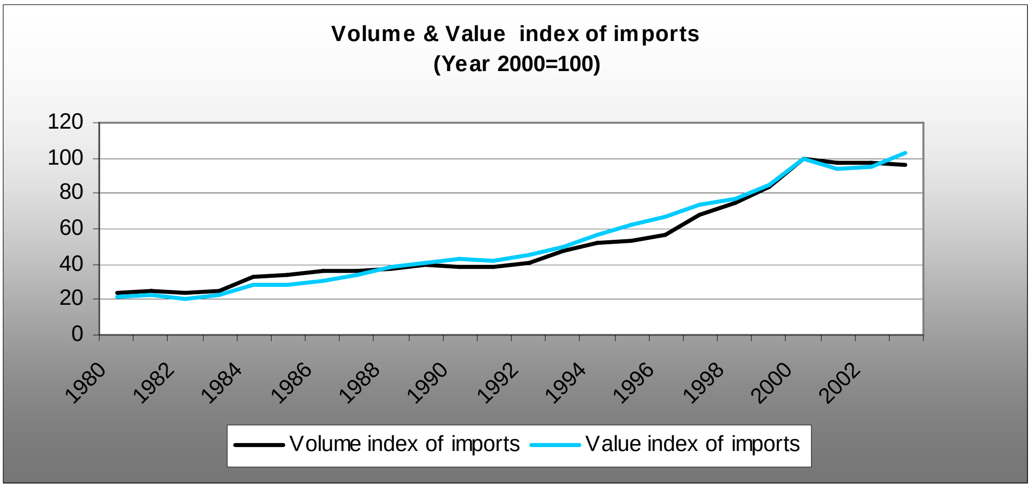
Part I: Structural Change identification and its Expressions

Chapter 1
Developed Economies: Changing trading profiles

The process of deindustrialisation results from a country's success in achieving economic progress. Hence being a "privilege" of the developed world. The consequent structural transformations observed have largely been pronounced by a change in the developed countries trading profiles.

At the same time the interplay of global mechanisms and industrialisation of part of the developing world have all contributed to a striking increase in international trade. Seen from the import view point of developed economies we observe an increase in both volume and value as illustrated below in figure 1.

Figure 1

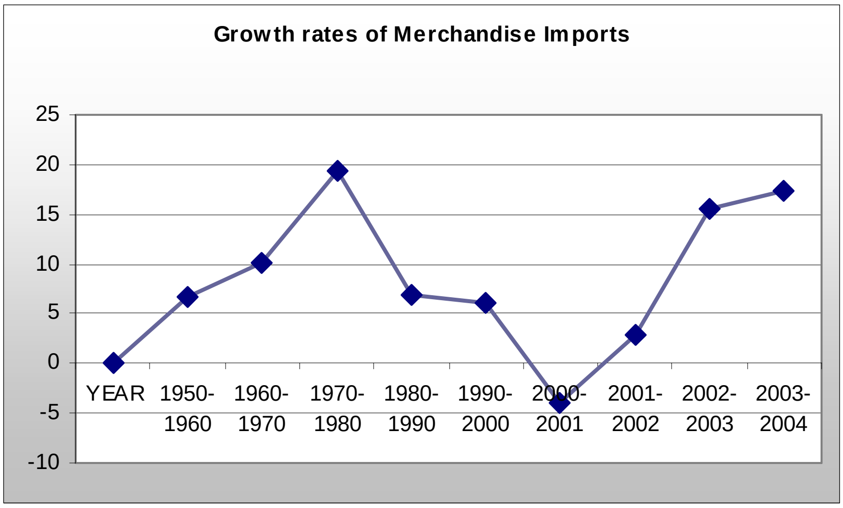


Source: UN Handbook of Statistics

Evidently, this continuously changing trading environment has affected a large range of industries in either positive or negative ways. In this paper we only concentrate on the effects of deindustrialisation on seaborne trade and hence we focus on merchandise and in particular merchandise imports[4], were continuous positive growth rates have been observed. Especially as shown in figure 2 merchandise imports have grown remarkably until the 1980's and continue to grow each year up until today.

[4] The concept of deindustrialisation involves both the manufacturing and services sector . Since however services are not physically traded goods we will not discuss their relation within this paper although certainly of great importance to our research.

Figure 2



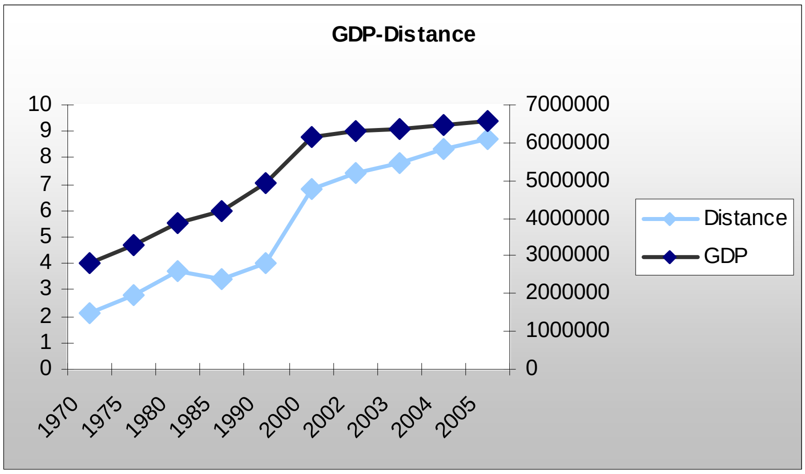
Source: UN Handbook of Statistics

Chapter 2
The reflection of Growth and Change on Seaborne Trade

The commonly identified reasons for international trade growth fall within the categories of decreasing costs of trade, productivity growth in the tradable goods sector and increasing income per head. The resulting changing trading patterns have had a tremendous effect on the transport sector as a whole but is has been due to the emergence of new global players, their strong competitive advantages and their critical location that have contributed to the unprecedented growth of seaborne trade, in particular Deep Sea Shipping.

On the basis of those common trends, their dominance and geography, two main factors have been identified as playing the key role in the case of seaborne trade, gross domestic product and distance. The expression of all above could easily be understood by considering North-South trade activity. Figure 3 demonstrates the increase in both distance (category other dry cargoes) and GDP of the European Monetary Union (in constant 2000 US dollars).

Figure 3



Source: World Bank (World Development Indicators) and UNCTAD Review of Maritime Transport 2006

In addition to the common increasing trend what this figure shows is the close correlation between distance and GDP which could be an interesting feature for future modelling purposes.

Chapter 3
EU Trading Profile

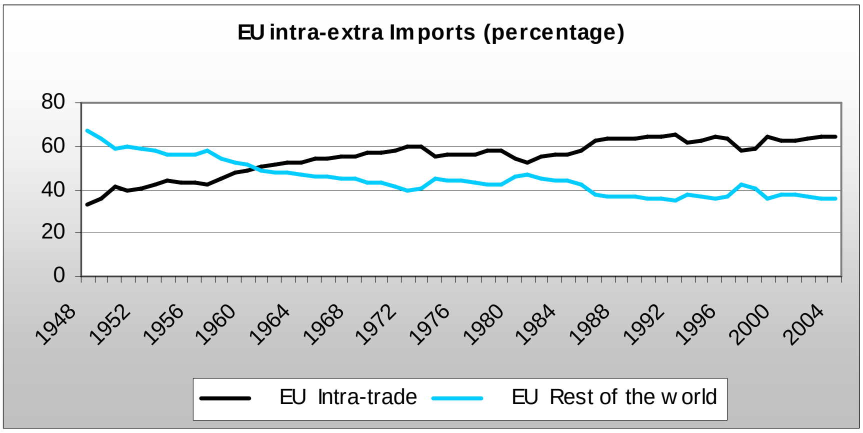
The extent to which the trading profile of the European Union has structurally changed could become quite complicated. It has often been related with the deindustrialisation process which has been debated by several parties (regarding whether the EU has indeed been deindustrialising). Nevertheless, in this paper we will not favour or oppose the statement, considering it a matter of terminology which could be interpreted either way. In this chapter we focus on the import side of the EU trade Profile and attempt to identify the structural factors affecting future trends of EU imports handled by the Deep Sea Shipping market.

3.1) Structural drivers

The creation of a common European market has critically affected the trading profile of European countries as shown in figure 4 below. The more Europeans trade among each other the less they import from the rest of the world. The majority of trade of each Member State (MS) despite varying degrees is currently being held with other MS[5].

The enlargement of the EU and the diversity it achieved, as it now includes both deindustrialised and industrialising countries, paints a miniature picture of current global trade mechanisms.

Figure 4



Source: UN Handbook of Statistics

The extent to which intra trade will continue to grow to the expense of trade with the rest of the world depends on the structural changes achieved in the transition economies and their consequent ability to attract Foreign Direct Investment (FDI flows[6])among other reasons.

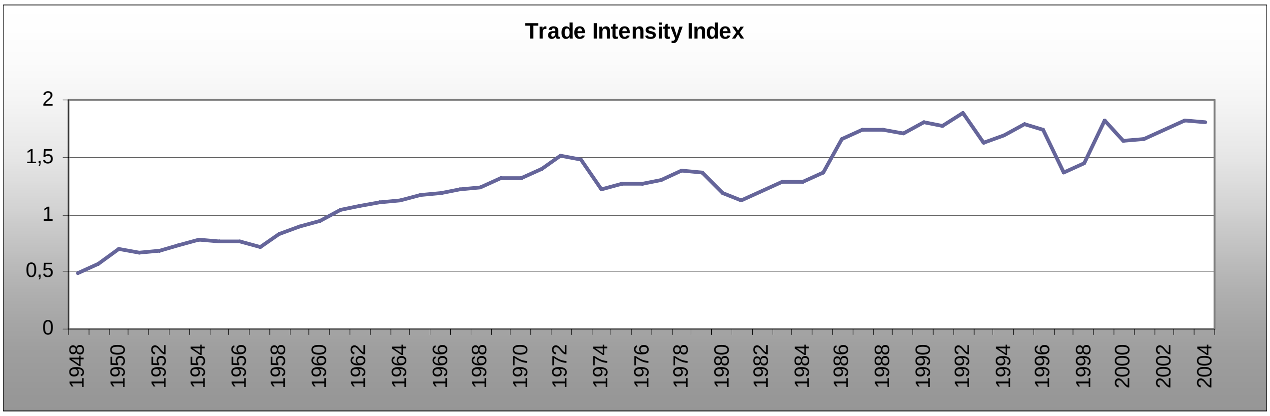
The complexity becomes even clearer if we consider the uncertainty of their trade preferences as they climb up the ladder of development. A natural question rising would ask whether a new period sustaining impressive growth rates of seaborne trade could arise as these transition countries commence intensive trading activities with other developing countries in the case of no other transport links between Asia and Europe existing at that time.

[5] Europe in figures Eurostat Yearbook 2006-07

[6] A comparison of FDI inflows for China and CEEC in Annex 3 shows how the latter group is underperforming

The identification however of the historic trend towards an even further intensified intra trade pattern could be illustrated in Figure 5 by the Trade Intensity Index (TII). The crucial point of this figure would be the year 1960 where TII equals one. From the 1960's and onwards its increasing pace beyond unity suggests that the EU displays trade diversion[7]. Clearly historic links between countries and geographical factors cannot be ignored.

Figure 5



Source: UN Handbook of Statistics

Within merchandise EU imports we choose to investigate separately the category of other manufactured goods which represents the second largest category of imported goods after machinery and transport equipment. By looking at (figure 6) the share of exports of manufactured goods (SITC 5 to 8 less 68) originating from the world, we could suggest, given its rather flat line, that the EU's importing profile for those goods has not dramatically changed in the last thirty years.

Figure 6

Source: UN Handbook of Statistics

By considering however the developing part of the world and Central Eastern European Countries share, we can clearly see that the structural shift observed in the EU has been expressed by a change in the origin of imports as a result of the reallocation of countries comparative advantages.

[7] Frankel (1997)

3.2) Interactions of imports trading routes and seaborne trade growth

We now look at Figure 7 which compares the share of exports of manufactured goods (SITC 5 to 8 less 68) to the European Union by origin, distinguishing the developing part of the world from Central Eastern European Countries. An alternative way of viewing this figure would be a DSS intensive and a DSS divertive part of the world respectively. The growing gap between them could broadly be interpreted as the growth of DSS. What we are actually suggesting is that if CEE countries manage to increase their percentage share of exports to the EU it would at the same time diminish the role of DSS to the advantage of road, rail or short sea shipping (SSS).

Figure 7

Source: UN Handbook of Statistics

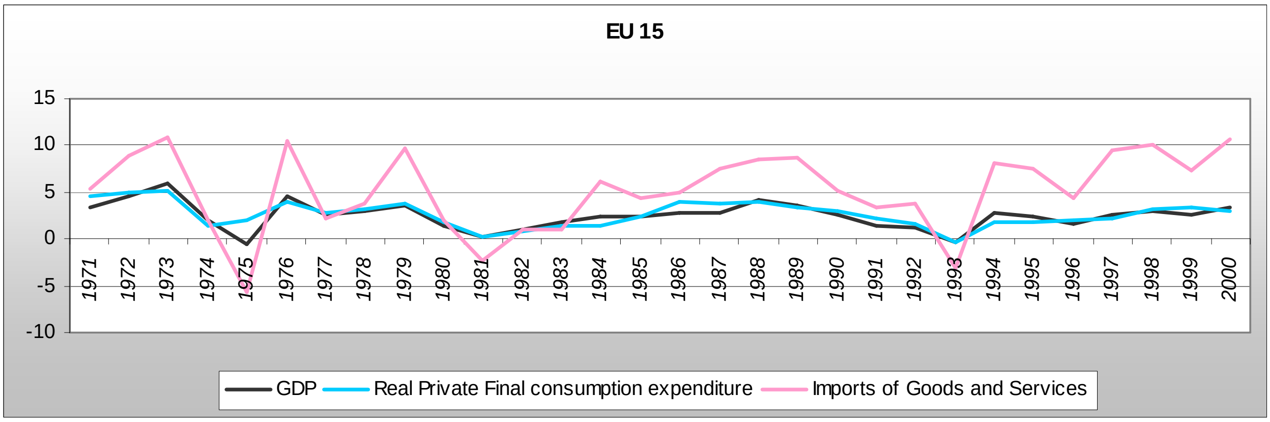
The expressions of the most important structural factors affecting EU-seaborne-imports as a result of the particularities characterizing the European Union identified in this chapter, include the Trade Intensity Index TII as a measure of enlargement and successful integration of MS and Foreign Direct Investment FDI as a measure of potential economic growth especially for the new and future MS. Nevertheless further research is required.

Chapter 4
Changing Consumption Patterns: EU 15

In chapter 3 we have concentrated on future trends that have yet not been observed to the extend that they could be reflected on seaborne trade flows. These trends relate mostly to the EU12 and beyond. The current EU27 however represents a quite unique case as an amalgamation of both developed and developing countries. It would therefore be necessary to separately examine the EU15 as the deindustrialising part of the EU.

For the purpose of collectively analyzing the trends in EU 15 imports we summarise in figure 8 all basic variables recognized by the trade literature as most relevant, Gross Domestic Product, Real Private Final Consumption Expenditure and aggregated Imports of both goods and services.

Figure 8

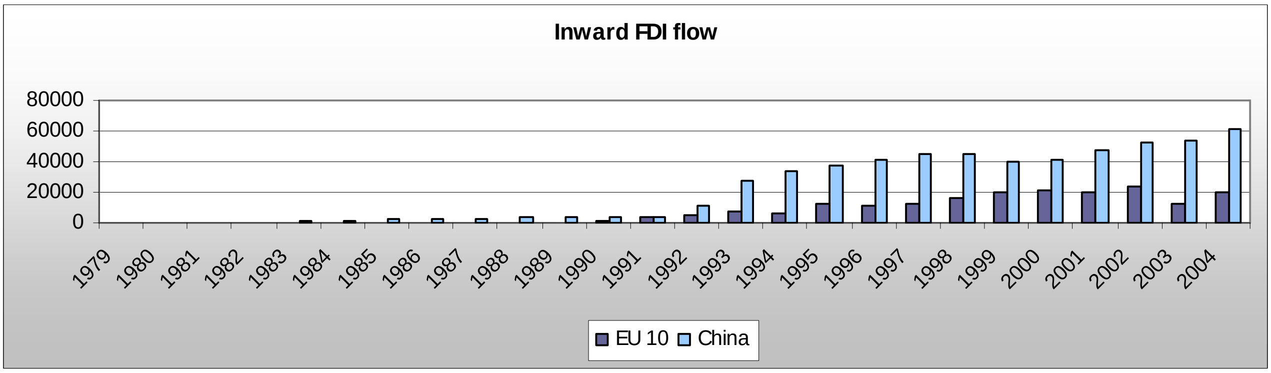


Source: UN Handbook of Statistics

What we observe is that all three variables follow the same pattern with the former two being closely correlated. Imports of Goods and Service series however are more volatile. The latter implies a higher degree of uncertainty about the influencing factors for imports of goods and services. Once again, further research is required.

Annex 1

FDI Trends



Source: UN Handbook of Statistics

Part II: Towards a Modelling approach

In this part of the paper two chapters have been included, each presenting two different and quite simplified modelling approaches. Chapter 1 is an econometric model while chapter 2 a Vector Error Correction model.

Chapter 1
Econometric Approach

A basic econometric approach will be presented in this part of the paper. At this point we assume that the econometric approach would be most suitable in demonstrating how structural changes have lead to the impressive growth of Deep Sea Shipping (DSS) and how these forces may reverse the trend towards a rather more moderate or even declining one.

1.1) Research statement and its expression: The dependent variable

By applying a multiple regression analysis we intend to study the relationship between the demand for DSS and the structural changes in the EU economy. In other words we will attempt to measure the joint effect of economic changes (as expressed in the variables explained in the next chapter) on DSS.

The dependent variable we have chosen to express as the Volume of Chinese exports to the European Union, in particular the EU 25. The reasons why we chose China as the origin is because of the ever growing trends in the volumes of their exports to the EU and the fact that so far the largest leg of transporting the goods of this route is possible only through DSS. An alternative view of the dependent variable from the European side would be the volume of imports of the EU 25 from China.

1.2) Independent Variables

The absence of an unambiguous economic (or other) theory addressing the research in question has prompted us into the consideration of a combi-theory comprising of economic, trade, consumption and transport theory. In this paper the macroeconomic factors affecting long term seaborne trade growth as identified by Martin Stopford in his book “Maritime Economics” (summarized below in table 1) was believed to provide a good starting point for our research.

Table 1: Explanatory variables

Long-term theory based variables	**Potential Measurements**
GDP	GDP
Trade Elasticity	% growth of trade in manufactured goods / % growth in industrial production
Changes in Demand	% growth of EU trade in manufactured goods within total trade including services
	Domestic Demand for manufacturers
	Import Growth of manufacturers
Changes in Supply Sources	Trade Intensity Index (EU Intra trade/Rest of the world)
Changes due to relocation of processing plants	
Distance	
Transport Policy	Trade Restrictiveness Index (IMF)
Transport Costs	Environmental taxes: (Energy, Transport, Pollution) taxes
Investment Flows	Outward/Inward Foreign Direct Investment (FDI)

Source: Based on M. Stopford, 1997, Maritime Economics

The evident conclusion drawn by this table would be the dependence of DSS on the growth of global economies as a result of both its international character and derived nature of demand. The rather abstract environment from which we are forced to source our variables increases the risk of failure in our model. Although the leading question is clear, being "what are the main growth drivers of the EU economy affecting deep sea shipping?" the answers vary considerably.

In this investigation the final selection will rely on the identification of those variables that contribute to structural changes occurring in the EU, on the basis of the process of deindustrialisation. By that we imply both deindustrialisation and industrialisation processes, in particular the European Union's and China's respectfully.

In particular two independent variables would be finally included in the model: 1)GDP of China, as a measurement of their economic growth, investigated due to its believed relation to the international trade activity also reflected in the EU's extra trade 2) Trade Intensity or as commonly known Trade Diversity Index (TDI) which could roughly be considered as summarising all three sub-variables (highlighted in table 1).

Regarding the other variables of table 1, changes in supply sources become less relevant in this application since only manufactured goods are being targeted and hence satisfactorily covered by changes due to relocation of processing plants. Distance, becomes important in the case of manufacturing imports from Asian countries being substituted by imports from Central Eastern European countries (CEEC). Trade elasticity and Changes in Demand as an indicator of the changing industrial structure of the EU, should normally be included in the model to show the shift from manufacturing to services. However for reasons of simplicity they were discarded from the model and left for future applications. Transport Policy cannot easily be quantified and remains a risk factor while transport costs and Investment although factors that largely contribute to the growth of international trade they will be discarded from the model for reducing its complexity.

1.3) Data

The model's data was based on the United Nations and OECD databases. In particular Exports Volume Index (EVI) was sourced by the United Nations common database constructed as the ratio of value index of Chinese exports to the European Union (EU 25) and unit value of Chinese exports. The purpose of including this variable was to provide a rough approximation of the actual volume of Chinese exports to the EU or alternatively EU 25 imports from China[8]. Gross Domestic Product refers to China's GDP in current US dollars serving as a macroeconomic variable of China's growth and has been sourced by the same database. Trade Diversity Index (TDI) or as usually called trade intensity index has been sourced by the United Nations Handbook of Statistics and calculated as a ratio of the EU 25 intra trade and EU 25 trade with the rest of the world.

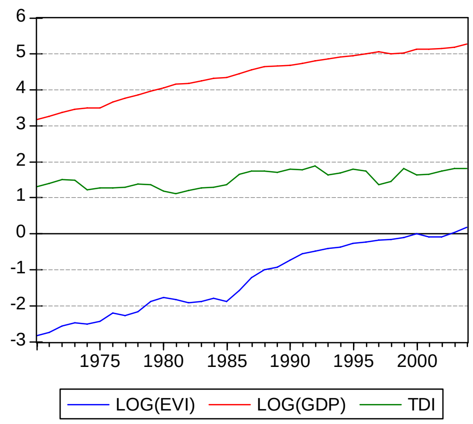
It should be noted that given the use of approximations of the volume indices data, consequent intrpretations should be viewed with caution and reservation. As a whole the use of this data is considered to be experimental, aiming to reflect trends and not accurate figures of the measured variables.

[8] All chinese data refer to China, Hong Kong Special admisnistrative region (due to data availability reasons)

1.4) Identifying Trends

A simple plot of the dependent and independent variables helps us to identify trends. As we would like to use this model for forecasting purposes the identification and subsequent elimination of trends becomes a quite critical step in our analysis.

Figure 1: Trends



By observing figure 1 we saw that both our dependent variable log (evi) and independent log (gdp) follow an upward trend as commonly observed in economic and business time series, while the second independent variable TDI is stable. In addition, other information we can also draw from this graph is a first indication of stationarity of the series which could hold true only for the latter variable TDI. Consequently we will need to correct for the non stationary series, log (evi) and log (gdp). We will however first need to establish non-stationarity by performing tests for all variables.

Before however performing any test we did a Correlogram view of the series where we observed that the autocorrelation patterns of all three series showed a typical first order autoregressive AR(1) process (see Annex 2 for tables). In particular the Autocorrelation AC decayed with a damped sine wave pattern while there was a significant spike of the partial autocorrelation PAC at lag one[9].

What the Correlogram also revealed was that the series were non stationary[10] but could probably be corrected by taking differences. We hence proceeded in checking for stationarity by performing the Augmented Dickey Fuller unit root tests. As anticipated, by taking first differences we could correct for non stationarity (see Annex 2 for test results).

1.5) Estimation results

We then estimated (using Ordinary Least Squares) an AR(1) log-model in E-views for the whole data set. We observed that the overall fit of the model was relatively low, R^2 = 0,4. This means that approximately 42% of the variation in the exports volume of China to the EU 25 (in log differences) can be attributed to the trade diversion index of the EU 25 (in differences) and China's GDP (in log differences). It becomes clear that other factors either observable or unobservable affect our dependent variable[11].

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[9] Where lag 1 was statistically different from zero, exceeding the approximate 95 percent confidence limit for $\rho_{k,}$ being -0,2089 and + 0,2089.

[10] For a particularity of the stationarity of Log(gdp) see details in Annex 2

[11]The independent variables seem all to be statistically important with probabilities close to zero, although the t-statistic of the d(tdi) is rather low. We will however not overstress these problems of the model since no hypothesis testing will be performed.

-The Durbin Watson DW=1,8 <2 gives us an indication of possible remaining autocorrelation in our model

The economic interpretation of the log parameters is in elasticities[12], which means that the coefficient of the (gdp) variable is interpreted as a percentage. Furthermore we have taken first differences and hence log (gdp) should be viewed as a yearly percentage change. So, a one year percentage change of China's gdp would result in a 1.56 percent increase in the volume of Chinese exports to the EU 25.

The variable Trade Diversion Index we have taken in first differences of the levels and hence the economic interpretation of the estimation result would be that a yearly change in the EU's (tdi) would result in 0.3 percent increase in the volume of Chinese exports to the EU 25.

Table 2: Estimation

Dependent Variable: D(LOG(EVI))
Method: Least Squares
Date: 07/20/07 Time: 12:57
Sample(adjusted): 1972 2004
Included observations: 33 after adjusting endpoints
Convergence achieved after 10 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.007795	0.032847	-0.237299	0.8141
D(LOG(GDP))	1.566273	0.361892	4.328012	0.0002
D(TDI)	0.160088	0.103322	1.549405	0.1321
AR(1)	0.347121	0.175144	1.981917	0.0570

R-squared	0.421581	Mean dependent var	0.088613
Adjusted R-squared	0.361744	S.D. dependent var	0.112872
S.E. of regression	0.090174	Akaike info criterion	-1.860930
Sum squared resid	0.235811	Schwarz criterion	-1.679535
Log likelihood	34.70534	F-statistic	7.045549
Durbin-Watson stat	1.841235	Prob(F-statistic)	0.001065
Inverted AR Roots	.35		

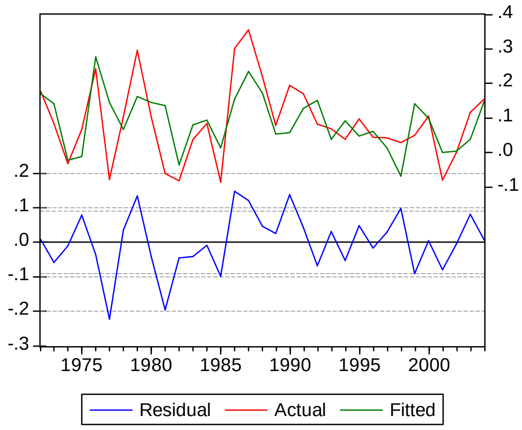
We already see that the model does not really capture what we had anticipated it would. The sign of the EU's trade diversion index we would have expected to be negative. Nevertheless given our poor data quality and mainly the fact that we used past data that reflect the impressive growth of Chinese exports to the EU we believe could be the main reason why the model did not capture the negative effect of the variable. However we will refrain from making any further explicit comments since it might very well be the case that the variable is indeed as shown by the low t-value not important and does not really affect our dependent variable. Clearly further research needs to be done.

1.6) Residuals

Since we are interested in forecasting we should further examine the properties of the residuals. We start by a graphical format of the residuals presented in figure 2. The variance of the errors is more or less stable which suggests that we have successfully de-trended the series and substantially corrected for serial correlation. Even though in the presence of heteroskedasticity and autocorrelation our OLS estimators are still unbiased or consistent they would be inefficient and hence no longer best linear unbiased estimators (BLUE) We thus proceed in testing for heteroskedasticity and for remaining autocorrelation.

[12] The log model assumes constant elasticity over all values of the data set

Figure 2: Residuals



We have already seen in our previous analysis that a first order autocorrelation existed in all our series where the partial autocorrelations (PACs) were cut off at lag one. Furthermore the OLS estimation results reported the Durbin Watson statistic DW= 1,84 which is below two indicating positive first order serial correlation. In order however to provide for a more general testing framework than the Durbin Watson we also performed the Breusch Godfrey LM test (see test results below) where we failed to reject the null hypothesis of no serial correlation.

Autocorrelation test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.655809	Probability	0.208707
Obs*R-squared	1.842530	Probability	0.174655

Additionally, in order to establish whether the variance of the error terms varies over the observations we performed White's test for heteroskedasticity. Given the high Obs probability of 0,6 we accepted the null hypothesis of no heteroskedasticity.

Heteroskedasticity test

White Heteroskedasticity Test:

F-statistic	0.609207	Probability	0.659377
Obs*R-squared	2.642042	Probability	0.619394

After acquiring acceptable results for the presence of both autocorrelation and heteroskedasticity we can with certain reservation though, assume that our model serves its purpose[13] and can thus proceed in making our forecasts.

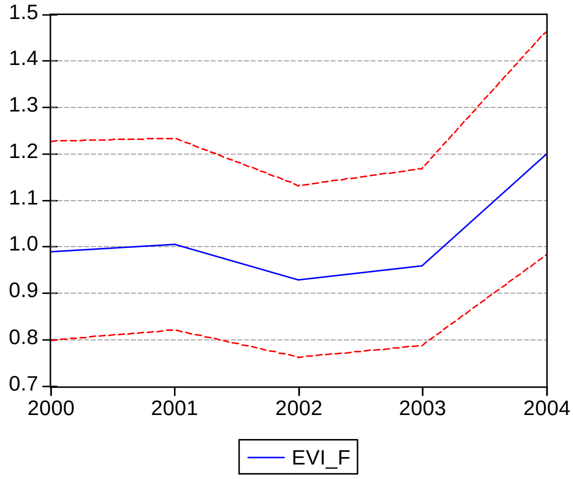
1.7) Forecasts

For making forecasts we have re-estimated the model using only a subset of our data from 1972 to 1999 in order to compare forecasts based upon this model to the actual data. The post estimation sample is for the period 2000 - 2004.

[13] By that we mean the purpose of this paper being its experimental approach in modeling for academic reasons

First we tried to make one step ahead forecasts. The results of the Static approach are presented below. What we observe is a close to zero Theil's inequality coefficient (U) while the results of the U's decomposition produce the desired results of a bias proportion (U^M) and variance proportion (U^S) that are very small and a higher than all three covariance proportion (U^C)[14].

Figure 3: Static Forecast



Forecast: EVI_F	
Actual: EVI	
Forecast sample: 2000 2004	
Included observations: 5	
Root Mean Squared Error	0.051611
Mean Absolute Error	0.037916
Mean Abs. Percent Error	3.848844
Theil Inequality Coefficient	0.025247
Bias Proportion	0.001671
Variance Proportion	0.041735
Covariance Proportion	0.956594

Next, we plot the actual values of EVI against the forecasted values (figure 4) and then we plot the actual values of EVI against the forecasted values and the approximate 95% confidence intervals for the forecasts (figure 5), where for the latter we observe that the actual values are within the forecast interval for the whole forecasted period while for the former the forecasted values interchangeably over and under predict the actual values.

Figure 4

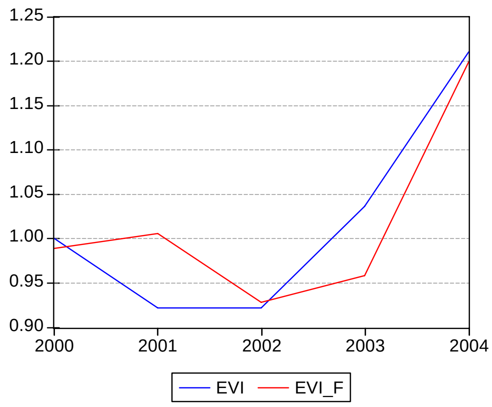
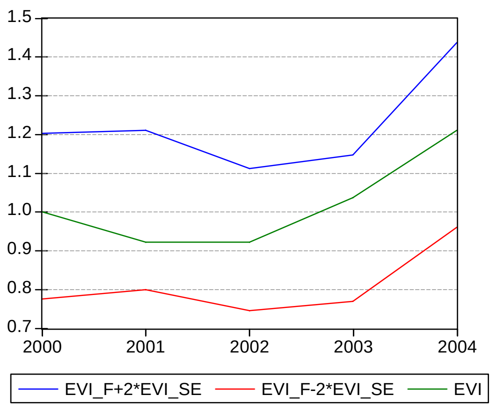


Figure 5



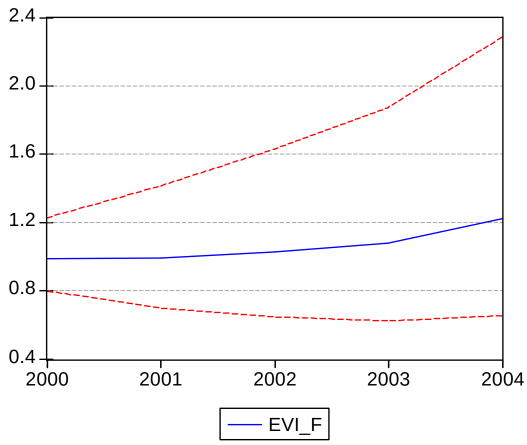
For the evaluation of the static approach we base ourselves on Theil's inequality coefficient, its decomposition and the above two figures. Although this evaluation procedure is by no means complete we could comment that up to this point of analysis our model produces mediocre forecasts. Nevertheless we do not consider this simplistic model suitable for making out of sample long term

[14] where (U^M) deviation form the average value, (U^S) compares fluctuations and (U^C) represents the unsystematic error. First two should be very small while the third the biggest of all three.(Meersman, 2006)

forecasts. This opinion could be further supported by the following presentation of our attempt in using the model for making dynamic forecasts.

By dynamic forecasts we mean that we forecast the period 2000 until 2004 period as if the model would have been used back in 1999 to make forecasts over the next four years. The results are presented in figures 6, 7, 8 below. Clearly here the results have substantially deteriorated. According to figure 6 the covariance proportion is no longer the highest of the three components of Theil's coefficient (U) while figure 7 shows that our model constantly overestimates true values. Nevertheless actual values are still within the forecast interval for the whole forecasted period.

Figure 6: Dynamic forecast



Forecast: EVI_F	
Actual: EVI	
Forecast sample: 2000 2004	
Included observations: 5	
Root Mean Squared Error	0.059319
Mean Absolute Error	0.047422
Mean Abs. Percent Error	4.966743
Theil Inequality Coefficient	0.028403
Bias Proportion	0.526563
Variance Proportion	0.108832
Covariance Proportion	0.364605

Figure 6

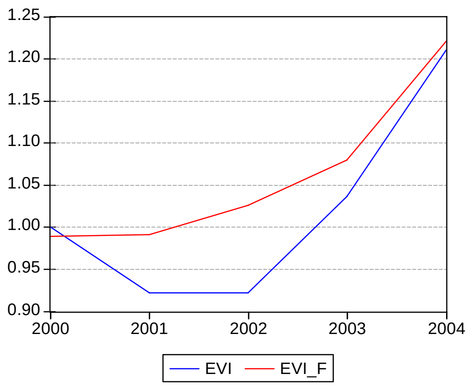
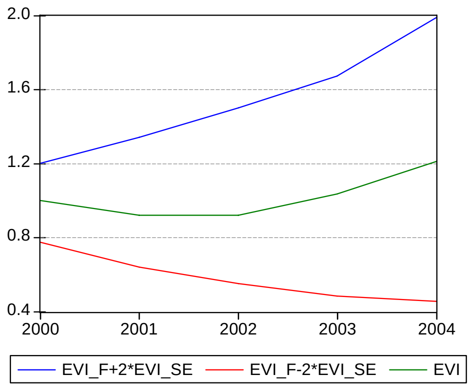


Figure 7



Clearly this model is unsuitable for making forecasts of any kind, either in the short term or long term. Further research should however be done using more sophisticated econometric models.

Annex 2

In the following three sections of Annex 2 a separate investigation of the three variables is documented in particular focusing on their autocorrelation patterns and stationarity properties.

a) LOG (EVI)

Typical first order autoregressive AR(1) process.

Correlogram of log(evi)

Date: 07/20/07 Time: 09:40
Sample: 1970 2004
Included observations: 35

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******|</td><td>. |*******|</td><td>1</td><td>0.920</td><td>0.920</td><td>32.259</td><td>0.000</td></tr>
<tr><td>. |****** |</td><td>. | . |</td><td>2</td><td>0.842</td><td>-0.035</td><td>60.057</td><td>0.000</td></tr>
<tr><td>. |****** |</td><td>. | . |</td><td>3</td><td>0.772</td><td>0.017</td><td>84.181</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. *| . |</td><td>4</td><td>0.698</td><td>-0.067</td><td>104.54</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. *| . |</td><td>5</td><td>0.610</td><td>-0.136</td><td>120.60</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>6</td><td>0.525</td><td>-0.033</td><td>132.92</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. | . |</td><td>7</td><td>0.452</td><td>0.012</td><td>142.39</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. *| . |</td><td>8</td><td>0.369</td><td>-0.116</td><td>148.90</td><td>0.000</td></tr>
<tr><td>. |**. |</td><td>. *| . |</td><td>9</td><td>0.282</td><td>-0.067</td><td>152.87</td><td>0.000</td></tr>
<tr><td>. |**. |</td><td>. | . |</td><td>10</td><td>0.207</td><td>0.001</td><td>155.10</td><td>0.000</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>11</td><td>0.138</td><td>-0.035</td><td>156.13</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>12</td><td>0.061</td><td>-0.095</td><td>156.34</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>13</td><td>-0.024</td><td>-0.122</td><td>156.37</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>14</td><td>-0.108</td><td>-0.108</td><td>157.09</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>15</td><td>-0.186</td><td>-0.055</td><td>159.33</td><td>0.000</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>16</td><td>-0.265</td><td>-0.087</td><td>164.14</td><td>0.000</td></tr>
<tr><td>***| . |</td><td>. | . |</td><td>17</td><td>-0.334</td><td>-0.021</td><td>172.14</td><td>0.000</td></tr>
<tr><td>***| . |</td><td>. | . |</td><td>18</td><td>-0.380</td><td>0.039</td><td>183.16</td><td>0.000</td></tr>
<tr><td>***| . |</td><td>. |* . |</td><td>19</td><td>-0.404</td><td>0.085</td><td>196.39</td><td>0.000</td></tr>
<tr><td>***| . |</td><td>. | . |</td><td>20</td><td>-0.414</td><td>0.064</td><td>211.20</td><td>0.000</td></tr>
</table>

As shown below by the Augmented Dickey Fuller test the first differences of the variable log (gdp) are stationary since the t statistic in absolute terms is higher than the critical values.

Augmented Dickey Fuller test

Null Hypothesis: D(LOG(EVI)) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.413402	0.0014
Test critical values:	1% level	-3.646342	
	5% level	-2.954021	
	10% level	-2.615817	

*MacKinnon (1996) one-sided p-values.

b) LOG (GDP)

The same as for the dependent variable log(evi) holds for the independent variable log(gdp) where we also observe a typical AR(1) process.

Correlogram of log(gdp)

Date: 07/20/07 Time: 09:43
Sample: 1970 2004
Included observations: 35

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*******|	. |*******|	1	0.912	0.912	31.699	0.000
. |****** |	. | . |	2	0.827	-0.029	58.565	0.000
. |****** |	. | . |	3	0.746	-0.025	81.092	0.000
. |***** |	. | . |	4	0.666	-0.041	99.597	0.000
. |**** |	. *| . |	5	0.579	-0.084	114.07	0.000
. |**** |	. *| . |	6	0.490	-0.071	124.78	0.000
. |*** |	. | . |	7	0.410	-0.004	132.55	0.000
. |**. |	. *| . |	8	0.327	-0.077	137.68	0.000
. |**. |	. | . |	9	0.247	-0.043	140.71	0.000
. |* . |	. | . |	10	0.173	-0.024	142.26	0.000
. |* . |	. | . |	11	0.103	-0.043	142.83	0.000
. | . |	. | . |	12	0.038	-0.026	142.91	0.000
. | . |	. *| . |	13	-0.026	-0.061	142.95	0.000
. *| . |	. | . |	14	-0.085	-0.041	143.40	0.000
. *| . |	. | . |	15	-0.139	-0.035	144.66	0.000
.**| . |	. *| . |	16	-0.196	-0.085	147.28	0.000
.**| . |	. | . |	17	-0.249	-0.050	151.72	0.000
.**| . |	. | . |	18	-0.290	-0.004	158.11	0.000
.**| . |	. | . |	19	-0.319	-0.001	166.34	0.000
***| . |	. | . |	20	-0.344	-0.026	176.54	0.000

Similarly, we perform the Augmented Dickey Fuller unit root test. However the test allows us to reject the null hypothesis that log (gdp) has a unit root since in absolute terms the t-statistic is higher than the critical values.

Augmented Dickey Fuller test

Null Hypothesis: LOG(GDP) has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.178578	0.0030
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

Nevertheless on the basis of the plot in figure 1 illustrating a clear upward trend and for the purpose of correcting for the existing autocorrelation we will estimate the model using the log(gdp) in first differences.

c) TDI

Once more the TDI seems to be an AR(1) with a damped sine wave pattern and a significant spike of the partial autocorrelation at lag one.

Correlogram of (tdi)

Date: 07/20/07 Time: 09:46
Sample: 1970 2004
Included observations: 35

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |****** |	. |****** |	1	0.778	0.778	23.067	0.000
. |**** |	. | . |	2	0.583	-0.057	36.421	0.000
. |**** |	. |**. |	3	0.557	0.310	48.990	0.000
. |**** |	. | . |	4	0.524	-0.009	60.467	0.000
. |*** |	.**| . |	5	0.346	-0.278	65.626	0.000
. |* . |	. *| . |	6	0.192	-0.071	67.270	0.000
. |* . |	. | . |	7	0.164	0.050	68.517	0.000
. |* . |	. | . |	8	0.138	-0.004	69.433	0.000
. |* . |	. | . |	9	0.066	0.046	69.651	0.000
. | . |	. *| . |	10	-0.031	-0.133	69.700	0.000
. *| . |	. *| . |	11	-0.084	-0.092	70.085	0.000
. *| . |	. |* . |	12	-0.075	0.071	70.404	0.000
. *| . |	. | . |	13	-0.083	0.001	70.812	0.000
. *| . |	. | . |	14	-0.137	-0.035	71.972	0.000
. *| . |	. *| . |	15	-0.182	-0.059	74.109	0.000
.**| . |	. *| . |	16	-0.190	-0.107	76.573	0.000
.**| . |	. *| . |	17	-0.213	-0.085	79.834	0.000
.**| . |	. *| . |	18	-0.299	-0.155	86.654	0.000
***| . |	. | . |	19	-0.330	0.055	95.452	0.000
.**| . |	. | . |	20	-0.312	-0.008	103.83	0.000

The Augmented Dickey Fuller unit Root test was performed where the non stationarity of the level series was observed but corrected by taking first differences.

Augmented Dickey Fuller test

Null Hypothesis: D(TDI) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.103295	0.0000
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

Chapter 2
Vector Error Correction (VEC) approach

This approach follows a model prepared by Veenstra and Haralambides titled "Multivariate autoregressive models for forecasting seaborne trade flows" for the purpose of making long term forecasts. In this paper, a Vector Error Correction Model (VECM) will be applied with only endogenous variables, the ones used in the previous model, EVI, GDP, TDI. The results presented here should however be viewed with caution given the poor quality of the data and the simplifications made in this application of a VECM.

2.1) The model

Since the VEC model is being formed according to the number of co-integration relations[15] we applied the Johansen's Co-integration Test. Before performing the test however we had to check for the stationarity of the variables and chose the optimal number of lags to include in the model.

2.1.1) Stationarity

In order to establish their non-stationarity, a necessary assumption for performing the Johansen test we applied the Augmented Dickey Fuller test to all variables, which showed that all our variables in logarithms were non-stationary in levels but corrected by taking first differences (see annex 3.1 for more details on the test results).

2.1.2) Lag Length selection

According to the pilot paper a lag order of one should be chosen on the basis of the assumption, that co-integration relations would contain the long run information required for long-term forecasts to be performed. At the same time however it is has been suggested that a higher order should be chosen depending on the Schwarz criterion. In our application the Shcwarz criterion indicated an optimal lag of 2 (see annex 3.2).

2.3) Cointegration test

For performing the Johansen co-integration test we have assumed the existence of a linear trend with lag intervals 1 to 2 as indicated from the Schwarz criterion. The result of the test showed that there exists one co-integrating relationship (see annex 2.3) between the variables.

2.4) Estimation results

In the pilot paper the estimation results have not been presented because 1) results were considered a poor basis for making inferences about the model and 2) no observations were saved for making in-sample forecasts due to few observations. The interpretation of the estimations of a Vector Error Correction model are quite complex and for this reason they will also not be presented in this paper.

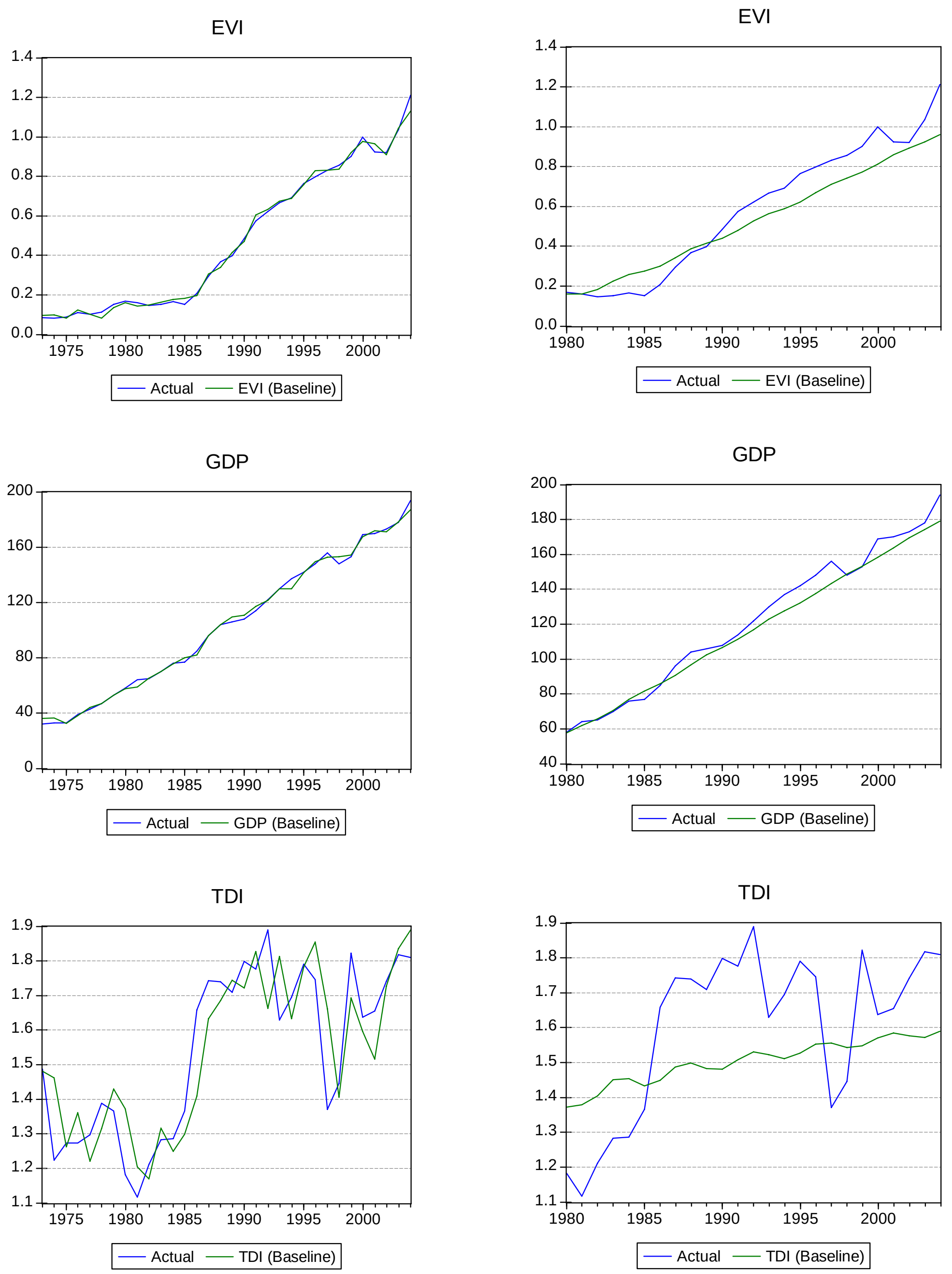
[15] Cointgegration: the existence of a long run relationship between I(1) variables. Condition to avoid spurious regression is that at least one linear combination of them is I(0) i.e. that they cointegrate.

2.5) Forecasting

The static approach shows a one step ahead predictor where it seems that our model performs quite well. In particular, concerning the Exports Volume Index (EVI), predictions perform really well and the same holds for China's GDP predictions. The Trade diversion Index (TDI) interchangeably over and under predicts the true values although however it generally follows the trend.

We will now evaluate the model according to its ability to forecast many periods into the future. We will hence make a dynamic forecast. What the results of this dynamic forecast illustrate is the performance of our model if we would have used it back in 1980 to make forecasts over the next twenty years.

Static	Dynamic



It is quite evident from the graphs that our forecasts deviate from the actual outcomes. Nevertheless they do follow the trend in all three cases. Consequently it would be unrealistic to use this model for making accurate forecasts. Clearly there exist other factors that determine the future behaviour of the considered variables which have not been captured by this simplistic model.

In addition, we would not prefer using such a model for making forecasts since all variables are endogenous and no shocks occurring in the economy could be predicted. We believe that such a model could be used when the variables forecasted are expected to remain more or less stable with no dramatic changes in their trends which according to this paper would not necessarily be the case for the long term future of deep sea shipping.

Annex 3

1. Checking for Stationarity

1a) Log EVI is Non stationary

Null Hypothesis: LOG(EVI) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.698270	0.8336
Test critical values:	1% level	-3.646342	
	5% level	-2.954021	
	10% level	-2.615817	

1b)Log TDI is Non stationary

Null Hypothesis: LOG(TDI) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

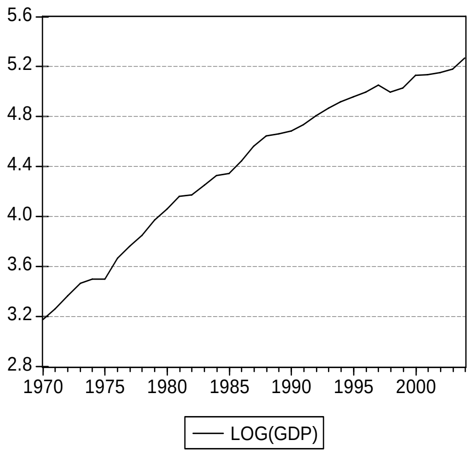
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.713751	0.4155
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

1c) Log GDP

Null Hypothesis: LOG(GDP) has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic based on SIC, MAXLAG=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.178578	0.0030
Test critical values:	1% level	-3.689194	
	5% level	-2.971853	
	10% level	-2.625121	

The Unit root test would allow us to accept log (gdp) as being stationary. However when looking at the log (gdp) graphical and autocorrelation representations below and given the fact that GDP and economic variables are very rarely stationary we assume that the log (gdp) series is indeed non stationary. Hence we can proceed in the Johansen co-integration test.



Autocorrelation

```
.  |*******|
.  |****** |
.  |****** |
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. *|  .    |
.**|  .    |
```

2. Selecting best lag length

VAR Lag Order Selection Criteria
Endogenous variables: EVI GDP TDI
Exogenous variables: C
Date: 07/16/07 Time: 10:54
Sample: 1970 2004
Included observations: 29

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-103.1880	NA	0.304149	7.323312	7.464757	7.367611
1	-0.565369	176.9356	0.000480	0.866577	1.432355	1.043772
2	15.56437	24.47270*	0.000301	0.374871	1.364982*	0.684962
3	27.38072	15.48350	0.000263	0.180640	1.595084	0.623626
4	42.43828	16.61524	0.000194*	-0.237123	1.601654	0.338759
5	54.00062	10.36623	0.000201	-0.413836*	1.849274	0.294942*
6	62.21666	5.666232	0.000304	-0.359769	2.327674	0.481904

3. Co-integration

Sample(adjusted): 1973 2004
Included observations: 32 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: EVI GDP TDI
Lags interval (in first differences): 1 to 2
Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.620652	40.82535	29.68	35.65
At most 1	0.229941	9.807751	15.41	20.04
At most 2	0.044197	1.446521	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 1 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.620652	31.01760	20.97	25.52
At most 1	0.229941	8.361230	14.07	18.63
At most 2	0.044197	1.446521	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level

Max-eigenvalue test indicates 1 cointegrating equation(s) at both 5% and 1% levels

Part III: An Alternative approach: Segmentation, a Holistic application

Trends within the Transport research field increasingly rely on engineering tools such as systems dynamics that capture the complexity of the transport problems in a more realistic way. In this third part of the paper, an attempt is being presented to accordingly adjust the ASTRA model[16] to fit a future application of the research question, "deindustrialisation and its consequences on seaborne trade".

1.1) Systems Dynamics and econometric models

The main reason why the system's dynamics approach would be more suitable than an econometric or time series analysis in addressing the research question is the fact that it could forecast effects that have not yet been observed in the past. Through a representation of the deep sea trade growth system (with reduced complexity) multi-scenarios could be incorporated and run with an ultimate goal of providing information about the alternative long-term trends of the indicators affecting the growth of deep sea shipping[17]. The scenarios could be in the field of GDP indicators, FDI, taxation etc. Although sacrificing the relatively high precision forecasts of applied econometric/time series models we believe that the use of historic data that capture the past and current trend in DSS might not correspond to future trends not yet observed.

1.2) Introductory remarks

The fundamental features of this application of the ASTRA model would reduce the original size of the model. In particular we refer to the:

1) Spatial Structure: Macro Regions
The macro regions to be included in the model would be reduced to three, the EU 15 countries, the EU 12 countries and China.
2) Transport Flows: Freight Categories
The freight categories would follow the Standard International Trade Classification (SITC) Rev.4, in particular section 6-Manufactured goods classified chiefly by material and Section 7-Machinery and Transport Equipment. In addition, a further disaggregation would be made on the basis of value, in particular between low and high value unitised goods. For last, the sectors of the economy included in the Macroeconomic (MAC) sub-model would cover both the Manufacturing and Services sector in order for it to capture the shift towards service based economies which should be reflected in the Regional Economic and Trade Sub-Model (RET**)** sub-model[18].
3) Spatial Representation: Freight Distance Bands
In this case only distance would be considered. Distance bands would be limited to two medium/long and long distances.

[16] We refer to the ASTRA model build by the University of Karlsruhe. An in-depth presentation of the ASTRA model is available on line at: http://www.iww.uni-karlsruhe.de/ASTRA/summary.html

[17] See chapters 3 and 4 of Part I.

[18] Both MAC and RET sub-models will be further explained in the following chapters

1.2.1) Leading Trends affecting Deep Sea Shipping

The observations of today's global economies, identified as crucial for the future growth of deep trade that should be reflected within the model and provide for forecasts according to different scenarios are summarized below in table 2.

Table 2: Trends

<table>
<tr><td>Demand depends on income: Higher income corresponds to a higher demand for services</td><td>√</td><td rowspan="4">Demand and Supply</td></tr>
<tr><td>Growth in value of manufacturers imports/
Greatest growth in high value goods</td><td>√</td></tr>
<tr><td>Trade maturity and new trade generation</td><td></td></tr>
<tr><td>Knowledge based economies shift towards services driven demand and supply structures</td><td>√</td></tr>
<tr><td>Increasing sophistication of logistics structures</td><td></td><td rowspan="2">Business strategies</td></tr>
<tr><td>FDI flows as a key force in changing trading patterns</td><td>√</td></tr>
<tr><td>Growing trend towards protectionism in Europe</td><td>√</td><td rowspan="2">Policy</td></tr>
<tr><td>Policies targeting the creation of a European integrated market</td><td>√</td></tr>
</table>

The ones that have been selected are the variables that could relatively easily be quantified and hence included in the sub-models. Nevertheless we consider it important to keep a rather broad view of the existing trends for future applications.

Chapter 2
The four Sub-Models

In this chapter we briefly present the four sub-models separately highlighting the parts where substantial deviations from the actual ASTRA model have been perceived, given the very early stages of our approach.

2.1) The macroeconomic sub-model

The structure of the MAC sub-model would fundamentally be kept the same as described in the ASTRA, applied for the EU 15, EU 12 and China macro zones. However, some modifications would be necessary for capturing the particularities of the targeted study within the further models that build up the MAC sub-model. Some of the essential features would be the following:

1. It would be build on a yearly basis.
2. The core identity would be the real GDP for each macro region.
3. It would be composed by a Demand, a Supply and an Input-Output model.
4. The macro regions to be included in the model would be reduced to three, the EU 15 countries, the EU 12 countries and China.
5. The model would simulate both demand and supply side driven economies, especially since these are crucial elements for the future formation of trade flows considering demand driven economies like the EU15, the currently highly supply driven Chinese economy and the emerging EU 12 economies.

2.1.1) Basic structure

The final output of the MAC model would be the total final demand for goods and services. The Demand and Supply side would be represented by the Keynesian and Potential Output models respectfully.

The analysis that follows intends to very briefly present the basic structure of the Supply and Demand side models focusing on the modifications that are judged as being necessary for the research in question.

2.1.2) Features of the Demand models

The *demand* side would be based on the Keynesian model for each of the re-specified macro regions. However a disaggregation of the demand for goods and services would be necessary in order for the sub model to capture the shift towards service based economies hence the deindustrialisation of the EU 15 and the industrialisation of the EU 12 and China.

The Final Demand would be composed by private consumption (C), investments (I), government expenditure (GE) exports (E) and Imports (I) wherein each should separately account for goods and services for each macro region. The modeling of the final demand components would be modeled as in the ASTRA. Main variations from the ASTRA application in each of the above models so far identified refer to their disaggregation:

- Within the Consumption, Investment, Employment models: where 1)the sectoral split would be limited to Manufacturers and Services and 2) no separation into a transport dependent and a transport independent share.
- The investment model would be disaggregated in Domestic and Foreign Direct Investment (FDI).

Another variation/addition to the Macro imports model would be the internalization of protectionism as explanatory variable. The reason would be that the model should reflect whether the targeted group-economies are closed or open to trade or more importantly whether there is a growing trend towards tariff or non tariff barriers such as quotas or import standards. The reason lies in the uncertain path the European Union would be taking in the future given the conflicts between its policy planners and EU based agriculture and manufacturing industries among others. The quantification could be based on the World Bank's indicators of tariff revenue as a share of import costs or UNCTAD's average import tariff rates.

2.1.3) Features of the Supply model

The *supply* side of the sub-model would according to the ASTRA application also be based on the Cobb Douglas production function that incorporates the three major production factors, labour supply, capital stock and natural resources. However it would be considered necessary to incorporate technical progress since the model would focus on the long term where the latter becomes of prime importance in economic growth. Clearly the sectors to be modeled would only be the manufacturing and services sectors.

2.1.4) Features of the Input-Output model

The aggregated input-output table would provide for a sectoral gross value added comparison on GDP shares for services and manufacturing.

The role of this application of the MAC model would be to drive the economies and hence capture the deindustrialisation process towards service based EU15 economies and industrialisation of the EU12 and Chinese economies. For the latter two it should be able to explain current comparative advantages, the rate of their industrialisation and consequent growth of their economies, while for the latter it should reveal the key role of protectionism for future international trade growth.
Clearly different growth and policy scenarios could provide us with valuable information concerning alternative future growth patterns for deep sea shipping.

2.2) Regional Economic and Trade Sub-Model (RET)

This sub-model would be based on the Regional Economic and Land use Sub-Model (REM). However in this application it would only incorporate the ASTRA REM freight model in the same way as originally designed, hence retaining the split into generation and distribution stages of freight flows, which partially explains why the title has been changed to Regional Economic and Trade Sub-Model (RET). It is also meant to change the approach and focus of the sub model targeting this time the demand for freight from a trade perspective.

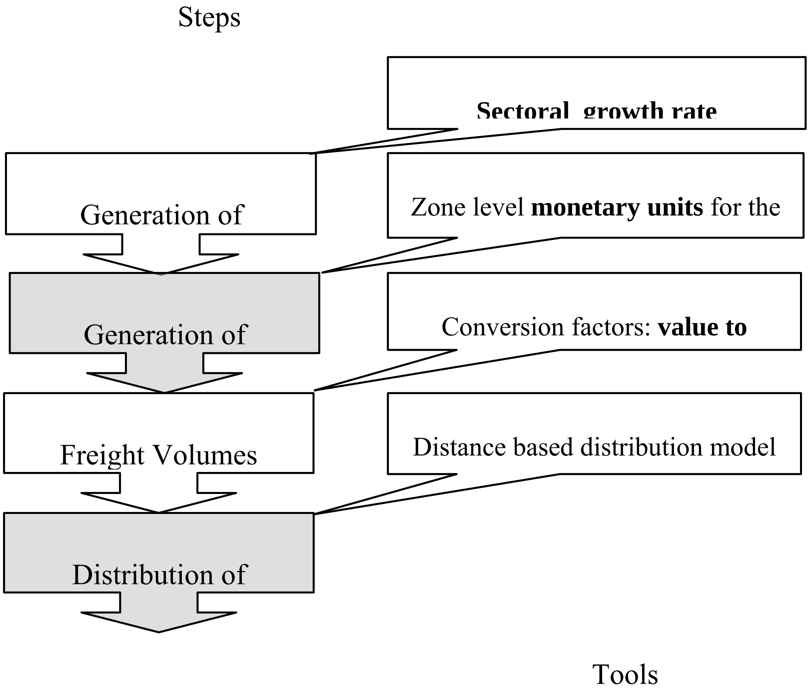
2.2.1) Leading Trends

Although the design would remain the same the mechanisms that generate the demand for freight and consequent changes in the trading patterns in this specialised case of deep sea trade would slightly differ, in the sense of reduced complexity by a reduction of the parameters involved. Hence on the basis of the derived demand hypothesis, the mechanisms driving freight demand depend on the future formation of the following observed trends:

- Increase in ton miles
- Increase in the value of unitised goods
- Reduction in unit cost of transport
- Attempts to expand the European Union common market

2.2.2) The Freight Model in brief

As in the Macro sub-module chapters we do not aim to recapitulate the entire model but provide a brief illustration, highlighting when necessary the adjustments to the research question investigated.
The build up of the freight model could be summarised in the following steps and supporting tools:



The Demand would *generate* at the EU15, EU12 and China levels. The value of production of the manufacturing sector would be obtained from the MAC's total growth in GDP- manufactured goods on which the relative growth rate of the manufacturing sector would be applied. The differential growth rates used should reflect the changing structures of the three economies. The monetary units of the manufacturing production would through the value to volume ratios be converted into tons. They would then be *distributed* across destination zones creating a set of Origin Destination (OD) matrices representing manufacturing freight flows in tons. The distribution would be made according to a distance based model, the Multi Nomial Logit.

However, both distances and Logit model would have to be differently defined. In particular, the distance would be split only in two bands (instead of four):1) medium-long ranging from 150 to 700 kms and 2) long for distances over 700 kms. Concerning the Logit model, the volume of trips for each of the macro zones would be distributed according to generalised cost and the relative attractiveness of that destination. While the later would be defined by the MAC it would be the component of generalised cost derived from the TRA model that would vary in this application since the TRA would have to be differently built[19].

For last the aggregation of the ASTRA model would not apply in our case since only one sector would be modeled in the freight model. However it might be useful to split the manufacturing sector into low and high value unitised goods.

The role of this application of the REM model would be to link the differential growths of the economies to their demand for manufacturing freight flows. Given the zoning selection and the build up of alternative scenarios derived from the MAC the future of several OD matrices would define the future for deep sea shipping.

2.3) Transport sub-model (TRA)

The Transport sub-model of this application would once more follow the guiding principles set by the ASTRA, but it would be even further simplified. It would simulate the modal split of only the freight travel demand as generated and distributed in the RET and transferred to the TRA according to distance bands. As also mentioned previously it would provide the generalized costs of the different macro zones.

2.3.1) TRA Framework

In this chapter we highlight the main features of the TRA with an emphasis to those that differ from the original ASTRA application.
Firstly, *sectors* would be: 1) modeled according to distance bands and 2) reduced in number to two: the medium distance and long distance
Secondly, *freight categories* for each distance would be: 1) categorized in low value unitized manufacturers, and high value unitized manufacturers and 2) analysed separately resulting in a different modal split.
Thirdly, *transport modes* would be limited to two, shipping in particular Deep Sea Shipping (DSS) and road, rail, short sea shipping and inland waterways all aggregated in one group.

2.3.2) The modal choice model in Brief

The modal choice would be based on a multinomial logit model. The utility function would be composed of the generalized cost associated to each mode/mode group and a modal constant. The generalised cost for freight transport would include direct costs like haulage, loading/unloading and other handling charges as well as other indirect logistic costs.

[19] See chapter 3.4, Transport sub-model p.

The role of the Transport sub model would be limited to the extent that it would become of importance only when generalized costs associated to each mode/mode group change substantially and ultimately influence the RET sub model. Factors that could potentially influence generalized cost in the future could be:
-changing corporate strategic behaviour e.g. replenishment strategies
-final agreement on liner conferences and its consequences on the market
-the growing importance of environmental costs resulting from huge concerns over the ever growing transport related CO_2 emissions.
All above could constitute scenarios to be run by different simulation exercises as soon as the model would be build.

2.4) The Environmental sub-model (ENV)

The objective of the environmental sub model applied in this approach would be on the calculation of the environmental burden as expressed by the fuel prices and taxes model of the ASTRA. In that sense it aims at capturing the trend towards the reduction of greenhouse emissions emitted by transport in particular ship/port emissions, especially as a consequence of increasing EU policy making.

The output from the ENV would rely on the first approach not yet implemented in the ASTRA, the adjustment of levels of policy measures. These measures would concern 1) imposition of fuel taxes, 2) pure fuel prices and 3) VAT. The goal would be to observe the effect increased environmentally based costs would have on the TRA, RET and MAC and observe how the amalgamation of those effects ultimately influence the demand for DSS.

The realization by the majority of the main player's, policy makers, industries and society that business as usual is no longer sustainable has probably been the biggest breakthrough of recent years. The efficiency of policies, the enforcement of regulation, the setting of international standards and the level of cooperation by the industries (transport and non transport) inevitably influence the transport sector directly or indirectly. A rather exaggerated view may even suggest that transport will become a luxury. Nevertheless the cost of climate change will be negatively felt by transport.

Chapter 3
Sub-models interaction

The chapters below present the links between the sub-models. The critical importance of the MAC model is evident while the RET, TRA and ENV would provide for the interpretation of macro effects on transport volumes and in particular deep sea trade.

3.1) MAC flows

The flows one to five below relate to MAC outflows to the RET and flow 6 to the TRA. Note that GDP output and main indicators would be split into the goods and services sectors. (p.20)

1. GDP information by macro zones
2. GDP goods from the Input-Output table to the RET to drive the freight generation model
3. Industrial output
4. Investment by macro zone
5. Personal disposable income by macro zone
6. annual GDP growth rates to the TRA

3.2) RET TRA flows

The RET provides for the freight demand O-D matrices by freight category and distance band to the TRA and vise versa the TRA provides for the generalised costs matrices by category for freight and by distance band to the RET.

3.3) ENV flows

Transport tax inputs from the ENV to the MAC and TRA.

CONCLUSIONS

The fundamental realization of this paper would be that the mechanisms of common human behaviour cannot easily be decoded despite their ostensible simplicity.

In this paper we have raised more questions rather than providing answers. What we have presented, is work in progress and consequent experimentation with some of the available research tools. Particularly, current and future indicators of growth and development contributing to the future development of seaborne trade between the EU and China have been identified, quantified and run into simple models. These two models signify the first step in modeling the research question where it was confirmed, that they cannot capture the intended long term goal in making dynamic forecasts that account for structural change.

The main conclusion reached is that the best way to incorporate change in our model could be through scenarios. By building a holistic system of seaborne trade we could incorporate change in a variety of ways and draw conclusions under the different circumstances. Although quite complex which might compromise the final quality of the results we believe that such applications should clearly illustrate future growth trends while overcome most technical difficulties by the use of appropriate simulation software.

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