Abstract: Joint econometric model of chain and shipment size choice for freight transport between Norway and Sweden

Elise Caspersen, TØI
Gerard de Jong, Significance
Inger Beate Hovi, TØI

Up until this point the logistic model for Norwegian freight transport is based on a deterministic cost minimisation model, which is conceptually equivalent to the all-or-nothing assignment method often used for allocating traffic flows to a network (de Jong and Ben-Akiva, 2007, section 8). In the Norwegian freight transport model, there are different available transport solutions for different f2f-flows, which assures some diversity between the choices.

After the prototype was developed in 2005/2006, the Norwegian freight model has been improved in a number of rounds, and calibration of aggregate data for a base year has been done. Still it follows the cost minimisation setup, where the choice of transport uniformly is given by minimisation of total transport cost. Recent studies show that this assumption is not always valid. Johnson and de Jong (2011) points out that mode and shipment size are close linked decisions, where large shipment size in general coincides with higher market shares for non-road transport. Windisch et al (2011) and Abate et al (2014) finds similar results through estimations of joint econometric model of freight transport and shipment size based on the Swedish Commodity Flow Survey (2004/2005). This indicates the need to update the freight model to take this link into account, when allocating freight flows and chain choice in the network.

There are several theoretical reasons to go from a deterministic to a random utility logistics model. A deterministic model effectively assumes that the researcher has full knowledge of all the drivers’ behaviour, that all freight transport agents behave according to economic theory and that there is no randomness in actual behaviour. A joint econometric model for chain choice and shipments size choice are based on revealed preference data, which provides a basis for real life and makes it possible to estimate average alternative specific constants, capturing unobserved factors like reliability. Also, adding the stochastic component in the random utility model makes the response functions (now expressed in the form of probabilities) smooth instead of lumped at 0 and 1, as is the case in a deterministic model, and by nature account for the influence of omitted factors. Using a stochastic part to decide mode choice and shipment size choice also solve the problem of “overshooting”, when for example the relevant logistic cost function is rather flat and a small change in some variable lead to a shift to a completely different optimum shipment size and transport chain. If the optimal alternative has much lower logistics costs than the second-best alternative, the model behaviour could be very stable, and not respond to a change in a relevant variable.
Based on the work by Windisch et al (2010) and Abate et al (2014), TOI are together with Significance working on a project to estimate the relation between mode chain and shipment size choice for freight transport in Norway. The project is a starting point to improve the Norwegian freight model to include a stochastic part on how mode chain and shipment size choice influence the total choice of transport alternative in the model, making it a random utility logistic model.

The stochastic part builds on a joint econometric model of chain and shipment size choice for freight transport, estimated on data from the Swedish Commodity Flow Survey 2009 (Trafikanalys, 2010). The foundational hypothesis for this work is that shippers make a joint decision of mode choice and shipment size for each f2f-flow, where the decision depend on certain attributes, rather than minimisation of total logistic costs.

To capture the link between mode choice and shipment size we estimate a model that has both shipment size and mode choice as the dependent variable, that is, the dependent variable is a combination of these two variables. Estimation of this kind of model can be done by estimating a joint model with both discrete mode and discrete shipment size choice or a joint model with discrete mode and continuous shipments size choice. Since the result of estimation is meant for further use in the Norwegian freight model, our priority is to estimate a discrete-discrete model. In the discrete-discrete model the joint choice of shipment size and chain is the main focus, while in a discrete-continuous model the estimated mode choice will be used as an input in the estimation of shipment size.

The joint discrete-discrete model is as follows:

\[ U_{i2} = \beta_2 X_2 + \phi_2 G_2 + \varepsilon_2 \]

Where:

- \( U_{i2} \) is the utility derived from a discrete combination of mode i and shipment size category
- \( X_2 \) is a vector of independent variables explaining chain choice.
- \( G_2 \) is a vector of independent variables explaining shipment size choice
- \( \beta_2 \) and \( \phi_2 \) are vectors of parameters to be estimated.

The dataset used for estimation is transport between Norway and Sweden from the Swedish Commodity Flow Survey (CFS) from 2009. The Swedish CFS is a sample of domestic and international shipments sent to and/or from Swedish shippers, capturing transport by (any combination of) road, rail, ferries/vessels and airplanes. The survey includes variables like origin and destination of the shipment, weight (in tons) and value (in SEK), Swedish commodity group in addition to transport modes used both in and outside of Sweden. The Swedish CFS does not include any information about transport costs, but contains enough information for cost to be calculated from the Norwegian national freight model.

To secure highest transferability from the analysis of the Swedish CFS to Norwegian freight transport, we have limited our sample to consist of only shipments registered between Norway and Sweden. As the direction of the shipment is of little importance, import and export are merged. This gives 105,533 registered shipments
between Norway and Sweden, of which 102 882 shipments are from Sweden to Norway, and 2 671 shipments from Norway to Sweden.

The choice set for the depending variable is a combination of possible mode chain choices and shipment size choices. The chain choice is a combination of the observed options in the CFS and the possible options from the network, represented by the cost data. There can be both one or several modes in a chain. The choice of shipment size is taken from the observations in the CFS. In our estimations we are focusing on three commodity groups, which all have a different spread on the shipment size. Different commodity group will therefore have a different choice set for estimation. The explanatory variables used for model estimation will be similar. The model can be estimated as a multinomial, nested or mixed multinomial model, depending on the assumptions that can be made about the distribution of the error term.

As this is a work in progress, we have no results to point to at this point of time, but will present the results from the estimation, along with some theory, at the conference.

References


