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A linear model to estimate modal split in international freight transport, based on revealed preferences about cost and time saving

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Abstract

We present a new model for estimating the distribution of international freight transport over transport modes that is directly applicable to aggregated data, allows estimations and predictions also when some modes are infeasible on some routes, and requires few processing time and memory space. It builds on the assumption that demand for transport by a given mode is driven by trading firms' and consumers' preferences about saving transport costs and time. In contrast to conventional mode-choice models, it is linear and grounded on consumer demand theory. Applying the model to international freight transport as recorded in the latest upgrade of UN Comtrade reveals an average cost elasticity of transport demand of − 0.32 and an average time elasticity of − 0.18. In addition, we find significant independent mode-specific effects. Cost and time elasticities are highly dependent on the type of commodity transported. The cost elasticity ranges from zero to − 1.9 and the time elasticity from zero to − 3.3 across commodity groups defined at the four-digit level of the Harmonized System classification. These findings suggest that policy measures, exogenous shocks or other events that change the relative transport costs and transit times across modes can cause modal shifts—for some commodities more than for others—thereby mitigating the loss in welfare.

Keywords: Freight transport, International trade, Modal split, Consumer demand theory, Linear models

Introduction

Background

In recent times, disruptions in the global freight transport system, caused for example by the COVID-19 pandemic, the Evergiven accident, and the war in Ukraine, inflicted strong repercussions on the world economy (UNCTAD 2021a, 2022). However, international freight transport has received relatively little attention in the literature during the past decades, providing a slim evidence base for assessing the economic impact of those shocks. Furthermore, international transport has been identified to be an important source of global greenhouse gas emissions. Therefore national governments, the

International Civil Aviation Organization and the International Maritime Organization (IMO) are developing strategies to reduce carbon emissions from trucks, trains, airplanes and ships (Barrowclough et al. 2021). In the light of these developments, there is growing need for assessing the impact of frictions in global freight transport and the effects of policy measures targeting decarbonization on the world economy.

External shocks and policy measures affecting transport are likely to induce changes in the distribution of demand across modes. Shippers can save costs by substituting expensive transport modes with less costly ones, thereby reducing the impact of that event on trade cost. In 2022, several European countries built new liquified natural gas terminals in ports to increase capacities to receive gas delivered by sea, in response to a drop of gas supply through pipelines from Russia. Trains carrying cereals for export to Africa left Ukraine through Europe—a transport route too expensive to be considered for that journey in the past. A recent study (Lugovskyy et al. 2023) predicts a significant shift of international freight transport towards the United States of America from maritime to air in response to rising costs of maritime transport caused by greenhouse gas reduction measures for ships currently under development by the IMO. Sometimes, policy measures are specifically targeted at promoting a shift of transport from more to less emission intensive modes (Kaack et al. 2018).

The possibility of behavioural adjustments to external shocks and policy measures as described above needs to be considered in any exhaustive impact assessment model. Transport costs and transport time are common intermittent variables in those models, as they are, on the one side, directly impacted by external shocks and policy interventions, and they shape shippers' mode choice on the other. Value-of-time analyses are also a common component in the evaluation of transport infrastructure projects and investments into new types of vehicles (Becker 1965; Binsuwadan et al. 2022). The aim of the present study is to analyze in detail effects of these variables on the allocation of international freight transport across modes.

Previous research

A broad and prolific literature analyzing model split in transport has emerged during the last decades. Comprehensive and systematic overviews can be found, for instance, in Nuzzolo et al. (2013), Beuthe et al. (2014), and Zlatoper and Austrian (1989). The vast majority of studies focus on passenger transport, where the estimation of the mode share has usually been treated as a discrete variable problem. Accordingly, empirical transport models have often been specified as multinomial logit models, usually estimated by means of maximum likelihood (McFadden 1974; Wen and Koppelmann 2001; Halim et al. 2018). In light of an increasing availability of big data in transportation, non-parametric approaches, including machine learning techniques, such as neural networks (Celikoglu 2006; Bentz and Merunka 2000) and random forests, have also become widespread (Wang et al. 2017, 2018; Lee et al. 2018).

Conventional discrete choice models are powerful tools for the estimation of modal split when the underlying dataset consists of microdata on categorical variables recording the individual choices made by—or on behalf of—the individual transported units among a constant set of available modes. This is usually the case for example in passenger surveys. The usefulness of conventional discrete choice models

is limited when the underlying dataset is comprised of aggregated data and includes continuous variables. It is especially complicated when the set of available choices varies across observation units.

Continuous variables occur for example in freight transport, where choices are usually made by shippers and logistics service providers, and these may choose to distribute transport of goods across several modes in specific proportions (ITF 2022). Examples for aggregated datasets include UN Comtrade, a global database on international merchandise trade with a breakdown by transport mode, as well as datasets obtained from aggregation of observations from automatic identification systems or transport tracking systems. Aggregation of categorical variables over a sufficiently large number of observations requires the use of continuous variables. These hide the distribution of choices made by individual actors, so that the main strength of multinomial logit, "to deduce from the individual choice model properties of population choice behaviour" or vice versa (McFadden 1974), cannot be leveraged.

The assumption of a constant set of available choices is violated for example when the database records transport from different origins or to different destinations and not all origins or destinations can be reached by all modes. The model presented in the paper is suited for estimations in these types of data environments. This methodological advancement will therefore enable efficient estimation of modal split in international trade data and other large freight transport datasets, cases in which conventional multinomial logit have reached their limits with regards to conceptual applicability, processing time and use of memory space. A recent application case has been the construction of the Trade-and-Transport Dataset, launched by UN Trade and Development and the World Bank in May 2024 (UNCTAD and World Bank 2024). The model could also help develop further the simulation of the modal split within the Global Trade Analysis Project.

In this study, we make use of macro-level data newly available in the UN Comtrade database in which the value of bilateral trade, detailed by commodity group, is reported gross and net of transport costs and broken down by the mode of transport. These data are not recorded at transaction level but represent sums of transactions at the level of countries and groups of commodities.

Friedlaender and Spady (1980) and, more recently, Hummels and Schaur (2013) present models for the estimation of mode shares in freight transport based on aggregated data. While Friedlaender and Spady treat transport as a factor of production, Hummels and Schaur consider delivery time as a determinant of quality of the supplied good, within an international trade model. Hummels' and Schaur's study has set a landmark by providing a micro-foundation of an international trade model on the macro-level, tracing revenue ratios observed at the level of countries to the underlying choice probabilities of individual firms engaged in international trade within those countries. In theory, the proportions in which firms with different characteristics are represented in the importing country may have an impact on the modal split of imports, according to the model. Yet, for the estimation, the aggregated nature of the data does not allow to leverage that effect. It is therefore treated as an unobservable component within the residual in Hummels' and Schaur's analysis.

Approach and proceeding

In the present study, we approach the estimation of modal split from a different angle, namely from the perspective of consumer demand analysis, treating bilateral trade as exogenous. Common models of consumer demand analysis differ from discrete choice models by treating population choice as the choice made by a representative consumer with regard to a *continuous* variable (Deaton and Muellbauer 1980; Varian 2010), rather than as the sum of *discrete* choices made by numerous actors. The resulting models are most often linear and can be estimated with least squares, a usually faster and more resource efficient technique than maximum likelihood and the machine learning techniques mentioned above, provided that certain conditions are met. Making slightly simplifying assumptions of consumer demand analysis, namely continuous choice and "exact aggregation" (Deaton and Muellbauer 1980), allows us to make predictions at the aggregate level, irrespective of whether the individual actors' mode choice is actually discrete or continuous, and in the absence of any information on the intra-country distribution of the determinants of those choices.

In this study, we focus on transport costs and transit time as the main determinants of modal split, in addition to possible independent mode-specific effects, and we explore the heterogeneity of the effects of these determinants across product groups. Transport costs and time have been identified by previous research as the main factors influencing mode choice (ITF 2022). Firms engaged in trade aim to keep transport costs low, as these add to the difference between purchaser prices and production costs. Transport costs negatively impact the firms' profit margin, to the extent that they are borne by the supplier, and reduce consumers' welfare, to the extent that they are passed through to the consumer. Saving transit time can be an important factor for firms engaged in trade to ensure cost-efficient production. Lengthy shipping times may impose inventory-holding and depreciation costs, lead to decay or technological obsolescence of traded goods, and lower firms' capabilities to rapidly adapt to changes in demand and supply (Hummels and Schaur 2013; ITF 2022). Consumers often appreciate quick delivery and freshness of certain consumption goods, such as cut flowers or foodstuffs, while they assign less importance of time for more durable goods such as cement, coal, and containerised non-edible goods. Shippers are well advised to take these preferences into account in their decisions on how to allocate the transport of internationally traded goods over different modes.

The contributions of this study to transport economics are both theoretical and practical. As regards its theoretical contributions, the study demonstrates how mode choice can be treated as a demand problem and presents an econometric model that can be directly applied to aggregated data, such as data on international merchandise trade; it is applicable in situations in which different sets of mode choices are available in the different observed cases; and it can be run in relatively short time on large amounts of data consuming few memory space. As regards its practical contribution, the study provides fairly comprehensive insights about the determinants of modal split in international freight transport, revealing in particular the costs of time from the market actors' perspective, at a fairly differentiated level of product disaggregation. This information can be useful for shipping companies and carriers to plan their supplies, for ports, airports and railway network agencies to take investment decisions, as well as for policy makers to assess the impact of

regulatory measures—for example a levy on fossil fuel consumption—and of global developments—as for example the closure of canals due to draught, opening up of new transport ways due to melting of arctic ice, unavailability of shipping routes due to military conflict—on their external trade.

In this study, we treat the modal split as the outcome of a demand problem in which shippers, in their efforts to match their customers' preferences, try to allocate the transport of given exports or imports over different modes, where we assume that the outcome of this allocation reveals firms' and consumers' competing preferences concerning low transport costs and short transit time. The remainder of this paper is organized as follows. In the next section, we formulate this demand problem algebraically and graphically. In Sect. "Data", we describe the data we use for the empirical analysis. In Sect. "Estimation", we develop the econometric model. In Sect. "Estimation results", we present the results. In Sect. "Conclusions", we discuss these results and conclude.

Optimal allocation of international trade across transport modes

The designation of variables in this and the next sections is as follows:

C commodity group.
C total transport costs.
d destination country.
D dummy variable for the use of a specific mode.
$D^{'}$ differential dummy variable.
o origin country.
p ad-valorem transport costs.
$p^{'}$ natural logarithm of ad-valorem transport costs.
s mode share.
t ad-valorem transit time.
$t^{'}$ natural logarithm of ad-valorem transit time.
T total transit time.
u utility.
y value of merchandise imports transported by a specific mode.
$y^{'}$ natural logarithm of the value of merchandise imports transported by a specific mode.
Y value of merchandise imports.
α total-imports elasticity of transport demand for a specific mode.
β cost elasticity of transport demand for a specific mode.
γ time elasticity of transport demand for a specific mode.
δ mode-specific fixed effect of transport demand for a specific mode.
ε error term.
Θ set of feasible transport modes.

Our aim is to model the allocation of merchandise imports of value Y over the different feasible modes, $i \in \Theta$, so that

$$Y = \sum\nolimits_{i \in \Theta} y_i. \tag{1}$$

Our guiding assumption is that this allocation is driven by market actors' preferences for saving transport costs and delivery time, where we assume that shippers, in their efforts to comply with the demands of their customers, maximize a utility function $u(C,T)$, where C designates transport costs and T designates total transit time, the sum of the hours which all units of goods, each worth one dollar, remain on transport. We assume that this utility function is differentiable and decreasing over C and T, with increasing marginal disutility:

$$\frac{\partial u(C,T)}{\partial C} < 0, \frac{\partial u(C,T)}{\partial T} < 0, \frac{\partial^2 u(C,T)}{\partial C} < 0, \frac{\partial^2 u(C,T)}{\partial T} < 0. \tag{2}$$

This reflects our assumption that market actors value saving transport costs and time, and that their incentive to do so increases with transport costs or transit time. We also assume homothetic preferences, i.e. any proportional increase of transport costs and time leads to a reduction of utility by the same factor:

$$u(\lambda C, \lambda T) = \frac{u(C,T)}{\lambda}. \tag{3}$$

The shippers' choice is optimized when they cannot achieve any gain in utility by shifting transport from one mode to the other. That means, in the optimum, for each pair of feasible modes for the transport of goods from a given origin to a given destination country, the marginal utility with respect to trade allocated to these modes must be equal,

$$\frac{\partial u(C,T)}{\partial y_i} = \frac{\partial u(C,T)}{\partial y_j}. \tag{4}$$

The budget spent on transport in the two modes is given by

$$C_{i\wedge j} = p_i y_i + p_j y_j, \tag{5}$$

where p_i and p_j designate the ad-valorem transport costs in the respective modes. The corresponding total transit time is given by

$$T_{i\wedge j} = t_i y_i + t_j y_j, \tag{6}$$

where t_i and t_j designate ad-valorem transit time, the time it takes to transport a good worth one dollar by the respective mode.

Applying formula (4), the optimum allocation of transport over the two modes can be derived as follows:

$$\frac{\partial u(C,T)}{\partial C}\frac{\partial C}{\partial y_i} + \frac{\partial u(C,T)}{\partial T}\frac{\partial T}{\partial y_i} = \frac{\partial u(C,T)}{\partial C}\frac{\partial C}{\partial y_j} + \frac{\partial u(C,T)}{\partial T}\frac{\partial T}{\partial y_j} \tag{7}$$

$$\frac{\partial u(C,T)}{\partial C}p_i + \frac{\partial u(C,T)}{\partial T}t_i = \frac{\partial u(C,T)}{\partial C}p_j + \frac{\partial u(C,T)}{\partial T}t_j$$

$$\frac{\frac{\partial u(C,T)}{\partial T}}{\frac{\partial u(C,T)}{\partial C}} = \frac{p_i - p_j}{t_j - t_i}$$

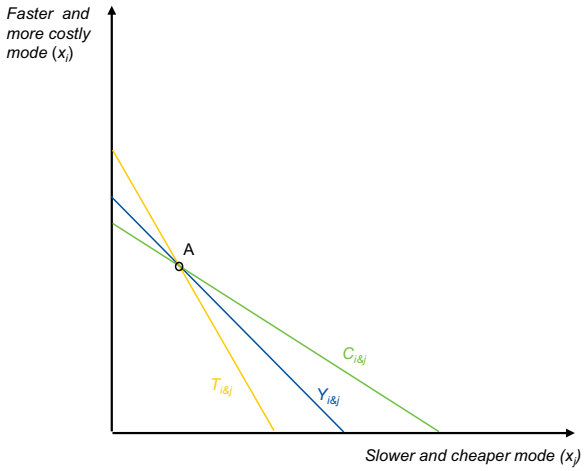

Fig. 1 Allocation of transport between modes

The term on the left-hand side is the marginal rate of substitution between transport costs and time. It is positive, as the first derivatives of the utility function with respect to transport costs and transit time, recorded in the numerator and the denominator, respectively, are negative. The term on the right-hand side represents the value of time, more precisely, the relative price of the time saving when mode i instead of mode j is chosen. It is positive whenever the faster mode is also the more expensive one.

From Eq. (7), we can derive the optimal total transit time for the trade in modes i and j as a function of the budget spent on transport in these modes at given ad-valorem freight rates and ad-valorem transit times: $T_{i\&j}^{*}(C_{i\&j}^{*}, p_i, p_j, t_i, t_j)$. By inserting the cost constraint from Eq. (5) for $C_{i\&j}^{*}$ and the time constraint from Eq. (6) for $T_{i\&j}^{*}$—both need to be met in the demand optimum—we can translate this function into an indirect relative demand function for mode i, expressed with reference to mode j: $y_i^{*}(y_j^{*}, p_i, p_j, t_i, t_j)$. We refer to this demand function as "indirect" because it expresses the demand for a given mode not as a function of its price, but as a function of the ad-valorem freight rates and ad-valorem transit times. We refer to it as relative, as it is expressed in relation to a reference mode, j. By summing up over all feasible modes i, keeping the reference mode j fixed, and inverting the result, we obtain the Marshallian (indirect) demand function of mode j:

$$\sum\nolimits_{i\epsilon\Theta} y_i\left(y_j, p_i, p_j, t_i, t_j\right) = Y\left(y_j, p_1, p_2, \ldots, t_1, t_2, \ldots\right) \tag{8}$$

$$\Longleftrightarrow y_j = y_j(Y, p_1, p_2, \ldots, t_1, t_2, \ldots)$$

Figures 1 and 2 show this optimization problem graphically. Let i denote the faster and more expensive mode and j the slower and cheaper mode. The graph in Fig. 1 depicts the three constraints that shippers face, formulated in the Eqs. (1), (5) and (6). The blue diagonal line represents the possible allocations of a constant volume of transported goods, of a total value of Y, over the modes i and j. The green, relatively flat, line represents the possible allocations over the two modes achievable with constant overall transport costs

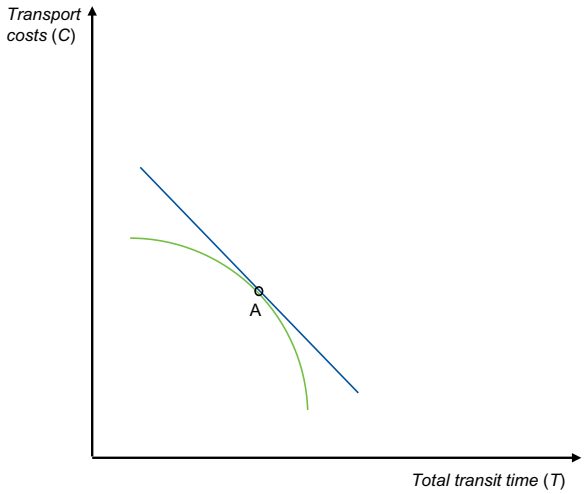

Fig. 2 Choice between transport costs and total transit time

(C). The yellow, relatively steep, line represents the allocations achievable with constant total travel time (T). In the demand optimum, all three constraints are met for the chosen combination of transport by the two modes, so the three lines need to intersect.

Figure 2 contrasts the achievable combinations of transport costs and total transit time with the shippers' preferences. The straight blue line is a possibility frontier depicting all at minimum achievable combinations of transport costs and total travel time in which the three constraints shown In Fig. 1 are met. Using Eqs. (1), (5) and (6), we can establish its functional form:

$$C = \frac{p_i t_j - p_j t_i}{t_j - t_i} Y - \frac{p_i - p_j}{t_j - t_i} T. \tag{9}$$

It shows that the slope of that line is determined by the relative price of time saving, introduced in Eq. (7) above. The green curve represents an indifference curve in line with the utility function in (2). The farther left or down an indifference curve is located, the higher the utility level it represents. If transit time increases, the market actors' utility will fall unless transport costs decrease. The compensation in transport costs needed to keep utility constant, after an increase of transport time by one unit, is the greater the higher transit time already is, due to the rising marginal disutility over transit time, and the smaller the level of transport costs, due to the rising marginal disutility over transport costs (see formula 2). The shape of the indifference curves is therefore concave.

Data

A recent upgrade of UN Comtrade (United Nations 2023), the main data source on international trade worldwide, offers new opportunities for the measurement of international freight transport. This upgrade has been made possible by a revision of the global compilation standards for international merchandise trade statistics in 2012 (UNSD 2011) which have gradually been implemented by countries in their compilation systems since then. For some countries, UN Comtrade Plus now records the value of imports in

terms of both the free-on-board (FOB) value and the cost-insurance-and-freight (CIF) value. While the free-on-board value is a fairly accurate representation of the market value of the transported goods—designated by variable *y* above—the difference between the CIF and the FOB value represents transport costs.

As another innovation, the value of imports, recorded CIF and FOB, is for some countries broken down by the mode of transport by which imported goods entered the importing country. This allows us to infer the proportions in which transport is realized via different modes as well as the corresponding transport costs.

It should be noted that the CIF-FOB margin calculated from the UN Comtrade data is a slightly different measure of transport costs than, for example, the shipping costs incurred by traders for physically transporting the goods, used by (UNCTAD 2021b) as a measure of the monetary component of the "total maritime logistic costs". First, the CIF-FOB margin includes not only the direct costs for moving the goods, but also the costs for their insurance against loss or damage. Second, conceptually, it is meant to measure the purely international transport costs, excluding the transport from the origin to the border of the exporting country and from the border of the importing country to the final destination (UNSD 2011).

With regard to the breakdown by modes, we should be aware that, by observing the mode by which transported goods entered the country, any change in mode during the travel of the goods from the exporting to the importing country is not taken into account. Goods may leave the exporting country by a different mode than the mode by which they arrive in the importing country, as they may be transloaded from one mode to the other on their way.

To obtain information on transport time, we combine the UN Comtrade Plus data with a matrix that records the time (t) needed for the shipment of a unit of a good from an exporting to an importing country on the optimal routes, depending on the chosen mode. These data have been compiled using a global transport network model based on a geographic information system (Halim et al. 2018).

At the time of our data extraction, for nine countries, data on imports in 2021 were recorded in UN Comtrade with the required level of detail—joint availability of the CIF and the FOB value and breakdown by mode—and for which transit times could be compiled in the time distance matrix. These comprise: Australia, Bolivia, Brazil, Czechia, the Dominican Republic, Ecuador, Serbia, Slovakia, and Türkiye. The data on these countries' imports are used for the estimation of the modal split in this study. Commodities are classified based on the Harmonized System (HS) classification, revision 2017, where we focus on the disaggregation at the heading level (four-digit codes) of HS. We limit our analysis to the imports that arrived in the reporting country by air, sea, rail, and road, as only for those modes transit times could be generated in the time distance matrix.

The constructed data set details imports from 128 origin countries, included in the time distance matrix, to the nine destination countries listed above. In this way we obtain data for 969 bilateral trade flows with their corresponding transport costs and transit times, involving 1,220 different commodity groups. Splitting up the 969 bilateral flows by the 1,220 commodity groups, we obtain 181,970 observations, for each of which a specific allocation of transport across modes can be observed.

In 111,726 cases, the entire trade took place by only one mode of transport: by air in 41,471 cases, by sea in 30,080 cases, by rail in 252 cases, and by road in 39,923 cases. They could therefore not be used for the estimation of the modal split. We estimate our model on the basis of the remaining 70,244 cases. In all except 177 cases, at least one mode of transport remained unused, likely due to its infeasibility on the specific trade link. For example, transport by rail or road is not possible for the delivery of goods to an island state; and transport by sea is not possible for the delivery of goods to a landlocked country. Non-validity of certain choices for a subset of observations usually imposes a challenge for the estimation of a demand system.

Estimation

One of the oldest models to estimate a demand function of the type in Eq. (8) is the double-logarithmic demand function, treated for the first time in systematic studies by Wold and Jureen (1952) and Stone (1954) (Brown and Deaton 1972; Deaton and Muellbaur, 1980). It assumes constant price and expenditure elasticities and follows from optimization of an additive and homothetic utility function (Sato 1972; Christensen et al. 1974). Applied to the present case, it would be formulated as:

$$y_{i,o,d} = \alpha Y_{o,d} {p_{i,o,d}}^{\beta} {t_{i,o,d}}^{\gamma} e^{\partial_i}, \tag{10}$$

where o designates the country of origin and d the destination country. β represents the cost elasticity and γ the time elasticity of transport demand. α is the total imports elasticity. It can be seen as the counterpart to total expenditures or income in the analysis of household demand. δ_i is a mode-specific effect that is independent of transport costs and time, caused for example by technical constraints, different degrees of reliability attached to specific modes, or shippers' preferences independently of their efforts for cost and time saving. All other variables in Eq. (10) have the same meaning as above.

Since the late 1960, double-logarithmic, also known as "constant elasticity", demand functions have become widespread in the estimation of import demand in international trade models (Mrázová and Neary 2014; Walmsley and Minor 2020). They form integral parts for example in the models of Armington (1969) and Dixit and Stiglitz (1977). By contrast, in private household demand analysis, they have been less frequently applied over time, mainly because the assumption of a constant income elasticity, having its counterpart as α in Formula (10), does not conform to Engel's law according to which expenditure shares vary across welfare levels (Brown and Deaton 1972). In the present case, however, Y is not a reflection of a representative consumer's level of welfare, but rather of overall transport demand generated by the merchandise trade between two countries, shaped by their size, their import demand and export supply. Our model of modal split is aimed to be independent of the size of the involved countries, the trade dependency and intensity of their trade relations. The constant elasticity of total transport demand is therefore seen as a reasonable assumption rather than a shortcoming for the present study. Among different functional forms tested on our data, the double-logarithmic form in Formula (10) matched the empirical relationships between the variables best. Its empirical validity is confirmed by the residuals plots below.

Another shortcoming of Stone's double-logarithmic demand function has been seen in its ignorance of the adding-up condition expressed in Formula 1 (Brown and Deaton 1972). In the present case, adding up is complicated by the fact that in most trade links not all modes are available. p_i and t_i are therefore not defined for all modes i in all observation units. For example, if the importing country is an island state, ad-valorem transport costs and transit times for rail and road are not defined; and if the importing country is landlocked, transport by sea is not an available choice. Consequently, the adding-up condition (1) cannot always be imposed on all existent modes, but only among the set of the modes ($\Theta_{o,d}$) that are feasible for the realization of the trade between country o to country d. Thus, the adding-up constraint from Eq. (1) is specific to the pair of trading partners:

$$Y_{o,d} = \sum\nolimits_{i \in \Theta_{o,d}} y_{i,o,d} \tag{11}$$

Estimating Eq. (10) as a demand system with one equation per mode, as it is common practice in consumer demand analysis, is therefore not an option.

Another particularity compared to conventional demand systems consists in the fact that the elasticities β and γ do not have the subscript i, as preferences for cost and time saving are independent of the pair of modes between which a choice is made. Dividing Eq. (10), which is defined for mode i, by the corresponding equation for an alternative mode j observed on the same trade link, thereby eliminating the large variation in $Y_{o,d}$ across trade links, we obtain:

$$\frac{y_{i,o,d}}{y_{j,o,d}} = \left(\frac{p_{i,o,d}}{p_{j,o,d}}\right)^{\beta} \left(\frac{t_{i,o,d}}{t_{j,o,d}}\right)^{\gamma} \frac{e^{\partial_i}}{e^{\partial_j}}. \tag{12}$$

The calculation of the mode share of mode j based on the corresponding set of pairwise ratios in Eq. (12) is straightforward, once we know the set of feasible modes:

$$s_{j,o,d} = \frac{y_{j,o,d}}{\sum_{i \in \Theta_{o,d}} y_{i,o,d}} = \left(\frac{\sum_{i \in \Theta_{o,d}} y_{i,o,d}}{y_{j,o,d}}\right)^{-1} = \left(\sum\nolimits_{j \in \Theta_{o,d}} \frac{y_{i,o,d}}{y_{j,o,d}}\right)^{-1}. \tag{13}$$

Taking the logarithm on both sides of formula (12) leads to

$$ln\left(\frac{y_{i,o,d}}{y_{j,o,d}}\right) = \beta ln\left(\frac{p_{i,o,d}}{p_{j,o,d}}\right) + \gamma ln\left(\frac{t_{i,o,d}}{t_{j,o,d}}\right) + \partial_i - \partial_j. \tag{14}$$

The term on the left is a log ratio, in binomial models also referred to as log odd. In contrast to the mode share, or the logarithm of the FOB value, or the FOB value itself, this number is unbounded from below and above and usually follows an approximately symmetric distribution, providing beneficial conditions for estimation with least squares. The distribution of the log ratio in the present data is presented in Fig. 3.

If $n_{o,d}$ designates the number of feasible modes in the transport from country o to country d, we will find $n_{o,d}$—1 linear independent pairwise ratios per pair of trading

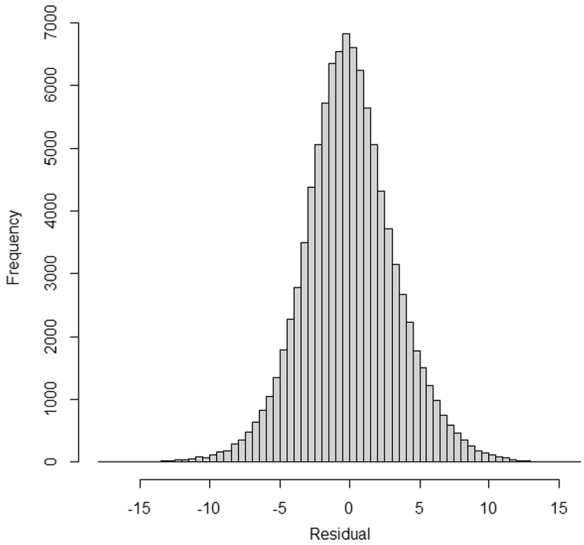

Fig. 3 Distribution of the log ratio of transport demand (FOB value) between modes

partners which we can use in the regression. The division by $y_{j,o,d}$ in Eq. (12) has the advantage that it cleans the estimation from trade-link specific fixed effects.

To estimate Eq. (14) with ordinary least squares (OLS), we define $y'_{i,j} = ln\left(\frac{y_i}{y_j}\right)$, $p'_{i,j} = ln\left(\frac{p_i}{p_j}\right)$ and $t'_{i,j} = ln\left(\frac{t_i}{t_j}\right)$. We also declare a set of dummy variables $D_{k,i}$ that are 1 if $k = i$ and zero otherwise. Adding the suffix c, to differentiate by commodity group, and adding a, by assumption, normally distributed error term ε, we arrive at the econometric model:

$$y'_{i,j,o,d,c} = \beta p'_{i,j,o,d,c} + \gamma t'_{c,i,j,o,d} + \left(\sum\nolimits_k \partial_k D_{k,i,o,d,c}\right) - \left(\sum\nolimits_k \partial_k D_{k,j,o,d,c}\right) + \varepsilon_{i,j,o,d,c}, \tag{15}$$

which can be simplified to

$$y'_{i,j,o,d,c} = \beta p'_{i,j,o,d,c} + \gamma t'_{i,j,o,d,c} + \left(\sum\nolimits_k \partial_k \left(D_{k,i,o,d,c} - D_{k,j,o,d,c}\right)\right) + \varepsilon_{i,j,o,d,c}. \tag{16}$$

We finally declare a variable that measures the difference between two dummy variables that refer to the same MoT:

$$D'_{k,i,j,o,d,c} = D_{k,i,o,d,c} - D_{k,j,o,d,c}. \tag{17}$$

This 'differential dummy' takes the value 1 if mode k is in the numerator, -1 if mode k is in the denominator, and zero otherwise. Note that the differential dummy of one mode is linear dependent on all others, as it takes the inverse value of their sum. To see this, consider that

$$\sum\nolimits_k D_{k,i,o,d,c} - D_{k,j,o,d,c} = 0 \tag{18}$$

$$\iff \sum\nolimits_k D'_{k,i,j,o,d,c} = 0.$$

Table 1 Pooled OLS regression of the log ratio of transport demand (FOB value) between modes over determinant variables

Variable	Coefficient/statistics	
Intercept	−2.256	(0.049) ***
Ad-valorem transport costs (log ratio)	−0.320	(0.007) +++
Transit time (log ratio)	−0.185	(0.014) +++
Mode: air (differential dummy)	−3.461	(0.046) ***
Mode: rail (differential dummy)	0.584	(0.048) ***
Mode: road (differential dummy)	2.209	(0.049) ***
N	99,182	
Degrees of freedom	99,176	
R^2	0.121	

Standard errors in parentheses. *** Significant at the 0.1 percent level, ** Significant at the 1 percent level. * Significant at the 10 percent level, +++ Significantly negative at the 0.1 percent level, ++ Significantly negative at the 1 percent level. +Significantly negative at the 10 per cent level

One differential dummy will therefore drop out from the regression. Using formula (17) in formula (16), we obtain the final econometric model:

$$y'_{i,j,o,d,c} = \beta p'_{i,j,o,d,c} + \gamma t'_{i,j,o,d,c} + \left(\sum\nolimits_k \partial_k D'_{k,i,j,o,d,c}\right) + \varepsilon_{i,j,o,d,c}. \tag{19}$$

Estimation results

Pooled estimation

Estimating the model in Eq. (19) with OLS, we obtain significantly negative effects of transport costs and transit time on transport demand at the 0.1 percent level (see Table 1). On average, an increase of ad-valorem transport costs in a mode by 1 percent leads to a reduction of transport demand in that mode by 0.32 per cent, and a 1 percent increase of transit time to a reduction of transport demand in that mode by 0.19 per cent, keeping the volume of bilateral trade of the commodity constant. The ratio between these two coefficients indicates the value of time. A one-percent increase of transit time in a mode would need to be offset by a decrease of transport costs by 0.58 percent—the ratio γ/β in formula (18)—to keep transport demand in that mode unchanged, as transport demand reacts to changes in transit time with a lower elasticity than to changes in transport costs. In addition, our results reveal significant mode-specific effects on the modal split that are independent of transport costs and time. These may be due to technical constraints, different degrees of reliability attached to specific modes, and other factors influencing market actors' preferences beyond considerations about transport costs and time.

As Fig. 4 shows, the residuals are approximately normally distributed with zero mean over the full range of the dependent variable. This supports our choice of the functional form. By pooling all observations in one regression we obtain sufficient degrees of freedom for highly precise estimates of the average effects. For example, the standard errors

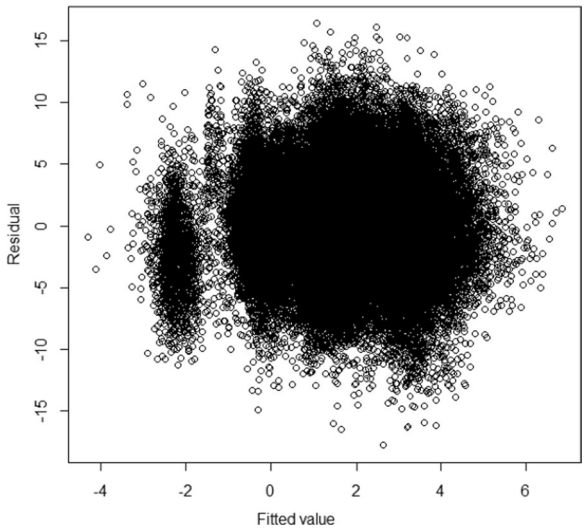

Fig. 4 Residuals-versus-fitted plot of the pooled regression

of transit time and ad-valorem transport costs amount to only 3 and 7 per cent of their corresponding point estimators, respectively. That means, stochastically, the true value of the transport cost elasticity lies between −0.334 and −0.306 and that of the time elasticity between −0.212 and −0.158 with a probability of 95 percent.

However, a considerable proportion of variation in the dependent variable is not explained by the pooled regression above, as the coefficient of determination (R^2) of 0.12 indicates. Many other factors beyond transport costs, transit time and mode-specific preferences may drive the allocation of transport over modes. The characteristics of the transported goods presumably play an important role. Some goods are more practical to be transported by a given mode than others, due to their technical circumstances. Time may be a relevant factor for the demand for perishable goods, for goods subject to sudden changes in demand and supply, such as medical equipment after the outbreak of a disease, and for products in sectors with a dynamic technological development. Transport costs may play a role mainly in the case of goods with high price-elasticity of demand or goods with a low market value compared to their transport costs (Hummels and Schaur 2013). This heterogeneity is not considered in the pooled estimation above.

Estimation by commodity group

To capture heterogeneity across commodity groups, we run the model in Eq. (19) individually for each commodity group, focusing on the 828 out of 1,187 groups represented with more than 20 observations in our dataset. The results are reported in Table 2 in the Annex. The R^2 calculated from the actual and fitted values over all 828 regressions reaches 0.383, indicating a much higher explanatory power of this model than with the pooled regression model above. In 86 group-wise regressions, we obtain an R^2 higher than 0.5. As expected, the confidence level of the individual coefficients is usually lower than in the pooled regression above, due to the smaller number of degrees of freedom per regression.

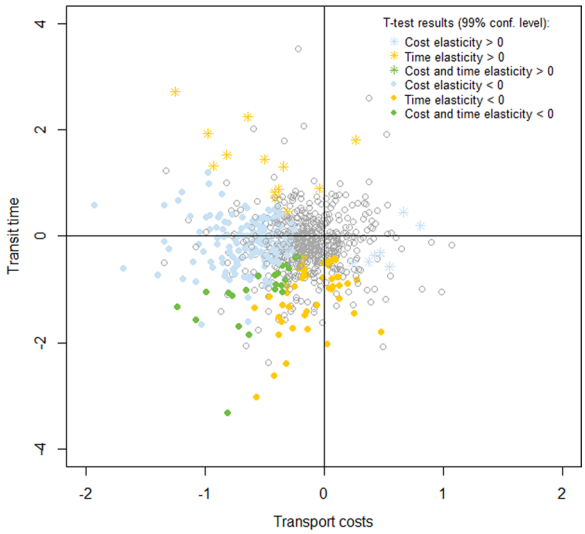

Fig. 5 Estimated elasticities of ad-valorem transport costs and transit time, by commodity group

We find a considerable variation of the coefficients across commodity groups. For almost one fourth (191 out of 828) of the analyzed commodity groups, the regressions reveal a negative effect of relative ad-valorem transport costs on mode-specific transport demand, at the 1-percent significance level (see Fig. 5). For 9 percent (71 out of 828) of the groups, a significantly negative effect has been found for transit time. Occurrences of significantly positive effects, which counteract with the theory outlined above, are rare, accounting for only 0.8 percent of the cases for the transport costs effect and 1.6 percent of the cases for the time effect, thus similar to the expected error margins of the applied t-test. While the estimator of the time elasticity is spread over a range down to − 3.3, the variation of the estimated cost elasticity is smaller and remains in a range down to − 1.9. Future research may use these elasticities reported in Annex 2 to obtain further inside into the relation between commodity characteristics and the prioritization of costs and time saving in their transport.

Conclusions

We have presented a linear model for the estimation of modal split in international freight transport that is derived from consumer demand analysis, thereby allowing for transport to be distributed over several modes and avoiding the complex aggregation from individual to collective choice. Even if the individual shipper may not be able to split up transport across modes, their behaviour as a group may result in such split. This collective outcome is represented by the transport demand function established above. The model has the practical advantage that it can be estimated with OLS, a relatively efficient method with regard to the use of processing time and IT resources.

The key determinants of the model are the firms' and consumers' preferences for saving transport costs and transit time which shippers take into account in their mode choice. Transport costs and transit time are key variables in impact assessment studies and main drivers of mode choice, as previous studies have shown. Applying our model to novel UN Comtrade data, we find significantly negative effects of relative

transport costs and relative transit time on transport demand, while mode-specific effects, independent from transport costs and time, also play an important role. On average, a one-percent increase in transport costs leads to a decrease of transport demand in that mode by one third of a percent, keeping the volume of bilateral trade in the given commodity constant. The effect of a one-percent increase in transit time is about half as strong. The estimated effects are therefore less than proportional. For comparison, Lugovskyy et al. (2023) obtain a much higher cost elasticity of the transport of imports to the United States of America by air and sea, amounting to −7.3 and −10.3, depending on the regression method. In their study in contrast to the present, possible effects on the volume of bilateral trade and substitution across commodity groups are included. Intuitively, a more than proportional response of transport demand to changes in transport costs, as their results suggests, seems difficult to believe.

Our study also shows that the type of traded commodity is an important determinant of the modal split. The commodity-specific transport costs elasticities vary within a range between zero and −2, and commodity-specific transit time elasticities in a range between zero and −4. Taking that heterogeneity into account raises the proportion of the variance explained by the model from 0.12 to 0.38. The cost- and time elasticities estimated for 828 commodity groups, reported in Table 2, may provide a ground for further research about the value of time in different product markets.

Interpreting the results above, we should consider that they have been obtained from a sample of only nine reporting countries. Although these include developing and developed countries from different continents, they may not be representative for the whole world. We should also be aware that transport costs reflect only the international component of freight transport, and that changes in mode during the shipment could not be taken into account. Although the data coverage in the UN Comtrade database with regard to mode of transport is steadily increasing, supported by targeted technical assistance provided by international organizations (see for example Saucedo Dávila et al. 2023), further research is needed to deal with missing data caused by countries' non-reporting, the cleaning of the data on international transport from potential components of domestic transport falsely included in them, as well as the adjustment for intermodal transshipment. Research on the missing data problem may benefit from approaches developed in Survey Statistics to deal with non-response. Cleaning of international transport data from domestic transport and the adjustment for intermodal transshipment may benefit from the use of global transport network models, for example built from geographic information systems and automatic identification systems, as these may provide the needed details about the exact routes the goods were actually shipped. Despite the limitations above, the results of this study provide strong evidence that modal split should not be neglected in any impact assessment of policy measures or external shocks affecting the international freight transport sector, at least in the long run. If one mode gets more expensive or slower, shippers will to some extent shift transport from that mode to other feasible modes, in order to mitigate the welfare loss for their customers.

Annex

See Table 2.

Table 2 OLS regressions of the log ratio of transport demand (FOB value) between modes over determinant variables, by commodity group

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
0303	Fish; frozen, excluding fish …	−0.59	−0.19	−0.17	−5.59**	–	–	35	0.50
0304	Fish fillets and other fish …	−0.43	−1.93^{+++}	0.58	−1.60	−1.65	–	40	0.65
0306	Crustaceans; in shell or not …	3.03	−0.80	−0.31	−2.97	−3	−2.77	35	0.15
0307	Molluscs; whether in shell o …	0.75	−1.14^{+}	0.31	−3.08	−1.16	−1.50	29	0.51
0402	Milk and cream; concentrated …	0.26	−0.59^{+}	0.09	−5.29*	−1.62	–	26	0.52
0406	Cheese and curd	8.39**	−1.3^{+++}	−0.23	−3.18*	−7.98***	−5.79*	41	0.60
0511	Animal products not elsewher …	0.00	−0.97^{++}	0.98	2.67	0.95	−0.08	49	0.22
0602	Plants, live; n.e.c. in head …	1.77	−0.40	−0.36	−1.91	−2.09	−0.17	49	0.10
0603	Flowers; cut flowers and flo …	−0.43	−0.24	−0.12	−4.53	−5.35	−2.96	27	0.27
0604	Foliage, branches and other …	−0.39	−0.33	−1.57^{+}	−8.83**	−4.07*	−1.23	28	0.40
0712	Vegetables, dried; whole, cu …	−1.19	−0.52^{++}	0.18	−5.70***	−2.04*	0.66	71	0.41
0713	Vegetables, leguminous; shel …	−2.58	−0.48	−0.31	−9.19***	−0.45	2.08	48	0.55
0801	Nuts, edible; coconuts, Braz …	1.69	−0.29	−0.18	−6.35	−0.29	−1.54	32	0.62
0802	Nuts (excluding coconuts, Br …	−1.96	−0.77^{+}	−0.71	−6.76***	1.83	3.26	49	0.53
0804	Dates, figs, pineapples, avo …	−1.12	0.45	−0.43	−6.09**	−0.23	−0.10	58	0.29
0806	Grapes; fresh or dried	−2.61	0.31	−0.06	−9.81**	−2.77	1.80	24	0.49
0810	Fruit, fresh; n.e.c. in chap …	1.01	−0.09	−1.43	−6.26	−2.17	–	28	0.20
0811	Fruit and nuts; uncooked or …	−4.36	0.36	0.61	−7.65*	1.31	4.28	21	0.55
0813	Fruit, dried, other than tha …	0.26	0.11	−0.38	−3.7*	1.17	1.09	58	0.19
0901	Coffee, whether or not roast …	0.39	−0.9^{+++}	−0.03	−5.38***	−2.16	−0.72	108	0.49
0902	Tea	−0.26	−0.38^{+}	−1.56^{+}	−7.41**	−0.04	0.44	76	0.21
0904	Pepper of the genus piper; d …	1.28	−0.14	−1.23^{+}	−6.86**	−0.72	−0.73	52	0.26
0909	Seeds of anise, badian, fenn …	0.09	−0.47^{+}	−1.12^{+}	−10.06***	−3.62	−1.09	40	0.36

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
0910	Ginger, saffron, tumeric (cu …	0.57	−0.4^{+}	−0.89^{++}	−6.48***	−2.12	−0.98	98	0.30
1001	Wheat and meslin	−4.29	−1.04^{++}	0.08	−11.44***	1.25	−0.69	26	0.81
1005	Maize (corn)	−1.00	−0.71^{++}	−1.69^{+++}	−11.06***	−0.45	−0.13	43	0.69
1006	Rice	−1.93	−0.70^{+}	0.50	−8.89***	−0.99	0.90	36	0.77
1102	Cereal flours; other than of …	−3.16	−0.72^{++}	−0.53	−6.49**	0.70	2.11	28	0.63
1106	Flour, meal and powder; of t …	−0.35	−0.81^{+++}	−3.32^{+++}	−10.82***	−0.44	−0.61	46	0.59
1108	Starches; inulin	0.52	−0.77^{++}	−0.62	−4.52*	0.09	−1.03	48	0.51
1206	Sunflower seeds; whether or …	0.51	−0.59	−1.34^{++}	−10.3***	−1.17	−1.86	34	0.63
1207	Oil seeds and oleaginous fru …	−0.37	−1.39^{+++}	−0.73	−5.95**	−1.31	−0.44	80	0.32
1209	Seeds, fruit and spores; of …	0.80	−0.32^{+}	−0.33	−0.26	−1.29	0.66	140	0.12
1211	Plants and parts of plants (…	0.61	−0.85^{+++}	−0.42	−3.98***	−1.68	−0.47	106	0.27
1212	Locust beans, seaweeds and o …	0.13	−0.48^{+}	−0.84^{+}	−6.21***	−1.23	−0.86	57	0.42
1301	Lac; natural gums, resins, g …	−0.24	−0.14	−0.52	1.20	4.88	1.03	44	0.33
1302	Vegetable saps and extracts; …	−2.6*	−0.79^{+++}	−0.20	−2.68*	0.64	1.99	149	0.23
1404	Vegetable products not elsew …	−0.58	0.98^{+}	−1.04	−5.30	2.69	1.75	26	0.29
1504	Fats and oils and their frac …	−3.27	−0.59	2.01	−3.39	−2.41	–	24	0.34
1509	Olive oil and its fractions; …	3.26	−1.68^{++}	−0.60	−5.51*	−3.96	–	26	0.44
1512	Sun−flower seed, safflower o …	2.60	−0.34	−0.71	−5.14*	−2.33	−1.46	30	0.34
1515	Fixed vegetable fats and oil …	−0.37	−0.36^{+}	0.31	−2.33	−0.66	−0.20	112	0.16
1516	Animal or vegetable fats and …	−4.27	−0.28	−1.30^{+}	−4.23*	6.59	4.91	55	0.33
1517	Margarine; edible mixtures o …	−3.21	−0.75^{++}	−0.58	−6.02**	1.34	4.88*	46	0.41
1518	Animal or vegetable fats, oi …	−4.68	−0.06	0.10	−4.54	2.95	3.53	24	0.43
1521	Vegetable waxes (other than …	−0.63	−0.09	−1.35	−8.48*	−1.54	−0.56	24	0.38
1604	Prepared or preserved fish; …	−3.10	−0.26	0.22	−7.76**	−1.85	1.77	60	0.36
1701	Cane or beet sugar and chemi …	−0.42	−0.35	−0.40	−5.66*	−1.45	−1.29	41	0.35
1702	Sugars, including lactose, m …	−2.43*	0.09	0	−8.2***	−1.25	1.64	97	0.43
1704	Sugar confectionery (includi …	−2.29	−0.31^{+}	−0.29	−6.09***	2.16	3.87**	117	0.43
1805	Cocoa; powder, not containin …	−2.74	−0.40^{+}	0.37	−8.46***	−2.05	1.50	43	0.66

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
1806	Chocolate and other food pre …	−1.83	-0.61^{+++}	−0.27	−5.49***	1.47	2.82*	141	0.45
1901	Malt extract; flour/groats/m …	−3.56***	-0.54^{+++}	−0.12	−6.35***	1.56	4.34***	87	0.60
1902	Pasta; whether or not cooked …	−0.28	−0.28	0.35	−5.83***	−0.50	−0.41	58	0.56
1904	Prepared foods obtained by s …	−0.98	-1.23^{+++}	-1.33^{++}	−5.92***	2.78*	2.59	66	0.55
1905	Bread, pastry, cakes, biscui …	−1.36	-0.43^{++}	0.32	−6.68***	−0.52	2.03*	136	0.53
2001	Vegetables, fruit, nuts and …	−1.33	−0.07	-1.29^{+}	−10.07***	0.29	0.11	39	0.58
2002	Tomatoes; prepared or preser …	−2.76	-0.57^{+}	−0.01	−7.26*	1.15	3.28	27	0.62
2005	Vegetables preparations n.e. …	0.82	−0.30	−0.55	−6.44***	−0.31	0.06	63	0.40
2007	Jams, fruit jellies, marmala …	−0.79	-0.38^{+}	−0.54	−5.7***	1.16	2.52	48	0.44
2008	Fruit, nuts and other edible …	−1.53	−0.19	-0.67^{+}	−8.53***	−0.40	2.02	123	0.45
2009	Fruit juices (including grap …	−4.70*	−0.08	0.17	−6.54***	2.2	5.55**	72	0.35
2101	Extracts, essences, concentr …	−0.58	−0.04	−0.37	−6.33***	−1.62	1.03	102	0.27
2102	Yeasts (active or inactive); …	−1.98	0.27	-0.82^{++}	−6.57***	0.54	2.16	91	0.30
2103	Sauces and preparations ther …	−0.74	−0.14	−0.49	−8.05***	−1.07	0.41	119	0.46
2104	Soups and broths and prepara …	−1.75	0.11	-1.30^{+}	−9.61***	0.07	1.78	34	0.54
2106	Food preparations not elsewh …	−2.11*	-0.38^{++}	-0.68^{++}	−4.55***	1.45	2.62**	268	0.20
2201	Waters, including natural or …	−2.26	−0.45	−0.21	−5.75**	0.86	–	26	0.45
2202	Waters, including mineral an …	−0.51	−0.24	−0.41	−7.5***	−0.9	1.46	80	0.51
2203	Beer made from malt	−0.45	-0.69^{++}	0.14	−9.13***	−2.87	−3.27	33	0.70
2204	Wine of fresh grapes, includ …	2.65	-0.96^{+++}	0.14	−5.17***	−4.05*	−2.51	73	0.54
2207	Ethyl alcohol, undenatured; …	−1.72	-1.12^{+++}	0.38	−5.05*	−0.52	0.24	32	0.73
2208	Ethyl alcohol, undenatured; …	−1.95**	-0.38^{++}	0	−6.20***	0.28	–	120	0.50
2209	Vinegar and substitutes for …	−1.15	0.9^{+}	−0.12	−10.29**	−2.44	–	21	0.64
2309	Preparations of a kind used …	−2.97**	-0.63^{+++}	-0.76^{+}	−8.76***	−0.62	1.81	134	0.52
2401	Tobacco, unmanufactured; tob …	−2.58*	-1.34^{+++}	0.58	−4.03	0.39	–	58	0.68
2402	Cigars, cheroots, cigarillos …	1.61	-0.96^{+++}	0.40^{+}	0.17	−2.24**	–	80	0.32
2403	Manufactured tobacco and man …	−3.08	−0.32	-2.38^{+++}	−8.75***	2.33	2.31	58	0.34
2501	Salt (including table salt a …	−1.35	−0.11	−0.70	−6.77***	−0.43	0.12	76	0.27

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
2504	Graphite; natural	− 2.54	0.48^{+}	− 1.80^{++}	− 13.87***	− 2.03	–	27	0.65
2505	Sands of all kinds; natural, …	− 0.93	− 0.35^{+}	0.74^{+}	− 4.90**	− 2.12	− 0.92	43	0.46
2507	Kaolin and other kaolinic cl …	− 4.20	0.22	− 0.46	− 7.92**	2.81	2.43	29	0.54
2508	Clays; (not including expand …	1.80	0.02	− 2.03^{+++}	− 10.59***	− 3.2	− 3.26	50	0.55
2512	Siliceous fossil meals (e.g. …	1.42	0.01	0.70	− 1.93	− 1.23	–	25	0.16
2513	Pumice stone; emery; natural …	− 0.26	0.33	0.33	− 3.35	− 0.89	− 0.61	27	0.29
2517	Pebbles, gravel, crushed sto …	− 1.16	− 0.19	0.79	− 2.93	0.59	1.20	28	0.44
2519	Natural magnesium carbonate …	− 0.41	− 0.63^{++}	− 1.84^{++}	− 10.59***	− 2.31	− 1.96	48	0.57
2523	Portland cement, aluminous c …	4.02	− 0.58^{+}	− 0.35	− 3.94	− 2.43	− 2.83	38	0.38
2526	Natural steatite; whether or …	− 2.52	− 0.19	− 1.22^{+}	− 8.18**	2.8	0.40	33	0.68
2530	Mineral substances not elsew …	0.98	− 0.58^{++}	− 0.25	− 6.11**	− 1.92	− 2.69	54	0.47
2707	Oils and other products of t …	− 10.63*	− 1.08^{++}	− 1.56^{++}	− 14.74***	4.49	8	24	0.83
2710	Petroleum oils and oils from …	− 2.93**	− 0.35^{+}	− 1.28^{+++}	− 11.81***	− 0.37	− 0.27	230	0.50
2711	Petroleum gases and other ga …	0.43	− 0.47	− 2.36^{+}	− 4.86	4.81	0.21	43	0.39
2712	Petroleum jelly; paraffin wa …	− 0.32	0.21	− 1.03^{+}	− 4.3*	3.54	1.93	65	0.26
2803	Carbon; carbon blacks and ot …	0.23	− 0.06	− 0.48	− 7.39***	− 1.61	− 1.27	61	0.43
2804	Hydrogen, rare gases and oth …	− 0.55	− 0.07	− 0.61	− 2.29	1.35	2.32	67	0.07
2807	Sulphuric acid; oleum	− 1.25	− 0.52	− 0.92	− 5.61	3.75	2.6	24	0.48
2809	Diphosphorus pentoxide; phos …	− 4.24	− 0.05	− 0.37	− 3.35	4.74	4.01	37	0.18
2810	Oxides of boron; boric acids	− 1.18	− 0.23	− 0.1	− 2.93	0.58	–	27	0.20
2811	Inorganic acids and other in …	− 2.23	0.18	0.05	− 5.72***	0.19	0.48	113	0.32
2815	Sodium hydroxide (caustic so …	− 1.25	− 0.11	-0.10	-5.32**	− 0.07	− 0.22	64	0.34
2817	Zinc; oxide and peroxide	1.49	− 0.42^{+}	− 2.61^{++}	− 11***	− 3.06	− 3.47	38	0.48
2818	Aluminium oxide (including a …	− 1.50	− 0.35	− 0.26	− 6.56***	− 1.21	− 0.07	69	0.43
2821	Iron oxides and hydroxides; …	0.49	− 0.25	0.06	− 2.92	− 1.03	− 0.95	49	0.15
2823	Titanium oxides	− 0.04	− 0.39	0.03	− 5.56*	− 1.83	− 2.43	34	0.40
2825	Hydrazine and hydroxylamine …	− 0.57	− 0.23	− 1.19^{+}	− 5.42*	1.83	1.96	54	0.19
2826	Fluorides; fluorosilicates, …	− 0.17	0.11	− 1.07^{+}	− 5.21*	1.19	− 1.55	42	0.35

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
2827	Chlorides; chloride oxides a …	−2.56	−0.06	−1.28^{++}	−7.86***	1.7	1.55	90	0.30
2829	Chlorates and perchlorates; …	0.74	0.52	1.91^{+}	0.08	−1	−1.74	34	0.26
2830	Sulphides; polysulphides whe …	−1.52	0.35	0.42	−2.60	2.54	–	24	0.31
2832	Sulphites; thiosulphates	−2.60	−0.04	0.31	−4.34	2	0.99	43	0.31
2833	Sulphates; alums; peroxosulp …	−2.48	−0.45^{+}	−0.46	−6.39***	0.68	1.96	97	0.28
2834	Nitrites; nitrates	−9.23**	0.40^{+}	0.15	−4.62	8.90**	7.77**	50	0.30
2835	Phosphinates (hypophosphites …	−3.43	−0.43^{+}	0.01	−6.39***	0.23	1.79	74	0.39
2836	Carbonates; peroxocarbonates …	−2.04	−0.03	−0.93^{+}	−7.5***	1.5	0.67	87	0.39
2839	Silicates; commercial alkali …	−2.74	−0.18	−0.12	−6.04*	0.17	1.76	47	0.35
2840	Borates; peroxoborates (perb …	9.81**	−0.2	0.71	0.07	−8.31*	−11.31**	29	0.39
2841	Salts of oxometallic or pero …	1.19	−0.26	0.75	−2.70	−2.66	−1.90	44	0.22
2842	Salts of inorganic acids or …	2.77	0.67^{++}	0.45	−0.69	−0.7	−1.97	60	0.20
2843	Colloidal precious metals; i …	1.93	−1.05^{++}	−0.15	0.69	−2.85	–	38	0.24
2846	Compounds, inorganic or orga …	2.01	−0.44	−0.87	−3.73	−4.34	−2.9	27	0.11
2847	Hydrogen peroxide; whether o …	6.13	0.38	2.59^{+}	−4.12	−11.43*	−12.87*	27	0.40
2849	Carbides, whether or not che …	1.48	−0.55^{+}	−1.75^{+}	−5.94*	−0.83	−3.18	37	0.45
2850	Hydrides, nitrides, azides, …	−8.32	−0.23	−0.11	−0.12	9.73**	8.33*	28	0.34
2853	Inorganic compounds n.e.c. (…	−5.92*	−0.54^{++}	0.20	1.56	6.87*	7.52*	45	0.26
2901	Acyclic hydrocarbons	−1.11	−0.33^{+}	−0.99^{+}	−7.24**	−0.04	−0.49	63	0.36
2902	Cyclic hydrocarbons	1.20	0.39^{+}	−1.23^{+}	−6.89**	−0.12	−2.22	70	0.25
2903	Halogenated derivatives of h …	−0.42	−0.04	0.15	−5.95**	−1.21	−2.09	69	0.3
2904	Sulphonated, nitrated or nit …	−1.24	−0.31	−0.45	−4.61	1.25	−0.78	54	0.33
2905	Acyclic alcohols and their h …	−2.12*	0.14	−0.63^{+}	−8.79***	0.28	−0.04	142	0.51
2906	Alcohols; cyclic, and their …	1.19	−0.38^{+}	−1.84^{+++}	−4.27**	0.6	0.47	64	0.27
2907	Phenols; monophenols, polyph …	0.26	−0.17	0.33	−3.46	−1.53	−2.57	67	0.28
2909	Ethers, ether−alcohols, ethe …	−3.85***	−0.34^{+}	0.48^{+}	−4.35***	1.13	2.91*	97	0.42
2910	Epoxides, epoxyalcohols, epo …	−0.92	−1.34^{+}	−0.51	−3.04	1.81	1.41	40	0.22
2911	Acetals and hemiacetals; whe …	0.68	0.5	−2.08^{+}	−6.75***	0.47	–	34	0.39

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
2912	Aldehydes, whether or not wi …	− 2.75	0.06	− 0.69^{+}	− 6.56***	1.17	2.30	79	0.37
2914	Ketones and quinones; whethe …	− 4.96**	0.1	− 0.07	− 4.12**	4.68**	3.95*	94	0.33
2915	Acids; saturated acyclic mon …	− 3.67***	− 0.22	− 0.51^{+}	− 7.59***	1.36	2.71**	141	0.40
2916	Acids; unsaturated acyclic m …	− 1.22	− 0.12	0.53	− 2.50	1.19	0.81	114	0.17
2917	Acids; polycarboxylic acids, …	− 1.59	0.39^{+}	0.16	− 6.39***	0.51	0.66	102	0.31
2918	Acids; carboxylic acid with …	− 3.49**	0.00	0.39	− 3.2*	2.19	2.66*	133	0.25
2919	Esters; phosphoric, and thei …	− 1.88	0.24	− 1.28^{+}	− 3.48	4.67	3.93	34	0.28
2920	Esters of other inorganic ac …	− 2.18	0.03	− 0.17	− 3.62	1.90	1.75	51	0.26
2921	Amine − function compounds	− 0.14	− 0.30	− 0.79^{+}	− 2.9	2.06	0.99	103	0.12
2922	Oxygen − function amino − compounds	− 3.09	− 0.40^{+}	− 0.14	− 4.77**	0.32	2.38	116	0.15
2923	Quaternary ammonium salts an …	− 2.39	− 0.01	− 0.36	− 6.79***	− 0.88	0.19	80	0.35
2924	Carboxyamide − function compou …	− 0.98	− 0.16	− 0.78^{+}	− 5.74***	− 1.2	0.1	101	0.15
2925	Carboxyimide − function compou …	− 4.24*	0.4^{+}	0.29	− 1.64	5.75**	4.54*	73	0.21
2926	Nitrile − function compounds	− 1.02	− 0.46^{+}	− 0.09	− 0.21	3.71	3.54	45	0.14
2927	Diazo −, azo − or azoxy − compounds	− 1.18	0.60	− 0.03	− 0.81	2.56	2.10	33	0.13
2928	Organic derivatives of hydra …	− 1.30	− 0.44^{+}	− 0.14	0.78	3.43	3.64	39	0.10
2929	Nitrogen − function compounds, …	− 2.15	− 0.44^{+}	0.25	− 1.89	3.35	2.35	57	0.25
2930	Organo − sulphur compounds	− 3.59**	− 0.71^{+++}	0.04	− 5.44***	1.40	2.35	92	0.45
2931	Other organo − inorganic compounds	− 0.85	− 0.64^{++}	0.01	− 3.73	− 0.37	− 0.29	74	0.25
2932	Heterocyclic compounds with …	− 4.17	− 0.55^{++}	− 0.02	− 2.02	2.78	3.86*	110	0.13
2933	Heterocyclic compounds with …	− 4.78***	− 0.41^{+}	0.72^{++}	− 0.02	3.96***	4.5***	145	0.20
2934	Nucleic acids and their salt …	− 5.19**	− 0.67^{++}	0.00	− 1.54	3.06	5.51***	86	0.23
2935	Sulphonamides	− 0.24	− 0.22	− 0.76^{+}	− 1.18	1.66	0.79	56	0.08
2936	Provitamins, vitamins; natur …	− 5.25***	− 0.19	− 0.08	− 2.15	4.33**	5.78***	99	0.20
2937	Hormones, prostaglandins, th …	0.94	0.39	− 0.11	0.63	− 2.85*	–	38	0.21

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
2938	Glycosides, natural or repro …	− 3.34	− 0.49	− 0.06	− 2.97	− 0.02	3.03	44	0.11
2939	Alkaloids, vegetable; natura …	− 5.68*	− 0.24	− 0.52	–	5.88*	8.08**	54	0.23
2940	Sugars, chemically pure, oth …	1.45	-0.46^{+}	− 0.75	− 4.04	− 2.15	− 2.65	55	0.10
2941	Antibiotics	− 0.33	-0.93^{+++}	1.31^{+++}	3.73*	0.19	2.67	69	0.32
2942	Organic compounds; n.e.c. in …	− 0.35	-0.38^{++}	0.48	− 0.7	− 1.19	–	45	0.14
3002	Human blood; animal blood fo …	0.65	-0.66^{++}	− 0.22	2.19	− 1.31	3.18	149	0.38
3003	Medicaments; (not goods of h …	3.35*	-0.38^{+}	-1.51^{++}	− 3.97*	− 4.21***	–	43	0.47
3004	Medicaments; (not goods of h …	− 3.42*	-0.65^{+++}	-1.00^{+++}	− 3.1***	2.12	5.63**	277	0.32
3005	Wadding, gauze, bandages (dr …	− 0.6	-0.33^{+}	− 0.4	− 3.32**	− 0.91	0.61	156	0.09
3006	Pharmaceutical goods	− 3.39**	-0.47^{++}	0.50^{+}	0.26	1.44	3.48**	186	0.12
3101	Fertilizers; animal or veget …	0.21	-0.63^{++}	− 0.81	− 6.20**	− 1.40	–	30	0.56
3102	Fertilizers; mineral or chem …	− 1.06	− 0.080	− 0.78	− 13.11***	− 2.83	− 2.33	65	0.69
3104	Fertilizers; mineral or chem …	− 0.48	-0.66^{+}	− 2.05	− 13.14***	− 1.46	− 2.62	33	0.62
3105	Fertilizers; mineral or chem …	0.90	-0.99^{+++}	-1.04^{++}	− 10.15***	− 3.51*	− 2.92	105	0.64
3201	Tanning extracts of vegetabl …	0.72	− 0.28	-1.4^{+}	− 6.21*	− 0.53	–	27	0.37
3202	Tanning substances; syntheti …	− 4.13*	-0.90^{+++}	0.16	− 6.21*	0.5	3.56*	32	0.74
3203	Colouring matter of vegetabl …	0.42	− 0.28	0.09	− 0.59	− 0.62	0.57	76	0.04
3204	Synthetic organic colouring …	− 3.74***	− 0.01	-0.78^{++}	− 6.87***	1.45	3.5***	170	0.37
3205	Colour lakes; preparations b …	− 3.63*	− 0.09	1.05^{+}	− 0.43	1.42	–	29	0.29
3206	Colouring matter and prepara …	− 1.85	− 0.24	− 0.38	− 6.5***	− 0.1	0.82	138	0.36
3207	Pigments, prepared; opacifie …	− 0.95	− 0.04	− 0.26	− 3.02	1.18	1.51	84	0.08
3208	Paints, varnishes; (enamels …	− 0.95	-0.41^{++}	-0.73^{++}	− 4.8***	0.75	2.38*	164	0.24
3209	Paints and varnishes (includ …	− 1.91	− 0.24	-0.74^{+}	− 5.46***	0.83	2.63	112	0.26
3210	Paints and varnishes (includ …	1.36	-0.38^{+}	− 0.54	− 2.43	− 0.43	–	69	0.11
3211	Driers; prepared	− 0.29	-0.49^{++}	− 0.14	− 5.3*	− 3.46	1.37	34	0.57
3212	Pigments (metallic powders a …	− 2.25	− 0.11	0.03	− 3.87**	0.40	1.24	103	0.20
3213	Colours; artists, students, …	− 0.4	− 0.14	-1.41^{+++}	− 5.46***	1.64	1.52	67	0.28
3214	Glaziers' putty, grafting pu …	− 3.2**	-0.31^{+}	-0.94^{++}	− 5.71***	2.51*	4.26***	163	0.30

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
3215	Ink; printing, writing or dr …	−0.04	−0.17	-0.71^{++}	−3.44***	−0.25	1.07	195	0.10
3301	Oils; essential (concretes, …	−0.43	-0.17^{+}	−0.23	−1.93*	−0.29	0.65	183	0.04
3302	Odoriferous substances and m …	−0.72	-0.5^{++}	-0.47^{+}	−3.72***	−1.29	1.38	158	0.2
3303	Perfumes and toilet waters	−6.09***	-0.33^{+}	-0.42^{+}	−2.86**	5.69***	6.92***	127	0.31
3304	Cosmetic and toilet preparat …	−3.76***	-0.38^{+++}	−0.14	−2.14**	2.4***	4.75***	297	0.27
3305	Hair preparations; for use o …	−3.54***	-0.42^{++}	0.50^{+}	−1.21	3.67***	4.42***	189	0.24
3306	Oral or dental hygiene prepa …	−0.78	-0.44^{++}	−0.29	−3.86**	−0.13	1.37	119	0.18
3307	Perfumery, cosmetic or toile …	−2.87***	−0.02	0.24	−2.66**	2.97**	3.73***	187	0.22
3401	Soap; organic surface – active …	−1.55	-0.51^{+++}	-0.4^{+}	−5.07***	0.29	1.86*	198	0.27
3402	Organic surface – active agent …	−3.03***	-0.41^{+++}	-1^{+++}	−9.06***	−0.31	1.58	235	0.47
3403	Lubricating preparations and …	−4.67***	0.27^{+}	-0.44^{+}	−5.63***	2.72**	3.84***	195	0.31
3404	Waxes; artificial, prepared	−3.28*	−0.19	-0.6^{+}	−6.09***	1.83	2.42	101	0.33
3405	Polishes, creams, scouring p …	−4.03**	-0.27^{+}	0.04	−4.47***	1.44	3.15*	128	0.23
3406	Candles, tapers and the like	−0.28	0.11	-0.63^{+}	−6.41***	−1.67	0.61	96	0.26
3407	Modelling pastes, including …	0.69	0.2	-0.88^{++}	−6.61***	−3.86*	−1.42	75	0.31
3502	Albumins (including concentr …	5.09	-0.86^{+}	-1.41^{+}	−5.96*	−4.96	−3.43	27	0.38
3503	Gelatin (including gelatin i …	−9.2**	−0.21	3.52^{+}	10.4	14.77**	13.84**	27	0.52
3504	Peptones and their derivativ …	−3.34	−0.18	0.10	−3.74*	1.97	1.92	76	0.21
3505	Dextrins and other modified …	−2.93**	-0.35^{+}	−0.39	−6.22***	1.31	1	80	0.57
3506	Prepared glues and other pre …	−3.42***	0.42^{+++}	-0.36^{+}	−5.66***	1.6	2.83**	233	0.29
3507	Enzymes; prepared enzymes no …	−3.34	-0.66^{+++}	−0.23	−2.04	2.34	3.98*	114	0.19
3603	Safety fuses; detonating fus …	2.08	−0.45	0.02	–	−1.76	–	23	0.12
3701	Photographic plates and film …	1.79	0.21	−0.14	−5.36*	−3.76	−3.44	52	0.22
3702	Photographic film in rolls, …	−0.83	−0.44	−0.47	−4.21	−2.47	–	31	0.13
3703	Photographic paper, paperboa …	4.95	0.19	−0.01	−5.92	−7.64*	−7.1*	23	0.33
3707	Chemical preparations for ph …	−3.41*	0.29^{+}	-0.63^{+}	−5.96***	1.94	3.49*	84	0.24
3801	Artificial graphite; colloid …	0.06	-0.46^{+}	−0.2	−4.18*	−0.78	−1.39	68	0.32
3802	Activated carbon; activated …	−2.88*	0.06	−0.29	−6.42***	0.99	1.54	74	0.45

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
3806	Rosin and resin acids and de …	−0.58	0.28	−0.41	−5.43***	−0.14	−0.26	46	0.40
3808	Insecticides, rodenticides, …	−2.45**	-1.01^{+++}	−0.29	−5.59***	−0.41	1.83	188	0.47
3809	Finishing agents, dye carrie …	−4.33***	-0.31^{+}	-1.05^{++}	−8.27***	2.2	2.89*	95	0.63
3810	Metal−pickling preparations; …	−1.95	−0.2	−0.4	−3.04*	1.78	1.27	102	0.14
3811	Anti−knock preparations, oxi …	−5.19**	-0.3^{+}	−0.18	−7.06***	2.51	3.89*	101	0.47
3812	Prepared rubber accelerators …	0.58	−0.07	−0.4	−8.38***	−3.11*	−2.27	82	0.50
3813	Preparations and charges for …	−1.83	−0.22	0.33	−4.7**	−1.11	1.58	32	0.40
3814	Organic composite solvents a …	−2.01	0.11	-0.76^{++}	−6.58***	−0.25	1.98	106	0.28
3815	Reaction initiators, reactio …	−0.95	-0.61^{+++}	-0.74^{+}	−6.03***	−1.26	0.17	115	0.28
3816	Refractory cements, mortars, …	−0.38	-0.64^{++}	-1.14^{+}	−9.36***	−2.82	−0.61	68	0.49
3819	Hydraulic brake fluids and o …	−0.42	0.17	0.5	−6.48***	−4.16***	–	55	0.52
3820	Anti−freezing preparations a …	−6.05**	−0.22	−0.2	−5.45***	3.97	5.07*	81	0.41
3821	Prepared culture media for t …	−4.73*	-0.50^{+}	−0.36	−2.7	1.47	3.8	76	0.17
3822	Reagents; diagnostic or labo …	−0.24	-0.30^{+}	-0.47^{+}	2.26*	1.12	3.21**	197	0.24
3823	Industrial monocarboxylic fa …	1.72	-0.79^{++}	−0.81	−8.51***	−5.03*	−4.17	49	0.47
3824	Prepared binders for foundry …	−2.93***	-0.21^{+}	-0.6^{++}	−6.06***	1.07	2.79***	262	0.37
3901	Polymers of ethylene, in pri …	−1.40	0.28^{+}	−0.27	−11.26***	−2.09*	−0.46	164	0.57
3902	Polymers of propylene or of …	−0.40	−0.07	-0.70^{+}	−10***	−2.06	−0.29	140	0.45
3903	Polymers of styrene, in prim …	−0.50	-0.33^{+}	−0.40	−8.25***	−1.9	−0.47	106	0.52
3904	Polymers of vinyl chloride o …	−2.54*	0.08	−0.22	−9.56***	−0.58	1.2	104	0.53
3905	Polymers of vinyl acetate or …	−3.75**	0.06	-0.99^{++}	−8.51***	1.8	2.01	77	0.50
3906	Acrylic polymers in primary …	−3.04**	−0.15	−0.35	−7.81***	−0.33	2.82**	148	0.42
3907	Polyacetals, other polyether …	−2.46**	0.09	-0.39^{+}	−7.84***	0.39	2.19*	196	0.40
3908	Polyamides in primary forms	−2.05*	-0.24^{+}	−0.39	−6.3***	−0.19	2.24*	104	0.46
3909	Amino−resins, phenolic resin …	−2.91**	0.13	-1.17^{++}	−7.58***	2.91*	2.81*	145	0.38
3910	Silicones in primary forms	−2.84*	-0.53^{+++}	0.05	−5.51***	−1.23	0.13	128	0.37
3911	Petroleum resins, coumarone− …	−1.58	0.04	-0.97^{++}	−6.91***	1.19	1.24	82	0.42
3912	Cellulose and its chemical d …	−1.04	0.06	−0.40	−6.91***	−0.59	−0.01	97	0.41

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
3913	Natural polymers (e.g. algin …	−2.08	-0.75^{+++}	−0.06	−0.87	2.09	2.04	85	0.19
3914	Ion − exchangers; based on pol …	3.99	-0.81^{+}	−1.09	−4.28	−3	−4.22	46	0.24
3915	Waste, parings and scrap, of …	−2.46	-0.78^{+}	0.48	−3.11	2.98	1.09	32	0.57
3916	Monofilament of which any cr …	−3.92***	−0.12	−0.2	−5.09***	1.34	4.39***	148	0.38
3917	Tubes, pipes and hoses and f …	−3.56***	-0.22^{+}	-0.43^{+}	−3.12***	3.29***	4.74***	357	0.24
3918	Floor coverings of plastics, …	−2.43*	0.05	0.32	−5.7***	−0.6	2.84**	106	0.43
3919	Self-adhesive plates, sheets …	−4.22***	-0.22^{+}	-0.38^{+}	−3.85***	2.51**	4.13***	308	0.20
3920	Plastics; plates, sheets, fi …	−2.55***	-0.31^{++}	-0.54^{++}	−6.69***	0.79	2.32***	288	0.34
3921	Plastic plates, sheets, film …	−2.38**	0.04	-0.33^{+}	−5.25***	0.66	3.17***	265	0.26
3922	Sanitary ware; baths, shower …	−1.70	-0.52^{++}	−0.11	−4.21***	−0.06	1.8	120	0.23
3923	Plastic articles for the con …	−3.60***	0.04	-0.55^{++}	−5.16***	2.35***	4.38***	398	0.32
3924	Tableware, kitchenware, othe …	−2.22**	−0.07	−0.04	−4.51***	1.69*	3.59***	230	0.27
3925	Plastics; builders' wares n. …	−3.24***	−0.04	−0.04	−3.85***	2.29**	4.33***	190	0.29
3926	Articles of plastics and art …	−4.15***	-0.2^{++}	−0.17	−3.49***	2.02***	4.36***	532	0.29
4001	Natural rubber, balata, gutt …	1.32	-0.98^{+++}	1.92^{++}	−2.34	−5.16**	−5.05*	51	0.56
4002	Synthetic rubber and factice …	−2.15	−0.05	−0.05	−8.02***	−0.36	0.1	129	0.45
4005	Compounded rubber, unvulcani …	−3.51*	0.08	-0.61^{+}	−7.08***	1.73	2.72	95	0.36
4006	Unvulcanised rubber in other …	−4.49***	−0.02	0.17	−4.41**	0.91	2.63*	90	0.27
4007	Vulcanised rubber thread and …	−2.83	−0.66	−0.36	−5.88	0.39	1.77	24	0.28
4008	Plates, sheets, strip, rods …	−2.28	0.04	0	−4.1***	0.60	2.46*	183	0.18
4009	Tubes, pipes and hoses, of v …	−5.22***	0.05	-0.27^{+}	−3.85***	3.79***	5.61***	353	0.35
4010	Conveyor or transmission bel …	−5.78***	0.2^{+}	−0.21	−4.83***	3.04***	4.64***	292	0.30
4011	New pneumatic tyres, of rubber	−2.51**	0.07	-0.94^{++}	−8.92***	1.52	1.51	211	0.41
4012	Retreaded or used pneumatic …	1.66	0.35^{+}	0.75	−3.54	−3.30	−3.31	75	0.27
4013	Inner tubes, of rubber	−3.14	0.1	−0.62	−7.4**	1.05	2.22	60	0.21
4014	Hygienic or pharmaceutical a …	−5.35	-0.66^{++}	0.57	−5.37**	0.90	1.88	64	0.35
4015	Articles of apparel and clot …	−0.93	−0.3	0.29	−2.54	−0.4	0.3	147	0.08
4016	Articles of vulcanised rubbe …	−4.89***	0.04	−0.19	−2.91***	3.04***	5.01***	466	0.33

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
4017	Hard rubber (e.g. ebonite) i …	0.12	0.05	0.08	−1.56	0.14	0.28	77	0.04
4104	Tanned or crust hides and sk …	1.79	−0.26	−1.72^{++}	−4.70*	0.83	–	31	0.38
4107	Leather further prepared aft …	−6.12*	−1.08^{+++}	−0.84^{+}	−2.92	4.29	6.45*	66	0.39
4201	Saddlery and harness for any …	−0.36	−0.46^{+++}	0.48^{+}	−0.02	−0.5	1.18	96	0.18
4202	Trunks; suit, camera, jewell …	−3.11***	−0.17^{+}	0.28^{+}	−2.27***	0.13	2.78***	350	0.21
4203	Articles of apparel and clot …	−2.37*	−0.21^{+}	−0.15	−2.98***	0.26	2.56**	182	0.21
4205	Leather or composition leath …	0.59	−0.61^{++}	−0.12	−2.16	−3.19	0.57	92	0.27
4302	Tanned or dressed furskins (…	−0.36	−0.77^{+}	0.01	−0.58	0.39	–	31	0.18
4303	Articles of apparel, clothin …	0.21	0.33	−0.04	−1.2	−1.31	0.31	28	0.09
4407	Wood sawn or chipped lengthw …	2.02	0.52	−1.18^{+}	−9.54***	−0.98	−2.45	36	0.70
4408	Sheets for veneering (includ …	−0.42	0.11	−0.05	−4.45**	0.33	–	40	0.46
4410	Particle board, oriented str …	−1.46	0.02	0.6	−9.15**	−1.71	0.98	22	0.73
4411	Fibreboard of wood or other …	−1.96*	−0.18	−0.57^{+}	−9.8***	−0.95	1.68	50	0.78
4412	Plywood, veneered panels and …	−0.38	0.53^{+}	0.03	−9.39***	−3.53	−0.38	54	0.60
4414	Wooden frames; for paintings …	−0.99	−0.51^{+}	0.37	−2.22	0.16	0.36	39	0.20
4415	Packing cases, boxes, crates …	−2.72	−0.44^{+}	0.05	−3.88**	0.20	4.19**	80	0.29
4417	Tools, tool bodies, tool han …	2.66	0.02	−0.46	−1.77	−2.01	−1.73	25	0.06
4418	Builders' joinery and carpen …	−2.04	−0.37^{+}	0.04	−7.28***	−0.24	1.57	74	0.49
4419	Tableware and kitchenware, o …	−1.39	0.18	0.16	−4.45***	−0.60	0.59	96	0.25
4420	Wood marquetry and inlaid wo …	−0.98	−0.13	0.09	−1.63	0.59	1.04	130	0.04
4421	Wooden articles n.e.c. in he …	−3.35**	−0.06	−0.55^{+}	−5.91***	1.28	3.07**	139	0.35
4503	Cork; articles of natural cork	−1.98	0.25	−0.62	−8.54*	−1.81	0.47	23	0.41
4504	Agglomerated cork (with or w …	−0.46	0.20	0.02	−6.45**	−2.70	−2.20	69	0.28
4601	Plaits and similar products …	−5.01*	0.56	0.05	−8.21***	0.54	1.86	29	0.64
4602	Basketwork, wickerwork and o …	−1.62	0.21	0.16	−4.53*	−0.57	0.48	73	0.20
4802	Uncoated paper and paperboar …	−2.67	−0.05	0.66	−6.27***	0	0.32	114	0.37
4803	Tissue, towel, napkin stock …	−7.94	−0.26	−1.36^{+}	−9.52**	6.18	8.31	34	0.40
4804	Uncoated kraft paper and pap …	−2.35*	−0.18	0.16	−7.58***	0.04	1.54	89	0.51

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
4805	Uncoated paper and paperboar …	−2.62*	−0.41^{+}	0.73^{+}	−6.56***	−0.98	2.23	91	0.43
4806	Vegetable parchment, greasep …	−2.53	−0.15	−0.42	−7.49***	1.73	0.99	53	0.5
4807	Composite paper and paperboa …	−3.79	−0.58	−1.01	−6.04*	4.76	3.44	24	0.53
4808	Paper and paperboard, corrug …	−0.73	0.14	−0.13	−5.44**	0.22	0.27	40	0.37
4809	Carbon paper, self copy pape …	−5.01	0.38	0.44	−8.64*	0.25	0.73	33	0.51
4810	Paper and paperboard, coated …	−2.26*	−0.44^{+++}	−0.31	−11.2***	−2.32*	−0.12	103	0.79
4811	Paper, paperboard, cellulose …	−3.44***	−0.22^{+}	−0.49^{+}	−7.83***	0.44	2.78**	185	0.4
4812	Filter blocks, slabs and pla …	1.16	0.43^{+}	0.24	−2.55	−1.87	−1.49	27	0.24
4813	Cigarette paper, whether or …	−1.96	−0.61^{+}	−0.2	−6.59**	−2.58	0.99	48	0.50
4814	Wallpaper and similar wall c …	4.95	−0.9^{+++}	−0.15	−1.55	−6.33*	−5.9*	73	0.26
4816	Carbon paper, self−copy pape …	−2.85	−0.15	−0.14	−6.74*	−0.03	−0.09	32	0.24
4817	Envelopes, letter cards, pla …	−0.34	−0.08	−0.14	−2.44	−0.57	0.15	69	0.06
4818	Toilet paper, width 36 cm or …	−0.63	−0.32	−0.9^{+}	−6.76***	0.31	1.53	113	0.30
4819	Cartons, boxes, cases, bags …	−3.88***	−0.18^{+}	−0.62^{++}	−5.25***	1.92*	4.5***	294	0.28
4820	Registers, account books, di …	−1.20	−0.29^{++}	0.04	−1.8*	0.48	1.98*	192	0.11
4821	Paper or paperboard labels o …	−3.1**	−0.09	−0.18	−2.34**	1.31	3.7***	241	0.15
4822	Bobbins, spools, cops and si …	−0.75	−0.05	−1.01^{+}	−6.78**	−0.53	–	22	0.57
4823	Paper, paperboard, cellulose …	−2.39*	−0.15	−0.72^{++}	−4.81***	1.29	3.06**	235	0.16
4901	Printed books, brochures, le …	−4.05***	−0.02	0.2	−1.23	2.75**	4.97***	291	0.18
4902	Newspapers, journals and per …	−8.63*	0.27	1.8^{+++}	−0.93	5.87	5.85	63	0.17
4903	Children's picture, drawing …	−1.29	−0.29	−0.13	−4.14*	0.95	1.1	36	0.24
4905	Maps and hydrographic or sim …	−1.91	−0.34	1.79^{+}	−0.25	−3.11	−0.16	27	0.28
4908	Transfers (decalcomanias)	−3.69*	−0.40^{++}	0.25	−0.16	2.48	4.41*	128	0.11
4909	Printed or illustrated postc …	−2.60	0	0.23	−2.87*	−0.71	2.07	58	0.23
4910	Calendars of any kind, print …	−1.04	0	−0.49^{+}	−2.27	0.51	1.3	105	0.07
4911	Printed matter, n.e.c., incl …	−3.81***	−0.25^{++}	−0.08	−1.69*	1.88**	5.02***	268	0.29
5107	Yarn of combed wool, not put …	3.66	0.11	−0.09	−0.70	−1.14	−0.89	34	0.02
5109	Yarn of wool or of fine anim …	−0.34	0.06	0.79	−3.68	−3.07	−1.57	29	0.32

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
5111	Woven fabrics of carded wool …	− 0.38	− 0.27	0.02	− 2.64	− 2.43	− 0.35	28	0.18
5112	Woven fabrics of combed wool …	− 2.29	-0.54^{+}	0.24	0.12	1.04	4.52	48	0.25
5204	Cotton sewing thread, whethe …	− 0.03	-0.99^{+}	0.07	− 2.02	− 1.97	–	22	0.21
5205	Cotton yarn (other than sewi …	3.88*	-0.59^{+}	0.03	− 3.82*	− 2.33	− 3.36	50	0.42
5206	Cotton yarn (other than sewi …	0.68	-0.82^{+}	0.03	− 3.06	1.57	0.27	25	0.57
5208	Woven fabrics of cotton, con …	− 1.45	-0.7^{+++}	− 0.4	− 4.2**	− 1.37	2.43	105	0.26
5209	Woven fabrics of cotton, con …	1.25	− 0.34	0.08	− 5.8***	− 5.67***	− 2	85	0.38
5210	Woven fabrics of cotton, con …	0.14	0.24	0.00	− 3.04	− 0.45	0.86	68	0.10
5211	Woven fabrics of cotton, con …	− 2.11	-0.82^{++}	-0.67^{+}	− 5.37***	− 0.63	2.48	69	0.35
5212	Other woven fabrics of cotto …	4.08	− 0.31	0.20	− 1.98	− 6.24*	− 4.96	52	0.18
5309	Woven fabrics of flax	− 3.15	− 0.29	-0.74^{+}	− 3.62**	1.88	3.85*	68	0.19
5401	Sewing thread of man – made fi …	− 3.13	-0.67^{+++}	-0.76^{+}	− 1.52	3.95*	4.82*	88	0.18
5402	Synthetic filament yarn (oth …	− 0.83	− 0.05	-0.66^{+}	− 6.79***	0.00	0.12	129	0.34
5404	Synthetic monofilament of 67 …	− 1.71	-0.62^{++}	0.18	− 5.11**	− 2.10	− 0.89	55	0.46
5407	Woven fabrics of synthetic f …	0.34	-0.51^{+++}	0.31	− 1.96	− 1.40	0.51	153	0.19
5408	Woven fabrics of artificial …	3.06	− 0.28	− 0.53	− 1.55	− 2.54	− 1.22	58	0.1
5503	Synthetic staple fibres, not …	− 1.02	-0.77^{++}	− 0.37	− 6.07***	0.1	0.24	68	0.52
5508	Sewing thread of man – made st …	− 4.99	0.83^{+}	− 0.99	− 13.19**	− 2.03	0	25	0.50
5509	Yarn (other than sewing thre …	− 2.78	0.03	0.31	− 3.67**	3.75	2.66	59	0.40
5510	Yarn (other than sewing thre …	− 3.57	-0.85^{++}	0.79	− 2.35	4.71	4.86	27	0.66
5512	Woven fabrics of synthetic s …	− 1.4	-0.94^{+++}	-0.59^{+}	− 3.49**	0.02	0.94	86	0.36
5513	Woven fabrics of synthetic s …	− 0.74	− 0.23	-1.15^{+}	− 3.44*	2.91	3.85	49	0.16
5514	Woven fabrics of synthetic s …	1.48	-0.69^{+}	− 0.4	− 0.83	− 0.09	0.67	42	0.1
5515	Woven fabrics of synthetic s …	1.73	-0.41^{+}	-0.57^{+}	− 1.82	− 0.32	0.26	78	0.1
5516	Woven fabrics of artificial …	0.77	-0.77^{+++}	− 0.39	− 1.43	− 0.6	− 0.08	66	0.19
5601	Wadding of textile materials …	1.01	-0.95^{+++}	− 0.48	− 5.05***	− 3.24	− 0.03	88	0.36
5602	Felt; whether or not impregn …	− 0.11	0.27^{+}	-0.74^{+}	− 5.53***	− 0.83	− 0.42	97	0.15
5603	Nonwovens; whether or not im …	− 1.34	-0.28^{+}	− 0.24	− 6.01***	− 0.36	0.97	161	0.38

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
5604	Rubber thread and cord, text …	−5.11*	0.20	0.33	−4.21*	3.11	3.05	40	0.37
5606	Yarn and strip and the like …	0.46	−0.74	0.43	−0.73	0.01	–	24	0.15
5607	Twine, cordage, ropes and ca …	0.98	−0.29^{+}	−1.32^{+++}	−4.88***	−0.87	−0.47	160	0.1
5608	Twine, cordage or rope; knot …	−0.19	0.07	−0.57	−3.81*	0.53	0.05	88	0.1
5609	Articles of yarn, strip or t …	0.07	−0.15	−0.12	−0.85	0.62	1.06	84	0.02
5701	Carpets and other textile fl …	−2.93	−0.66^{++}	−0.76	−3.4	1.9	2.13	58	0.21
5702	Carpets and other textile fl …	−2.22	−0.13	−0.23	−3.53**	1.55	2.98**	110	0.17
5703	Carpets and other textile fl …	−1.37	0.14	−0.56^{+}	−6.73***	−0.69	1.36	128	0.30
5704	Carpets and other textile fl …	−0.61	−0.18	0.15	−2.91	0.86	0.78	27	0.30
5705	Carpets and other textile fl …	−0.76	−0.11	0.37	−5.83*	−3.92*	−1.07	68	0.24
5801	Fabrics; woven pile and chen …	−1.60	−0.19	−0.17	−2.39	1.19	2.54	78	0.13
5804	Tulles and other net fabrics …	0.25	−0.21	−0.11	−1.02	0.14	1.44	45	0.06
5806	Fabrics; narrow woven, other …	−1.63	−0.05	−0.36	−4.26***	−0.58	1.46	154	0.16
5807	Labels, badges and similar a …	−3.15	−0.4^{+}	0.3	0.91	2.81	4.54**	81	0.14
5808	Braids in the piece; ornamen …	4.19	−0.11	−0.31	−2.07	−4.95	−3.17	53	0.12
5810	Embroidery; in the piece, in …	−2.36	−0.26	0.72^{+}	−1.26	−1.54	0.66	48	0.16
5901	Textile fabrics, gum or amyl …	3.61	0.11	−0.06	−0.24	0.67	−0.93	28	0.09
5902	Textile fabrics; tyrecord of …	0.95	−0.08	−0.87^{+}	−6.32**	−1.86	−0.7	42	0.32
5903	Textile fabrics impregnated, …	−3.24**	−0.24^{+}	0.03	−3.23**	1.91	4.43***	142	0.27
5905	Textile wall coverings	3	−0.82^{+}	1	4.51	−1.72	–	21	0.32
5906	Textile fabrics, rubberised; …	−3.26	−0.26	−0.45	−5.55**	0.37	2.09	89	0.26
5907	Textile fabrics; otherwise i …	−3.61	−0.19	0.38	−0.87	4.46*	3.99*	47	0.24
5909	Textile hose piping and simi …	0.55	−0.28	−0.25	−1.08	0.22	0.35	51	0.03
5910	Textiles; transmission or co …	−3.16	−0.41^{+++}	−0.3	−2.05	2.06	2.68	101	0.16
5911	Textile products and article …	−1.49	−0.32^{++}	−0.19	−3.14***	−0.54	1.23	205	0.14
6001	Fabrics; pile fabrics, inclu …	−3.72*	−0.31	−0.16	−5.81***	0.63	4.21**	58	0.40
6002	Fabrics; knitted or crochete …	−2.09	−1.33^{+}	1.24^{+}	−2.74	−4.33	0.06	23	0.36
6003	Fabrics; knitted or crochete …	−2.41	0.10	0.76	−5.07**	−1.88	–	28	0.41

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
6004	Fabrics; knitted or crochete …	0.05	−0.49^{+}	0.23	−3.86*	−4.07*	−0.66	52	0.29
6005	Fabrics; warp knit (includin …	−3.14*	−0.38^{+}	−0.19	−7.04***	−1.16	1.75	68	0.43
6006	Fabrics; knitted or crochete …	−2.08	−1.1^{+++}	−0.48	−3.44**	0.36	2.92*	100	0.31
6101	Coats; men's or boys' overco …	0.40	−0.38^{++}	0.38^{+}	−1.56	−2.31*	0.09	149	0.20
6102	Coats; women's or girls' ove …	2.09	−0.59^{+++}	0.08	−2.96**	−5.42***	−2.06	157	0.27
6103	Suits, ensembles, jackets, b …	−2.11	−0.21^{+}	−0.26	−3.7***	−0.03	2.53*	228	0.19
6104	Suits, ensembles, jackets, d …	−3.25**	−0.26^{++}	0.23	−2.53***	0.33	4***	290	0.25
6105	Shirts; men's or boys', knit …	−2.61*	−0.15	0.35^{+}	−2.71***	−0.38	2.49*	219	0.22
6106	Blouses, shirts and shirt−bl …	−0.94	−0.42^{+++}	0.36	−2.2*	−1.86	1.37	188	0.27
6107	Underpants, briefs, nightshi …	−2.56*	−0.19	0.01	−3.75***	0.47	3.42**	153	0.25
6108	Slips, petticoats, briefs, p …	−4.64**	−0.41^{++}	0.83^{++}	−1.38	1.8	4.63**	161	0.21
6109	T−shirts, singlets and other …	−1.8*	−0.2^{+}	−0.08	−2.37***	0.37	3.19***	356	0.21
6110	Jerseys, pullovers, cardigan …	−1.89*	0.07	0.05	−2.33***	−0.1	2.99***	326	0.24
6111	Garments and clothing access …	−0.65	0.45^{+}	0.48	−2.67*	−0.65	1.08	126	0.13
6112	Track suits, ski suits and s …	0.57	−0.41^{++}	0.10	−2.4*	−2.86*	0	160	0.17
6113	Garments made up of knitted …	0.04	−0.1	−0.29	−3.12*	−1.27	0.4	45	0.14
6114	Garments; knitted or crochet …	−0.28	−0.15	0.1	−1.62	−1.92	1.07	167	0.18
6115	Hosiery; panty hose, tights, …	−5.08***	−0.34^{+}	0.36	−3.52***	1.91	4.71***	198	0.23
6116	Gloves, mittens and mitts; k …	−1.04	−0.16	−0.09	−3.12***	−0.09	1.39	140	0.16
6117	Clothing accessories; made u …	−2.45	−0.09	−0.06	−2.36*	0.99	2.56	140	0.09
6201	Overcoats, car−coats, capes, …	−1.8	0.02	0	−2.18**	0.18	2.63**	236	0.15
6202	Coats; women's or girls' ove …	−1.69	−0.19	−0.12	−2.76***	−1.23	2.28*	220	0.25
6203	Suits, ensembles, jackets, b …	−2.75**	−0.17^{+}	−0.19	−3.43***	0.23	3.28***	338	0.27
6204	Suits, ensembles, jackets, d …	−3.23***	−0.10	0.01	−2.61***	0.13	3.87***	327	0.31
6205	Shirts; men's or boys' (not …	0.27	0	−0.36^{+}	−2.9***	−1.81	0.86	235	0.16
6206	Blouses, shirts and shirt−bl …	−2.69*	−0.21^{+}	−0.04	−2.01**	0.32	3.54***	225	0.26

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
6207	Singlets and other vests, un …	−0.49	0.08	−0.41	−3.42**	−0.35	1.95	113	0.13
6208	Singlets and other vests, sl …	−1.60	−0.10	0.06	−1.32	0.61	2.88*	128	0.13
6209	Garments and clothing access …	−1.57	−0.36^{+}	0.22	−5.16***	−3.12	−0.08	109	0.25
6210	Garments made up of fabrics …	−1.45	0.08	−0.1	−2.04	0.98	2.81*	129	0.09
6211	Track suits, swimwear and ot …	−0.25	−0.03	0.09	−1.38*	−1.66	1.22	243	0.21
6212	Brassieres, girdles, corsets …	−4.79*	−0.33^{+}	0.28	−2.55*	1.94	4.79**	169	0.18
6213	Handkerchiefs (not knitted o …	1.10	1.07^{+}	−0.17	−1.88	−0.53	−0.4	26	0.25
6214	Shawls, scarves, mufflers, m …	−2.33	−0.50^{+++}	0.10	−0.43	0.43	3.03**	82	0.34
6215	Ties, bow ties and cravats (…	−3.34	−0.24	−0.07	−3.12	0.18	2.99	39	0.25
6216	Gloves, mittens and mitts (n …	−0.12	−0.23^{+}	0.48	−2.85	−2.64	−1.06	90	0.16
6217	Clothing accessories n.e.c.; …	−1.6	−0.28^{+}	−0.09	−1.28	0.11	3.22**	121	0.28
6301	Blankets and travelling rugs	−1.61	−0.26^{+}	0.13	−1.91	0.67	2.74	114	0.13
6302	Bed linen, table linen, toil …	−1.07	−0.1	0.09	−4.97***	−1.95	1.1	191	0.25
6303	Curtains (including drapes) …	−2.03	−0.29^{+}	0.57^{+}	−2.84*	−1.11	0.74	115	0.15
6304	Furnishing articles; excludi …	−2.10	−0.21	0.07	−5.62***	−2.20	1.04	100	0.29
6305	Sacks and bags, of a kind us …	−1.96	−0.59^{++}	−0.32	−3.13*	1.49	2.28	88	0.15
6306	Tarpaulins, awnings and sunb …	−2.6*	−0.24	0	−6.43***	−2.03	0.38	105	0.28
6307	Textiles; made up articles n …	−2.83***	0.11	0.05	−1.97**	2.11**	4.28***	333	0.16
6308	Textiles; sets of woven fabr …	−2.47	−0.64^{+}	2.24^{++}	0.14	−3.21	–	22	0.46
6309	Textiles; worn clothing and …	4.20	−0.57	−3.02^{++}	−7.01*	−2.74	−1.6	26	0.44
6310	Rags; used or new, scrap twi …	−0.72	−0.87^{++}	0.4	−2.89	−0.17	–	33	0.49
6401	Footwear; waterproof, with o …	−0.07	−0.16	−1.47^{++}	−6.55***	−0.77	0.85	67	0.22
6402	Footwear; with outer soles a …	−1.53	−0.24^{+}	0.12	−3.8***	−0.99	1.71	172	0.22
6403	Footwear; with outer soles o …	−0.46	−0.24^{+}	−0.16	−4.08***	−1.91*	0.69	224	0.21
6404	Footwear; with outer soles o …	−1.46	−0.04	−0.04	−4.96***	−1.68	1.17	187	0.26
6405	Footwear; other footwear n.e …	−0.99	0.07	−0.31	−3.08*	0.38	2.30	86	0.10

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
6406	Footwear; parts of footwear; …	−0.21	−0.49^{++}	−0.82^{+}	−3.71**	−0.7	0.90	118	0.16
6504	Hats and other headgear; pla …	−4.27	−0.5^{+}	1.45^{+++}	−2.82	−1.8	0.14	52	0.33
6505	Hats and other headgear; kni …	−1.26	−0.33^{++}	−0.26	−3.17***	−0.87	1.25	207	0.15
6506	Headgear; n.e.c. in chapter …	−1.79	−0.15	−0.14	−4.31***	−0.67	1.05	172	0.17
6507	Head − bands, linings, covers, …	1.48	−0.45^{+}	0.17	−1.29	−2.46	−2.2	68	0.10
6601	Umbrellas; sun umbrellas (in …	−2.13	0.03	−0.09	−5.38***	−1.18	0.65	69	0.21
6602	Walking − sticks, seat − sticks, …	−3.19	−0.76^{+}	0.05	−5.34	−1.21	0.84	27	0.37
6603	Trimmings, parts and accesso …	1.12	−0.56^{+}	0.66	−4.51*	−4.26*	−3.66	23	0.56
6702	Flowers, foliage and fruit, …	−1.85	0.16	−0.76	−8.09**	−2.15	0.38	43	0.32
6704	Wigs, false beards, eyebrows …	−5.36*	0.27^{+}	0.08	−0.84	4.86**	6.25**	68	0.21
6802	Monumental or building stone …	−1.82	0.25	−0.14	−9.37***	−2.72**	−0.48	93	0.54
6804	Millstones, grindstones, gri …	−1.54	−0.29^{++}	−0.09	−1.51	1.14	2.32**	218	0.09
6805	Abrasive powder or grain; na …	−3.23**	−0.07	0.07	−3.55***	2.07*	3.76***	179	0.20
6806	Slag, rock wool and similar …	−1.69	0.47^{++}	−0.31	−6.12***	−0.08	1.88	108	0.35
6807	Asphalt or similar material; …	−1.66	−0.36	−1.59^{++}	−11.57***	−1.77	0.91	29	0.76
6809	Plaster or compositions base …	0.44	0.42	−1.00	−8.07*	−1.53	−2.07	23	0.63
6810	Cement, concrete or artifici …	0.00	−0.45^{++}	−0.88^{+}	−7.56***	−0.91	−0.56	69	0.48
6811	Asbestos − cement, of cellulos …	0.35	−0.50	−0.57	−3.47	3.26	3.34	24	0.31
6812	Fabricated asbestos fibres; …	−5.39	−0.17	2.06	–	1.11	–	34	0.05
6813	Friction material and articl …	−2.18	−0.15	0.25	−1.96*	1.05	2.25	138	0.11
6814	Mica; worked, articles of, i …	−1.68	−0.72^{++}	0.01	−0.82	0.6	2.14	49	0.13
6815	Stone or other mineral subst …	−3.45***	−0.02	0.19	−2.38*	1.62	2.54**	184	0.13
6902	Refractory bricks, blocks, t …	−2.58	0.29	−0.89^{+}	−8.25***	1.31	1.13	77	0.49
6903	Ceramic goods; (e.g. retorts …	−1.40	−0.14	0.19	−0.96	1.65	2.41	106	0.07
6907	Ceramic flags and paving, he …	−1.25	−0.57^{++}	0.23	−9.53***	−3.38**	−0.03	70	0.60
6909	Ceramic ware for laboratory, …	0.18	−0.31^{+}	0.04	−0.81	−0.81	−0.14	99	0.04
6910	Ceramic sinks, wash basins, …	2.8*	−0.48^{++}	0.01	−4.69***	−4.23**	−3.11*	100	0.34
6911	Tableware, kitchenware, othe …	−2.51	−0.4^{+}	−0.6^{+}	−7.18***	−1.14	1.76	120	0.3

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
6912	Ceramic tableware, kitchenwa …	− 2.56	− 0.44^{++}	− 0.46	− 6.21***	0.01	1.16	115	0.3
6913	Statuettes and other ornamen …	0.28	− 0.03	− 0.50	− 4.28**	− 1.75	− 0.20	103	0.11
6914	Ceramic articles; n.e.c. in …	− 2.41	− 0.15	− 0.37	− 3.13**	1.76	1.60	87	0.16
7002	Glass in balls (other than m …	1.33	− 0.27	− 0.45	− 3.21	− 2.26	0.34	40	0.24
7005	Glass; float glass and surfa …	2.06	− 0.14	− 1.75^{+++}	− 7.71***	− 0.98	− 2.56	45	0.49
7006	Glass of heading no. 7003, 7 …	− 2.71	0.02	0.41	− 3.62	0.56	1.63	36	0.21
7007	Safety glass, consisting of …	− 3.58***	− 0.14	− 0.13	− 3.18***	2.23**	4.69***	240	0.22
7009	Glass mirrors; whether or no …	− 3.95***	0.03	− 0.02	− 5.94***	0.51	2.48***	235	0.36
7010	Carboys, bottles, flasks, ja …	− 1.80	− 0.61^{+++}	− 0.37	− 4.66***	1.10	2.17	134	0.29
7013	Glassware of a kind used for …	− 3.16***	− 0.3^{+}	− 0.12	− 5.54***	0.50	2.8**	202	0.24
7014	Signalling glassware and opt …	3.77	− 0.43^{++}	− 0.48^{+}	− 2.78*	− 5.33**	− 4.44*	49	0.34
7015	Clock, watch and similar gla …	2.49	− 0.12	− 0.71	–	− 0.49	–	26	0.04
7016	Glass; paving blocks, slabs, …	− 4.56	0.10	0.68	− 4.2	2.41	3.43	39	0.30
7017	Laboratory, hygienic or phar …	− 0.69	− 0.02	− 0.29	− 0.87	0.34	0.74	112	0.02
7018	Glass beads, imitation pearl …	− 2.22	− 0.5^{++}	− 0.57	− 4.00**	0.7	0.57	77	0.24
7019	Glass fibres (including glas …	− 2.98***	0.09	− 0.29	− 5.24***	0.89	3.14***	199	0.27
7020	Glass; articles n.e.c. in ch …	− 2.80**	0.03	− 0.25	− 1.60	2.35*	4.32***	125	0.16
7103	Precious (excluding diamond) …	− 1.60	− 0.81^{++}	0.03	− 3.03	− 2.09	− 0.90	49	0.22
7106	Silver (including silver pla …	− 9.98*	− 0.98^{++}	1.19^{+}	− 0.59	5.58	7.28	43	0.20
7113	Jewellery articles and parts …	2.65	− 0.99^{++}	0.36	5.06*	− 3.85***	–	63	0.38
7116	Articles of natural or cultu …	− 5.35*	− 0.73^{+}	0.62	− 2.48	− 1.67	3.17	45	0.40
7117	Imitation jewellery	− 2.01	− 0.53^{+++}	0.07	0.12	− 0.36	2.31	139	0.27
7202	Ferro – alloys	1.08	− 0.73^{++}	− 0.52	− 8.08***	− 2.97	− 2.44	52	0.64
7205	Granules and powders, of pig …	− 2.38	− 0.65^{++}	− 0.16	− 5.26**	− 0.31	2.17	55	0.30
7207	Iron or non – alloy steel; sem …	− 5.44*	− 1.08^{+}	− 0.21	− 10.61**	− 1.02	3.78	47	0.37
7208	Iron or non – alloy steel; fla …	− 0.61	− 0.33	− 0.24	− 8.96***	− 2.79*	− 1.63	75	0.47
7209	Iron or non – alloy steel; fla …	0.21	− 0.61	0.16	− 7.68**	− 4.00*	− 2.67	44	0.46
7210	Iron or non – alloy steel; fla …	− 1.72	− 0.28^{+}	0.24	− 9.08***	− 1.81	0.52	87	0.57

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
7211	Iron or non – alloy steel; fla …	− 0.74	− 0.04	0.35	− 4.03*	0.10	0.21	65	0.23
7212	Iron or non – alloy steel; fla …	1.07	− 0.28	− 0.16	− 5.69**	− 2.08	− 1.06	54	0.33
7213	Iron or non – alloy steel; bar …	0.59	0.56	− 0.74^{+}	− 12.84***	− 1.17	− 2.19	25	0.78
7214	Iron or non – alloy steel; bar …	− 0.38	− 0.46^{++}	− 0.33	− 8.01***	− 2.65	− 1.07	62	0.38
7215	Iron or non – alloy steel; bar …	− 2.97	− 0.18	− 0.25	− 7.16***	0.4	2.4	57	0.37
7216	Iron or non – alloy steel, ang …	0.84	− 0.32^{+}	0.02	− 6.13***	− 2.29	− 0.76	81	0.33
7217	Wire of iron or non – alloy steel	1.59	− 0.53^{++}	− 0.29	− 5.75***	− 1.9	− 2.43	83	0.35
7219	Stainless steel; flat – rolled …	1.89	0.11	0.07	− 4.82**	− 1.66	− 0.66	99	0.19
7220	Stainless steel; flat – rolled …	− 2.94*	0.03	0.25	− 5.26***	0.64	1.85	77	0.34
7222	Stainless steel bars and rod …	− 0.14	− 0.16	0.44	− 2.37	− 0.48	0.66	110	0.08
7223	Stainless steel wire	− 1.51	− 0.30^{+}	− 0.88^{+}	− 7.22***	− 0.87	− 0.35	87	0.22
7224	Alloy steel in ingots or oth …	1.78	− 0.11	− 0.35	− 5.86**	− 3.18	− 2.41	28	0.42
7225	Alloy steel flat – rolled prod …	− 0.67	− 0.38^{+}	0.08	− 8.06***	− 2.03*	− 1.16	65	0.64
7226	Alloy steel flat – rolled prod …	− 3.29	− 0.49^{++}	− 0.93^{+}	− 8.36***	0.81	1.77	55	0.44
7228	Alloy steel bars, rods, shap …	1.76	0.08	− 0.28	− 4.62***	− 0.98	− 0.45	117	0.14
7229	Wire of other alloy steel	1.57	− 0.35^{+}	− 0.38	− 4.59	− 1.56	− 0.05	69	0.09
7302	Railway or tramway track con …	2.29	0.65^{+}	− 0.24	− 4.07	− 1.11	− 3.9*	57	0.37
7303	Tubes, pipes and hollow prof …	3.46	0.25	− 0.01	− 1.33	− 2.49	− 2.68	35	0.08
7304	Tubes, pipes and hollow prof …	− 3.70***	− 0.04	− 0.24	− 5.20***	1.79	3.7***	222	0.28
7305	Iron or steel (excluding cas …	− 2.40	0.09	− 0.20	− 2.94	3.72	2.12	33	0.26
7306	Iron or steel (excluding cas …	− 2.38*	− 0.46^{+++}	− 0.10	− 4.15***	0.94	3.51**	189	0.2
7307	Tube or pipe fittings (e.g. …	− 4.55***	− 0.17^{+}	− 0.35^{+}	− 3.49***	2.65***	5.09***	332	0.25
7308	Structures of iron or steel …	− 1.51	− 0.35^{++}	− 1.04^{+++}	− 6.56***	0.85	1.97*	199	0.32
7309	Reservoirs, tanks, vats and …	3.29	− 0.22	− 0.47	− 6.36***	− 5.06**	− 4.63*	61	0.37
7310	Tanks, casks, drums, cans, b …	− 0.91	0.13	− 0.93^{++}	− 7.15***	− 1.53	0.16	135	0.28
7311	Containers for compressed or …	− 0.53	0.55^{++}	− 0.57	− 5.08***	0.73	0.14	95	0.20
7312	Stranded wire, ropes, cables …	− 1.45	− 0.16	− 0.14	− 4.02***	0.18	1.61	219	0.12
7314	Cloth (including endless ban …	0.63	− 0.16	0.02	− 1.82	− 0.8	− 0.06	116	0.04

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
7315	Chain and parts thereof, of …	−5.17***	−0.33^{++}	0.38^{+}	−2.91**	2.38*	4.41***	229	0.23
7316	Anchors, grapnels and parts …	−1.28	−0.72^{++}	−0.27	−6.06**	−2.82	−0.27	32	0.40
7317	Nails, tacks, drawing pins, …	−2.01	−0.35^{+}	0.03	−3.55*	0.60	1.94	111	0.16
7318	Screws, bolts, nuts, coach s …	−3.77***	−0.08	−0.18	−2.74***	2.16***	4.61***	466	0.24
7319	Sewing and knitting needles, …	−0.47	−0.16	0.44	1.18	0.69	1.47	71	0.03
7320	Springs and leaves for sprin …	−4.15***	−0.1	−0.35^{+}	−3.56***	1.91**	4.09***	317	0.21
7321	Stoves, ranges, grates, cook …	−0.24	−0.17	−0.22	−4.25***	0.09	1.30	153	0.20
7322	Radiators for central heatin …	−3.77*	0.07	−0.09	−5.7***	0.54	3.83*	74	0.35
7323	Table, kitchen, other househ …	−2.01*	−0.19^{+}	−0.04	−4.06***	1.00	2.27*	198	0.18
7324	Sanitary ware and parts ther …	−1.38	−0.31^{+}	0.37	−2.96*	−0.47	2.48*	117	0.23
7325	Iron or steel; cast articles	1.39	0.25^{+}	−1.44^{+++}	−3.84**	0.23	0.93	132	0.15
7326	Iron or steel; articles, n.e …	−3.38***	0.24^{++}	−0.5^{++}	−4.3***	1.75**	3.74***	431	0.27
7403	Copper; refined and copper a …	−1.12	−0.38	−0.28	−4.93*	−0.49	−0.34	57	0.28
7406	Copper; powders and flakes	−5.09	0.81^{++}	0.19	−4.87*	3.82	4.14	28	0.39
7407	Copper; bars, rods and profiles	−0.46	−0.44^{++}	−0.47	−1.75	1.89	3.24	101	0.09
7408	Copper wire	0.51	−0.24	−0.80	−6.95**	−1.91	−1.14	77	0.19
7409	Copper plates, sheets and st …	−1.72	−0.2	−0.43	−3.39	1.97	2.32	75	0.06
7410	Copper foil (whether or not …	−0.94	0.36	−1.01^{+}	−8.13*	−1.71	−0.97	43	0.16
7411	Copper tubes and pipes	−2.29	−0.04	−0.26	−4.59*	2.00	1.86	111	0.14
7412	Copper; tube or pipe fitting …	−4.35***	0.17^{+}	0.05	−5.1***	0.61	3.12***	195	0.25
7413	Copper; stranded wire, cable …	−4.59	−0.17	0.00	−4.48*	1.45	3.36	66	0.17
7415	Copper, nails, tacks, drawin …	−1.89	−0.12	0.36	−1.05	0.73	1.94	190	0.06
7418	Copper; table, kitchen or ot …	−4.75***	−0.24	0.45	−4.07**	0.65	3.61**	73	0.35
7419	Copper; articles thereof n.e …	−2.31*	−0.13	0.15	−2.72**	−0.93	2.10*	182	0.19
7504	Nickel; powders and flakes	0.39	−0.75^{++}	−0.71^{+}	−5.37*	−4.05**	–	24	0.39
7505	Nickel; bars, rods, profiles …	−2.87	−0.24	0.85^{+}	−0.45	0.99	2.93	52	0.18
7506	Nickel; plates, sheets, stri …	4.32	−0.64^{++}	−1.61^{+}	–	−0.87	2.16	26	0.45
7507	Nickel; tubes, pipes and tub …	−1.65	−0.48^{+}	−0.16	–	2.23	3.46	43	0.14

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
7508	Nickel; articles thereof n.e …	1.80	−0.60^{+++}	0.28	−0.44	−5.52**	−2.58	64	0.31
7601	Aluminium; unwrought	−2.65	−0.20	−0.40	−8.87**	−0.75	1	44	0.48
7604	Aluminium; bars, rods and pr …	−1.42	−0.57^{+++}	−0.06	−3.67***	0.07	2.73**	180	0.26
7605	Aluminium wire	−2.91	−0.03	0.23	−6.88***	0.40	0.87	54	0.55
7606	Aluminium; plates, sheets an …	−1.77	−0.02	0.59^{+}	−3.09*	1.24	3.05*	128	0.20
7607	Aluminium foil (whether or n …	−1.65	−0.55^{+++}	−0.75^{++}	−4.42**	1.69	3.15*	154	0.21
7608	Aluminium; tubes and pipes	0.19	−0.3^{+}	−0.67^{+}	−2.78	0.8	2.69	124	0.12
7609	Aluminium; tube or pipe fitt …	−2.19	−0.22^{+}	0.36	0.05	1.63	3.79*	137	0.14
7610	Aluminium; structures (exclu …	−0.85	−0.07	−0.35^{+}	−5.41***	−1.08	0.79	158	0.25
7612	Aluminium casks, drums, cans …	−1.15	−0.08	−0.48	−2.74	1.49	2.31	102	0.07
7613	Aluminium; containers for co …	2.62	−0.41^{+}	0.25	2.56	1.11	–	41	0.15
7615	Aluminium; table, kitchen or …	−1.46	−0.2	−0.32	−5.77***	0.13	1.61	95	0.3
7616	Aluminium; articles n.e.c. i …	−3.41***	−0.35^{++}	−0.55^{++}	−3.46***	1.72*	4.15***	302	0.2
7806	Lead; articles n.e.c. in cha …	3.33	−0.35^{+}	0	5.11	2.77	2.35	46	0.07
7907	Zinc; articles n.e.c. in cha …	−3.5*	−0.18	0.06	−3.88**	0.35	2.85	110	0.19
8003	Tin; bars, rods, profiles an …	0.19	−0.28	−0.49	−3.25	0.31	0.85	26	0.15
8007	Tin; articles n.e.c. in chap …	8.31	−0.02	−1.61^{+}	2.88	0.22	−3.73	26	0.22
8101	Tungsten (wolfram); articles …	−3.88	−0.25^{+}	0.78^{+}	0.1	1.45	2.55	46	0.18
8102	Molybdenum; articles thereof …	−4.25	−0.37	0.69	1.53	2.97	3.26	23	0.14
8104	Magnesium; articles thereof, …	−2.92	−0.09	0.25	−1.9	2.39	3.82	38	0.10
8105	Cobalt; mattes and other int …	−3.58	0.30	−0.64	−8.36*	−0.98	–	38	0.17
8108	Titanium; articles thereof, …	−2.07	−0.04	0.89^{++}	0.20	0.02	1.63	70	0.11
8112	Beryllium, chromium, germani …	0.95	0.25	0.26	0.81	1.50	–	28	0.11
8113	Cermets; articles thereof, i …	−1.11	−0.34	1.31^{++}	1.95	−0.87	–	26	0.26
8201	Tools, hand; spades, shovels …	0.42	−0.18	−0.59	−4.49**	−1.13	−0.02	95	0.15
8202	Tools, hand; saws and blades …	−1.79	−0.33^{++}	−0.81^{++}	−3.55**	1.43	2.74*	165	0.14
8203	Tools, hand; files, rasps, p …	−2.78*	−0.11	−0.22	−3.13***	1.4	2.67*	205	0.10
8204	Tools, hand; hand−operated s …	0.07	−0.25^{+}	0.03	−0.69	−0.13	0.81	208	0.03

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
8205	Tools, hand; (including glaz …	−1.84*	−0.07	−0.22	−2.72***	0.41	1.97**	306	0.11
8206	Tools, hand; two or more of …	1.04	−0.54^{+++}	0.09	0.31	−0.53	1.07	126	0.15
8207	Tools, interchangeable; for …	−4.40***	−0.17^{+}	0.06	−0.86	3.08***	5.46***	307	0.23
8208	Knives and cutting blades, f …	−1.29	−0.07	−0.29	−0.52	1.51	1.78	241	0.03
8209	Tools; plates, sticks, tips …	−5.81***	−0.5^{++}	−0.04	1.55	3.64*	7.01***	87	0.36
8210	Tools; hand−operated mechani …	2.38	−0.8^{++}	0.26	−2.21	−3.66	−2.64	46	0.30
8211	Knives; with cutting blades, …	0.78	−0.11	−0.15	−0.90	0.15	0.41	150	0.01
8212	Razors and razor blades; (in …	0.23	−0.04	−0.83^{+}	−5.12**	−0.21	0.01	79	0.13
8213	Scissors; tailors' shears an …	−4.20*	−0.36^{+}	−0.07	−4.24**	1.06	2.94	88	0.22
8214	Cutlery; other articles, (e. …	−1.64	−0.38^{++}	0.88^{++}	0.96	1.72	1.86	103	0.13
8215	Cutlery; spoons, forks, ladl …	−4.70**	−0.26^{+}	−0.06	−4.72***	2.33	4.32**	113	0.25
8301	Padlocks and locks (key, com …	−3.40***	−0.14	−0.01	−3.28***	0.9	3.87***	299	0.24
8302	Base metal mountings, fittin …	−2.67***	−0.17^{+}	−0.40^{++}	−4.55***	0.48	2.88***	368	0.27
8303	Safes; armoured or reinforce …	0.95	0.54^{+}	0.59	−3.92*	−3.62*	−2.64	41	0.37
8304	Office equipment; filing cab …	−2.52	0.13	0.98	−3.69	−1.21	2.27	23	0.37
8305	Stationery; fittings for loo …	−0.04	0.12	−0.18	−4.33*	−0.84	0.91	60	0.13
8306	Bells, gongs and the like; n …	−1.20	−0.19^{+}	0.29	−1.34	−0.05	1.53	126	0.11
8307	Tubing; flexible, with or wi …	−2.13	−0.03	0.12	−2.54*	0.42	2.58	155	0.12
8308	Clasps; frames with clasps, …	−2.55**	−0.4^{++}	−0.26	−2.64**	0.94	2.99**	152	0.18
8309	Stoppers, caps, lids (includ …	−4.65**	0.06	−0.79^{++}	−5.59***	3.5*	4.38**	190	0.18
8310	Sign plates, name plates, ad …	−1.71	−0.1	0.31^{+}	−0.41	0.90	3.17**	153	0.16
8311	Wires, rods, tubes, plates, …	2.29	−0.36^{++}	−0.93^{++}	−5.35***	−3.10	−3.22	144	0.2
8402	Boilers; steam or other vapo …	−3.40	−0.13	−0.65	−6.97***	0.36	0.14	73	0.27
8403	Central heating boilers; exc …	−3.65*	−0.2	−0.31	−3.92***	3.14*	5.56***	64	0.37
8404	Auxiliary plant for use with …	−0.09	0.15	−0.16	−2.44	−0.01	0.89	49	0.07
8405	Generators for producer or w …	0.07	−0.12	0.61	0.15	−0.34	–	44	0.05
8406	Turbines; steam and other va …	3.85	0.42	−0.04	−3.33	−5.59	−6.19	55	0.11
8407	Reciprocating or rotary inte …	−1.63	−0.83^{+++}	0.27	−4.23*	−2.37	−0.26	128	0.21

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
8408	Compression – ignition interna …	– 2.97	– 0.18	0.2	– 2.99	2.52*	3.2**	129	0.12
8409	Parts suitable for use solel …	– 4.75***	– 0.12	– 0.36^{+}	– 2.45***	3.75***	5.86***	371	0.28
8410	Turbines; hydraulic water wh …	5.89***	0.02	– 0.87^{+}	–	– 2.87**	–	45	0.20
8411	Turbo – jets, turbo – propellers …	– 1.58	– 0.54^{++}	0.33	–	– 2.13	1.27	102	0.19
8412	Engines and motors; n.e.c. (…	– 2.29*	– 0.06	– 0.23^{+}	– 0.63	2.71***	4.07***	316	0.13
8413	Pumps; for liquids, whether …	– 4.12***	– 0.05	– 0.22^{+}	– 2.61***	2.91***	4.61***	412	0.27
8414	Air or vacuum pumps, air or …	– 2.16***	0.12	– 0.76^{+++}	– 3.67***	1.8***	3.08***	386	0.21
8415	Air conditioning machines; c …	– 3.02**	– 0.09	– 0.13	– 5.62***	– 0.07	1.87*	267	0.15
8416	Furnace burners for liquid f …	– 1.51	– 0.25	– 0.29	– 0.38	2.25	4.56*	119	0.15
8417	Furnaces and ovens; industri …	– 1.39	– 0.06	0.75^{+}	– 0.47	1.84	2.09	116	0.08
8418	Refrigerators, freezers and …	– 2.86***	– 0.11	– 0.18	– 4.96***	1.24	3.05***	301	0.18
8419	Machinery, plant (not domest …	– 3.59***	0.11	– 0.3^{+}	– 4.06***	1.91**	3.56***	333	0.19
8420	Machines; calendering or oth …	1.02	0.09	– 0.26	0.66	2.39	2.73	71	0.07
8421	Centrifuges, including centr …	– 4.95***	0.02	– 0.48^{+++}	– 3.98***	3.5***	5.35***	453	0.34
8422	Dish washing machines; machi …	– 2.16**	– 0.05	– 0.1	– 2.2**	1.34	2.21**	280	0.09
8423	Weighing machines; excluding …	– 1.13	– 0.04	– 0.2	– 2.21*	0.28	1.46	150	0.05
8424	Mechanical appliances for pr …	– 4.70***	0.05	– 0.03	– 3.48***	2.99***	4.55***	308	0.19
8425	Pulley tackle and hoists oth …	– 3.44*	0.01	0.23	– 3.41**	1.58	3.08*	197	0.11
8426	Derricks, cranes, including …	4.65*	– 0.27	0.30	– 1.54	– 2.38	– 4.34	55	0.29
8427	Fork – lift and other works tr …	– 2.48	– 0.43^{+}	– 0.38	– 5.71**	2.86*	3.33*	69	0.49
8428	Lifting, handling, loading o …	– 4.23**	– 0.19	– 0.36^{+}	– 4.21***	3.99**	4.87***	191	0.18
8429	Bulldozers, graders, levelle …	7.92*	– 0.84^{++}	– 0.02	– 6.82*	– 6.16*	– 9.51**	32	0.78
8430	Moving, grading, levelling, …	4.11	– 0.73^{++}	– 0.47	– 4.76*	– 4.4	– 5.03	65	0.4
8431	Machinery parts; used solely …	– 3.97***	– 0.13	– 0.28^{+}	– 2.65***	2.98***	4.25***	406	0.16
8432	Agricultural, horticultural …	– 1.86	0.15	– 0.04	– 6.1***	– 0.54	0.24	141	0.17
8433	Harvesting and threshing mac …	– 3.15*	0.38^{+++}	– 0.48^{+}	– 6.45***	1.43	1.43	198	0.21
8434	Milking machines and dairy m …	– 0.21	– 0.01	– 0.08	– 2.25	– 0.29	–	104	0.03
8435	Presses, crushers and simila …	– 1.44	– 1.19^{+++}	– 0.8^{+}	– 9.46**	– 4.29	– 1.76	41	0.36

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
8436	Agricultural, horticultural, …	− 2.68	− 0.24^{+}	0.21	− 3.63**	0.88	2.42	155	0.15
8437	Machines for cleaning, sorti …	2.45	− 0.21	− 0.12	− 2.93*	− 2.71	− 2.33	123	0.06
8438	Machinery n.e.c. in this cha …	− 2.48*	− 0.39^{+++}	− 0.35^{+}	− 4.17***	0.37	1.8	240	0.18
8439	Machinery; for making pulp o …	− 2.66	0.03	0.01	− 2.87	1.81	3.11*	124	0.09
8440	Book − binding machinery; incl …	1.96	0.12	0.39^{+}	0.1	− 0.87	− 0.13	56	0.07
8441	Machines; for making up pape …	− 1.95	− 0.11	0.28	− 2.04*	0.51	1.42	183	0.07
8442	Machinery, apparatus and equ …	− 1.60	− 0.5^{+++}	0.37^{+}	− 0.33	0.27	1.35	101	0.18
8443	Printing machinery; used for …	− 3.84***	− 0.23^{+}	0.16	− 2.42**	1.30	3.56***	298	0.17
8445	Textile machinery; spinning, …	− 2.53	− 0.42	1.11^{+}	− 2.97	1.18	0.67	39	0.47
8447	Knitting machines, stitch − bo …	− 4.49*	0.09	− 0.02	− 7.92*	1.33	2.39	36	0.45
8448	Machinery, auxiliary; for us …	− 5.31*	− 0.27^{+}	− 0.22	− 2.81**	2.05	4.44*	167	0.18
8449	Machinery; for manufacture o …	− 1.95	− 0.25	− 0.68	− 4.36	1.26	1.16	26	0.21
8450	Household or laundry − type wa …	− 3.48**	− 0.10	0.32	− 4.38***	1.87	2.66*	132	0.25
8451	Machinery (not of heading no …	− 4.45***	− 0.22^{+}	0.19	− 4.06***	2.51*	3.35**	160	0.26
8452	Sewing machines; other than …	− 1.63	− 0.07	0.43	− 1.31	− 0.01	0.77	122	0.04
8453	Machinery for preparing, tan …	− 1.11	0.38^{+}	1.03^{+}	− 0.52	− 0.55	0.19	51	0.14
8454	Converters, ladles, ingot mo …	0.97	− 0.14	0.00	− 1.53	− 0.92	0.55	87	0.06
8455	Metal − rolling mills and roll …	− 2.34	0.12	− 0.14	− 5.53***	0.28	1.25	93	0.26
8456	Machine − tools; for working a …	− 3.77**	− 0.52^{++}	− 0.15	− 4.02*	2.03	3.2*	85	0.26
8457	Machining centres, unit cons …	5.83	0.03	− 0.52	− 2.22	− 1.04	− 5.5	28	0.50
8458	Lathes for removing metal	2.82	− 0.68^{+}	− 0.11	− 3.98	− 2.45	− 0.9	44	0.26
8459	Machine − tools; (including wa …	− 0.92	− 0.36^{+}	− 0.28	− 3.75**	0.59	1.44	77	0.22
8460	Machine − tools; for deburring …	− 3.33	− 0.17	− 0.25	− 4.44*	1.91	3.37	92	0.18
8461	Machine − tools; for planing, …	− 0.02	0.04	− 0.38	− 3.41*	0.33	0.98	69	0.10
8462	Machine − tools; (including pr …	0.12	− 0.22^{+}	0.06	− 3.14**	0.22	0.6	119	0.17
8463	Machine − tools; n.e.c. for wo …	2.30	− 0.45^{+}	− 0.37	− 2.51	− 1.50	− 0.51	63	0.07
8464	Machine − tools; for working s …	0.01	− 0.65^{++}	0.54	− 1.58	− 0.77	− 0.21	67	0.11
8465	Machine − tools; (including ma …	2.76	− 0.15	0.15	− 2.16	− 2.40	− 2.04	88	0.07

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
8466	Machine – tools; parts and acc …	− 4.1***	− 0.02	0.01	− 1.55	2.21*	3.66***	271	0.13
8467	Tools; for working in the ha …	0.72	− 0.47^{+++}	− 0.38^{+}	− 1.26	− 0.59	1.41	259	0.12
8468	Machinery and apparatus for …	− 2.93	− 0.65^{+++}	0.21	− 3.88*	− 0.63	1.54	92	0.23
8470	Calculating machines and poc …	− 4.16**	0.15	− 0.64^{+}	− 4.17**	2.53	3.25*	87	0.17
8471	Automatic data processing ma …	− 3.85***	0.08	− 0.09	0.31	2.56**	6.11***	301	0.35
8472	Office machines; not elsewhe …	− 4.35*	− 0.39^{+}	− 0.23	− 4.11*	2.34	2.3	97	0.14
8473	Machinery; parts and accesso …	− 5.37***	− 0.16	− 0.26	− 0.64	3.48**	6.62***	215	0.31
8474	Machinery for sorting, scree …	− 4.44***	− 0.06	− 0.15	− 4.47***	2.53**	3.56***	241	0.17
8475	Machines; for assembling ele …	− 2.33	0.28	0.61^{+}	− 1.95	− 0.78	–	56	0.16
8476	Automatic goods – vending mach …	− 0.13	− 0.31^{+}	0.30	− 0.78	0.54	1.10	60	0.07
8477	Machinery; for working rubbe …	− 1.33	− 0.28^{++}	− 0.04	− 1.49	0.89	2.22*	241	0.08
8478	Machinery; for preparing or …	3.84*	− 0.33	− 1.47^{+}	–	0.94	–	41	0.14
8479	Machinery and mechanical app …	− 2.60***	− 0.31^{++}	− 0.35^{+}	− 2.74***	1.35*	3.16***	388	0.16
8480	Moulding boxes for metal fou …	− 1.94*	− 0.45^{+++}	− 0.45^{+}	− 3.53***	− 0.23	2.5**	179	0.31
8481	Taps, cocks, valves and simi …	− 3.7***	− 0.19^{+}	− 0.19	− 1.24*	3.09***	5***	433	0.26
8482	Ball or roller bearings	− 4.19***	− 0.16^{+}	0.08	− 3.12***	1.82***	3.4***	382	0.17
8483	Transmission shafts (includi …	− 4.42***	− 0.11	− 0.07	− 2.29***	2.98***	4.29***	432	0.19
8484	Gaskets and similar joints o …	− 2.72***	0.06	− 0.01	− 0.42	2.30***	3.65***	347	0.12
8486	Machines and apparatus of a …	1.33	− 0.84^{++}	− 0.75^{+}	–	0.12	1.27	50	0.25
8487	Machinery parts; not contain …	− 5.33***	− 0.07	0.27^{+}	− 0.95	4.2***	6.04***	278	0.46
8501	Electric motors and generato …	− 3.85***	0.01	− 0.18	− 3.45***	1.86**	3.62***	378	0.19
8502	Electric generating sets and …	− 1.20	− 0.12	0.13	− 6.2***	− 1.03	0.31	98	0.22
8503	Electric motors and generato …	− 3.86**	− 0.32^{++}	− 0.08	− 3.29**	1.35	3.81***	237	0.17
8504	Electric transformers, stati …	− 3.56***	− 0.01	− 0.26^{+}	− 2.75***	1.6**	3.81***	416	0.21
8505	Electro – magnets; permanent m …	− 3.40**	− 0.25^{++}	0.13	− 2.37*	0.60	2.95**	239	0.18
8506	Cells and batteries; primary	− 2.51	− 0.17	0.02	− 2.20	1.09	3.11*	159	0.13
8507	Electric accumulators, inclu …	0.26	− 0.16	− 0.63^{++}	− 3.35**	− 0.25	1.08	269	0.08
8508	Vacuum cleaners	1.26	− 0.44^{++}	0.02	− 2.54*	− 1.91	− 0.63	133	0.12

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
8509	Electro – mechanical domestic …	− 0.36	− 0.16	-0.49^{+}	− 4.98***	− 0.51	0.57	115	0.28
8510	Shavers, hair clippers and h …	− 2.71	− 0.07	− 0.43	− 2.95	2.80*	4.33**	64	0.27
8511	Ignition or starting equipme …	− 5.59***	− 0.17	− 0.26	− 6.14***	1.12	2.65**	304	0.15
8512	Lighting or visual signallin …	− 5.69***	-0.16^{+}	-0.3^{+}	− 5.07***	2.57***	4.42***	359	0.36
8513	Lamps; portable, electric, d …	− 2.31	− 0.18	0	− 1.24	0.96	2.06	104	0.05
8514	Industrial or laboratory ele …	− 1.74	0.04	0.41^{+}	− 2.88*	− 0.81	0.49	159	0.1
8515	Electric (electrically heate …	− 3.57**	− 0.14	− 0.09	− 2.6**	2.08*	3.15***	224	0.1
8516	Electric water, space, soil …	− 1.60**	-0.17^{+}	-0.27^{+}	− 3.35***	0.49	2.37***	328	0.19
8517	Telephone sets, including te …	− 2.73***	-0.18^{+}	-0.78^{+++}	− 0.33	2.06**	5.4***	335	0.37
8518	Microphones and their stands …	− 1.74*	-0.28^{++}	0.25	− 0.88	0.29	2.62**	275	0.17
8519	Sound recording or reproduci …	3.40	-0.77^{+++}	0.42	0	− 4.32	− 3.44	70	0.19
8521	Video recording or reproduci …	− 5.00**	-0.53^{++}	0.18	− 2.02	1.78	4.37*	75	0.22
8522	Sound or video recording app …	1.79	-0.47^{+}	0.34	− 1.30	− 4.85	− 4.04	42	0.2
8523	Discs, tapes, solid – state no …	− 5.27***	-0.27^{++}	0.10	1.09	3.57**	6.77***	253	0.26
8525	Transmission apparatus for r …	− 0.02	-0.53^{+++}	0.11	1.31	− 0.80	1.88	222	0.20
8526	Radar apparatus, radio navig …	0.88	− 0.03	-0.43^{+}	− 2.38*	− 3.35**	− 1.4	229	0.13
8527	Reception apparatus for radi …	− 2.89	0.09	− 0.18	− 3.37*	0.84	2.11	148	0.1
8528	Monitors and projectors, not …	0.04	-0.29^{++}	-0.6^{++}	− 2.3*	− 1.28	1.23	228	0.17
8529	Transmission apparatus; part …	− 1.20	-0.3^{++}	− 0.13	− 1.5	− 0.96	0.81	269	0.08
8530	Signalling, safety or traffi …	− 1.03	-0.81^{+++}	-1.05^{++}	− 2.82	0.24	1.70	106	0.14
8531	Signalling apparatus; electr …	− 0.98	0.09	-0.42^{++}	− 0.56	0.66	2.76**	287	0.18
8532	Electrical capacitors; fixed …	− 5.61***	0.17	-0.34^{+}	− 4.2**	2.01*	4.61***	229	0.24
8533	Electrical resistors (includ …	− 4.50***	-0.20^{+}	0	− 2.35*	1.33	3.88***	268	0.22
8534	Circuits; printed	− 3.72***	− 0.02	0.19	− 1.48	0.79	3.61***	197	0.24
8535	Electrical apparatus for swi …	− 6.23***	-0.28^{+}	− 0.08	− 3.74**	3.14**	5.02***	225	0.18
8536	Electrical apparatus for swi …	− 3.20***	-0.24^{++}	-0.40^{++}	− 1.33*	2.45***	4.91***	517	0.27
8537	Boards, panels, consoles, de …	− 3.59***	− 0.01	-0.31^{+}	− 2.39***	2.04***	4.42***	408	0.28
8538	Electrical apparatus; parts …	− 3.08***	0.04	-0.47^{++}	− 3.46***	0.59	3.39***	368	0.24

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
8539	Lamps; electric filament or …	−2.77**	−0.22^{+}	−0.03	−1.22	1.83*	3.94***	257	0.16
8540	Thermionic, cold cathode or …	−3.40	−0.66^{+}	−0.65	−1.66	1.08	3.34	54	0.16
8541	Diodes, transistors, similar …	−3.45*	0.07	−0.28	−1.85	1.45	4.08***	283	0.19
8542	Electronic integrated circuits	−5.00***	−0.35^{++}	−0.19	0.32	2.48**	6.64***	260	0.37
8543	Electrical machines and appa …	−2.8***	−0.32^{+++}	−0.03	−0.47	1.54*	3.89***	328	0.21
8544	Insulated wire, cable and ot …	−5.17***	0	−0.49^{++}	−4.32***	2.61***	5.72***	483	0.31
8545	Carbon electrodes, carbon br …	−4.46**	−0.28^{+}	0.74^{+}	−3.68**	−0.31	1.59	160	0.14
8546	Electrical insulators of any …	−2.38	−0.14	−0.41^{+}	−4.09**	0.50	0.97	155	0.08
8547	Insulating fittings; for ele …	−3.38*	0.01	−0.37^{+}	−6.08***	−1.42	1.88*	244	0.25
8548	Waste and scrap of primary c …	−4.15***	−0.31^{+}	0.45^{++}	−0.38	1.81*	4.58***	140	0.4
8607	Railway or tramway locomotiv …	0.29	−0.41^{++}	−0.9^{++}	−2.63*	0.47	2.38*	126	0.19
8608	Railway or tramway track fix …	−0.57	−0.48^{+}	−0.51	−2.55	0.63	1.84	49	0.15
8609	Containers; (including conta …	0.43	−0.37^{+}	0.05	−1.20	0.48	−0.16	49	0.25
8701	Tractors; (other than tracto …	4.40	−1.20^{++}	0.84^{+}	−7.07**	−7.04***	−7.92**	29	0.82
8703	Motor cars and other motor v …	−0.22	−1.34^{+++}	−0.09	−11.44***	−6.02***	−2.77	92	0.66
8704	Vehicles; for the transport …	14.04***	0.19	−0.67^{+}	−5.59	−10.28***	−18***	44	0.77
8707	Bodies; (including cabs) for …	−2.93*	−0.26	0.68	−5.28	−0.13	–	29	0.50
8708	Motor vehicles; parts and ac …	−3.05***	0.12	−0.25^{+}	−5.01***	0.39	3.39***	506	0.31
8709	Works trucks, self−propelled …	1.60	0.06	0.53	0.41	0.31	–	62	0.02
8711	Motorcycles (including moped …	−1.3	−0.85^{+++}	−0.49	−7.34***	−0.99	1.19	70	0.44
8712	Bicycles and other cycles; i …	−1.44	−0.3^{+}	0.35	−4.46**	−1.52	0.54	78	0.26
8713	Carriages for disabled perso …	1.13	0.36	0.11	−2.04	−1.74	−2.1	52	0.15
8714	Vehicles; parts and accessor …	−3.32**	−0.22^{+}	−0.20	−3.91***	1.34	3.01***	247	0.17
8715	Baby carriages and parts thereof	0.58	−0.28	−0.02	−5.88*	−4.07	−1.47	30	0.36
8716	Trailers and semi−trailers; …	−1.74	−0.25^{+}	−0.93^{++}	−7.16***	−0.02	1.96	174	0.30
8802	Aircraft n.e.c. in heading n …	5.27	−1.03^{+++}	−1.65	4.29	2.9*	–	33	0.43
8803	Aircraft; parts of heading n …	1.31	−0.64^{+++}	0.01	0.49	−2.91	−1.1	123	0.14

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
8903	Yachts and other vessels; fo …	1.91	−0.81^{+}	−0.51	−7.76***	−4.49	−4.32	66	0.44
8907	Boats, floating structures, …	0.90	−0.59^{+}	−0.68	−3.25	−0.81	–	44	0.10
9001	Optical fibres and optical f …	−4.2**	−0.06	−0.51^{+}	−3.20*	0.76	4.19***	159	0.24
9002	Lenses, prisms, mirrors and …	−2.02	−0.39^{++}	0.56^{+}	1.82	−0.81	3.62	112	0.42
9003	Frames and mountings; for sp …	−4.86	0.34	0.63^{+}	−0.51	2.33	3.36	70	0.11
9004	Spectacles, goggles and the …	−4	−0.06	−0.05	−0.84	3.09	4.34*	131	0.07
9005	Binoculars, monoculars, othe …	−2.76	−0.31	−0.77^{+}	−3.22	−0.13	1.11	40	0.16
9006	Cameras, photographic (exclu …	−0.75	−0.08	0.21	−3.72*	−4.15*	−0.88	61	0.29
9007	Cinematographic cameras and …	−2.00	−0.47^{+}	−0.97	−6.26	−3.56	−0.68	29	0.32
9010	Photographic (including cine …	3.01	0.02	−0.34	−2.96	−3.73	−3.17	50	0.12
9011	Microscopes, compound optica …	2.34	−0.29^{+}	−0.99^{+}	−1.29	−3.45	−0.72	65	0.35
9012	Microscopes (excluding optic …	1.44	−0.23	0.00	–	−2.47	–	25	0.14
9013	Liquid crystal devices not c …	−2.15	−0.22^{+}	−0.26	−0.55	0.04	2.85	114	0.24
9014	Navigational instruments and …	0.16	−0.4^{++}	−0.47	−0.51	−1.59	0.09	93	0.11
9015	Surveying (including photogr …	1.79	−0.47^{+++}	0.32	2.47	−1.95	−0.55	167	0.15
9016	Balances; of a sensitivity o …	−1.77	−0.89^{+++}	0.36	−1.13	−1.21	0.92	48	0.32
9017	Drawing, marking – out, mathem …	−1.95	−0.19	0.53^{+}	−0.28	0.37	2.25	186	0.09
9018	Instruments and appliances u …	−4.94***	−0.26^{++}	−0.29^{+}	−1.45*	3.74***	5.69***	371	0.26
9019	Mechano – therapy, massage app …	−3.55**	−0.05	−0.35^{+}	−3.29***	1.41	3.22**	181	0.14
9020	Breathing appliances and gas …	1.57	−0.19	−0.48^{+}	−3*	−3.14	−2.61	96	0.10
9021	Orthopaedic appliances; incl …	−3.73**	−0.69^{+++}	0.35^{+}	1.85*	1.38	4.47***	172	0.36
9022	X – ray, alpha, beta, gamma ra …	−1.75	−0.03	−0.51^{+}	−1.1	2.19	3.01**	145	0.09
9023	Instruments, apparatus and m …	−0.78	−0.38^{+++}	−0.50^{+}	−1.22	−0.03	1	139	0.13
9024	Machines and appliances for …	−5.16***	−0.03	−0.09	−2.05	3.17**	4.4***	122	0.22
9025	Hydrometers and similar floa …	−4.14***	−0.31^{+++}	−0.22	−1	2.46***	4.43***	303	0.23
9026	Instruments, apparatus for m …	−4.27***	−0.13^{+}	0	−0.82	2.63***	5***	375	0.26
9027	Instruments and apparatus; f …	−2.09*	−0.36^{+++}	0.19	0.65	0.06	2.31**	302	0.15
9028	Gas, liquid or electricity s …	−0.81	−0.01	−0.02	−0.99	1.19	1.83	129	0.02
9029	Revolution counter, producti …	−2.54**	−0.14^{+}	0.07	−1.80	0.14	2.19*	255	0.12

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
9030	Instruments, apparatus for m …	−3.51***	−0.43^{+++}	−0.24	−0.92	0.9	3.82***	264	0.23
9031	Measuring or checking instru …	−3.95***	−0.21^{+}	−0.21	−1.74*	1.74**	4.29***	360	0.25
9032	Regulating or controlling in …	−4.74***	−0.22^{++}	−0.38^{++}	−2.81***	2.26***	4.56***	397	0.27
9033	Machines and appliances, ins …	−3.53***	−0.21^{+}	0.05	−0.30	1.55*	4.4***	182	0.32
9101	Wrist−watches, pocket−watche …	−0.01	−1.25^{++}	2.71^{++}	5.78	−1.65	–	26	0.36
9102	Wrist−watches, pocket−watche …	−3.27	−0.85^{++}	0.13	−1.98	−2.03	2.4	77	0.34
9104	Instrument panel clocks and …	−1.07	−0.39^{+}	0.23	–	−0.39	–	36	0.05
9105	Clocks, other, n.e.c	0.35	−0.33^{+}	0.63^{+}	−3.82**	−5.37**	−3.34	66	0.28
9106	Time of day recording appara …	−1.32	−0.11	−0.38	−4.06**	−1.86	0.04	66	0.18
9107	Time switches; with clock, w …	−4.36**	−0.09	−0.71^{+}	−6.67***	−0.02	2.21	75	0.22
9113	Watch straps, watch bands, w …	−8.32***	−0.19	0.48	−2.97	2.44	4.17*	36	0.39
9114	Clock or watch parts; n.e.c. …	−1.48	−0.08	−0.02	−0.83	−0.07	–	39	0.01
9202	Musical instruments; string, …	1.12	−0.58^{+}	0.36	−3.24	−4.05	−3.31	56	0.15
9205	Musical instruments; wind (e …	1.82	−0.73^{++}	−0.13	0.66	−0.37	−0.61	45	0.15
9206	Musical instruments; percuss …	1.04	−0.58^{+}	0	−1.38	−0.99	−1.16	53	0.12
9207	Musical instruments; the sou …	1.57	0.13	0.77^{+}	0.07	−1.43	−1.35	68	0.05
9208	Musical boxes, fairground an …	−4.88*	−0.39	0.03	−5.32	0.59	3.64	30	0.35
9209	Musical instrument parts (fo …	−1.03	0.13	0.30	−1.44	−0.07	0.56	98	0.04
9304	Firearms; (e.g. spring, air …	0.80	0.08	0.60	−0.38	−2.68	−1.33	41	0.10
9305	Firearms; parts and accessor …	−5.38	−0.55^{++}	−0.31	−5.70	−1.91	0.15	67	0.19
9306	Bombs, grenades, torpedoes, …	−1.49	−1.22^{+++}	0.67	−5	−4.23	−1.77	42	0.38
9401	Seats (not those of heading …	−5.23***	0.09	−0.44^{++}	−6.11***	3.33***	5.31***	330	0.33
9402	Furniture; medical, surgical …	−0.40	−0.19	−0.30	−4.21**	−1.51	−0.17	141	0.12
9403	Furniture and parts thereof, …	−4.33***	−0.11	−0.05	−5.76***	1.44*	3.80***	301	0.36
9404	Mattress supports; articles …	−1.35	−0.19	−0.54^{++}	−5.84***	0.32	1.90	183	0.24
9405	Lamps, light fittings; inclu …	−1.45*	0.06	−0.46^{++}	−2.85***	0.37	2.74***	301	0.19
9406	Buildings; prefabricated	−0.55	−0.23	−0.35	−5.55	0.68	0.67	41	0.25
9503	Tricycles, scooters, pedal c …	−3.05***	−0.33^{++}	−0.19	−4.39***	1.77*	3.92***	237	0.28
9504	Video game consoles and mach …	−1.97	−0.40^{++}	−0.31	−4.93***	−1.22	0.97	155	0.21

Table 2 (continued)

Commodity		Intercept	Transport costs (log ratio)	Transit time (log ratio)	Air (differential dummy)	Rail (differential dummy)	Road (differential dummy)	N	R^2
9505	Festive, carnival or other e …	−1.52	−0.35^{+}	−0.14	−2.82	1.22	1.95	102	0.12
9506	Gymnastics, athletics, other …	−2.31**	−0.15	−0.23	−3.64***	0.99	2.56**	265	0.16
9507	Fishing rods, fish − hooks and …	−2.92*	−0.10	0.10	−1.96	1.62	2.97*	99	0.10
9508	Roundabouts, swings, shootin …	−1.21	0.24	0.59	−4.61	−1.53	−4.35	31	0.50
9602	Vegetable, mineral carving m …	1.62	−0.60	−0.06	2.11	1.71	1.19	55	0.08
9603	Brooms, brushes (including p …	−2.06*	−0.19^{+}	−0.26	−3.86***	0.72	2.58**	247	0.18
9604	Hand sieves and hand riddles	5.97**	−0.15	0.43	−2.88	−8.45*	−10.08*	31	0.29
9606	Buttons, press − fasteners, sn …	−1.32	−0.52^{++}	0.36	0.06	1.10	2.36	74	0.12
9607	Slide fasteners and parts th …	2.13	−0.47^{+}	0.01	−1.18	−2.10	−1.49	79	0.09
9608	Pens; ball − point, felt tippe …	−4.2***	−0.51^{++}	0.14	−2.9*	2.32*	3.94***	175	0.19
9609	Pencils (not of heading no. …	−1.42	−0.49^{+}	−0.1	−3.41**	0.89	0.88	103	0.20
9610	Slates and boards, with writ …	−1.04	−0.82^{+++}	1.52^{++}	0.06	−0.97	1.17	34	0.43
9611	Stamps; date, numbering, sea …	1.49	−0.15	−0.2	−1.38	−0.91	−0.91	49	0.03
9612	Typewriter, similar ribbons, …	−1.48	−0.14	−0.17	−1.01	1.89	2.14	119	0.04
9613	Cigarette lighters and other …	−5.3***	−0.39^{+}	0.57^{+}	−1.37	3.6**	5.72***	83	0.38
9614	Smoking pipes (including pip …	−1.8	−0.2	−0.57	−4.02*	1.94	0.52	32	0.27
9615	Combs, hair − slides and simil …	−4.41*	−0.32^{+}	−0.19	−4.42**	1.25	3.79*	82	0.21
9616	Scent sprays and similar toi …	−7.23***	0.18	0.78	−1.44	5.4**	4.49*	62	0.29
9617	Vacuum flasks and other vacu …	−1.22	−0.22	−0.56	−4.64**	0.19	1.61	69	0.17
9618	Tailors' dummies and other l …	2.73	−0.19	−0.56^{+}	−2.77*	−3.66	−2.08	59	0.20
9619	Sanitary towels (pads) and t …	−0.96	−0.45^{+}	−1.12^{++}	−9.46***	−0.43	1.37	81	0.55
9620	Monopods, bipods, tripods …	−0.43	−0.17	−0.06	−0.57	0.11	2.03	63	0.11
9701	Paintings, drawings, pastels …	2.74	−0.30	0.07	0.39	−3.97	−1.44	77	0.17
9703	Sculptures and statuary; ori …	0.94	−0.79^{+++}	−0.3	−0.28	−1.47	–	52	0.31
9705	Collections and collectors' …	4.65	−0.47	−1.41	–	−1.43	–	22	0.24
9706	Antiques; of an age exceedin …	0.90	−0.65^{+}	−0.09	–	−1.49	–	28	0.20
9999	Commodities not specified ac …	0.87	−0.77^{+++}	−1.11^{+++}	−2.4	−0.63	1.9*	236	0.31

Note: Commodity codes correspond with the codes of headings in the 2017 Revision of HS

Abbreviations

CIF Cost, insurance, freight
FOB Free on board
HS Harmonized System
OLS Ordinary least squares

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Author contributions

OH developed the demand model in Sect. "Optimal allocation of international trade across transport modes" and guided the econometric analysis. BD carried out the data processing and helped in the analytical work using R. The authors jointly conducted the literature review, discussed the findings, and drafted the paper.

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Availability of data and materials

This study is based on two sources of data: UN Comtrade (United Nations 2023). A Time-Distance Matrix that records optimal transit time for the transport of goods from one country to another, differentiated by transport mode, prepared by Ronald Halim in the scope of the project "Development of a Global Transport Costs Database for International Trade with a Special Focus on International Maritime Transport" in 2020, available on Sharepoint under the link below: https://unitednations.sharepoint.com/:x:/r/sites/UNCTAD_GDS-DSIB_STAT-StatsCoop/Shared%20Documents/MarTC/Coop_MTC/3_Work-in-Progress/External-Data/DRMatrix_reformatted_Clean.csv?d=wd842cbe1a9e04db1a09ac801d77497c7&csf=1&web=1&e=OuKzxE. Access can be provided by the corresponding author on reasonable request.

Declarations

Competing interests

The authors declare that they have no competing interests.

Disclaimer

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References

Armington PS (1969) A theory of demand for products distinguished by place of production. Int Monet Fund Staff Papers 16(1):159–178
Barrowclough D, Bouhia R, Hoffmeister O, Peltola A (2021) Measuring trade, investment and financial aspects of climate change: Stakes, new indicators and insights from a developing country perspective.
Becker GS (1965) A theory of the allocation of time. Econ J 75(299):493–517
Bentz Y, Merunka D (2000) Neural networks and the multinomial logit for brand choice modelling: a hybrid approach. J for 19(3):177–200
Beuthe M, Jourquin B, Urbain N (2014) Estimating freight transport price elasticity in multi-mode studies: a review and additional results from a multimodal network model. Transp Rev 34(5):626–644
Binsuwadan J, De Jong G, Batley R, Wheat P (2022) The value of travel time savings in freight transport: a meta-analysis. Transportation 491183–1209
Brown A, Deaton A (1972) Surveys in applied economics: models of consumer behaviour. Econ J 82(328):1145–1236
Celikoglu HB (2006) Application of radial basis function and generalized regression neural networks in non-linear utility function specification for travel mode choice modelling. Math Comput Model 44(7–8):640–658
Christensen LR, Jorgenson DW, Lau LJ (1975) Transcendental logarithmic utility functions. Am Econ Rev 65(3):367–383
Deaton A, Muellbauer J (1980) Economics and consumer behavior. Cambridge University Press, Cambridge
Dixit AK, Stiglitz JE (1977) Monopolistic competition and optimum product diversity. Am Econ Rev 67(3):297–308

Friedlaender AF, Spady RH (1980) A derived demand function for freight transport. Rev Econ Stat 62(3):432–441
Halim RA, Kirstein L, Merk O, Martinez L (2018) Decarbonization pathways for international maritime transport: a model-based policy impact assessment. Sustainability 10(7):2243
Hoffmeister O, Halim R, Lazarou NJ, Barnat N, Cristallo D, Englert D, Hoffmann J (2022) Developing a global transport costs dataset for international trade. UNCTAD Research Paper 85.
Hummels D, Schaur G (2013) Time as a trade barrier. Am Econ Rev 103(7):2935–2959
ITF (2022) Mode Choice in Freight Transport ITF Research Reports. OECD Publishing, Paris
Kaack L, Vaishnav P, Granger Morgan M, Azevedo IL and Rai S (2018). Decarbonizing intraregional freight systems with a focus on modal shift. *Environ Res Lett* 131–29
Lee D, Sybil D, Pereira FC (2018) Comparison of four types of artificial neural network and a multinomial logit model for travel mode choice modeling. Transp Res Rec 2627(49):101–112
Lugovskyy V, Skiba A, Terner D (2023) Unintended consequences of environmental regulation of maritime shipping: carbon leakage to air shipping. https://doi.org/10.2139/ssrn.4499196
McFadden D (1974) Conditional Logit Analysis of Qualitative Choice Behavior. In: Zarembka P (ed) Frontiers in Econometrics. Academic Press, New York
Mrázová M, Neary JP (2014) Together at last: trade costs, demand structure, and welfare. Am Econ Rev Papers Proc 104(5):298–303
Nuzzolo A, Coppola P, Comi A (2013) Freight transport modeling: review and future challenges. Int J Transp Econ 40(2):151–181
Saucedo Dávila A, Bourgeon C, Hoffmeister O (2023) Improving availability of maritime transport costs data in the Pacific region. UNCTAD Transport and Trade Facilitation Newsletter. 97.
Sato K (1972) Additive utility functions with double-log consumer demand functions. J Polit Econ 80(1):102–124
Stone JRN (1954) Linear expenditure systems and demand analysis: an application to the pattern of British demand. Economic J 64
UNCTAD (2021a) Review of Maritime Transport 2021. Challenges Faced by Seafarers in View of the COVID-19 Crisis. United Nations publication. Sales No. E.21.11.D.21. New York and Geneva
UNCTAD (2021b) UNCTAD Assessment of the Impact of the IMO Short-Term GHG Reduction Measure on States.
UNCTAD (2022) Review of Maritime Transport 2022. Navigating Stormy Waters. United Nations publication. Sales No. E.22.II.D.42. Geneva
UNCTAD and World Bank (2024) Trade-and-Transport Dataset. UNCTADstat Data Centre. https://unctadstat.unctad.org. Accessed 20 June 2024.
United Nations (2023) UN Comtrade database. https://comtrade.un.org/. accessed 10 November 2023.
UNSD (2011) International merchandise trade statistics: concepts and definitions 2010. United Nations publication. Sales No. E.10.XVII.13. New York
Varian HR (2010) Intermediate microeconomics. A modern approach. W. W. Norton & Company, New York
Walmsley T, Minor P (2020) Demand shifts and willingness to pay in applied trade models. World Economy 43:1499–1520
Wang H, Zhang Y, Meng Q (2018) How will the opening of the Northern Sea Route influence the Suez Canal Route? An empirical analysis with discrete choice models. Transp Res A Policy Pract 10775–89
Wang KXY, Ram MP, Zou Y (2017) On the development of a semi- nonparametric generalized multinomial logit model for travel-related choices. PLoS ONE 12(10):e0186689
Wen C-H, Koppelmann FS (2001) The generalized nested logit model. Transp Res B Methodol 35(7):627–641
Wold H, Jureen L (1952) Demand analysis. Almqvist and Wicksells, Uppsala
Zlatoper TJ, Austrian Z (1989) Freight transportation demand: a survey of recent econometric studies. Transportation 1627–46

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