

Determinants of modal choice for freight essay



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According to the European Commission's White Paper European Transport policy for 2010: Time to Decide road's share of the freight market has been growing constantly, from 41% in 1990, to 44% in 1998 and is expected to reach 47% by 2010 (percentages of ton miles).

This process of growing concentration of the European modal split is generating large externalities, in terms of congestion costs, environmental external costs and accidents. Spanish trade flows to Europe further aggravate this situation, as 73.25% of Spanish exports and 53.58% of imports are in fact transported by road (percentages over total exported tones, 2001)ii.

The objectives of this paper are twofold. First, we intend to identify the determinant variables of mode choice for freight transport.

The mode alternatives to be studied are: air and maritime transport. Second, we aim to achieve empirical evidence on cost and time elasticity for differentiated industrial sectors according to their logistic processes. The paper is organized as follows: Section 2 reviews the literature on mode choice. Data and sources are described in Section 3.

Section 4 presents the estimation of a modal choice model and empirical results. Finally, Section 5 concludes.

REVIEW OF LITERATURE ON MODE CHOICE Interest in estimating key parameters that determine the use of different modes of transport has motivated economic research on transport demand. The estimation and evaluation of these previously mentioned determinant factors contributes to

a better understanding of modal competition within the fields of passenger and freight transport [2]. A behavioral model has been selected in order to estimate mode choice in the present paper.

As a particular case of disaggregate demand models, the chosen specification benefits from theoretical and empirical advantages of disaggregate over aggregate demand models.

Disaggregate models are based on individual behavior, therefore taking into account important characteristics of the session-maker, which make possible a richer model specification. A better understanding of intermeddle competition is accomplished due to the fact that these models are estimated using the actual attributes of modes and characteristics of the good to be transported. The principal limitations of disaggregate models are the considerable amount Of data required, difficulties compiling this data on individual mode choices and the complexity of defining all attributes that determine choice.

Numerous applications have followed the first empirical application of McFadden behavioral models.

However, considerably less studies have been conducted on modeling freight rather than passenger demand. McFadden, Winston and Borsch-Span (1985) [3] analyses freight demand using a multinomial profit. More recently, Kiang, Johnson and Called (1999) [4] modeled freight demand in France by using a disaggregate nested logic. This latter study does not include attributes of transport services, such as cost and time, among the explanatory variables, given the lack of data regarding these features.

According to a standard behavioral model, decision-makers choose the alternative that provides the axiom level of utility. The utility function (U_{in}) in this kind of model depends on the attributes of the mode of transport, X_{in} , and the characteristics of the decision-maker, S_n , as well as including a stochastic component allowing for unknown parameters, ϵ_{in} , where V is not stochastic and reflects representative preferences of the population and ϵ_{in} is stochastic and includes the effect of the individual on preferences and on non-observable attributes of the alternatives.

Therefore, the probability of selecting an alternative I can be formulated as: $P_i = \text{Prob} \{ U_{in} > U_{jn} \mid X_{in}, S_n, \epsilon_{in} \}$ for $j \neq i$, (2) All those variables and characteristics of individuals that affect decisions independently of the selected option are assembled in vector S_n . This set of variables is usually called "characteristics of the decision-maker" as most applications including these factors have been carried out on passenger transport.

In our study, this set of variables includes the characteristics of export firms and factors concerning trade, such as environmental restrictions to lorry circulation, seeing that both affect mode choice decisions. Vector D_{in} - stochastic impotent of the utility function- varies along with changes in preferences and unobserved attributes of different options and thus will affect demand. This vector incorporates all attributes of alternatives and individuals' characteristics that are not able to be measured.

The most frequently applied models in order to determine stochastic choice are logit and probit models. Empirical applications of this type of models have been carried out by McFadden and Domencici (1975) [5] - applied to

passenger transport-, rot; czar and allocable (1998) [6] and Baht (1998) AS mentioned above, McFadden, Winston and Borsch-Span (1985) have carried out an application for freight transport using a multinomial profit.

The evaluation of this type of models shows some differences to traditional models.

Even though the ratio of an estimated coefficient to its corresponding estimated standard error follows a t-Student distribution, the F test or the standard RE are not appropriate for these models. The most commonly accepted test is the pseudo-RE, a scalar measure Of the explanatory power Of the model, derived from the maximum likelihood ratio. The interpretation of coefficients in a conditional logic model also presents explicit differences to the rest of models.

Literature on this issue provides diverse explanations, thus requiring a review of the studies of original authors in order to know the actual economic information that coefficients offer. According to these sources, and regarding binary choice logic and profit models, the sign of coefficients denotes the direction of switch, not its magnitude.

In a conditional logic model, coefficients corresponding to attributes of the dependent variable are not directly linked to marginal effects, hence not drawing up the switch ratios researcher is usually searching for.

Each set of attributes X_x affects all the probabilities of the various alternatives of the dependent variable. The influence of these attributes on the choice probabilities of a specific option is measured by elasticity, not by

coefficients -bearing in mind that it is the attributes' coefficients we are referring to, not the decision-maker characteristics or the attributes of variables that do not change no matter which mode is chosen-. Given the previously explained arguments, there is not a clear and broadly accepted interpretation of the coefficients of attributes.

Some authors, such as McCarthy (1997) [8] and Abdullah and Gregarious (1992) [9], have interpreted coefficients and elasticity as suppliers of the same information about mode switch. Other researchers, such as Yardman, Toner and Whelan (1997) [10], considered these attributes as explanatory variables of every option, regarding road cost and sea-transport cost, for example, as exogenous variables. DATA AND SOURCES Four sectors were selected for analysis: surroundings (wine, canned food and vegetable oils), ceramic tiles, motor vehicle parts and accessories, and household appliances.

The selection Of sectors was made according to criteria based on the main features of their most representative products, attempting to find sectors with differentiated transport needs. Given the complexity of studying all Spanish export trade flows, the aim of selecting four sectors is to achieve a significant overview of mode choice determinants by researching a representative sample of the Spanish production framework.

All four selected sectors are among the top 10 most exporters, both in terms of weight and exported value, with the exception of household appliances (which only ranks mongo the top 10 of exported value).

On the one hand, gradualists products and ceramic tiles may be considered low value-added commodities -in comparison to vehicle parts and household appliances-, these two goods showing a large weight-to-value ratio. Both surroundings and ceramic tiles present a similar modal distribution, shipping being used by more than 30% Of their exports (in tones). On the Other hand, motor vehicle parts and household appliances may be seen as high value-added products, while presenting a large volume-to-weight ratio.

Vehicle parts and household appliances alike transport only 5% of their exports by sea, their logistic chains being largely dominated by haulage. The particular features of these four commodities will allow an evaluation of the influence of attributes such as weight, volume, value/weight, packaging against humidity or crashes, etc. On mode choice. Aiming at building a database that would permit the specification and estimation of a modal choice model, 238 interviews were conducted among transport decision-makers in 11 different regions in Spain.

Fieldwork conducted was based on personal interviews with import/export ND logistics managers at export companies (160 interviews), and freight forwarding agents (78 interviews). 1,251 observations were compiled as a result of these interviews, of which, 1,028 were valid observations for the models' regression.

From a statistical point of view, the collected sample is representative of the studied population and the results and conclusions are therefore in line with those to be expected from the Spanish industrial structure. Table 1 provides averages of the variables and the number of interviews per sector.

Errors detected on answers provided by various freight forwarders have motivated this special treatment. On responding the question of the average frequency of shipments and the average shipment size of their average customer, freight forwarders supplied information corresponding to total number of shipments per year and total shipment size exported by all their customers to a specific country of destination, provoking the above mentioned errors.

Therefore, most freight forwarders' replies about frequency and size provide a larger value than those supplied by export companies. The remaining of variables are not significantly affected by the type of interviewee, thus not being necessary to calculate an average of total number of observations and an exporters' average.

ESTIMATION OF A MODAL CHOICE MODEL AND EMPIRICAL RESULTS A mixed logic has been used as the analytical tool to evaluate how demand and supply influence mode choice.

Although initially four modes of transport were included in the questionnaire -road, sea-transport (combined with road or combined with rail), rail and air transport-, only two of them (road and maritime transport combined with road) have been incorporated in the model, given the residual character of sea transport combined with rail, rail and air transport, and the lack of observations using these modes. The first del was specified as follows: Additionally, a road-constant (inherent to the model) has been included in the equation, in order to evaluate to what extent a given sector shows a revealed preference for road transport.