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## Analysing freight shippers' mode choice preference heterogeneity using latent class modelling

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### Abstract

This paper describes a study to improve understanding of the decision-making process of New Zealand firms, freight shippers and agents when making freight transport mode choice decisions. Such studies, despite their importance, are relatively scarce due to issues related to data confidentiality, restraining firms from taking part in such studies. To achieve the objective, we use latent class (LC) modelling, which postulates that firms' behaviour depends on two components: 1) some observable attributes, such as travel distance and size of operations; and 2) unobserved latent heterogeneity. The latter is taken into account by sorting firms into a number of classes based on similarities in their characteristics. Subsequently, the behaviour of firms in each class is explained by a set of parameter estimates, which differs from the sets assigned to other classes. In this study, data were gathered using stated preference surveys from 190 NZ firms, freight shippers and agents. Based on their freight operations, participants were grouped into: 1) long-haul and large shipments and 2) long-haul and small shipments. Furthermore, as each participant evaluated 18 choice scenarios, the data set contains 3,420 choice records. The results of the LC modelling allow policy makers to design more appropriate strategies and policies for different segments of the population to improve intermodal transport and to attract the largest latent class for both cases. In addition, the LC model indicates that the potential improvement in modal shift, which can be achieved by applying different policy options, varies with both transport distance and the size of shipments. Furthermore, in order to promote sustainable freight transport, one policy would be to increase the reliability of both the rail and sea freight transport services.

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## 1 Introduction

Freight transportation has become an important issue in logistics and supply chain management, due to the increasing concern about congestion, environmental impacts and safety. However, despite these concerns, shippers and logistics providers cannot easily change their transport mode choice because they feel constrained by the logistics trade-offs, such as the trade-off between the levels of transport cost and time. Due to market globalisation, the demand for more reliable, flexible, cost-effective, timely and visible door-to-door freight services has increased, not only in New Zealand (NZ) but also around the world.

NZ is a country heavily dependent on international trade, particularly in agricultural products. Exports account for around 24% of NZ's output, which is a relatively high figure compared with small EU (European Union) countries. NZ's economy was also built upon on a narrow range of primary products, such as wool, meat and dairy products. In 2000, NZ's production in the primary sector, which encompassed agriculture, forestry and fishing, was 8.7 percent of its total production. Of the then 30 OECD member countries, only Turkey and Iceland had a higher percentage for the primary sector than NZ (OECD, 2004). In terms of its accessibility to inter-national markets, NZ is also one of the two most geographically isolated countries in the world (Shangquin et al. 2009). NZ is remote from major international markets; the trade-route between Australasia and the west coast of the U.S. is about 8,000 miles and is one of the longest in the world (Byrne et al, 1994). Despite this, many NZ industries are oriented towards exports, because of the small domestic market. NZ is the third smallest national market in the OECD, with a total national market which is equivalent in scale to only a medium sized urban market in the U.S. As at 2009, 97% of firms in NZ were SMEs (*Small and Medium Enterprises*) and the proportion has remained relatively constant over time. The small size of NZ firms makes it very difficult to include all components of the supply chain. Boehme et al. (2007) found that most NZ companies face high uncertainty, with weakly integrated and inefficient supply chains. The Ministry of Transport (2010) shows that NZ firms spend 8.4% of annual turnover on total logistics cost and the major component is the direct transport cost (about 60% for both international and domestic transport). The Ministry of Transport (2011) has estimated that the domestic portion of freight charges for exporting a 20-foot container between the two largest cities in NZ (about 1,060km from Christchurch to Auckland, prior to exporting to an overseas port) is NZ\$1,515 for coastal shipping and NZ\$2,070 for rail. These freight charges are considerably higher than the NZ\$1,476 for ocean freight charges from NZ (Auckland) to Singapore and \$694 from NZ (Auckland) to Sydney or Melbourne. The Ministry of Transport (2011) study did not identify why the domestic coastal shipping rate is nearly twice the international shipping rate charged for shipments to Australia and Singapore. Due to the unique business environment, NZ firms are under pressure to lower domestic logistics costs.

Market globalisation and developing service economies have increased the demand for reliable, flexible, cost-effective, timely and viable door-to-door freight services by the shippers in NZ and around the world. Freight transport demand in NZ has grown by more than 32% during the last decade and is expected grow about 70% by 2020 (Richard Paling Consulting, 2008). At the same time, road transport has become a more dominant mode of freight transport. To reduce the negative impacts of the dependency on road transport (e.g. congestion, pollution), innovative actions, policies and technologies should be introduced. Thus, insight into factors considered when making freight transport decision becomes more important. However, only a few studies have been done in the NZ to investigate the relationship between the shipper's mode choice and their logistics characteristics. Three recent studies, done by Bolland et al., (2005), Richard Paling Consulting (2008), and Rockpoint (2009), have attempted to develop freight demand models to understand the reasons behind the recent declines in rail and coastal shipping and the rise in road freight movements. However, none of those studies have used modelling approaches to find the weights attached to factors influencing shippers' mode decisions.

Hence, this study aims to improve understanding of the decision-making process of NZ firms, freight shippers and agents when making a freight transport mode choice decision, and to find the weights attached to factors influencing their decisions. For this, the study involved a stated preference (SP) survey which was given to a sample of NZ freight shippers and agents. The respondents provided a relatively large spectrum of information regarding firms' characteristics, freight operations, and factors and constraints affecting their mode choice. Data were obtained from 190 respondents and they were analysed using two latent class (LC) modelling approaches.

The LC model is an efficient method when analysts do not know the distribution of taste heterogeneity in the sample. The most common form of LC model is the latent class multinomial logit (LCMNL) model. Recently, Bujosa et al. (2010) examined alternative approaches for incorporating heterogeneity in LC models, and thus extended the LC model to give a latent class mixed logit (LCML) model. They applied that modelling approach in the context of

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