Interurban freight mode choice in Brazil: A case study of Rio Grande do Sul

Ana Margarita Larranaga*, Julian Arellana\*

*Industrial and Transportation Engineering Department, Federal University of Rio Grande do Sul, Porto Alegre, RS, Brazil. Email: analarrau@gmail.com
\*Departamento de Ingeniería Civil y Ambiental, Universidad del Norte, Barranquilla, Colombia. Email: jarellana@uninorte.edu.co

Extended abstract

Objectives and motivation

Brazil's freight modal split is mainly focused on road transport. In the state of Rio Grande do Sul, one of the most populous states of Brazil, 85.3% of the total cargo is transported by road. The former value is above the Brazilian mean of 68.6% transported by road (SECRETARIA DA COORDENAÇÃO E PLANEJAMENTO, 2015). The imbalance between different transport modes suggests a need to promote alternative modalities to strengthen the competitiveness and provide a more sustainable economic development. Planning for a more efficient and sustainable transport system within the state is being carried out through studies that seek to promote the rationalization of transport flows among different modes, encouraging multimodality. The final aim is to increase competitiveness in logistics of Rio Grande do Sul that allows better access to domestic and international markets.

Increasing the efficiency of transport systems to improve the competitiveness of a region needs the formulation of appropriate transport policies which can be found when knowing supply chain actors’ preferences about different attributes of available transport modalities. In this regard, assessing firms’ value of service for freight transport in different modes is important for policy makers, public agencies, local governments and researchers (Daniels y Marcucci, 2007). The goal of this paper is to identify logistics managers’ preferences for freight transport service attributes for the case of Rio Grande do Sul in Brazil, and discuss which transport policies could encourage multimodality and more sustainable uses of available transport infrastructure. In this paper a stated preference (SP) technique for collecting data on respondents’ choices among hypothetical options is described and then standard econometric discrete choice models are used to estimate a model that allow us to identify the preferences and discuss some possible sustainable policies that could increase the competitiveness of the region.

General description

Personal interviews were conducted between January and March 2015. 50 shippers and logistics managers from Rio Grande do Sul were interviewed. The selection of shippers considered the diversity of production chains, type of cargo to be carried, transport volumes, economic value of the cargo and final destination of the cargo (state, national or international). Previous information about the shippers for selection was obtained from two sources: (i) Analysis System of International Trade Information-ALICE (Ministério do Desenvolvimento, Indústria e Comercio Exterior, 2014); and (ii) Business Ranking - Índice Empresarial Grandes (Amanhã, 2014). The type of products transported within Rio Grande do Sul and selected to be included in this study were those with high density of transport, which represent at least 80% of all products generated in the State and considered the most representative in the commercial balance of the State, and those with low added value but with a strategic importance for the state economy. 22 products were selected, being the most important: footwear, soybeans, tobacco, vehicles, frozen meat, chemicals and leather.

A set of 18 choice situations were presented to each interviewee. During the stated preference experiments logistics managers were asked to point out their favorite transport option between 3 alternatives available: (i) Road, (ii) Intermodal considering rail, (iii) Intermodal considering inland waterway transport. Each alternative was described by four attributes: Total transport cost, Total transport time, On-time delivery percentage and Percentage of deliveries delayed more than 2 days. Each attribute was specified with 3 levels. The experimental design was structured using a Efficient design (Rose and Bliemer, 2009) and implemented in NGene (Choice Metrics, 2013). In the generation design was adopted a Bayesian approach of the parameters rather than take them fixed, considering they follow an uniform distribution. This technique allows to include the uncertainty in the initial parameters’ values.

To enforce realism of the experiment, shippers were categorized according to the transport distance (considering the location of producers and consumers) and the type of product, and a specific design was developed for each segment, considering different attribute levels. The segmentation was considered in the design, performing an efficient Fisher design in which each design is weighted by the number of shippers that belong to each segment. A total of 6 designs were generated. According to the most representative shipment for each shipper, logistics managers were asked to respond only one design.

Using the data collected, discrete choice models were estimated to determine the effect of freight service attributes on the logistics managers’ preferences. The discrete choice models used in the modeling of transport demand were built according to the random utility theory (McFadden, 1974). Based on the principle of utility maximization, in which the decision maker is modeled by selecting the most useful alternative among those available at the time of choice. Several discrete choice model structures were tested, seeking better fit of the model regarding the data collected. The model structures studied were: (i) multinomial logit; (ii) mixed logit as a special case of
random coefficients (ML-RC model); (iii) mixed logit error components- considering panel effect (ML-EC model) and (iv) mixed logit error components – including possible correlations between attributes of the intermodal alternatives (ML-EC2 model). The model estimation was performed using the software Biogeme (Bierlaire, 2003).

Parameters estimated from discrete choice models were used to compute subjective value of time savings or, equivalently, the willingness to pay to reduce travel time by one unit. Value of time for freight transport is a critical component of Cost-Benefit Analysis of transport projects and policies. Finally, direct- and cross-elasticities were computed to analyze the change in the probability of choosing a transport mode when a given percentage change in the independent variables occur. The first relate to attributes of the transport mode under consideration and the second to attributes of competing modes. Elasticities were computed for individuals’ choices and aggregated by sample enumeration techniques, to apply these results to the entire population of the study area.

Results and conclusions
The estimated models showed satisfactory overall fit and the signs for the parameters are consistent with microeconomic theory. That is, the coefficients of Total transport cost, Total transport time, and Delay greater than 2 days had a negative sign, indicating that the utility of modes decreases with increases in time, cost and delays (more than two days). The variable related with the percentage of on-time deliveries presented positive sign suggesting that increases in shipments percentage that satisfy the delivery time increases the propensity of using a particular transport mode. The choice of the best model was based on likelihood ratio test and the criterion of parsimony, selecting the ML-EC model among the estimated models.

The subjective value of time savings for the selected model was Euro/t.h 0.34 (R$/t. h 1.088). This value was compared with results obtained from other studies, showing that it is within the range of variation of the different studies in the literature. The direct and cross elasticity values of the probability of choosing a transport mode for the different attributes studied shows that the shippers significantly value the fulfillment of delivery time and cost, suggesting that those attributes are the most important ones in the choice of transport mode in this State of Brazil.

References

Keywords: freight transport; mode choice; stated preference; discrete choice model.