How Further Trade Liberalization would Change Greenhouse Gas Emissions from International Freight Transport

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Executive Summary

This paper provides an estimate of the change in greenhouse gas emissions associated with a complete liberalization of the world trade system, with a primary focus on the international transportation channel. It is clear that trade liberalization leads inevitably to more trade and greater demand for international transport. How this affects greenhouse gas emissions depends on which products and country pairs see the most growth, and the intensity with which these products use fuel-intensive airplanes relative to other modes.

The exercise proceeds in four steps. First, I use the GTAP 6 model to simulate the effect of a full trade liberalization; that is, removing all existing import and export tariffs and subsidies. Second, I convert these changes in trade values into units (kg) that are common across all sectors, and can be linked to transportation use. Third, I use extensive data on how traded goods move between countries to convert growth in the weight-distance profile of trade into growth in modal usage. Fourth, I draw on estimates in the literature on greenhouse gas emissions associated with various transportation modes to calculate how trade growth in each mode will combine to yield aggregate changes in emissions.

The primary findings are these. Full trade liberalization leads to modest 5.8 percent growth in trade by value. This growth is concentrated in those products (agriculture, textiles and wearing apparel) that are subject to the highest rates of protection. More importantly, liberalization eliminates tariff preferences enjoyed primarily by nearby trading partners (as in NAFTA and the EU). This results in a shift in trade away from proximate partners and toward distant partners, especially those who cannot be reached by land transport. Growth in trade measured in kilogram-km terms is twice as great as growth in trade by value. In terms of modal use, this leads to significant contraction in the world-wide use of road and rail transport and an expansion in air and ocean transport.

Combining this information with emissions data by mode, I calculate that CO2 emissions associated with international transportation would rise by as much as 10 percent, with emissions associated with air cargo responsible for more than half the transportation related total. In contrast, production related emissions see no growth as a result of trade liberalization.

I. Introduction

The purpose of this paper is to provide an estimate of the change in greenhouse gas emissions associated with a complete liberalization of the world trade system, with a primary focus on the international transportation channel. Since traded goods must be transported between trading partners, a full liberalization, and the associated growth in trade, will result in greater demand for international transport. This much is obvious. What is unclear is the extent and composition of the change.

International trade makes use of a large variety of transportation modes (ships of all sizes and types, planes, trucks, rail, pipelines) with widely varying greenhouse gas emissions per quantity shipped. These modes are chosen by trading firms based on product characteristics (weight, value, fragility, spoilage, the need for timeliness in delivery) and geographic characteristics (land adjacency, distance to markets, existence of and access to infrastructure). As a consequence, the composition of trade has a first-order impact on the types of transportation employed and the associated greenhouse gas emissions. Put another way, a million euro value of exports shipped on rail from France to Germany may have a dramatically different emissions component than a million euro value of exports shipped on airplanes from China to Germany.

This is especially relevant because trade liberalization is likely to lead not only to growth in the quantity of trade but in changes in its product and country-pair composition. The reason is that the structure of protection is not uniform. Certain products such as agriculture, textiles and wearing apparel are subject to much higher tariff rates than are products like oil or pharmaceuticals. And the bilateral structure of protection is also skewed in a particular way, with preferential tariffs most typically offered to local trading partners. This means that liberalization may result in especially large growth in trade in product categories and between (distant) country pairs where high tariff rates previously prevailed.

The exercise in this paper proceeds in four steps. First, I use a 40 country 29 sector aggregation of the GTAP model to simulate the effect of a full trade liberalization; that is, removing all existing import and export tariffs and subsidies. The simulation generates predicted growth in output for each country x sector, and bilateral trade flows for each of 1600 country pairs in each sector. Second, I convert these changes in trade values into units (kg) that are common across all sectors. This is necessary because one million euro of coal is vastly heavier than a million euro of microchips, with important implications for the associated transportation usage. Third, I use extensive data on how traded goods move between countries to convert growth in the weight-distance profile of trade into growth in modal usage. (Not only is the one million euro of coal much heavier than the one million euro of microchips, but it uses an entirely different transportation mode. And coal moved within Europe uses a different mode of transport than coal moved from South America to Europe). Fourth, I draw on estimates in the literature on greenhouse gas emissions associated with various transportation modes to calculate how trade growth in each mode will combine to yield aggregate changes in emissions. These compositional shifts could be quite pronounced – growth in trade that primarily employs airplanes will yield far greater growth in greenhouse gas emissions than growth in trade that primarily employees 5000 TEU containerships.

This is, to my knowledge, the first paper to attempt such a calculation. It requires a fairly daunting integration of data from four distinct and not entirely compatible sources: a CGE simulation, data on the weight/value of traded goods, data on transportation usage for each country pair and commodity, and data on emissions associated with transport. Accordingly, I will attempt to be extremely clear throughout the paper regarding the limitations of the approach and assumptions necessary to make the calculations work. Some of these are highly specific bits of minutiae, but a few are important to highlight at the outset.

First, the simulation generates trade growth associated with ceteris paribus trade liberalization in a base year. It is not a forecast of likely trade growth that would result from a combination of liberalization, growth in population, or income per capita. To see the difference, trade liberalization has likely played a small positive role in the remarkable growth in China's trade, but its effect is swamped by other market reforms, technological change and capital deepening. This approach is in contrast to many studies of future transportation demand which rely on straight line extrapolation of trade or GDP growth.

Second, the data on product weight/value and transportation modes is incomplete. I have explicit data from European, North American and Latin America sources that cover roughly two-thirds of world trade by value. The remaining data is either estimated or imputed (details in section two). In most cases I have a reasonably high confidence in the estimates. For example, one can use the available data to calculate an average weight/value that is specific to each exporter and product and has properties that are plausible and consistent with the literature on unit values in trade.[1] Similarly, one can estimate the split between air and ocean modal choice with a high degree of precision given product and geographic characteristics, and this is sufficient for any country pairs for which land transportation is made infeasible by oceans. However, data on the use of land transportation is sparse or non-existent for much of Asia and Africa, and here somewhat heroic imputation must be employed. I take comfort that this is a vanishingly small fraction of the overall sample, but results on within-Asia and within-Africa land trade should be taken with a full shaker of salt.

Third, and related, there is no way to cleanly separate international transportation from domestic transportation or to identify a particular flow as only employing a single transportation mode. A shift away from domestic sources of supply and toward international sources could raise or lower domestic transportation use. Consider the North American auto industry. A Detroit automaker who switches from a parts supplier in far off Tennessee to a parts supplier just over the Ambassador Bridge in Windsor Ontario would increase international transportation output while lowering domestic transportation output. However, an automaker that sources parts from Japan increases both international and domestic transportation output, and employs intermodal linkages to get parts from that supplier. Trade liberalization undoubtedly results in a complex set of interactions of this sort that I cannot track.

[1] For example, bulk products have much higher weight/value than manufactures, and within each sector, high income countries produce goods with lower weight/value (higher prices).

Fourth, the exercise deliberately abstracts from important substitution margins. It assumes, for example, that the modal share of air and ocean transport employed to move processed agricultural goods from the US to Asia does not change as a result of the trade liberalization. This assumption allows me to combine vectors of trade growth with vectors of modal usage to generate changes in modal usage without fully modeling the process of modal choice. This approach is consistent with a view that transportation is subject to constant returns to scale in production and that the liberalization episode does not affect input costs differentially across modes. Similarly, the exercise takes the existing composition of the transportation fleet and its associated greenhouse gas emissions as given and unchanged by the liberalization exercise (other than switching between broad modal categories). The key point in both instances is that I do not model how changes in fuel prices, spurred either by rising demand for fuel or changes in carbon/fuel taxes, affect mode-specific prices or demand. Put another way, the exercise focuses entirely on how trade affects the fuel use and greenhouse gas emissions of international transport while ignoring any feedback effects from international transport's fuel use and emissions to trade.[2]

The paper proceeds as follows. Section two describes the four main data components for the exercise, and provides calculations of trade growth by value, weight, weight-distance, and transportation usage. Section three draws these together along with data on emissions by mode to generate predicted emissions growth. Section four concludes.

II. Data Components

In this section I describe the four main data components necessary for the exercise. These components are: the GTAP trade liberalization exercise, with associated changes in output and trade volumes; data on the weight/value ratio for each bilateral pair and product; data on transportation mode for each bilateral pair and product; and data on the emission intensity of each transportation mode.

A. The GTAP Trade Liberalization Exercise

The starting point of the paper is to estimate the changes in output and trade volumes associated with a full liberalization of trade, that is, reducing all import tariffs, export tariffs, and subsidies to zero. This requires the use of a computable general equilibrium (CGE) model of trade. I employ version 6 of the GTAP model. A highly detailed description of this model can be found in Hertel and Tsigas (1997), I will briefly summarize key characteristics here.

At its maximum disaggregation, GTAP 6 allows one to model production and trade for 57 traded and non-traded sectors between 87 regions. Within each sector firms are constant returns to scale with a production structure that is Leontief in factor inputs (labor, capital, and land) and intermediate inputs. Substitution between factor inputs is governed by a CES structure, as is substitution between

[2] One can imagine a different, and far more ambitious, exercise that would attempt to assess how carbon taxation would affect fuel prices and therefore modal choice, and how that would feedback into changes in trade patterns. That would be a fascinating study, but not it is not this study.

intermediate inputs that are Armington differentiated by origin. On the consumption side, households have Cobb-Douglas preferences over consumption, government spending and saving. Demands over consumption goods employ a CDE (constant difference of elasticities) form, and households regard the output of each source country as Armington differentiated.

For those readers unfamiliar with CGE models, the assumption of Armington differentiation is the key feature of this model from the standpoint of evaluating a trade liberalization exercise. Each household and firm wants to buy the output offered by every producer of a good, in (log-linear) proportion to their prices. A trade liberalization exercise works by changing these relative prices, shifting import demands toward those goods and source countries which have become less expensive after liberalization occurs.

In general it is not computationally feasible to run trade experiments with the full 87 country x 57 sector version of GTAP 6. However, the model allows for flexible aggregation across regions and sectors in order to examine certain especially interesting subsets of the whole dataset. For current purposes, I employ a 40 region, 27 sector version of the model, the detailed listing of which is reported in Appendix Tables 1 and 2. Of course, any aggregation obscures potentially important differences across countries and sectors. This particular aggregation scheme was chosen to serve two purposes. One, countries and sectors with "similar" transportation characteristics are aggregated together. For example, all bulk agriculture, which relies heavily on international ocean transport, is aggregated into one category while processed agriculture, which is more likely to employ air transport, is aggregated into a second category. Two, the aggregation scheme allows more disaggregation for regions for which I have weight/value and transportation mode data, and less disaggregation for regions and sectors where these data are lacking. This allows me to minimize the amount of imputation that must be employed to complete the database.

Tariffs Levels and Trade Growth

A quick summary of the features of the underlying tariff and trade data can be found in Table 1 (organized by sectors) and Tables 2a (by exporter) and Table 2b (by importer). The first column in Table 1 reports the (trade-weighted) average tariff impeding world trade in that sector. The corresponding column in Table 2a reports the (trade-weighted) average tariff facing each exporter and that column in Table 2b reports the (trade-weighted) average tariff imposed by each importer.

Three things are noteworthy. First, there are large differences across sectors in the rates of protection they face, with agriculture, textiles, and wearing apparel facing especially high tariffs. Similarly, average levels of protection are much higher in Asia, Latin America and Africa than they are in Europe and North America.

Second, trade-weighted tariffs are very low, just over 3 percent world-wide. This is somewhat misleading, as trade flows will be low when tariffs are high, providing very small weights on higher tariffs when calculating the average. In contrast, the simple average tariff, which weights all flows equally, is 5.5 percent. In these data, there are 36,800 possible trade flows (40 importers x 40 exporters x 23 traded goods sectors). Of these, there is no tariff imposed on 14441 flows, just under 40 percent of the total. Considering the remaining flows, the simple average tariff is 8.98 percent. This suggests a considerable scope for trade liberalization.

Third, tariff rates are not set uniformly across trading partners and significant preferences are given to partners within trading blocs such as the EU and NAFTA. Because trading blocs tend to be geographically concentrated, tariffs tend to be much lower for more proximate partners and especially for land-adjacent partners. This can be shown using a simple regression of tariffs on (log) distance between partners. Let o denote origin (exporting) country, d denote destination (importing) country, g denote GTAP sector, and incorporating an importer-product fixed effect, a_{dg}, I find

$$TARIFF_{odg} = .88 + .022 \ln DIST_{od} + a_{dg}$$

That is, controlling for the average level of tariffs set by an importer in a sector, doubling distance increases the tariff rate by 2.2 percentage points. Similarly, using a dummy variable for land adjacent partners

$$TARIFF_{odg} = 1.055 - .045 BORDER_{od} + a_{dg}$$

This says that the average tariff for non-adjacent partners is 5.5 percent, while the tariff for adjacent partners is less than 1 percent.

This is an important phenomenon from a transportation perspective because land-adjacent and otherwise proximate countries trade very differently from more distant partners. As I detail below, rail and road transport dominate international trade between land-adjacent countries. And the choice of air versus ocean transport depends critically on the distance between (non-land-adjacent) countries. Since preferential tariff rates currently favor proximate partners, reducing these rates to a uniform zero should tend to create more trade at a distance.

The second column of Table 1 shows the initial share of each sector in world trade, while the third column shows the percentage growth in trade in that category as a result of the liberalization exercise. The corresponding columns for Table 2a, 2b show the same information organized by exporter and importer. Several things are noteworthy.

First, trade growth is concentrated in a few sectors: agriculture, textiles, wearing apparel, leather products, mineral products and manufacturers nec. Similarly, export growth is concentrated in Asia, Latin America and Africa. Second, this growth is closely related to the initial tariff levels. The higher is the initial tariff the greater the growth in trade. Third, not all countries experience trade growth and some, notably in Europe, actually see a reduction in trade volumes. This is the result of ending tariff preferences that had given these countries preferential access to local import markets.

B. The Weight of Trade

With most trade-focused liberalization experiments, output and trade are expressed in value terms. However, to calculate the effects on transportation demand, fuel usage and emissions, it is necessary to convert these values into a physical unit of measurement that is consistent across countries and products and meaningful from a transportation perspective. The most feasible conversion is to express trade in terms of kilograms shipped (or in kilograms-kilometers shipped). This is not a perfect measure, as it neglects transportation relevant issues such as bulk, the need for special packaging or refrigeration. But it is the best universal measure that can be employed.

To calculate the weight of trade, I collect data on trade expressed both in value and in kilogram terms. This allows me to construct a weight/value ratios for each exporter and product. Multiplying the value measures by the relevant weight/value ratio yields the weight of trade for that flow.

More specifically, I draw on three primary data sources.

1. US Imports and Exports of Merchandise. These data contain US imports and exports with every partner country worldwide at the 10 digit level of the Harmonized system. They include information on whether trade took place via airplane, ocean-going vessel, or overland, with separate values and weights for each mode. The data are available on DVD's from the US Bureau of the Census.

2. Eurostats data. These data include information on the imports and exports of the 27 EU countries with each other and the rest of the world, by value and by weight in kilograms. For trade outside the EU data are reported at the HS6 level, disaggregated by transportation mode. These data are available for download from Eurostats, at:

> http://europa.eu/estatref/download/everybody/comext/MOST_RECENT_COMEXT_DATA/transport_HS/

Data on intra-EU trade by transport mode are reported at the 3 digit level of the NSTR and were compile on special request by statisticians at Eurostats.

3. ALADI trade data. These data include the imports of 11 Latin American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay and Venezuela) from all exporters worldwide, at the HS 6 level, disaggregated by mode of transport and containing data on traded product value and weight in kilograms.

The bilateral pair coverage represented by these three datasets is displayed in Appendix Table 3. Because the US and European data include both imports and exports all countries worldwide are represented extensively in the data. Altogether approximately two-thirds of world trade by value is covered.

In each instance it is necessary to concord the data to the 23 traded sectors used by the GTAP model. This means that for each importer and exporter there may be several hundred HS codes corresponding to a single GTAP sector such as "electronic equipment". To arrive at a weight/value ratio for each exporter and product, I separately sum the weight of trade and the value of trade and express them as a ratio. This is equivalent to a share-weighted average of the weight/value ratio for each product traded by that exporter. More formally, let k represent an HS6 product contained in GTAP sector g, traded between origin o and destination d. To get the weight/value ratio for each origin and GTAP sector

$$WV_{og} = \frac{\sum_d \sum_{k \in g} WGT_{odk}}{\sum_d \sum_{k \in g} VAL_{odk}} = \sum_d \sum_{k \in g} \frac{WGT_{odk}}{VAL_{odk}} s_{odk}$$

where s_{odk} is the share of observation o,d,k in trade for origin o and GTAP sector g.

In principle, it would be possible to have separate weight/value ratios for each exporter-importer-sector (o-d-g) triplet. However, I choose to use the more aggregated exporter-sector approach for four reasons. One, it is reasonable to expect that two countries producing the same product may have different weight/value ratios because they are producing different qualities or varieties of the good. For example, the literature on unit values in trade shows a strong correlation between level of development and product prices, with richer countries producing higher priced (lower weight/value) goods. (This strong correlation is also found in my constructed data) But presumably there is more similarity in the weight/value ratio for the same country and good when those goods are shipped to different destinations. Two, because I do not have weight of imports data for all countries in the 40 country GTAP aggregation, it would be necessary to rely on exporter-product averages for the countries not explicitly represented. Three, trade by weight is not measured as carefully as trade by value. Duties are generally applied to values rather than weights, so a careful accounting of weight fields in trade declaration forms may be lacking. In the European data in particular, no weight data at all are reported in roughly 20 percent of observations. (These cases are excluded from the construction of the aggregated variable.) Relying on more aggregated observations smoothes out these measurement errors. Four, because each GTAP sector is an aggregation of many HS codes, the composition of trade within the GTAP sector can have a very large effect on measured weight/value ratio. Put another way, if the shares s_{odk} in the above equation vary across destinations, then the weight/value calculated can vary substantially.

The fourth column of Table 1 reports the weight/value ratio measured in kilograms per dollar of trade by sector (and the corresponding columns in Tables 2a, 2b report the weight/value of aggregate trade for each exporter and importer). The ratios vary significantly and plausibly across sectors, with bulk agriculture, forestry, minerals, oil, and petroleum and coal products the heaviest. The heaviest GTAP sector (minerals) has a weight/value ratio 260 times greater than the lightest (wearing apparel). Similarly, the ratios vary substantially across exporters with commodity suppliers (Russia, Australia, Latin America and Africa) having much heavier trade than exporters of lightweight electronics and pharmaceuticals (Japan and Ireland).

The weight/value ratios allow me to calculate the weight of trade and the growth of trade by weight. This appears in the next two columns of Tables 1, 2a, 2b. Curiously the growth of trade by weight (6.8 percent worldwide) is similar to the growth of trade by value (5.8 percent). The reason is that there are rapidly growing trade sectors at both the heavy (bulk agriculture) and light (wearing apparel, textile) end of the weight continuum.

Finally, it is common to express the quantity of transport services in terms of the product of weight shipped and distance traveled. The last column on Tables 1, 2a,2b calculates growth in the weight-distance (kilogram-kilometers) profile of trade. Here we find something very interesting. Kilogram-kilometers traded grow twice as fast as either the value or weight of trade, with extremely large growth in agriculture and double-digit growth in 9 other sectors. Recall that tariff preferences are biased toward proximate trading partners. Elimination of all tariffs lowers the relative price of goods offered by distant trading partners and causes concentrated growth in trade at a distance. This pronounced compositional shift, and the attendant consequences for transportation demand and fuel use, is the primary finding of the liberalization experiment.

C. Modal Usage in the Base Year

For every kg shipped, planes use more fuel and generate more greenhouse gases than trucks, which use more fuel and emit more than large containerships. Knowing the intensity with which trading countries employ planes, trains, and automobiles, and how modal use will shift as the composition of trade changes is critical for calculating emissions changes.

The data for this exercise come from the same three sources as the weight/value data described above. Each of those datasets contains information on the weight and value of trade by origin-destination-product , with product measured at the HS6 level for US, ALADI and EU trade with non-EU partners, and at the NSTR 3 digit level for intra-EU trade. To construct modal value shares, I sum product value over all product codes traded between o-d that fall under each GTAP sector grouping and express that sum as a share of total traded value between o-d. Modal weight shares are constructed similarly by summing weights. Modal weight-distance shares take this value and multiply by the distance between o-d.

Several challenges remain. First, as noted above, the weight field is missing for roughly 20 percent of EU observations, though these tend to be relatively small value flows. These weight=0 observations are excluded from the summations of both weight and value so they will not bias the results unless there is a systematic relationship between being excluded and the employment of a particular transport mode. If there is a systematic relationship, this will tend to understate both the value share and the weight share of that mode by small amounts.

Second, unlike the EU and ALADI data, the US data on overland trade do not provide further disaggregation into rail and road modes. To provide this split we employ data on US imports and exports within North America taken from the Transborder Surface Freight Data. These data have rail v. road splits, but are more aggregated at the HS2 level. We take each land-based trade flow from the more disaggregated HS 10 data and divide it using the splits found in the corresponding HS 2 data. We then aggregate to the broader GTAP 27 data.

Third, because modal usage is central to this exercise it is necessary to estimate modal shares for the roughly one-third of world trade where no direct information on modal use is available. I employ the following procedure.

1. Estimate the share of trade that moves by land.

a. If an o-d country pair is not on the same continent, or a destination could not reasonably be reached by land transport, rail and road shares are set to zero. (That is, Japan is part of Asia, but lacks a land bridge so its rail and road shares are zero.)
b. For European country pairs not covered explicitly by the EU data, I estimate a modal share model with first the rail share of trade and then the road share as a dependent variable. Regressors include fixed effects for origin, destination, and GTAP sector, the distance between countries, a dummy for land-adjacency, and the weight/value ratio of the exporter-sector. The sample employed is the EU data for which I do have modal information – recall that all the EU 27 countries report their imports from all European countries and their exports to all European countries. I then use out of sample prediction to generate modal splits for the remaining countries. This allows me to estimate, for example, the share of rail in Russian exports of coal by calculating its conditional average share of rail to the EU27 countries (the origin fixed effect), the weight/value of Russian coal, and the distance to each market).
c. This leaves intra-continental trade within Africa and land-adjacent Asian countries, roughly 1.8 percent of world trade by value. For Asia I use calculations by Prabir De (2007) that report the modal shares of Indian trade with its land-adjacent neighbors, summed over all products and partners. These shares do not vary over sectors. For intra-African trade (a vanishingly small share of world trade) I could find no data on modal shares and so imposed road shares of 75 percent and rail shares of 0.

2. Calculate the share of trade that moves via ocean or air as the residual of 1 – rail share – road share.
3. Split the (air+ocean) share by estimating a model where the dependent variable is the ratio of air/ocean and the regressors include the weight/value ratio of the exporter-product, distance between markets, whether they are land-adjacent and vectors of fixed effects by origin, destination, and GTAP sector. These origin and destination fixed effects capture all market characteristics such as level of development, and quality and composition of infrastructure that strongly affect this modal split. The product fixed effects absorb issues such as bulk, spoilage, the need for special packing, and timely delivery. Again, the estimation sample includes the EU, US, and ALADI data for which I have explicit modal share data and I use out of sample prediction to generate modal splits for the remaining countries. The high R2 in these regressions (.75) suggests that the model does a good job of identifying share variation.

The results of the various explicit data collection, estimation and some minor imputation generates a full matrix of modal shares for each origin-destination-GTAP sector both by weight and by value. Table 3 reports the trade-weighted average of modal shares for each GTAP sector. Several things are noteworthy.

One, because these are an aggregation of modal use over all o-d pairs I can also calculate the difference between the weight of trade and the weight-distance profile of trade. For example, road transport constitutes a large share of weight moved in trade, but it is concentrated in the trade of proximate partners. As a result, road transport represents a very small share of kilogram-kilometers shipped.

Two, a similar composition issue explains the difference in air shares when calculated on a value vs. a weight basis. High weight/value goods move by sea and low weight/value goods move by air. Air shares by value are then quite substantial for fishing and for many manufacturing products, amounting to 20 percent of world trade by value. But on a per weight basis air shipping is less prominent, amounting to only 2.3 percent of world trade by weight.

Tables 4a, 4b describe modal shares by exporter and importer, aggregating over all sectors. There are dramatic differences across countries, primarily as a function of what they ship and whether their major trading partners can be accessed by rail or road. Europe as a whole has very high shares of rail and road transport, except for countries like the UK, Ireland, and Finland. Most of Asia has very small shares of land transport because the largest trading partners are separated by (short) stretches of ocean. South America, for which land transport is actually an option has rather low land transport shares, probably because economic activity is concentrated on coasts rather than in the interiors close to land borders.

D. Growth in Modal Use

I now combine the information on base year modal use for each origin-destination-GTAP sector (o-d-g) with growth in trade for each o-d-g to calculate growth in modal usage. The nature of this calculation works entirely through compositional change rather than changes in modal use within an o-d-g. That is, the share of wearing apparel that the US imports by air from China remains the same throughout the exercise. All that changes is the relative importance of Chinese wearing apparel in US imports (or from a sector perspective, the importance of US-China trade out of all trade in wearing apparel).

This approach rules out the possibility that the trade liberalization affects modal choice decisions at the micro level. This is sensible if liberalization does not change the composition of goods within a broad sector (e.g. raising the share of fresh produce that must be air shipped in the total of agriculture), and if liberalization has no effect on the relative price and desirability of various transport modes. Consider a few cases that would violate this assumption. Trade liberalization could result in economies or diseconomies of scale in transport, re-route transportation networks, and alter the price of oil. As trade grows, diseconomies of scale are evident as ports become congested and slow, raising the desirability of modes that can avoid the congestion. But important economies of scale may also be evident. More ships can operate on routes, thereby offering greater service frequency or more direct routing between origin-destination pairs. There may also be pro-competitive effects on prices, as routes large enough to support multiple carriers will tend to see lower prices than those on which a single carrier dominates. Perhaps most relevant to this study, changes in the price of oil would alter the relative price of fuel-intensive modes such as airplanes and trucks. (This affect can be seen very clearly in the modal data from 2002-2008. As fuel prices rise, the relative price of air cargo rose and the share of air shipment in trade fell significantly. See Hummels 2009) And of course, this suggests an important scope for fuel-saving technological progress in transportation that would in turn feed back again onto oil prices…

While all of these feedback loops would be fascinating to explore in depth they are beyond the scope of this paper. I proceed by assuming that modal shares within each o-d-g are fixed and that liberalization affects modal demand entirely via composition. This, it turns out, is more than enough to generate significant shifts in modal use.

Table 5 reports percentage growth rates in modal use by value, weight, and weight-distance, for each GTAP sector. These are not modal shares, but overall use of that mode, so that a growing sector could see increased modal use across the board. For example, trade in bulk agriculture is predicted (in Table 1) to grow by 33.7 percent (by value), 38.7 percent (by weight) and 70 percent (by weight-distance). Table 5 shows how the use of each mode will grow in the service of internationally transporting bulk agriculture. Sea use grows the most (kg-km shipped rising by 71.8 percent), followed by air, road, then road. In other sectors such as textiles, there are pronounced differences in mode growth, with kg-km shipped growing substantially for sea (37.8 percent) and air (20.7 percent), but shrinking significantly for rail (-24.4 percent) and road (-38.2). In the aggregate, sea and air usage rises by double digit , road usage falls and rail usage rises slightly.

They key reason for these changes is a major shift in the trading partner composition of trade. As highlighted above, trade liberalization will eliminate preferential tariff rates offered to proximate trading bloc partners and lower the relative price of goods sold by distant exporters. Since distant exporters cannot be reached by land transport, road usage falls and sea and air usage grows substantially. This same story plays out in Tables 6a, 6b which show growth in modal usage by exporter and importer. Declines in road use are concentrated in those countries for which land transport is an option and for which the tariff advantage of regional trading blocs would be eliminated.

III. Changes in International Transport Emissions

The final portion of this study consists of translating the growth in modal use into changes in emissions. Here, compositional change again plays a substantial role. Since fuel use per kg-km shipped varies widely across the modes, changes in modal use have the potential to significantly alter fuel use and emissions in the aggregate.

A key input into this calculation is the emission of CO2 by transport mode. While there are many studies that provide information on total CO2 production, my calculations require data on CO2 per weight-distance shipped. This is necessary in order to see how changes in the weight of trade by commodity, and the distance of trade by country pair affect fuel use and emissions.

I draw on data from several studies. First, the most recent and comprehensive study for maritime transport comes from "Ship Emissions Study", National Technical University of Athens Laboratory for Maritime Transport (2008). It reports emissions in grams of CO2 per tonne-km shipped for many distinct ship types, as well as variability across vessels of different sizes within each type. In Table 11, I reproduce the fleet averages for each broad ship type I use.[3] . The University of Athens research is the

[3] In general, CO2 emissions per tonne-km shipped are much lower for larger vessels within each type. For example, post-Panamax (> 4400 TEU) containerships produce 1/3 the emissions of a less than 500 TEU feeder ship. Because I have no data on the ship size composition of flows, I employ fleet averages for each fleet type. The

only study, to my knowledge, that produces detailed breakdowns of CO_2 per tonne-km shipped by ship type. Several other studies (Kristensen 2006, Giannouli and Mellios, 2005) provide data that is specific to containerized cargo, and they arrive at similar numbers for the container fleet.

To apply these maritime emissions to my data, I split the GTAP sector commodities into ship type as follows.

Ship Type	GTAP Sectors
Bulk	Bulk agriculture, forestry, minerals, coal products
Container	Processed agriculture, fishing, textiles, wearing apparel, leather products, wood products, paper products and publishing, ferrous metals, metals nec, metal products, motor vehicles and parts, transport equipment nec, electronic equipment, machinery and equipment, manufactures nec
Oil Tanker	Oil
LNG	Gas
LPG	Petroleum
Chemical	Chemical products

For rail and road transport I rely on estimates from Giannouli and Mellios, European environmental agency, 2005. Note that these estimates are for transport within the EU, and so presumably rely on relatively efficient rail and truck transport.

There are few detailed studies of emissions associated with air cargo and these arrive at widely varying estimates of emissions per tonne-km. A Maersk 2007 pamphlet cited in the University of Athens study reports that a Boeing 747-400 emits 552 grams of CO_2 per tonne-km shipped. A California Climate Change pamphlet for 2006 reports emissions per tonne-km shipped ranging from 476-1020 grams of CO_2. Finally, 2007 data from the Air Transport Association of America shows that US cargo airlines used 163.6 gallons of jet fuel per thousand ton-miles shipped. Converting gallons of jet fuel into grams of CO_2 and cargos into tonne-km, I calculate carbon emissions of 963.45 grams of CO_2 per tonne-km.

I also attempted to construct an independent estimate of CO_2 emissions associated with air cargo using data taken from Aircraft Economics, 1999. "Freighter Cost Comparisons". This source provides data for 14 major cargo plane types on total fuel use, revenue ton-miles flown, and share in the fleet. CO_2 emissions per tonne-km flown ranged from 493 to 1834, depending on the plane type and how it was used (i.e. for short v. long haul cargo carriage). Notably, my calculation for the Boeing 747 is 700 grams of CO_2 per tonne-km which is close to the Maersk study. Taking a weighted average of these emission numbers over the fleet shares reported, I arrive at an average emissions of 972 grams. This study relies on older data. Updating the fleet composition using 2008 shares (from ATA) I arrive at average emissions of 912.1 grams. The wide range suggested by these numbers is likely due to fleet composition -- as with maritime data, calculations of fuel use and emissions are sensitive to vessel size and use. In

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study also provides data for highly specialized ship types such as Reefers and Ro-Ros. I do not employ this data as my broader trade aggregates contain a mix of goods that would employ these specialized types as a small subset of goods that generally employ container vessels.

the calculations that follow I employ 552 as a "LOW" emissions scenario for air, and 950 as a "HIGH" emissions scenario.

To calculate emissions changes in global trade I combine the data on emissions per tonnes-km by transport mode with the data on trade measured in kg-km (converted into tonnes-km) for each origin-destination-GTAP sector. This results in emissions associated with each o-d-g flow both in the aggregate and by mode.

Table 7 aggregates emissions over all o-d pairs for a given GTAP sector g. It reports the share of each mode in total emissions after the liberalization scenario under the "LOW" and "HIGH" scenarios for air cargo, as well as growth in aggregate emissions. Total emissions associated with international transport are predicted to growth from 9.4 (LOW) to 10.2 percent (HIGH) as a result of trade liberalization. Air cargo is responsible for between 49 and 62 percent of total emissions after liberalization.

The breakouts by sector are also instructive. Recall from Table 1 that bulk agriculture was predicted to increase its kg-km by 70 percent, while Table 7 suggests the emissions growth could be as low as 45.8 percent. The reason is the heavy reliance on bulk cargo carriers, which are the least CO_2 intensive of all included modes. In contrast, emissions growth for trade in wearing apparel is large (56 percent) and in proportion to growth in kg-km traded due to its reliance on air cargo.

Examining the cuts by exporter and importer in Tables 8a, 8b, we see marked differences across countries. For some countries that rely heavily on air cargo such as the US, UK, Ireland, and East Asia, air cargo emissions represent the lion's share of the total, as much as 88.6 percent of Ireland's international transportation related emissions. While many countries exhibit single-digit change in emissions growth, others such as Argentina and Ireland are predicted to see very rapid growth in CO_2 emissions.

As a final point of contrast, I calculated the predicted change in emissions associated with production changes as a result of liberalization. That is, trade liberalization causes each country to change its pattern of specialization and output, and with it, to change its emissions associated with production. For each origin country and GTAP sector I took the base year level of emissions and multiplied it by the change in output level to get the new emissions level.

Table 9 reports for each sector its share of output and the level of CO_2 and nonCO_2 greenhouse gas emissions in the base year. It then reports changes in output levels and changes in emissions. Table 10 repeats this breakout, but organized by producing country. What is striking about this exercise is production-related CO_2 emissions are actually predicted to decline slightly as a result of trade liberalization. This is somewhat counterintuitive, but can be explained by two factors. First, trade liberalization primarily results in a reorganization of production, and not necessarily growth in the value of production. Second, the liberalization in question does reorient production toward countries with higher emissions intensities, but this effect is very small.

This very simple exercise fixes the level of emissions per dollar of output, and essentially abstracts away from many of the substitution margins that could cause emissions to change. As such it should be viewed as a kind of back of the envelope calculation. Still it is useful to draw a contrast between the drop in emissions associated with production and the rise in emissions associated with trading goods over longer distances.

IV. Conclusions and Implications

In this paper I combined data from four distinct sources to understand how a complete liberalization of international trade would lead to changes in CO_2 emissions. The primary findings are these. Full trade liberalization leads to modest 5.8 percent growth in trade by value. This growth is concentrated in those products (agriculture, textiles and wearing apparel) that are subject to the highest rates of protection. More importantly, liberalization eliminates tariff preferences enjoyed primarily by nearby trading partners (as in NAFTA and the EU). This results in a shift in trade away from proximate partners and toward distant partners, especially those who cannot be reached by land transport. Growth in trade measured in kilogram-km terms is twice as great as growth in trade by value. In terms of modal use, this leads to significant contraction in the world-wide use of road and rail transport and an expansion in air and ocean transport.

Combining this information with emissions data by mode, I calculate that CO_2 emissions associated with international transportation would rise by as much as 10 percent, with emissions associated with air cargo responsible for more than half the transportation related total. In contrast, production related emissions see no growth as a result of trade liberalization.

A reminder of several important caveats is now in order. First, the exercise only considers the effect of trade liberalization, and is not a projection of trade growth that would result from a combination of liberalization and growth in output worldwide. As such it almost certainly understates likely increases in CO_2 emissions associated with international transport. Second, the scenario relies on data for product weight/value and transport mode that is extensive, but not universal. Some imputation and estimation was necessary in the construction of the primary datasets. Domestic transportation use and its complex interactions with international transportation is largely neglected. Three, beyond capturing broad modal use by country pair and product, the treatment of international transport was somewhat simplistic. In particular, in an effort to get world-wide scope and coverage it was necessary to abstract from considerable heterogeneity in emissions across ship and plane types.

Finally, fully modeling the endogenous choice of transportation mode in international trade was beyond the scope of the current study, but could be extremely useful for understanding interactions between trade, transportation and emissions. In particular, it would be interesting to understand how trade liberalization affects relative prices of transport modes through shocks to transport inputs or through the realization of economies or diseconomies of scale. Similarly, the much higher fuel intensity of air cargo, and its associated CO_2 emissions, suggests that climate mitigation policies such as a carbon tax could have pronounced effects on how goods move and the kinds of goods that nations trade.

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Appendix I Country Aggregation: 40 regions are in bold, with constituent countries listed in parentheses

Austria, Belgium (Belgium, Luxembourg**), Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom, Rest of European Union** (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia (EU 10); Bulgaria, Romania)**, Rest of European Countries** (Switzerland, Rest of EFTA (Iceland, Liechtenstein, Norway), **Other CEE and Other CIS** (Albania, Croatia, Turkey, Rest of Europe (Andorra, Bosnia and Herzegovina, Faroe Islands, Gibraltar, Macedonia, Monaco, San Marino, Serbia and Montenegro), Rest of Former Soviet Union (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova (Republic of), Tajikistan, Turkmenistan, Ukraine, Uzbekistan)**, Russia**

Canada, Unites States, Mexico

Japan, Korea, Singapore, Malaysia-Indonesia, China-Hong Hong, Taiwan, East Asia (Democratic People's Republic of Korea, Macau, Mongolia), **Rest of South Asia** (Bangladesh, Sri Lanka, Afghanistan, Bhutan, Maldives, Nepal, Pakistan)**, Rest of South East Asia** (Philippines, Thailand, Vietnam, Rest of Southeast Asia (Brunei Darussalam, Cambodia, Lao People's Democratic Republic, Myanmar, Timor Leste)**, India**

Oceania Countries (Australia, New Zealand, American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia (Federal States of), Nauru, New Caledonia, Norfolk Island, Northern Mariana Islands, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna)

Argentina, Brazil, Chile, Rest of South America (Colombia, Peru, Uruguay, Venezuela, Bolivia, Ecuador, Falkland Islands, French Guiana, Guyana, Paraguay, Suriname)

Central and Caribbean America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Anguilla, Aruba, Cayman Islands, Cuba, Guadeloupe, Martinique, Montserrat, Netherlands Antilles, Turks and Caicos, British Virgin Islands, Antigua and Barbuda, Bahamas, Barbados, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, U.S. Virgin Islands, Bermuda, Greenland, Saint Pierre and Miquelon)

Middle East and North Africa (Morocco, Tunisia, Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Palestinian Territory, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Yemen, Algeria, Egypt, Libyan Arab Jamahiriya) **South Africa, Sub-Saharan Africa** (Botswana, Madagascar, Malawi, Mozambique, Tanzania, Uganda, Zambia, Zimbabwe, Lesotho, Namibia, Swaziland, Angola, Congo (the Democratic Republic of the), Mauritius, Seychelles, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Mali, Mauritania, Mayotte, Niger, Nigeria, Reunion, Rwanda, Saint Helena, Sao Tome and Principe, Senegal, Sierra Leone, Somalia, Sudan, Togo)

Table A2. Sectoral Aggregation.

27 Sectors in bold, aggregation of constituent 57 GTAP sectors listed in parentheses)

Bulk Agriculture (Paddy rice; Wheat; Cereal grains nec; Oil seeds; Sugar cane, sugar beet; Plant-based fibers; Crops nec);

Processed Agriculture (Vegetables, fruit, nuts; Bovine cattle, sheep and goats, horses; Animal products nec; Raw milk; Wool, silk-worm cocoons; Bovine meat products; Meat products nec; Vegetable oils and fats; Dairy products; Processed rice; Sugar; Food products nec; Beverages and tobacco products

Forestry, Fishing, Minerals (Coal, Mineral nec, Oil, Gas)

Textiles, Wearing apparel, Leather products, Wood products, Paper products and publishing

Petroleum and coal products; Chemical and rubber and plastic products, Mineral products nec, Ferrous metals, Metals nec, Metal products

Motor vehicles and parts, Transport equipment nec, Electronic equipment, Machinery and equipment nec, Manufactures nec

Electricity, Gas manufacture and distribution

Services: (Water; Construction; Trade; Communication; Financial services nec; Insurance; Business services nec; Recreational and other services; Public Administration, Defense, Education, Health; Dwellings)

Transport nec, Water transport, Air transport

Table A3. Sources of Modal Data

TO → FROM ↓	US	EU15	EU10	Romania and Bulgaria	LAC	ROW
US	--	*European Import or US Export Data*	*European Import or US Export Data*	*European Import or US Export Data*	*US Export or Aladi Import data*	*US Export data*
EU15	*European Export or US Import Data*	*European Export data (1999)**	*European Export data (1999)**	*European Export data*	*European Export data*	*European Export data*
EU10	*European Export or US Import Data*	*European Import Data*	*European Import Data*	*European Import Data*	*European Export data*	*European Export data*
Romania and Bulgaria	*European Export or US Import Data*	*European Import Data*	*European Import Data*	*European Import Data*	*European Export data*	*European Export data*
LAC	*US Import Data*	*European Import Data*	*European Import Data*	*European Import Data*	--	--
ROW	*US Import Data*	*European Import Data*	*European Import Data*	*European Import Data*	--	--

*Year 1999 is the base for data in both the 2000 and the 2004 datasets.

Table1 --Trade Growth by Sector

By commodity	Tariff	Trade Value		Trade Weight			KG-KM
		Initial Shares	% Growth	Weight/ value	Initial Shares	% Growth	% Growth
Bulk Agriculture	18.3	1.4	33.7	3.0	5.1	38.7	70.0
Processed Agriculture	10.9	5.4	20.1	0.9	6.4	26.0	42.6
Forestry	0.9	0.1	1.0	6.7	1.2	0.8	1.8
Fishing	2.4	0.1	1.7	0.3	0.0	0.6	2.8
Minerals	1.4	0.9	0.3	17.2	18.7	-0.2	-0.5
Oil	1.2	3.3	2.0	4.6	18.8	1.9	1.7
Gas	0.1	0.8	2.3	4.8	4.9	1.7	1.1
Textiles	7.8	2.8	22.6	0.3	1.2	1.7	24.2
Wearing apparel	9.4	2.3	26.6	0.1	0.2	24.7	57.2
Leather products	7.0	1.3	12.4	0.2	0.3	11.5	27.6
Wood products	1.9	1.8	4.1	1.0	2.3	4.4	13.0
Paper products, publishing	1.9	2.1	3.2	1.2	3.3	3.0	6.3
Petroleum, coal products	2.9	1.5	4.9	4.3	7.9	5.3	8.1
Chemical, rubber, plastic products	3.1	10.2	5.9	0.8	10.0	9.3	15.7
Mineral products nec	4.0	1.6	7.9	1.9	3.8	8.5	12.1
Ferrous metals	3.5	2.1	5.0	1.9	5.0	6.0	7.3
Metals nec	2.1	2.3	3.6	0.5	1.4	3.2	3.6
Metal products	3.1	1.9	7.7	0.9	2.1	5.8	15.4
Motor vehicles and parts	3.6	7.7	4.1	0.2	1.6	2.2	11.5
Transport equipment nec	2.7	3.0	3.5	0.1	0.3	10.7	13.4
Electronic equipment	1.6	11.8	0.9	0.1	1.2	0.6	2.5
Machinery and equipment nec	2.7	14.8	4.8	0.2	3.9	4.9	9.6
Manufactures nec	4.2	2.7	8.7	0.2	0.5	4.0	9.3
Electricity	0.2	0.4	0.3				
Gas manufacture, distribution	0.0	0.0	0.6				
Services	0.0	13.1	0.1				
Transport nec	0.0	2.1	0.6				
Water transport	0.0	0.7	3.6				
Air transport	0.0	1.9	-0.2				
Total	3.2	100.0	5.8	0.8	100.0	6.8	11.8

Table2a--Trade Growth by Exporter

By Exporter	Tariff	Trade Value		Trade Weight			KG-KM
		Initial Shares	% Growth	Weight/ value	Initial Shares	% Growth	% Growth
World	3.2	100.0	5.8	0.8	100.0	6.8	11.8
Europe							
Austria	1.3	1.3	-0.8	0.2	0.4	-0.7	7.3
Belgium	1.6	2.8	-1.4	0.5	1.6	-2.3	8.6
Denmark	2.3	0.9	-1.4	0.4	0.5	-1.6	10.9
Finland	2.0	0.7	1.2	0.5	0.4	-0.1	4.9
France	2.1	5.0	0.6	0.3	2.1	-1.6	8.3
Germany	2.1	8.8	1.2	0.3	2.9	-1.8	8.5
Greece	1.8	0.4	3.0	0.6	0.3	5.9	6.8
Ireland	1.0	1.3	-1.0	0.1	0.1	-3.6	3.2
Italy	2.7	4.1	1.7	0.3	1.4	1.9	11.9
Netherlands	1.3	2.2	-1.3	0.8	2.3	-2.8	3.9
Portugal	1.5	0.5	1.8	0.3	0.2	7.7	17.8
Spain	1.9	2.3	1.1	0.4	1.1	2.6	15.3
Sweden	1.8	1.3	0.1	0.5	0.9	-1.7	4.5
United Kingdom	1.8	4.8	2.3	0.3	1.9	2.0	9.1
Rest of European Union	2.2	2.7	4.5	0.7	2.5	9.8	14.6
Rest of European Countries	1.5	2.5	0.5	0.8	2.5	0.3	4.5
Other CEE and Other CIS	3.4	1.5	6.5	2.0	3.7	8.9	15.3
Russia	2.0	1.4	13.3	3.1	5.6	13.5	10.5
North America							
Canada	1.1	3.9	0.5	1.1	5.1	2.6	12.3
Unites States	3.5	12.9	6.0	1.0	16.4	11.7	22.2
Mexico	1.0	2.4	5.5	0.6	1.8	3.9	7.1
Asia							
Japan	5.0	6.6	10.4	0.1	1.2	13.5	9.7
Korea	6.4	2.6	10.7	0.5	1.7	9.1	4.6
Singapore	3.5	1.6	0.1	0.2	0.4	3.6	4.3
Malaysia-Indonesia	4.3	2.8	5.0	1.9	6.6	2.7	1.7
China-Hong Hong	5.1	6.9	19.7	0.3	2.7	11.5	14.0
Taiwan	4.4	2.0	5.7	0.2	0.4	14.8	10.4
East Asia	8.3	0.1	8.9	0.7	0.1	1.5	7.3
Rest of South Asia	6.9	0.4	22.8	0.3	0.1	37.9	35.3
Rest of South East Asia	5.4	2.1	13.2	0.5	1.2	16.8	12.4
India	5.2	0.9	35.5	0.5	0.6	33.1	34.8
Oceania	6.6	1.4	8.5	2.9	5.0	3.2	2.6
Latin America							
Argentina	12.1	0.4	12.0	2.5	1.4	33.3	86.3
Brazil	8.5	1.0	13.8	2.6	3.2	9.8	12.3
Chile	3.7	0.3	3.3	1.3	0.5	3.9	-0.7
Other South America	3.8	0.9	9.2	3.6	4.0	5.3	8.2
C America & Caribbean	4.9	0.9	12.4	1.0	1.1	16.8	31.9
Africa							
Middle East & N Africa	2.3	3.9	8.3	2.6	12.4	4.9	4.5
South Africa	5.0	0.6	2.4	1.5	1.1	0.0	1.0
Sub-Saharan Africa	2.8	1.0	11.3	2.0	2.4	4.7	4.0

Table2b--Trade Growth by Importer

By Importer		Trade Value		Trade Weight			KG-KM
	Tariff	Initial Shares	% Growth	Weight/ value	Initial Shares	% Growth	% Growth
World	3.2	100.0	5.8	0.8	100.0	6.8	11.8
Europe							
Austria	0.5	1.4	-0.6	0.5	0.8	2.4	12.9
Belgium	0.8	2.9	-0.6	0.7	2.5	2.7	8.3
Denmark	0.6	0.8	-0.1	0.4	0.5	1.0	6.1
Finland	0.8	0.5	2.0	1.2	0.8	3.5	5.4
France	0.6	4.8	0.0	0.6	3.8	2.2	5.0
Germany	0.7	8.0	0.8	0.7	6.5	3.3	8.4
Greece	0.7	0.6	0.8	0.7	0.5	3.8	7.1
Ireland	0.4	1.1	-1.1	0.4	0.5	3.3	11.6
Italy	0.7	3.9	1.2	0.8	4.0	3.1	5.7
Netherlands	1.1	2.5	-0.5	0.8	2.5	2.7	7.5
Portugal	1.1	0.6	-1.3	0.8	0.6	4.7	15.1
Spain	0.7	2.5	0.4	1.0	3.0	2.6	2.9
Sweden	0.5	1.1	1.4	0.6	0.9	1.7	6.7
United Kingdom	1.1	5.5	1.3	0.5	3.3	6.8	15.4
Rest of European Union	3.6	2.9	5.5	0.9	3.1	9.2	8.8
Rest of European Countries	3.0	2.1	3.1	0.5	1.2	5.7	11.4
Other CEE and Other CIS	3.5	1.6	7.3	1.5	3.0	6.9	6.7
Russia	7.2	1.0	14.2	1.0	1.2	14.7	29.5
North America							
Canada	1.2	3.4	0.1	1.0	4.4	-3.1	0.2
Unites States	1.5	18.2	2.1	0.6	13.8	0.5	1.5
Mexico	4.4	2.1	6.5	1.1	3.0	-7.3	4.1
Asia							
Japan	4.0	5.7	9.3	1.4	10.3	9.3	11.1
Korea	8.3	2.3	15.1	1.5	4.3	7.1	10.4
Singapore	0.0	1.8	1.1	0.6	1.3	3.6	5.0
Malaysia-Indonesia	4.2	1.7	8.5	0.6	1.3	5.2	2.1
China-Hong Hong	8.2	5.5	26.3	0.8	5.2	35.8	54.8
Taiwan	3.3	1.6	7.2	1.1	2.3	4.6	5.1
East Asia	0.0	0.1	6.5	0.8	0.1	4.5	2.4
Rest of South Asia	13.2	0.4	22.0	1.1	0.6	14.4	6.3
Rest of South East Asia	7.1	1.9	16.5	0.9	2.1	10.4	11.7
India	21.5	0.9	40.9	1.8	1.9	27.9	22.3
Oceania	4.4	1.3	10.9	0.6	1.0	15.8	17.0
Latin America							
Argentina	7.3	0.4	18.0	0.7	0.3	12.8	31.8
Brazil	7.5	1.0	21.1	1.0	1.3	7.9	13.1
Chile	5.3	0.3	6.0	1.4	0.5	5.1	7.3
Other South America	8.5	0.9	11.1	1.0	1.0	13.6	19.0
C America & Caribbean	8.2	1.2	12.2	1.2	1.8	8.3	13.3
Africa							
Middle East & N Africa	8.0	3.8	10.4	0.8	3.5	10.3	4.2
South Africa	5.5	0.4	9.7	0.8	0.4	6.6	7.7
Sub-Saharan Africa	11.6	1.1	13.2	0.7	0.9	18.6	22.3

Table3-- Initial Modal Shares by Sector

By Commodity	By Value				By Weight (Kg)				By Weight-Distance (Kg Km)			
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	Sea	Air	Rail	Road
Bulk Agriculture	77.7	3.0	3.3	16.0	79.7	1.6	5.2	13.5	96.8	0.4	1.6	1.3
Processed Agriculture	58.5	2.9	1.9	36.5	61.5	2.8	1.8	33.8	92.0	0.7	0.8	6.5
Forestry	69.9	1.6	8.0	20.4	64.5	0.8	14.8	19.8	92.5	0.4	3.4	3.5
Fishing	37.3	29.6	0.6	32.5	35.6	25.8	0.6	38.0	46.2	39.7	0.2	13.3
Minerals	85.7	4.7	3.8	5.8	88.0	3.2	4.1	4.7	98.5	0.1	0.8	0.7
Oil	96.5	0.0	1.0	2.5	96.5	0.0	1.0	2.5	98.3	0.0	0.4	1.1
Gas	62.1	0.0	17.3	20.6	77.8	0.0	11.0	11.2	92.4	0.0	4.8	2.2
Textiles	57.0	9.9	0.7	32.4	49.2	9.5	0.5	40.9	76.8	6.8	0.1	16.3
Wearing apparel	53.2	19.1	0.5	27.1	53.9	20.0	0.4	25.6	71.1	20.4	0.1	8.4
Leather products	57.0	14.6	1.2	27.2	55.5	14.9	1.1	28.4	84.2	8.7	0.2	6.8
Wood products	51.3	2.5	7.8	38.4	44.2	2.1	10.8	42.9	86.7	0.7	2.8	9.9
Paper products, publishing	46.8	5.5	7.2	40.5	50.1	6.0	8.0	35.9	87.7	1.6	1.5	9.2
Petroleum, coal products	89.8	0.3	2.5	7.1	89.7	0.3	2.6	7.1	96.4	0.3	0.8	2.5
Chemical, rubber, plastic products	45.7	16.6	2.5	35.1	48.7	13.9	4.6	32.7	90.8	1.3	1.4	6.6
Mineral products nec	49.5	10.6	2.1	37.7	57.6	7.4	2.6	32.2	89.3	1.6	1.3	7.8
Ferrous metals	61.4	1.6	7.6	29.2	67.9	1.5	7.2	23.3	92.7	0.3	2.2	4.8
Metals nec	51.1	17.6	3.5	27.7	55.3	14.1	2.9	27.6	93.4	1.3	0.8	4.5
Metal products	42.3	11.4	2.1	44.1	34.6	17.0	1.7	46.7	76.7	9.6	0.5	13.2
Motor vehicles and parts	44.1	3.1	15.1	37.6	35.8	3.1	19.5	41.5	78.9	3.8	4.4	12.3
Transport equipment nec	34.8	44.1	3.5	17.6	51.1	28.0	3.4	17.4	85.2	11.4	0.7	2.5
Electronic equipment	29.2	52.4	0.6	17.7	19.3	64.9	0.4	15.3	53.6	41.2	0.1	4.7
Machinery and equipment nec	37.5	27.7	2.6	32.3	33.0	35.3	1.9	29.8	77.6	14.9	0.4	7.1
Manufactures nec	39.5	43.6	0.5	16.4	39.4	42.2	0.5	17.8	87.2	9.4	0.1	3.3
Total	47.4	20.6	3.7	28.2	80.3	2.3	5.1	12.2	93.4	2.0	1.1	3.5

Table4a-- Initial Modal Shares by Exporter

By Exporter	By Value				By Weight (Kg)				By Weight-Distance (Kg Km)			
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	Sea	Air	Rail	Road
World	47.4	20.6	3.7	28.2	80.3	2.3	5.1	12.2	93.4	2.0	1.1	3.5
Europe												
Austria	10.9	10.4	6.7	72.0	11.2	6.1	12.5	70.2	54.6	6.2	9.0	30.0
Belgium	18.6	13.8	3.8	61.1	25.1	7.4	4.6	58.9	79.8	1.9	2.0	16.1
Denmark	68.6	10.8	0.2	20.4	85.3	3.2	0.2	11.2	92.9	2.7	0.2	3.9
Finland	73.2	17.2	1.2	8.4	89.2	2.9	1.9	6.1	95.4	1.4	0.9	2.2
France	21.6	19.1	4.1	55.2	35.7	7.1	4.8	52.4	79.8	3.9	2.4	13.8
Germany	21.9	12.8	5.8	59.5	24.1	6.8	5.8	63.4	73.8	3.8	3.1	19.2
Greece	43.5	11.5	0.4	44.7	65.0	4.5	0.7	29.7	88.4	1.6	0.2	9.7
Ireland	40.3	41.7	0.1	17.9	64.5	21.2	0.1	14.2	87.1	9.7	0.0	3.2
Italy	26.0	13.0	3.0	58.0	38.8	5.9	2.7	52.6	76.0	2.8	2.1	19.1
Netherlands	25.1	7.5	2.7	64.7	48.6	2.6	10.4	38.4	77.0	1.9	7.3	13.8
Portugal	29.5	6.9	0.2	63.3	39.6	4.3	0.3	55.7	76.3	2.6	0.1	20.4
Spain	30.2	5.9	6.6	57.3	41.3	3.3	2.1	53.4	79.4	1.3	0.7	18.6
Sweden	59.3	20.0	1.5	19.2	71.7	4.5	10.6	13.2	85.5	1.8	7.2	5.2
United Kingdom	63.2	29.3	1.8	5.8	87.5	8.5	1.0	3.0	95.9	3.2	0.2	0.6
Rest of European Union	21.1	6.9	14.7	57.3	34.9	3.4	21.3	40.5	65.8	1.8	13.7	18.6
Rest of European Countries	43.3	19.1	2.1	35.5	74.5	3.3	2.4	19.8	91.9	1.2	1.5	4.8
Other CEE and Other CIS	59.6	5.3	5.5	29.6	71.5	0.8	12.5	15.2	83.6	0.2	8.5	7.8
Russia	75.0	5.4	9.0	10.5	79.1	1.3	11.9	7.7	90.1	0.3	7.1	2.4
North America												
Canada	15.7	8.7	22.4	53.1	44.6	2.7	16.7	36.0	91.3	0.3	4.5	3.8
Unites States	30.7	39.4	3.3	26.6	48.6	19.5	4.1	27.8	85.1	7.6	0.9	6.4
Mexico	16.5	7.3	10.3	65.9	75.4	1.2	4.5	18.9	86.7	0.3	3.4	9.6

Table4a-- Initial Modal Shares by Exporter

By Exporter	By Value				By Weight (Kg)				By Weight-Distance (Kg Km)			
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	Sea	Air	Rail	Road
Asia												
Japan	67.7	32.3	0.0	0.0	85.4	14.6	0.0	0.0	95.8	4.1	0.0	0.0
Korea	75.7	24.3	0.0	0.0	89.8	10.2	0.0	0.0	97.3	2.6	0.0	0.0
Singapore	49.3	50.7	0.0	0.0	90.9	9.1	0.0	0.0	95.0	4.9	0.0	0.0
Malaysia-Indonesia	72.4	27.6	0.0	0.0	99.0	1.0	0.0	0.0	99.8	0.2	0.0	0.0
China-Hong Hong	78.8	15.8	1.2	4.2	89.7	5.3	0.9	4.1	97.1	1.3	0.2	1.4
Taiwan	66.1	33.9	0.0	0.0	90.1	9.9	0.0	0.0	96.4	3.5	0.0	0.0
East Asia	68.4	22.7	1.8	7.1	64.6	12.0	4.7	18.8	83.3	9.4	1.4	5.8
Rest of South Asia	79.4	16.3	0.7	3.5	81.5	7.6	1.9	9.0	93.8	4.0	0.4	1.8
Rest of South East Asia	70.0	28.4	0.0	1.6	92.7	5.0	0.0	2.3	97.8	1.2	0.0	1.0
India	69.9	26.4	0.6	3.0	90.4	5.1	0.8	3.7	98.1	1.1	0.1	0.6
Oceania	87.6	12.4	0.0	0.0	96.8	3.2	0.0	0.0	99.8	0.2	0.0	0.0
Latin America												
Argentina	76.1	8.0	0.3	15.6	86.2	2.0	0.4	11.5	96.0	0.5	0.1	2.6
Brazil	77.8	13.8	0.1	8.3	95.0	2.1	0.1	2.9	98.9	0.3	0.0	0.7
Chile	85.9	9.5	0.2	4.4	91.8	4.4	0.1	3.7	98.6	0.8	0.0	0.6
Other South America	83.5	9.2	0.0	7.2	95.4	1.9	0.1	2.6	98.6	0.3	0.0	1.0
C America & Caribbean	77.3	17.1	0.2	5.5	86.6	7.2	0.2	5.9	97.2	1.1	0.1	1.5
Africa												
Middle East & N Africa	80.8	12.2	0.0	7.0	95.1	0.9	0.0	4.0	98.2	0.1	0.0	1.7
South Africa	56.3	24.9	0.0	18.8	69.3	17.9	0.0	12.8	92.7	0.3	0.0	7.0
Sub-Saharan Africa	76.4	14.2	0.0	9.4	91.3	2.0	0.0	6.7	95.9	0.2	0.0	3.1

Table4b--Initial Modal Shares by Importer

By Importer	By Value				By Weight (Kg)				By Weight-Distance (Kg Km)			
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	Sea	Air	Rail	Road
World	47.4	20.6	3.7	28.2	80.3	2.3	5.1	12.2	93.4	2.0	1.1	3.5
Europe												
Austria	14.9	7.2	8.3	69.7	24.7	4.2	21.4	49.7	65.1	3.5	13.7	17.5
Belgium	33.5	13.7	5.3	44.8	57.9	11.3	2.5	25.6	95.8	1.1	0.5	2.5
Denmark	38.5	9.3	2.7	49.6	62.5	4.3	1.6	31.6	89.3	2.0	0.6	8.0
Finland	40.9	16.2	7.2	35.8	58.7	2.8	23.0	15.4	87.6	1.1	6.9	4.4
France	28.4	14.2	4.7	52.6	62.1	7.2	2.4	28.2	91.3	2.4	0.8	4.9
Germany	30.3	17.0	4.9	47.8	55.9	7.9	6.0	30.3	88.9	3.3	1.7	6.1
Greece	45.3	9.5	3.5	41.7	77.1	3.5	1.0	18.3	90.4	1.0	0.6	8.0
Ireland	44.8	31.4	0.4	23.4	65.3	19.5	1.4	13.8	86.0	10.5	0.3	3.1
Italy	33.7	9.1	7.0	50.2	66.8	3.9	6.0	23.3	90.6	1.2	2.5	5.6
Netherlands	50.6	7.7	1.9	39.8	77.0	3.1	0.5	19.3	97.3	0.7	0.1	2.0
Portugal	27.4	7.5	2.0	63.1	65.5	3.2	0.6	30.7	92.0	1.1	0.2	6.6
Spain	36.3	7.0	4.5	52.2	81.0	2.3	0.9	15.8	96.7	0.3	0.2	2.8
Sweden	41.7	12.1	2.1	44.0	74.4	5.1	1.6	19.0	90.8	2.5	0.8	5.9
United Kingdom	39.7	24.4	0.6	35.3	59.4	21.7	0.4	18.5	93.1	4.8	0.1	2.1
Rest of European Union	23.0	9.7	10.8	56.6	41.6	3.6	26.9	27.9	70.2	2.1	18.1	9.1
Rest of European Countries	28.3	15.3	4.8	51.6	45.4	10.2	7.1	37.3	82.2	4.3	2.9	10.5
Other CEE and Other CIS	53.1	10.0	6.2	30.7	77.5	1.6	9.4	11.5	87.0	0.6	6.5	5.8
Russia	43.3	8.5	5.1	43.1	64.1	1.9	8.6	25.4	80.0	0.9	6.1	13.0
North America												
Canada	22.2	16.1	6.9	54.9	24.0	5.0	8.1	63.0	91.4	8.1	0.1	0.4
Unites States	47.8	25.7	6.2	20.3	73.1	4.8	6.7	15.4	95.7	1.2	1.3	1.8
Mexico	24.2	14.3	7.3	54.1	24.7	3.5	11.1	60.7	39.5	0.8	7.8	51.9

Table4b--Initial Modal Shares by Importer

By Importer	By Value				By Weight (Kg)				By Weight-Distance (Kg Km)			
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	Sea	Air	Rail	Road
Asia												
Japan	72.2	27.8	0.0	0.0	94.5	5.5	0.0	0.0	98.0	2.0	0.0	0.0
Korea	70.3	29.7	0.0	0.0	95.5	4.5	0.0	0.0	98.4	1.6	0.0	0.0
Singapore	57.5	42.5	0.0	0.0	86.7	13.3	0.0	0.0	92.7	7.2	0.0	0.0
Malaysia-Indonesia	71.7	28.3	0.0	0.0	92.5	7.5	0.0	0.0	96.6	3.4	0.0	0.0
China-Hong Hong	65.9	27.9	1.4	4.9	90.8	6.8	0.4	1.9	97.8	1.6	0.1	0.4
Taiwan	67.6	32.4	0.0	0.0	93.6	6.4	0.0	0.0	97.0	3.0	0.0	0.0
East Asia	69.5	15.6	3.0	11.9	83.3	4.3	2.5	9.9	96.5	1.4	0.4	1.7
Rest of South Asia	78.1	13.4	1.5	7.0	91.4	3.2	0.9	4.5	98.2	0.6	0.2	0.9
Rest of South East Asia	68.1	30.4	0.0	1.5	92.1	6.0	0.0	1.9	96.4	2.8	0.0	0.8
India	71.2	27.7	0.2	0.9	95.5	4.0	0.1	0.3	99.3	0.6	0.0	0.0
Oceania	73.9	26.1	0.0	0.0	89.3	10.7	0.0	0.0	97.1	2.9	0.0	0.0
Latin America												
Argentina	58.7	22.4	0.5	18.4	69.7	9.3	1.1	19.9	91.8	1.6	0.3	6.3
Brazil	62.3	31.8	0.2	5.7	84.2	8.9	0.5	6.4	95.9	2.0	0.1	1.9
Chile	68.5	19.3	0.1	12.2	75.0	4.5	0.1	20.4	80.7	1.7	0.1	6.1
Other South America	69.5	19.7	0.0	10.8	78.6	9.0	0.0	12.4	90.4	1.6	0.1	7.9
C America & Caribbean	79.8	15.3	0.1	4.8	90.2	5.0	0.2	4.6	97.7	0.9	0.1	1.4
Africa												
Middle East & N Africa	69.6	23.2	0.0	7.3	81.0	6.1	0.0	12.9	93.4	1.3	0.0	5.3
South Africa	60.1	27.2	0.0	12.7	55.9	7.1	0.0	37.0	72.3	2.2	0.0	25.6
Sub-Saharan Africa	69.2	13.9	0.0	16.9	73.9	3.9	0.0	22.2	86.4	0.9	0.0	12.7

Table5-- Growth in Modal Use by Sector

By Commodity	Value				Weight				Weight-Distance (Kg-Km)			
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	Sea	Air	Rail	Road
Bulk Agriculture	41.2	28.3	8.8	3.4	43.9	18.8	10.5	2.3	71.8	32.7	15.3	7.8
Processed Agriculture	37.1	30.9	2.9	-7.1	40.9	30.3	6.0	-7.7	46.2	43.9	5.3	-3.7
Forestry	0.8	0.5	0.4	1.7	1.0	1.5	0.2	0.6	1.9	1.5	0.3	2.5
Fishing	2.7	3.7	-1.6	-1.4	1.4	3.5	-2.6	-1.7	3.1	3.8	-2.4	-0.9
Minerals	0.3	-0.1	1.3	0.0	-0.2	-5.2	0.8	-0.2	-0.5	-3.8	0.1	3.7
Oil	1.9		6.1	5.0	1.7		6.4	6.0	1.7		7.5	2.9
Gas	2.5		0.9	3.0	1.4		0.5	12.7	0.6		3.9	14.7
Textiles	51.3	55.3	-19.1	-37.2	32.0	-31.1	-25.8	-38.0	37.8	20.7	-24.4	-38.2
Wearing apparel	52.6	55.7	0.3	-44.2	49.2	39.8	1.0	-44.9	68.6	60.9	3.0	-46.9
Leather products	27.0	21.0	-17.3	-21.4	27.3	10.1	-16.2	-24.7	32.9	23.5	-16.7	-31.7
Wood products	6.8	13.6	0.3	0.6	8.7	12.4	0.2	-0.9	15.3	25.0	-0.3	-3.8
Paper products, publishing	6.1	8.5	0.2	-0.3	5.7	1.1	0.2	-2.6	7.7	6.2	-0.8	-6.0
Petroleum, coal products	5.2	12.6	10.6	-0.6	5.5	16.8	9.8	0.5	8.2	26.7	11.0	-0.5
Chemical, rubber, plastic products	12.7	9.4	-2.8	-3.8	14.0	8.3	-2.6	-3.4	17.5	12.4	-0.2	-4.7
Mineral products nec	14.7	13.8	4.2	-2.4	11.8	18.1	9.2	-1.8	13.1	20.5	13.7	-2.0
Ferrous metals	8.3	8.1	3.0	-1.5	7.6	3.9	7.1	-1.8	7.8	11.8	9.6	-4.8
Metals nec	5.3	6.0	-0.9	-0.3	4.4	12.9	-0.2	-0.4	3.7	13.0	0.2	-0.4
Metal products	15.6	17.6	1.0	-2.0	16.9	1.9	0.9	-13.3	21.2	18.3	-3.3	-19.7
Motor vehicles and parts	12.8	13.7	-3.6	-3.7	10.3	-2.6	-5.7	-6.3	15.9	13.1	-9.2	-9.8
Transport equipment nec	11.9	0.6	-4.3	-4.1	15.6	1.6	0.2	-1.5	15.3	1.3	2.8	5.2
Electronic equipment	0.4	1.5	-3.5	-0.3	1.8	3.5	-7.8	-11.1	2.6	4.3	-7.8	-14.7
Machinery and equipment nec	8.2	9.3	-1.5	-2.6	9.1	6.5	-2.8	-8.0	11.3	11.8	-6.3	-13.8
Manufactures nec	11.3	13.4	-11.6	-9.1	8.2	7.1	-13.2	-17.9	10.0	15.0	-15.6	-24.4
Total	14.7	8.5	-1.6	-5.6	9.0	3.0	2.2	-4.7	12.6	12.4	4.0	-6.6

Table6a-- Growth in Modal Use by Exporter

By Exporter	Value				Weight				Weight-Distance (Kg-Km)			
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	Sea	Air	Rail	Road
World	14.7	8.5	-1.6	-5.6	9.0	3.0	2.2	-4.7	12.6	12.4	4.0	-6.6
Europe												
Austria	13.7	8.7	-2.5	-5.3	11.0	13.8	-1.4	-3.7	14.3	15.5	-1.2	-4.3
Belgium	6.4	7.0	-3.3	-6.4	2.5	8.7	-3.6	-5.6	11.5	11.5	-3.9	-4.0
Denmark	-1.1	6.5	-8.6	-9.7	-1.2	2.6	-7.1	-7.5	11.9	3.9	-7.7	-7.6
Finland	-1.9	10.9	10.7	6.8	-1.0	9.0	11.4	9.8	4.8	8.1	9.2	7.4
France	10.3	8.5	-3.9	-6.3	2.7	12.6	-4.5	-6.5	10.5	15.4	-3.4	-4.6
Germany	15.6	10.4	-3.7	-5.9	4.1	13.9	-2.0	-6.0	12.1	16.0	-1.0	-5.1
Greece	8.3	4.0	4.0	-7.0	5.9	11.7	8.8	5.7	7.1	14.5	9.1	2.9
Ireland	-5.3	3.1	-10.0	-6.1	-2.8	7.0	-7.4	-13.3	3.0	9.4	-7.3	-11.2
Italy	17.1	19.5	-3.5	-8.9	10.3	25.0	-4.4	-6.6	16.2	30.2	-3.1	-6.3
Netherlands	1.3	4.8	-9.6	-4.7	-0.3	5.5	-12.1	-4.3	7.0	3.4	-15.8	-2.9
Portugal	18.2	26.3	-5.5	-10.8	15.8	13.2	4.1	-0.9	23.3	22.7	4.0	-2.4
Spain	16.0	19.1	-3.5	-8.8	13.7	34.5	-4.6	-9.5	20.5	43.8	-3.6	-8.2
Sweden	-0.7	15.5	-6.9	-9.9	-0.7	12.7	-2.8	-7.4	5.6	17.5	-3.0	-7.5
United Kingdom	1.9	4.8	-3.7	-5.7	2.2	8.4	-1.1	-6.9	9.1	10.8	-2.4	-7.0
Rest of European Union	11.7	13.9	6.4	1.3	10.6	9.6	7.5	10.9	16.2	12.8	9.6	12.4
Rest of European Countries	3.8	4.4	-4.0	-5.1	0.9	10.8	-2.6	-1.3	5.1	7.8	-3.0	-1.2
Other CEE and Other CIS	13.0	8.4	13.2	-6.7	9.1	7.8	8.6	8.2	16.8	15.6	8.9	7.0
Russia	15.0	20.7	14.6	14.2	13.6	28.0	13.4	11.4	10.2	31.0	13.9	12.1
North America												
Canada	16.2	6.7	-3.3	-4.3	8.2	17.6	-3.5	-2.3	13.7	23.6	-3.9	-2.4
Unites States	23.2	8.0	-8.9	-11.3	18.7	0.3	1.6	-21.5	26.8	10.6	1.6	-21.5
Mexico	13.6	16.1	4.8	2.5	4.6	16.8	2.3	0.9	8.0	21.0	2.3	0.7

Table6a-- Growth in Modal Use by Exporter

By Exporter	Value				Weight				Weight-Distance (Kg-Km)			
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	Sea	Air	Rail	Road
Asia												
Japan	12.8	8.8			13.6	9.0			9.9	6.2		
Korea	17.5	0.5			9.3	0.1			4.8	-1.8		
Singapore	5.9	0.4			3.4	12.9			3.6	17.0		
Malaysia-Indonesia	11.2	-4.1			2.7	5.8			1.7	7.1		
China-Hong Hong	28.0	31.2	-17.3	-10.1	12.0	40.8	-17.1	-1.7	13.8	47.5	-16.6	6.0
Taiwan	12.9	-4.8			15.2	1.4			10.7	0.0		
East Asia	10.3	18.4	36.8	36.8	4.8	12.3	-10.5	-10.5	8.2	13.8	-10.5	-10.5
Rest of South Asia	26.1	18.7	68.3	68.3	35.6	22.0	60.5	60.5	35.3	22.3	56.9	56.9
Rest of South East Asia	20.5	3.7		43.5	16.2	13.2		44.1	12.1	13.9		44.1
India	43.4	40.5	48.0	48.0	32.5	46.4	42.3	42.3	34.5	51.1	42.3	42.3
Oceania	12.7	11.1			3.1	28.2			2.6	30.6		
Latin America												
Argentina	24.1	-9.0	-27.7	-13.3	42.2	22.8	-20.4	-9.1	90.0	45.9	-21.5	-13.2
Brazil	23.6	0.0	-27.6	-15.7	10.5	11.3	-24.5	-13.5	12.4	19.4	-21.7	-11.1
Chile	1.7	1.0	35.0	52.0	2.4	1.0	39.9	48.6	-0.9	-2.1	40.0	42.2
Other South America	13.9	-0.2	3.7	-18.1	5.7	7.7	-2.5	-10.6	8.3	9.5	-2.0	-3.1
C America & Caribbean	23.0	5.5	-14.8	-2.5	18.5	8.3	-14.7	-12.0	32.8	12.3	-14.0	-9.1
Africa												
Middle East & N Africa	9.3	14.1		9.6	4.5	30.7		15.2	4.3	34.0		13.1
South Africa	10.1	2.4		-20.0	1.0	7.5		-6.7	1.2	9.0		-2.2
Sub-Saharan Africa	13.0	16.9		1.7	4.7	49.1		1.4	3.9	47.1		1.5

Table6b-- Growth of Modal Use by Importer

By Importer	Value				Weight				Weight-Distance (Kg-km)			
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	Sea	Air	Rail	Road
World	14.7	8.5	-1.6	-5.6	9.0	3.0	2.2	-4.7	12.6	12.4	4.0	-6.6
Europe												
Austria	22.9	8.4	-2.2	-6.6	11.2	10.6	2.5	-3.7	19.3	10.6	3.6	-3.3
Belgium	9.4	6.6	-4.7	-9.5	5.7	10.7	-2.6	-6.6	8.7	8.8	-1.8	-4.4
Denmark	6.2	12.5	-3.5	-7.9	2.9	16.2	-4.0	-4.1	6.8	18.2	-3.9	-4.0
Finland	8.1	6.1	4.2	-6.1	4.4	7.2	4.8	-3.4	6.0	7.4	4.1	-5.6
France	9.8	8.1	-3.7	-6.6	4.3	11.9	-2.9	-3.6	5.3	12.7	-2.7	-2.5
Germany	11.7	7.5	-1.8	-7.1	5.7	10.5	-1.0	-2.8	9.1	11.1	2.0	-1.1
Greece	8.9	4.4	-4.6	-7.8	5.2	11.8	-1.7	-3.7	8.1	15.4	-3.0	-4.7
Ireland	0.8	1.0	-4.4	-7.0	4.8	8.8	-2.2	-7.4	12.5	9.9	-2.5	-7.5
Italy	13.7	9.3	-4.3	-6.9	6.3	11.8	-7.7	-5.3	6.6	12.0	-8.0	-5.0
Netherlands	8.2	0.7	-5.1	-10.9	4.7	5.8	-5.6	-8.5	7.8	5.9	-4.1	-4.1
Portugal	22.4	3.1	-5.4	-11.4	11.7	9.9	-11.4	-14.2	17.2	13.1	-10.4	-13.4
Spain	10.4	6.5	-4.0	-6.4	3.5	10.3	-5.1	-3.5	3.0	11.7	-5.2	-3.2
Sweden	6.1	8.2	-4.0	-4.9	2.7	10.0	-3.3	-3.8	7.4	11.1	-3.7	-4.4
United Kingdom	10.5	5.9	-7.9	-10.2	10.3	11.7	-10.6	-12.9	16.2	12.7	-8.5	-13.6
Rest of European Union	11.0	13.3	9.4	2.8	7.9	24.1	11.6	8.6	7.2	26.3	13.3	9.6
Rest of European Countries	13.8	9.4	1.4	-3.3	8.2	9.0	7.4	0.5	12.7	12.1	9.8	1.9
Other CEE and Other CIS	12.8	3.5	10.3	4.7	6.3	7.4	6.7	12.2	6.4	6.4	7.9	9.6
Russia	21.8	19.0	14.8	15.0	16.7	18.7	13.3	9.1	34.3	21.7	12.9	8.5
North America												
Canada	10.2	2.4	-3.8	-3.6	-1.4	-8.5	-1.8	1.0	0.7	-5.7	-1.8	1.0
Unites States	5.9	1.7	-1.4	-1.7	1.3	6.4	-3.1	-1.8	1.5	6.9	-1.9	-0.9
Mexico	61.5	41.0	-15.8	-22.4	21.9	63.6	1.1	-21.3	36.8	67.8	1.1	-21.3

Table6b-- Growth of Modal Use by Importer

By Importer	Value				Weight				Weight-Distance (Kg-km)			
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	Sea	Air	Rail	Road
Asia												
Japan	12.7	8.8			9.2	11.9			11.0	12.2		
Korea	17.8	13.2			7.0	15.0			10.3	15.7		
Singapore	0.9	-1.4			3.6	4.2			5.0	5.3		
Malaysia-Indonesia	12.5	2.2			5.1	7.4			1.9	8.1		
China-Hong Hong	35.2	28.5	-17.3	-9.3	36.7	38.8	-18.2	-0.7	55.3	41.9	-17.9	9.7
Taiwan	9.9	2.7			4.6	5.8			5.0	6.1		
East Asia	7.5	8.8	3.1	3.1	5.1	11.5	-0.8	-0.8	2.3	11.3	-0.8	-0.8
Rest of South Asia	25.9	11.4	48.4	48.4	13.0	21.1	38.9	38.9	5.9	9.8	38.2	38.2
Rest of South East Asia	23.6	4.2		46.8	10.3	4.0		25.3	11.8	2.3		25.3
India	50.4	53.1	86.0	86.0	27.6	39.3	88.9	88.9	22.2	40.5	88.9	88.9
Oceania	13.7	8.4			15.9	11.5			17.2	11.7		
Latin America												
Argentina	33.6	26.1	-3.0	-14.1	17.9	15.8	-10.6	-9.4	34.8	38.3	-14.7	-10.9
Brazil	28.9	24.7	-24.7	-3.5	8.4	30.8	-19.7	-6.6	13.0	31.1	-15.0	1.7
Chile	7.3	7.5	4.7	4.1	6.0	8.4	-0.1	2.6	7.4	8.0	0.4	4.2
Other South America	20.2	9.5	-17.5	-20.2	18.1	20.2	-13.9	-17.3	21.9	22.0	-13.0	-14.5
C America & Caribbean	14.4	8.2	10.0	17.9	8.9	9.7	-3.9	-8.8	13.6	10.6	3.9	-4.5
Africa												
Middle East & N Africa	15.7	6.4		7.2	9.5	3.8		15.8	3.6	2.1		15.6
South Africa	15.2	6.6		2.7	9.8	7.9		1.1	9.8	7.8		1.6
Sub-Saharan Africa	25.4	13.0		-9.4	24.6	19.3		-2.2	25.9	19.8		-1.8

Table7-- Emissions Modal Shares and Growth, by Commodity

By Commodity	Emissions Shares HIGH Scenario				Emissions Shares LOW Scenario				Emissions Growth	
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	HIGH Sc.	LOW Sc.
Bulk Agriculture	53.4	32.0	3.0	11.6	61.6	21.5	3.5	13.4	45.8	48.1
Processed Agriculture	48.7	28.2	0.6	22.5	55.3	18.6	0.7	25.5	30.1	28.5
Forestry	32.7	27.7	6.1	33.5	37.0	18.2	6.9	37.9	1.9	1.9
Fishing	1.4	94.8	0.0	3.8	2.3	91.4	0.0	6.3	3.6	3.5
Minerals	73.8	8.0	2.9	15.3	76.4	4.8	3.0	15.8	-0.2	0.0
Oil	77.3	0.0	1.4	21.4	77.3	0.0	1.4	21.4	2.0	2.0
Gas	78.5	0.0	5.8	15.6	78.5	0.0	5.8	15.6	2.8	2.8
Textiles	12.5	75.7	0.0	11.8	18.3	64.4	0.0	17.2	10.1	5.7
Wearing apparel	4.4	94.0	0.0	1.6	7.2	90.1	0.0	2.7	56.1	53.2
Leather products	11.2	84.2	0.0	4.6	17.3	75.6	0.1	7.1	20.0	18.1
Wood products	37.5	25.3	1.9	35.3	41.9	16.5	2.2	39.5	9.4	7.9
Paper products, publishing	30.0	41.9	0.9	27.1	36.4	29.5	1.1	32.9	2.9	2.3
Petroleum, coal products	56.0	22.8	1.4	19.9	61.9	14.6	1.5	22.0	10.0	8.5
Chemical, rubber, plastic products	37.8	39.3	0.9	22.0	45.3	27.3	1.1	26.3	9.8	9.2
Mineral products nec	30.8	45.3	0.9	23.1	38.0	32.5	1.1	28.5	12.2	10.4
Ferrous metals	55.8	16.6	2.5	25.2	59.9	10.3	2.7	27.1	5.0	4.5
Metals nec	38.1	43.9	0.6	17.5	46.7	31.2	0.7	21.4	6.7	5.4
Metal products	8.6	81.7	0.1	9.7	13.0	72.2	0.1	14.7	13.3	10.9
Motor vehicles and parts	16.8	61.7	1.4	20.2	22.6	48.4	1.8	27.2	7.6	5.9
Transport equipment nec	9.5	87.8	0.1	2.5	15.1	80.8	0.2	4.0	2.5	3.3
Electronic equipment	1.6	97.3	0.0	1.1	2.7	95.4	0.0	1.9	4.0	3.8
Machinery and equipment nec	5.9	89.9	0.0	4.1	9.5	83.8	0.1	6.6	10.4	9.6
Manufactures nec	9.9	87.5	0.0	2.6	15.6	80.2	0.0	4.1	13.0	11.8
Total	24.7	62.8	0.7	11.7	33.6	49.6	1.0	15.8	10.2	9.4

Table8a-- Emissions Modal Shares and Growth, by Exporter

By Exporter	Emissions Shares HIGH Scenario				Emissions Shares LOW Scenario				Emissions Growth	
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	HIGH Sc.	LOW Sc.
World	24.7	62.8	0.7	11.7	33.6	49.6	1.0	15.8	10.2	9.4
Europe										
Austria	6.5	60.7	1.8	30.9	8.8	47.3	2.4	41.5	8.2	6.0
Belgium	20.5	41.3	0.9	37.3	24.8	29.0	1.1	45.1	5.1	3.8
Denmark	24.3	64.9	0.1	10.6	33.4	51.8	0.2	14.6	5.5	6.1
Finland	39.3	50.3	0.8	9.7	49.8	37.0	1.0	12.3	7.2	6.9
France	12.9	63.2	0.8	23.1	17.6	50.0	1.1	31.4	9.7	7.7
Germany	12.2	57.0	1.0	29.9	16.0	43.5	1.3	39.3	8.5	6.3
Greece	24.7	44.1	0.1	31.0	30.3	31.4	0.2	38.1	8.9	7.7
Ireland	8.4	88.6	0.0	3.0	13.4	81.9	0.0	4.8	8.1	7.3
Italy	14.6	52.2	0.7	32.5	18.7	38.8	0.9	41.6	13.7	9.8
Netherlands	19.6	41.5	3.1	35.8	23.7	29.1	3.8	43.4	0.9	0.3
Portugal	15.4	47.4	0.0	37.2	19.2	34.4	0.1	46.4	12.4	10.1
Spain	20.0	37.2	0.3	42.6	23.6	25.6	0.4	50.4	12.6	8.2
Sweden	23.7	55.9	4.4	15.9	31.0	42.5	5.7	20.8	9.1	6.7
United Kingdom	21.3	76.9	0.1	1.7	31.4	66.0	0.2	2.5	10.7	10.6
Rest of European Union	13.8	35.1	6.1	45.0	16.2	23.9	7.2	52.7	13.1	13.2
Rest of European Countries	29.2	47.4	1.3	22.0	36.5	34.4	1.6	27.5	4.8	4.1
Other CEE and Other CIS	40.2	7.7	9.0	43.1	41.5	4.7	9.3	44.6	10.9	10.7
Russia	49.1	22.6	10.1	18.1	54.3	14.5	11.2	20.0	15.7	14.3
North America										
Canada	41.5	24.2	6.2	28.1	46.2	15.6	6.9	31.3	9.6	8.2
Unites States	10.7	82.8	0.2	6.2	16.4	73.7	0.3	9.5	9.0	8.2
Mexico	25.7	16.5	3.7	54.1	27.6	10.3	4.0	58.1	6.2	5.2

Table8a-- Emissions Modal Shares and Growth, by Exporter

By Exporter	Emissions Shares HIGH Scenario				Emissions Shares LOW Scenario				Emissions Growth	
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	HIGH Sc.	LOW Sc.
Asia										
Japan	23.1	76.9	0.0	0.0	34.1	65.9	0.0	0.0	7.1	7.6
Korea	33.1	66.9	0.0	0.0	46.0	54.0	0.0	0.0	0.2	1.0
Singapore	15.0	85.0	0.0	0.0	23.2	76.8	0.0	0.0	14.9	13.8
Malaysia-Indonesia	75.6	24.4	0.0	0.0	84.2	15.8	0.0	0.0	4.6	4.3
China-Hong Hong	36.8	57.6	0.1	5.5	48.5	44.2	0.2	7.2	30.9	26.4
Taiwan	27.9	72.1	0.0	0.0	39.9	60.1	0.0	0.0	2.8	4.0
East Asia	8.1	86.4	0.2	5.3	12.7	78.7	0.4	8.2	11.6	10.4
Rest of South Asia	21.3	73.4	0.2	5.2	30.7	61.5	0.3	7.5	25.6	27.2
Rest of South East Asia	44.7	48.6	0.0	6.7	56.1	35.5	0.0	8.4	15.0	15.3
India	41.5	54.7	0.1	3.7	53.8	41.2	0.2	4.8	45.2	43.5
Oceania	75.6	24.4	0.0	0.0	84.2	15.8	0.0	0.0	9.1	7.1
Latin America										
Argentina	55.4	31.3	0.1	13.2	63.8	20.9	0.1	15.2	39.1	38.2
Brazil	61.5	32.3	0.0	6.1	71.2	21.7	0.0	7.1	15.3	14.7
Chile	48.0	45.8	0.0	6.2	59.4	32.9	0.0	7.7	0.8	1.5
Other South America	62.9	26.7	0.1	10.3	70.8	17.5	0.1	11.6	10.5	10.6
C America & Caribbean	50.9	43.0	0.1	6.1	62.0	30.5	0.1	7.4	22.3	24.8
Africa										
Middle East & N Africa	68.5	7.9	0.0	23.6	70.8	4.8	0.0	24.4	11.0	10.4
South Africa	34.2	19.2	0.0	46.6	37.2	12.1	0.0	50.6	1.7	1.2
Sub-Saharan Africa	46.2	25.2	0.0	28.6	51.6	16.4	0.0	32.0	13.1	10.1

Table8b-- Emissions Modal Shares and Growth, by Importer

By Importer	Emissions Shares HIGH Scenario				Emissions Shares LOW Scenario				Emissions Growth	
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	HIGH Sc.	LOW Sc.
World	24.7	62.8	0.7	11.7	33.6	49.6	1.0	15.8	10.2	9.4
Europe										
Austria	11.0	54.0	4.8	30.1	14.3	40.6	6.2	39.0	7.0	6.0
Belgium	39.2	47.8	0.5	12.5	49.0	34.7	0.6	15.6	8.3	8.2
Denmark	20.9	55.8	0.3	23.0	27.2	42.3	0.5	30.0	10.4	8.2
Finland	25.1	47.7	6.7	20.5	31.4	34.7	8.3	25.6	5.5	5.1
France	20.5	64.8	0.4	14.3	28.1	51.7	0.6	19.6	9.0	7.7
Germany	15.4	69.6	0.8	14.3	21.7	57.1	1.1	20.2	9.5	8.9
Greece	29.4	38.0	0.5	32.1	35.0	26.3	0.6	38.2	7.3	5.8
Ireland	7.4	89.7	0.1	2.8	11.9	83.5	0.1	4.5	9.9	9.8
Italy	28.2	46.1	2.0	23.7	35.0	33.2	2.4	29.3	6.9	5.7
Netherlands	48.5	38.8	0.1	12.6	57.9	26.9	0.1	15.1	7.8	8.2
Portugal	30.6	44.4	0.2	24.9	37.5	31.7	0.2	30.6	8.9	8.0
Spain	48.2	27.6	0.3	23.9	54.5	18.2	0.3	27.1	4.7	3.9
Sweden	18.0	64.8	0.4	16.7	24.8	51.7	0.6	22.9	8.7	7.9
United Kingdom	16.0	80.6	0.0	3.4	24.1	70.7	0.1	5.1	12.9	13.0
Rest of European Union	12.0	53.0	9.8	25.2	15.4	39.6	12.6	32.4	18.6	16.5
Rest of European Countries	12.3	67.7	1.1	18.9	17.1	55.0	1.5	26.4	10.4	9.8
Other CEE and Other CIS	35.8	25.0	6.7	32.4	40.0	16.2	7.5	36.2	7.9	8.1
Russia	27.2	26.3	3.9	42.5	30.6	17.2	4.4	47.8	20.4	20.2
North America										
Canada	9.8	89.6	0.0	0.6	15.7	83.3	0.0	0.9	-5.0	-4.6
Unites States	35.7	53.3	1.3	9.6	46.0	39.9	1.7	12.4	4.3	3.6
Mexico	7.4	19.2	2.6	70.8	8.0	12.1	2.8	77.0	-8.4	-11.9

Table8b-- Emissions Modal Shares and Growth, by Importer

By Importer	Emissions Shares HIGH Scenario				Emissions Shares LOW Scenario				Emissions Growth	
	Sea	Air	Rail	Road	Sea	Air	Rail	Road	HIGH Sc.	LOW Sc.
Asia										
Japan	27.4	72.6	0.0	0.0	39.4	60.6	0.0	0.0	11.9	11.7
Korea	30.0	70.0	0.0	0.0	42.5	57.5	0.0	0.0	14.1	13.4
Singapore	11.0	89.0	0.0	0.0	17.5	82.5	0.0	0.0	5.5	5.5
Malaysia-Indonesia	20.2	79.8	0.0	0.0	30.3	69.7	0.0	0.0	8.1	8.0
China-Hong Hong	31.6	66.5	0.0	1.8	43.9	53.6	0.1	2.4	41.9	42.0
Taiwan	20.6	79.4	0.0	0.0	30.8	69.2	0.0	0.0	6.7	6.9
East Asia	27.6	63.5	0.4	8.5	37.6	50.3	0.6	11.6	8.8	7.9
Rest of South Asia	51.9	39.0	0.3	8.7	62.1	27.1	0.4	10.5	12.6	13.2
Rest of South East Asia	23.7	73.1	0.0	3.3	34.1	61.2	0.0	4.7	6.0	7.7
India	48.8	50.5	0.0	0.6	61.9	37.2	0.0	0.8	37.1	36.2
Oceania	27.2	72.8	0.0	0.0	39.1	60.9	0.0	0.0	13.7	14.6
Latin America										
Argentina	32.5	51.1	0.1	16.3	41.4	37.8	0.2	20.7	26.9	24.1
Brazil	26.0	67.7	0.1	6.3	36.3	54.9	0.1	8.8	25.4	23.2
Chile	23.2	53.2	0.0	23.6	29.8	39.8	0.1	30.4	7.2	6.9
Other South America	28.4	50.2	0.0	21.4	36.0	36.9	0.0	27.0	11.7	9.2
C America & Caribbean	49.0	43.4	0.1	7.5	59.9	30.8	0.2	9.2	10.6	10.6
Africa										
Middle East & N Africa	30.1	43.6	0.0	26.3	36.8	31.0	0.0	32.2	7.3	8.5
South Africa	12.8	36.2	0.0	51.0	15.1	24.8	0.0	60.1	4.8	4.3
Sub-Saharan Africa	29.9	28.2	0.0	41.9	33.9	18.6	0.0	47.5	11.6	10.6

Table9-- Output related Greenhouse Gas Emissions by Sector

By Commodity	Base Year Levels				Growth			
	Output Share	CO2 Emis.	Non-CO2 Emis.	Greenhouse Gas	Output	CO2 Emis.	Non-CO2 Emis.	Greenhouse Gas
Bulk Agriculture	1.1	136.6	1637.1	1773.7	-2.5	0.7	-2.1	-1.9
Processed Agriculture	7.1	421.0	3714.1	4135.1	-1.3	-0.4	1.5	1.3
Forestry	0.2	27.3	0.2	27.5	-0.6	-1.0	-1.7	-1.0
Fishing	0.2	78.4	0.4	78.8	0.5	1.7	1.4	1.7
Minerals	0.6	134.4	375.7	510.1	-1.6	-3.1	-2.3	-2.5
Oil	0.7	252.7	256.5	509.2	1.0	0.2	2.3	1.3
Gas	0.2	115.0	104.8	219.8	0.7	-2.0	1.8	-0.2
Textiles	1.3	88.4	0.4	88.8	-0.9	6.7	-6.7	6.6
Wearing apparel	0.9	23.4	0.0	23.4	-2.9	1.0		1.0
Leather products	0.4	9.8	0.0	9.8	-1.2	2.1		2.1
Wood products	1.0	31.5	0.1	31.6	-1.1	-2.5	-0.6	-2.5
Paper products, publishing	2.1	215.7	2.1	217.8	-0.9	-1.6	-1.1	-1.6
Petroleum, coal products	1.3	625.9	180.4	806.3	-0.5	0.1	1.7	0.5
Chemical, rubber, plastic products	4.6	909.4	307.1	1216.5	-1.7	-0.7	-3.7	-1.5
Mineral products nec	1.4	676.2	4.3	680.5	-0.5	-1.0	-0.3	-1.0
Ferrous metals	1.4	562.7	5.3	568.0	-1.2	-3.3	-2.0	-3.3
Metals nec	0.8	148.6	64.4	213.0	-1.4	-3.1	-1.7	-2.7
Metal products	1.7	72.9	0.3	73.2	-0.9	-2.1	-3.1	-2.1
Motor vehicles and parts	2.9	42.8	0.1	42.9	-1.0	-5.1	-2.6	-5.1
Transport equipment nec	0.9	20.4	0.1	20.5	-0.5	0.0	-1.8	0.0
Electronic equipment	2.9	31.2	166.1	197.3	-0.9	0.1	-0.5	-0.4
Machinery and equipment nec	4.4	103.6	0.7	104.3	-0.9	-3.4	-3.5	-3.4
Manufactures nec	1.1	46.3	0.5	46.8	-1.3	-4.6	-1.5	-4.6
Electricity	1.9	9181.6	52.5	9234.1	-0.4	-0.6	-0.8	-0.6
Gas manufacture, distribution	0.2	202.5	193.5	396.0	-0.3	-0.4	-0.8	-0.6
Services	53.5	1276.1	1364.9	2641.0	-0.5	0.0	0.4	0.2
Transport nec	3.7	2543.6	464.8	3008.4	0.0	0.1	0.0	0.1
Water transport	0.6	373.5	9.4	382.9	6.3	6.1	6.5	6.1
Air transport	0.8	0.0	34.3	34.3	0.3		0.1	0.1
Total	100.0	18351.5	8940.1	27291.6	-0.7	-0.4	0.2	-0.2

Table10-- Output related Greenhouse Gas Emissions by Country

By Country	Base Year Levels				Growth			
	Output Share	CO2 Emis.	Non-CO2 Emis.	Greenhouse Gas	Output	CO2 Emis.	Non-CO2 Emis.	Greenhouse Gas
World	100.0	18351.5	8940.1	27291.6	-0.7	-0.4	0.2	-0.2
Europe								
Austria	0.6	40.7	14.0	54.7	-0.9	0.1	-3.2	-0.7
Belgium	0.8	76.9	22.2	99.1	-1.4	0.3	-5.9	-1.1
Denmark	0.5	39.9	14.8	54.7	-0.6	-0.2	-1.4	-0.5
Finland	0.4	46.9	11.6	58.5	-0.5	-0.4	-5.2	-1.3
France	3.9	230.1	145.5	375.6	-1.2	-0.2	-3.6	-1.5
Germany	6.0	576.4	151.2	727.6	-0.9	-0.3	-3.2	-0.9
Greece	0.4	72.8	24.9	97.7	-1.3	1.0	-1.6	0.3
Ireland	0.4	31.2	24.0	55.2	-1.6	-1.6	-11.8	-6.0
Italy	3.3	292.4	83.2	375.6	-1.0	-0.6	-2.1	-1.0
Netherlands	1.3	150.9	41.4	192.3	-1.5	-0.3	-3.9	-1.1
Portugal	0.4	50.1	16.5	66.6	-3.0	-1.2	-5.5	-2.3
Spain	1.8	215.8	67.6	283.4	-1.2	0.2	-3.2	-0.6
Sweden	0.7	32.7	14.1	46.8	-0.1	0.7	-4.2	-0.8
United Kingdom	4.5	421.4	96.6	518.0	-1.2	-0.8	-1.8	-1.0
Rest of European Union	1.8	570.1	181.3	751.4	-1.2	-0.2	-0.5	-0.3
Rest of European Countries	1.3	74.8	21.1	95.9	-1.2	-0.6	2.6	0.1
Other CEE and Other CIS	2.0	817.8	553.8	1371.6	-2.0	-0.8	-1.3	-1.0
Russia	1.1	1249.5	366.7	1616.2	1.6	1.4	2.0	1.6
North America								
Canada	2.1	416.9	151.9	568.8	-1.4	-0.8	2.5	0.1
Unites States	30.6	4340.9	1090.8	5431.7	-1.3	-1.1	2.7	-0.3
Mexico	1.8	299.3	184.3	483.6	-2.1	-1.8	-1.8	-1.8

Table10-- Output related Greenhouse Gas Emissions by Country

By Country	Base Year Levels				Growth			
	Output	CO2	Non-CO2	Greenhouse	Output	CO2	Non-CO2	Greenhouse
Asia								
Japan	12.5	842.2	92.3	934.5	0.1	0.5	-5.4	-0.1
Korea	1.7	303.5	61.4	364.9	2.6	5.5	-11.2	2.7
Singapore	0.4	37.5	4.0	41.5	3.0	8.3	-1.2	7.4
Malaysia-Indonesia	0.9	314.5	233.6	548.1	2.0	1.6	2.1	1.9
China-Hong Hong	6.1	2637.5	1451.8	4089.3	0.9	-1.7	-6.5	-3.4
Taiwan	1.0	184.2	28.9	213.1	1.4	3.5	-3.7	2.5
East Asia	0.1	73.9	60.0	133.9	2.4	1.3	1.1	1.2
Rest of South Asia	0.4	117.6	255.9	373.5	-2.5	-5.2	-3.0	-3.7
Rest of South East Asia	1.0	256.6	321.6	578.2	2.5	1.6	5.5	3.8
India	1.5	830.2	540.6	1370.8	-3.9	-4.9	-6.1	-5.4
Oceania	1.3	339.1	199.6	538.7	2.4	0.6	11.2	4.5
Latin America								
Argentina	0.7	91.5	149.1	240.6	3.4	2.0	13.2	9.0
Brazil	1.5	212.0	496.7	708.7	2.1	0.4	15.5	11.0
Chile	0.2	40.6	19.5	60.1	0.2	-1.1	2.2	-0.1
Other South America	0.9	210.5	314.8	525.3	-1.4	-3.3	4.2	1.2
C America & Caribbean	0.7	157.0	79.5	236.5	0.7	-2.3	7.5	1.0
Africa								
Middle East & N Africa	2.5	1248.6	441.4	1690.0	-0.7	2.8	-1.5	1.7
South Africa	0.4	295.3	75.0	370.3	-1.0	-1.6	2.5	-0.8
Sub-Saharan Africa	0.7	111.7	836.9	948.6	-2.3	-1.8	0.0	-0.2

Table 11 CO_2 Emissions by Transport Mode

	CO_2 Emissions (g / t-km)	Source:
Maritime		
Dry Bulk	4.5	University of Athens 2008
Container	12.1	University of Athens 2008
Crude Oil	5	University of Athens 2008
LNG	16.3	University of Athens 2008
LPG	12.7	University of Athens 2008
Chemical	10.1	University of Athens 2008
Land		
Road	119.7	Giannouli and Mellios, EEA, 2005
Rail	22.7	
Air		
Boeing 747	552	Maersk
Various	476-1020	California Climate Change 2006
US Cargo Fleet	963.45	Author's calculations based on ATA fuel usage data
US Cargo Fleet	912	Authors' calculations based on Aircraft Economics 1999 data