The First Carrier Choice SP Survey for the Quebec City – Windsor Corridor: Shipper Preferences Suggest Uphill Battle for Increasing Rail Freight Market Share

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Introduction

With the advent of the Kyoto Protocol, Canada, like many countries around the world is searching for ways to decrease it greenhouse gas (GHG) emissions. Because of the fact that transportation is such a large contributor to GHGs, it is also seen as a sector where significant GHG reductions are possible. One method often considered to reduce GHG emissions in freight transportation is to increase the proportion of freight that is transported by rail relative to road.

Evaluating the potential for government policy to be used to move more freight to rail requires realistic analytical and empirical models of mode choice. Various methodologies have been used to approach the question of freight mode choice. This paper describes the development of a carrier choice model that is based on a stated preference survey of shippers in the Quebec City – Windsor Corridor of Canada. The survey was designed specifically to evaluate shipper preferences for carriers who send shipments by "trailer on flat car" (TOFC).

The paper begins with background information on the transportation sector in Canada, its contribution to overall GHG emissions, how Canada expects to be able to reduce emissions in the freight transportation sector, the study region, as well as some information on the performance to date of TOFC in Canada. Following this, the paper describes the current study beginning with background on previous freight choice studies and then a description of the development and design of the current study. The paper continues by describing the main results of the survey, as well as a description of the shipper choice model to have been developed, and in particular, a description of what the model results imply for the potential for TOFC to increase rail mode share in freight.

Background

Canada, Kyoto and Transportation

Freight transportation is a critical component in the economies of countries. Cheap and reliable freight movement is the lifeblood of an economy and helps businesses to be competitive. At the same time, transportation more generally, and freight transportation in particular imposes many external costs on society.

The transportation sector is the second largest GHG contributing source category in Canada, producing around one quarter of all emissions. Freight's GHG contribution stands at around 10% of overall Canadian emissions, with road freight making up more than half of these emissions and rail freight around 10%. Road freight's contribution has been increasing while rail's contribution has been declining (Environment Canada 2004). It might be argued given this information that the reason that road freight makes such a large contribution to GHG emissions is because of the fact that road carries much more freight.

In fact, rail carries the lion's share of all freight in Canada, although this pattern is changing very quickly. In 1990 rail carried 76% of all freight, whereas by 2003, it carried only 63% showing the very rapid growth in road freight (Transport Canada 2005). While these figures may seem surprising, it is worth noting that much of the freight that is carried by rail is bulk, i.e. commodities such as grain or coal that are very heavy and tend to be transported over long distances, thus accounting for the large proportion of tonne-kms transported by rail. In fact, around 90% of railway freight is made of bulk commodities, petroleum and cars and car parts (Transport Canada 2005).

The fact that while rail moves a much larger proportion of freight, whereas road freight contributes 5 times more to GHG emissions speaks to the fact that rail is much more GHG efficient. In fact, rail is 13 times more efficient than road, although both modes have been increasing their GHG efficiency at a similar relative rate (Environment Canada 2004)

The trends are clear: more freight is being carried by road; road freight transportation is more than ten times less GHG efficient than rail; as such, if current trends persist, GHG emissions in the transportation sector will continue to increase.

In December 2002, Canada ratified the Kyoto Protocol thereby committing itself to reducing its GHG emissions by 6% relative to 1990 levels during the first implementation period (2008-2012). In the government's *Climate Change Plan for Canada* (Government of Canada 2002) 1 Mt of GHG reductions are expected to come from "further public-private collaboration to promote the use of intermodal freight opportunities and to increase the use of low-emission vehicles and modes" (Government of Canada 2002).

The Quebec City – Windsor Corridor

The Quebec City-Windsor corridor is the 100-kilometre-wide strip that hugs the Canada-United States border for about 1,100 kilometres between Quebec City, Quebec and Windsor, Ontario. Quebec and Ontario are the two most populous provinces of Canada containing roughly half of the population of the country. The Quebec-Windsor corridor is home to 85 percent of the populations of Quebec and Ontario, as well as the location of 3 of the 4 largest cities in Canada. It is also the industrial heartland of Canada (Environnement Canada 2002). Due to this concentration of industry and population it is the busiest and most important trade and transportation corridor in Canada. As a result, it is also of considerable interest for any attempts to increase the rail mode share of freight in the Country.

The Search for Intermodalism in Canada

Intermodal transportation is simply transportation using more than one mode, or form of transportation (e.g. truck, train, plane, etc.). Intermodal ground transportation (hereafter referred to as intermodal) involves trucks and trains. There are several possible configurations of intermodal ground transportation. There can be containers on flat cars (COFC), double-stacked container rail cars, trailers on flat cars (TOFC) or trailers on rail bogies.

While it has been possible to carry containers or trailers by either truck or train since the 1950s, traditionally the advantages of truck transportation, namely simpler logistics, greater reliability of scheduling and less movement in loads has given trucks a large advantage over rail transport, which helps explain the rapid increase in truck traffic

In order to overcome the disadvantages of intermodal trains relative to trucks, both the Canadian National Railway (CN) and the Canadian Pacific Railway (CP) developed intermodal services with new technologies and new service configurations in the late 1990s to try to compete with truck traffic (Canadian National Railway 2000;Canadian Pacific Railway 2002;Canadian Pacific Railway 2004b). These new services were scheduled and equipment reengineered to require short loading time and to offer much smoother ride quality.

While obtaining figures on the importance of intermodal traffic for railways is relatively straightforward – intermodal has now become the largest single revenue generator for CP and one of the top three single revenue generators for CN (Canadian National Railway 2004;Canadian Pacific Railway 2004a) – determining the proportion of intermodal traffic made up by these new intermodal systems is more difficult and is not publicly available from the railroad companies.

At the same time, according to Statistics Canada (Statistics Canada 2004), intermodal traffic makes up around 10% of railroad car loadings and Transport Canada (2003) reports that between 1996 and 2001, the proportion of containers on flat cars (COFC) increased from 77% to 92% at the expense of trailers on flat cars (TOFC).

As such, the implicit question being asked by this research is why, if it is indeed the case that improvements have been made in the TOFC services, has TOFC traffic performed so badly?

The Shipper Survey

Stated Choice Methods

It is almost a cliché to say that getting access to freight data is difficult. In the context of freight choice analysis, informational requirements can be particularly burdensome. If one is attempting to estimate conditional discrete choice models, information is required not only on the alternative chosen, but also on the alternatives not chosen. As a result, it is quite possible that a respondent does not know accurately (or even at all) the characteristics of the rejected alternatives, and while there are methods to estimate what those characteristics might be, the fact remains that this information will be unreliable and will introduce measurement error into the variables. Finally, it is generally the

case that pertinent choice variables are correlated. The result of this is that the use of 'real' (also referred to as revealed preference data) can lead to problems in accurately estimating the influence of the different characteristics on mode choice.

In freight choice analysis, Stated Choice Methods have been used to overcome these difficulties. Whereas revealed preference techniques ask respondents about their actual choices, Stated Choice techniques involve asking respondents to choose between hypothetical (albeit realistic) alternatives, designed to simulate the actual choice environment. The key references that discuss the application of Stated Choice methods for transportation are Louviere, Hensher and Swait (2000) and Hensher, Rose and Green (2005).

Because of the fact that in Stated Choice methods respondents make choices between alternatives for which information has been provided, respondents do not need to reveal any competitive information. Moreover, because characteristic information is provided to the respondent, there is no measurement error in the explanatory variables. Finally, Stated Choice techniques involve using an experimental design of attribute values thereby overcoming the problem of correlated attribute values.

Previous Stated Preference Freight Studies and Rationale for Current Approach

As a result of these benefits, there have been a number of freight choice stated preference studies that have appeared recently in the literature (Fowkes and Tweddle 1988;Fridstrom and Madslien 2001;Norojono and Young 2003;Shinghal and Fowkes 2002;Vellay and de Jong 2003;Wigan, Rockliffe, Thoresen, and Tsolakis 2000). Each of the studies is slightly different in terms of geographical and research foci, and who is being surveyed.

These studies can be divided between within-mode (Wigan et al. (2000); (Fowkes and Tweddle 1988;Fridstrom and Madslien 2001) and between-mode choice surveys (Norojono and Young 2003;Shinghal and Fowkes 2002;Vellay and de Jong 2003). Within-mode surveys either restrict the surveys to include one modal option or do not consider separate modes explicitly. In between-mode choice surveys more than one mode is considered explicitly and respondents choose between modes.

Freight choice studies can also be classified by the type of shipper that is surveyed. Shipping decision makers are generally classified into three categories: shippers, receivers and carriers. Shippers are the agents that have a shipment that needs to be delivered. The receiver is the agent to whom the shipment is destined. Carriers are the agents that actually move the shipment from the shipper to the receiver. To be sure, these categories are not necessarily mutually exclusive. For example, it is possible for shippers to own their own equipment and deliver their own goods. Shippers that ship their own goods are known as own-account shippers whereas shippers who hire other companies (carriers) to ship their goods are referred to variously as 'hire and reward' shippers or shippers using for-hire carriers: what we refer to as 'end-shippers.' It is also possible for receivers to organize shipments to themselves. In this case, receivers can be thought to behave as shippers.

When looking at TOFC use, there are potentially two agents who make the decision about using such services: shippers and carriers. Normally, it is the carrier who decides whether a shipment would go by TOFC, since it is the carrier that organizes the movements of its consignments from end-shipper to receiver. That having been said, carrier decisions about whether or not to use TOFC services will ultimately be constrained by shipper preferences. As such, the end-shipper can be seen as the true backstop for the demand for TOFC services.

It is this reasoning that is at the basis of the survey instrument used in the study. As a result, while previous mode choice studies have surveyed end-shippers and own-account shippers, this study focuses on end-shippers.

Because of this, the form that the survey instrument took was most similar to a within mode end-shipper survey of freight services choice such as that undertaken by Wigan et al. (2000). The main difference is that the current study includes not only standard carrier and shipment attribute information, but also information on whether or not the carriers ever use TOFC to carry their consignments on the long-haul portion of the trip. We refer to this type of study as a carrier choice study.

Survey Development, Population and Design

Survey Development

An initial literature review of stated preference freight studies was undertaken to establish the attributes used in previous studies. This was used as the basis of telephone interviews of potential respondents. Initial interviews involved asking shippers about the factors that affected the shippers' choice of carrier and the normal ranges of these factors. Particularly knowledgeable respondents in the Montreal area were also asked whether they would be interested in participating in more in-depth in-person interviews. All together, five hundred and fifty phone calls were made, sixty-five interviews were undertaken and seven people were interviewed in person.

Once the telephone and in-person interviews were completed, the actual survey instrument was developed. The web-based survey was developed using Sawtooth Software's SSI Web software package. SSI Web provides functionality as a flexible web page editor that integrates functionality to produce factorial designs as part of the survey design process.

A preliminary version of the survey was tested by asking for comments from respondents interviewed in the first stage of development, as well as various other knowledgeable informants either in the field of freight transportation or in web-based surveys. Based on comments received, the survey was finalized and launched.

Survey respondents were contacted by a firm specializing in telephone market research. The firm: contacted the companies in the list provided to them; conducted a preliminary interview to ensure that the company was within the survey population; and asked whether the respondent would participate in the study. Those who agreed received a link to a URL and a password to access the survey. Follow-up calls were made if respondents who had agreed to take the survey did not complete it.

Once a survey was completed, the results could be downloaded from the survey host site and after some automated manipulation and preparation, the data were ready to be analyzed.

Survey Population

The initial perceived universe of end-shippers was considered to be manufacturers, wholesalers and large retailers and third party logistics companies (3PLs). The people sought to be interviewed were the shipping managers responsible for their establishments. The list of companies used for the survey was Dun & Bradstreet's Million Dollar Database (MDDI) of companies in Ontario and Quebec.

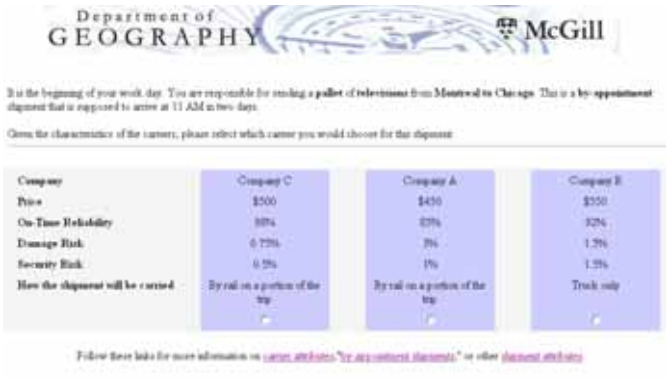
The population was narrowed to include all manufacturing facilities with greater than 50 employees, wholesalers and retailers that were either head offices or single locations with greater than 50 employees at that location and all 3PLs. In total, 7,004 companies fell into this population.

Survey Design

The survey itself took the form of what has been referred to in the literature as a 'contextual stated preference' or CSP survey. In fact, there were two surveys one in English and the other in French, reflecting the primary mother tongues of respondents. The surveys themselves were divided in two parts. The first section described the purpose of the survey, as well as how the survey was intended to be completed.

The second part of the survey was the actual CSP survey, involving 18 questions for each respondent. For each question, the respondent was asked to make a choice between three alternative carriers in the context of a particular shipment, whose details were described. This included information, such as the origin and destination of the shipment, when the shipment was to arrive, whether the shipment was 'by-appointment,' whether the shipment was of high or low value, whether the shipment was fragile or perishable, and the size of the shipment (truckload or LTL). Figure 1 below shows a sample CSP question from the survey.

Figure 1 - A Sample Question from the Survey



With respect to the carrier attributes, after the literature review, initial interviews and survey testing, five attributes were used: cost, on-time reliability, damage risk, security risk and whether the carrier would send the shipment by TOFC for a portion of the journey.

Cost estimates were obtained from the Freight Carriers Association of Canada Rating System – Version 3. This software provided estimates of shipment costs based on how much of what is being shipped and between which origins and destinations. These estimates were adjusted based on the advice of the person responsible for the Rating System in Canada and checked for realism by shippers contacted in survey development and survey testing.

The cost attribute, based on the interviews, was given a maximum difference between carriers of 20%. The attribute itself had 3 levels with the medium cost being the cost estimate arrived at by the method described above. That is the highest cost was 10% higher than the estimated shipment cost and the lowest was 10% lower.

The other continuous attributes also had three levels. The values assigned to them based on interviews were as follows: on-time reliability ranging from 85% to 98%; damage risk varying from 0.5% to 3% (LTL shipments had higher damage risk associated with them) and security risk varying from 0.5% to 1.5%.

The last attribute was whether the carrier would send the shipment by TOFC on a portion of the journey. The reason for this was that in interviewing shippers it seemed shippers were generally not terribly concerned with how their shipments arrived as long as they arrived on time and in the proper condition. As such, it was decided to include the variable to test whether the fact that a carrier used TOFC would affect carrier choice at all. The factorial design was created by the SSI Web design algorithm that ensures jointly the orthogonality, balance and minimal overlap of attribute values.

Survey Model and Results

The survey occurred between mid-August and early December 2005. All companies in the list sent to the marketing firm were contacted (7,004). Of these companies, 680 agreed to participate. In the end, completed results were obtained for 392 respondents. Respondents came from all of the industries in the initial survey in the approximate proportion of the original company list with roughly two-thirds from manufacturing and a quarter from wholesalers and retailers. Third party logistics companies were, however, slightly underrepresented at around 6% whereas there were around 10% in the entire company list. The respondents represented a relatively large spectrum of establishment sizes with the smallest being a 3PL of only a few employees and the largest being an electronics wholesaler with 1,400 employees.

Because of the large variety of shipment types, as well as the various categories of end shippers (manufacturers, wholesalers, retailers and 3PLs), an extremely large number of different models could be estimated from the data. One of the aims of later research will be to estimate different models for different subsets of the data. The current analysis, however, will focus upon global results.

Table 1 - Results from Global Multinomial Logit

Variable	Coefficient	Exp(B)	P - Value
Cost (ln)	-4.19		0
On-time Reliability	0.11	1.12	0
Damage Risk	-0.4	0.67	0

Security Risk	-0.1	0.91	0
TOFC	-0.71	0.49	0
Number of obs =	21,222		
Pseudo R^2 =	0.22		
LR Chi Square(5) =	3415.49		
Prob > Chi Square =	0		

Overall, these results are quite reasonable. The model fits well with a pseudo R^2 of 0.22, and each of the continuous variable coefficients is significant and in the right direction. Increases in cost, damage risk and security risk decrease the probability that a carrier is chosen. At the same time, an increase in on-time reliability also increases the probability that a carrier will be chosen.

With respect to cost, because the variable itself was in natural logarithms, the coefficient of –4.19 suggests that a 1% increase in cost would result in a 4% decrease in the odds that a carrier would be chosen, and a 10% increase would decrease the odds by 33%. This figure is in the range of other similar studies. In Fridstrom and Madslien's (2001) "shipment level" model they report an estimate of –2.21 (half the magnitude of our estimate), whereas Wigan et al. (2000) report coefficients from –0.049 to –0.298. The latter are based on nominal figures and not natural logarithms. When our model is run with cost in nominal terms, the coefficient on cost is much lower than their estimates at -0.004.

The coefficient of on-time reliability suggests a similarly strong effect on carrier choice as cost. The coefficient of 0.11 suggests that if the on-time reliability for a company were to improve by 1%, the odds of choosing that carrier would improve by 12% (see column Exp(B)) and would triple with an increase of 10%. In more intuitive terms, supposing the initial likelihood of a carrier being chosen were one half, a 10% increase in on-time reliability would improve its likelihood of being chosen to three quarters. It is less straightforward to compare this coefficient with other studies, since other studies have tended to quantify on-time

reliability in terms of percentage late as opposed to percentage on-time. That having been said, this seems a reasonable estimate.

The coefficient on damage risk of -0.40 suggests an increase of 1% in damage risk would decrease the odds of choosing a carrier by a third. This would reduce a probability of a third to approximately a fifth. The coefficient is within the range of other studies with Fridstrom and Madslien and Wigan et al. reporting coefficients of -0.25 and ca. -500 respectively. The extremely large coefficients reported in Wigan et al. likely has partly to do with a stricter definition of damage risk.

While other studies have not reported on security risk, the coefficient reported here of -0.1 seems reasonable. An increase in 1% of security risk will reduce the odds of choosing a carrier by 9%. This would result in a decrease in probability of choosing a carrier with an initial probability of a third to a quarter.

The coefficients for the continuous variables in the model seem quite strong and reasonable. The big surprise in these results comes from the coefficient on TOFC, given that it was not at all clear in interviews with shippers whether the fact that a carrier used TOFC services would affect their being chosen. As the only suggestion that it would play a part at all in the decision was that it might even be a positive, this only increased the surprise. A coefficient on TOFC of -0.71 suggests that the odds of choosing a carrier that uses TOFC is halved. If for example the probability of choosing a particular carrier were one half knowing that the carrier used TOFC services would reduce the probability of using the carrier to a third.

Model Implications

This model represents the first attempt to develop a carrier choice model for the most important trade corridor in Canada. As such, it is a useful tool for understanding the importance of factors that affect carrier choice. Moreover, this model can be used to develop market share estimates for different service offerings, whether it be used solely in the road transportation sector, or in order to produce potential market share estimates between road only and TOFC services. The term “potential market share” is used here, because in reality, and as discussed above, it is carriers that choose whether or not to put their trailers on trains. Naturally, such a model can also be used

to test how market share might change under differing circumstances such as different service offerings, lower prices, etc. Even more importantly is that through varying the attribute values in a way that might be expected as a result of changing government policy (e.g. if tolls were collected on major highways in this corridor, thereby increasing the relative cost of road transport with respect to rail) it would be possible to estimate how such policy might affect the balance between rail and road freight market share.

It is indeed this issue where the model provides the most intriguing results. In particular, the coefficient estimate for carriers that use TOFC services implies that irrespective of other service attributes (cost, on-time reliability, etc.) there is a very strong bias against the use of rail. That is, even if a carrier had the same cost, on-time performance, etc. as another carrier, but used TOFC services, the odds of its being chosen would be halved. This can only be interpreted as a bias, because the purpose of using a factorial design of attribute values is precisely to be able to extract the influence of variables separately, i.e. it cannot be claimed that it is because rail is often unreliable that there is such a strong negative coefficient for TOFC, because on-time reliability should already captured in the coefficient for on-time reliability. The fact that the attributes were presented in the way that they were in the survey ensures that other factors are at play in explaining the results.

Although it is not clear exactly why, after having controlled for other factors influencing carrier choice, there is such a strong negative influence of TOFC, one fact does remain clear. These results suggest that increasing rail share of freight transportation on this corridor will require more than just improvements in the standard carrier attributes. It suggests that rail needs to change its reputation.

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