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

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Abstract

The Quebec City-Windsor corridor is the busiest and most important trade and transportation corridor in Canada. The transportation sector is the second largest contributor to greenhouse gas (GHG) emissions in the country. Governments around the world, including Canada, are considering increased mode share by rail as a way to reduce transportation emissions. To understand whether freight mode shift is a realistic means to reduce transportation emissions, an analytical model is needed that can predict the effect of government policy on mode split.

This paper presents the findings of the first such model developed for the Quebec City-Windsor Corridor. The model itself is a stated preference carrier choice model of shippers in this busy corridor. The model was developed using the results of a stated preference survey undertaken in the fall of 2005. The survey was designed explicitly to evaluate shipper preferences for the carriage of intercity consignments, and particularly their preferences for carriers that contract the services of rail companies to carry these shipments via trailer on flat car (TOFC). The results of the study show that shippers are very mistrustful of using rail to move their consignments and suggests that increasing rail's share of freight faces tremendous challenges.

Keywords

Freight Transportation – Intermodalism – Environment

1. 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. This is as true for freight transportation as it is for passenger transportation. 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. The reason for this is simply that rail transportation is more energetically, and thereby GHG, efficient than road transportation.

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.

2. Background

2.1 Canada, Kyoto & 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. These costs take many forms. They can be in the form of: habitat loss from road construction, noise pollution, congestion or air pollution, among many others.

The transportation sector (see Table 1) 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%. The balance of freight emissions come from the off-road, domestic marine and air freight categories. One thing to notice about road and rail contributions is that road freight's contribution to freight emissions are increasing while rail's contribution has been declining. 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.

Table 1 – Transportation Sector Contributions to GHGs in Canada (Mt)

	1990	**2003**
Total CDN GHG Emissions	596000	740000
Transportation Sector GHG Emissions	149000	188000
% Canadian Emissions from Transportation	25%	25%
Total Freight Emissions	59608	79998
% Freight of Canadian Emissions	10%	11%
Total Road Freight Contribution	30441	47744
% Road Freight of Total Freight	51%	60%
Total Rail Contribution	6897	5752
% Rail Freight of Total Freight	12%	7%

Derived by the authors based on (Environment Canada 2004) and updated with data from Canada's GHG Inventory On-line Database.

As can be seen from Table 2, this is not the case. 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. 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).

Table 2 – Freight Activity – Billions of Tonne-Kms

	Road[1]		Rail[2]		
	Billions of Tonne-KMs	**%**	**Billions of Tonne-KMs**	**%**	**Total**
1990	78	24%	248	76%	326
2003	184	37%	318	63%	502
Growth	137%		28%		
1 - Total for-hire truck traffic annual tonne-kms					
2 - Revenue tonne-kms by railway sector					
Source: (Transport Canada 2005) Appendix A7-9					

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. Table 3 calculates the GHG intensity of the different modes. Note that rail is 13 times more efficient than road, although both modes have been increasing their GHG efficiency at a similar relative rate (30% over 1990-2000).[1]

Table 3 – Trends in Shipping/Freight-Related GHG Intensity

	1990	**2000**	**Change Since 1990**	
			Absolute	**Relative**
Rail				
GHG Emissions[1]	6.9	6.5	-0.4	-6.20%
Activity[2]	235.9	320.5	84.6	35.90%
GHG Intensity[3]	29.2	20.2	-9.1	-31.00%
Trucking				
GHG Emissions[1]	27.7	43.7	16	57.80%
Activity[2]	74.7	165.1	90.3	120.90%
GHG Intensity[3]	370.4	264.7	-105.8	-28.50%
[1] Mt CO_2 equivalent				
[2] Tonne Kilometre shipped (Billions)				
[3] grams CO_2 equivalent per tonne-kilometre shipped				
Source: Environment Canada 2004				

The trends are clear: more and more freight is being carried by road; despite the fact that there have been substantial improvements in the GHG intensity of road freight transportation, it remains more than ten times less GHG efficient than rail; as such, one can expect GHG emissions in the transportation sector to increase into the future if current trends persist.

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). Leading up to Canada's ratification, the federal government released its *Climate Change Plan for Canada* (Government of Canada 2002). This document outlined how the

[1] Note, discrepancies between GHG emissions and freight activity between the various tables were present in the original documents.

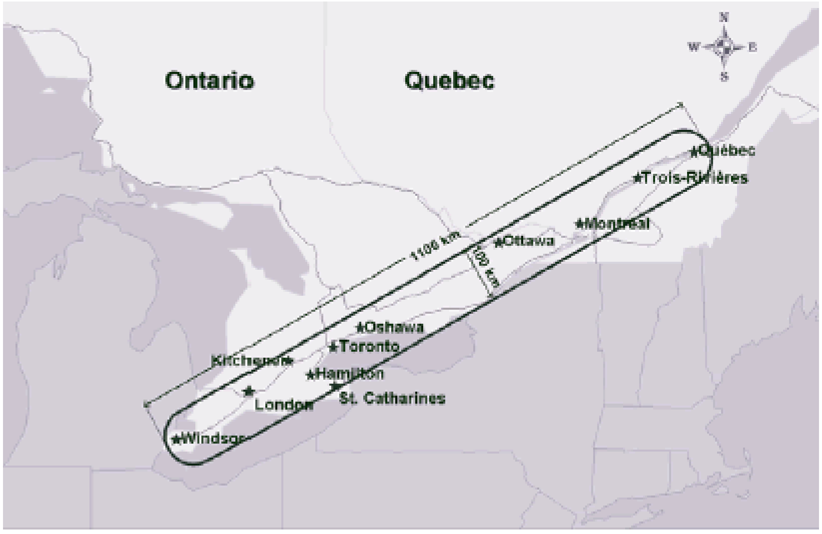
government expects to be able to attain its GHG reduction commitments, by identifying sectors of the economy and assigning reduction targets to those sectors.

Perhaps not surprisingly given the large contribution that the transportation sector makes to GHGs in Canada, it was also one of the “key areas for action” in the reduction of GHGs. In fact, the transportation sector was targeted as an area where 21 Mt of reductions are to be made. Of these 21 Mt, 1 Mt is 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). More recently, the government published *Project Green*. While not assigning goals as in the *Climate Change Plan*, it does refer to exploring “options for more efficient integration of intermodal freight transportation” (Government of Canada 2005). To put the goals mentioned in the *Climate Change Plan* into context, a back of the envelope calculation for the impact on GHGs of diverting freight transportation was done. Using the GHG intensities of the road and rail modes for the year 2000 provided in Table 3 suggests that in order to reduce 1 Mt of GHG, around 4 billion tonne-kms of freight would need to be diverted from road to rail – a 2% decrease in road freight traffic, and a 0.8% increase in rail over 2000 levels.

2.2 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 (see Figure 1 below). 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. 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.

Figure 1 – The Quebec City – Windsor Corridor



2.3 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.

Intermodal rail freight transportation was first developed by CP Rail in the 1950s with its first attempts at using TOFC between Montreal and Toronto (Canadian Pacific Railway 2002b). Intermodal transport more generally took off internationally and particularly in the international marine trade with the advent of containerization (Slack 2001). 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. The increase in truck traffic in Canada (resulting in a 130% increase in road diesel emissions between 1980 and 2001) can also be explained by freer trade in North America, the shift towards Just-In-Time (JIT) delivery and production processes, as well as by the deregulation of trucking activities (Transport Canada 2003).

In order to overcome the disadvantages of intermodal trains relative to trucks, both the Canadian National Railway (CN) and the Canadian Pacific Railway (CP) have developed intermodal services with new technologies and new service configurations.

In 1996-1997 CP developed and tested their Expressway™ service which came online in 2000. Expressway™ is a scheduled rail service that has specially developed railcars that allow for regular non-reinforced truck trailers to be carried. (Other services require specially reinforced trailers in order to avoid damaging them or their loads). Also, this system avoids damaging cargo, first because there is none of the crane-lifting associated with traditional container placement on train cars, and also because the new railcars deliver a superior ride. This type of intermodal technology is more commonly referred to as a smooth ride piggy-back system. As well, the service involves only 15-minute terminal turnaround times and transit times comparable to those currently provided by trucks (Canadian Pacific Railway 2004b; Canadian Pacific Railway 2002a). CP currently provides its Expressway service on its routes between Montreal, Toronto and Windsor (Canadian Pacific Railway 2006).

In the same vein, CN has made adjustments to service and adopted new technologies to make it more competitive with trucks in the short-haul market. Whereas CP made its Expressway system a scheduled service, CN made its entire rail service scheduled in 1998. In addition to this, in 1999 CN introduced the use of dual-mode RoadRailer® equipment. RoadRailer® was developed by Wabash National and involves the use of a specially designed dual-mode trailer that can be pulled on the road by truck, and can be mounted onto a specially designed rail bogie[2] that carries the trailer along rails. As with CP's Expressway, the system is engineered to have improved ride so as to prevent damage associated with load movement, and is in this sense a smooth ride system. The system was initially implemented on routes between Montreal and Toronto and by September of 2000, service was extended from Montreal to Chicago (Canadian National Railway 2000;Canadian Pacific Railway 2006;Wabash National 2004), but has since been mostly discontinued.

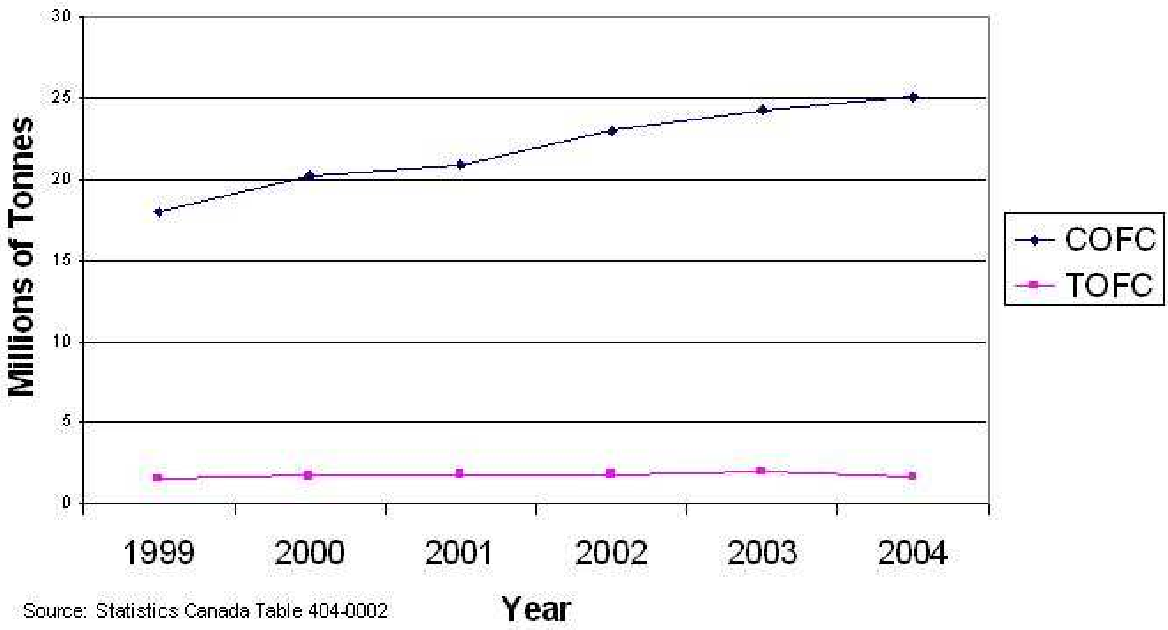
While obtaining figures on the importance of intermodal traffic for railways is relatively straightforward – intermodal has now become the largest single revenue generator for CP and one of the top three single revenue generators for CN (Canadian National Railway 2004; Canadian Pacific Railway 2004a) – 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, evidence from the federal government suggests that these systems still make up a very small proportion of freight being carried by the railways. According to Statistics Canada (Statistics Canada 2004), intermodal traffic makes up around 10% of railroad car loadings. At the same time, 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). This trend can be seen from data obtained from Statistics Canada in Figure 2 below. Assuming that both the Expressway and RoadRailer

[2] A bogie is a 4- or 6-wheeled truck used in pairs under long-bodied railway vehicles. The bogie has a central pivot point which allows it to turn as the track curves and thus guide the vehicle into the curve. On the RoadRailer, the bogies are removable.

would be considered as TOFC, this suggests that these intermodal systems make up a very small share not only of rail freight traffic but of intermodal traffic as well.

Figure 2 - COFC and TOFC Activity in Canada from 1999 to 2004



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

3. The Shipper Survey

3.1 Stated Choice Methods

It is almost a cliché to say that getting access to freight data is difficult. There are many reasons for this, but the prime one is that the transportation industry is very competitive. Moreover, freight data is generally private and as a result of its competitive importance, companies can be reluctant to provide information to researchers that they think might compromise their competitive position, or simply because they are constrained by contractual obligation not to reveal information.[3]

In the context of freight choice analysis, informational requirements can be particularly burdensome. If one is attempting to estimate conditional discrete choice models (e.g. McFadden's multinomial logit), information is required not only on the alternative chosen, but also on the alternatives not chosen. That is, the analyst needs to know about the cost, on-time reliability, etc. of the chosen mode, as well as the same characteristics for the alternative(s) not chosen. It is quite possible that the 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. For example, it is generally true that a carrier that places more emphasis on on-time reliability is also more expensive. That is, cost and on-time reliability are correlated in the 'real world.' 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, one method by which attempts have been made to overcome difficulties in obtaining information about freight choice is through the use of Stated Choice (or Stated Preference) methods. 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.[4] Stated Choice methods have been developed and practiced (particularly in the field of marketing, but increasingly in transportation research) for well over 20 years and are

[3] Shippers are often under contractual obligation not to reveal information about their shipment costs.

[4] This type of stated choice analysis is also referred to as "Choice-Based Conjoint Analysis" in the marketing literature and the terms will be used interchangeably dependent upon the context hereafter.

now well accepted in the fields of marketing and transportation. 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). The benefit of the Stated Choice approach is that it can overcome some of the drawbacks of revealed preference techniques.

In particular, the fact respondents make choices between alternatives for which information has been provided means that the respondent does not have to reveal any information of a competitive nature that might discourage participation in the survey. Moreover, because characteristic information is provided to the respondent, there is no measurement error in the explanatory variables. Finally, Stated Choice techniques also involve using an experimental design of attribute values thereby overcoming the problem of correlated attribute values.

3.2 Previous Stated Preference Freight Studies and Rationale for Current Approach

As a result of the benefits associated with stated choice methods, particularly in a context as fraught with concerns about the competitive sensitivity of data as in transportation, there have been a number of freight choice stated preference studies that have appeared recently in the literature (Wigan, Rockliffe, Thoresen, and Tsolakis 2000; Vellay and de Jong 2003; Fowkes and Tweddle 1988; Shinghal and Fowkes 2002; Norojono and Young 2003; Fridstrom and Madslien 2001). Each of the studies is slightly different in terms of geographical and research foci (some use the studies to develop freight value of time estimates (e.g. Wigan et al. (2002), others for understanding the relative competitiveness of road vs. rail (Vellay and de Jong 2003)), 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 (Shinghal and Fowkes 2002; Norojono and Young 2003; 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. This last point is of particular interest and speaks to a more general question about who decides on shipping mode. 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 consignee. 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 considering the question of the use of TOFC services, there are potentially two agents who make the decision about using such services: shippers and carriers. It is generally the case that the decision to use TOFC services will be that of the carrier, since it is the carrier that organizes the movements of its consignments from end-shipper to receiver. That having been said, and while it should be the case that end-shippers are indifferent to how their shipments are shipped (as long as they arrive in good condition and on time), carrier decisions about whether or not to use TOFC services will ultimately be constrained by shipper preferences. For example, if it is the case that shippers have a strong positive/negative preference for the use of TOFC for the transportation of their goods, this will encourage/dissuade the use of TOFC by carriers. 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 both end-shippers, as well as own-account shippers, this study focuses on end-shippers. In particular, it was designed to be able to establish whether or not the fact that a carrier used TOFC services would affect the end-shipper's choice of carrier.

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 uses 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.

4. Survey Development, Population and Design

4.1 Survey Development

An initial literature review of stated preference freight studies was undertaken to establish the attributes used in previous studies. A preliminary list of attributes was compiled and was used as the basis of telephone interviews of potential respondents.

Initial interviews with potential respondents involved asking about the factors that affected the shippers' choice of carrier, employing the commonly used attributes drawn from other studies as a guide. Respondents were asked whether these attributes provided sufficient information to allow them to make a choice between carriers, as well as whether other information would be required. In addition to what information was required to choose between carriers, respondents were also asked what would be realistic ranges of the attributes. That is, for example, they were asked what would be the largest difference in price between different carriers before price would dominate the choice of carrier. Particularly knowledgeable respondents in the Montreal area were also asked whether they would be interested in participating in a focus group relating to the design of the survey.

All together, five hundred and fifty phone calls were made to two hundred and twenty seven companies. Sixty-five interviews were undertaken and six people agreed to attend the focus group (another 6 said that they would like to attend but were not able to). In the end, only one person attended the focus group. Recognizing the difficulty in recruiting this category of worker (relatively well-paid individuals in an often stressful occupation), as well as the fact that the benefits of using a focus group to elicit information[5] were not necessarily that great in this context, it was decided to undertake individual interviews in person. This turned out to be a good approach, and all of the six people who had agreed to participate in the focus group in addition to one other respondent, were interviewed.

Once the telephone and in-person interviews were completed, the actual survey instrument was developed. The intention all along was to host the surveys on the internet. In order to

[5] One of the benefits of a focus group is that they can help people think of things they would not have otherwise thought of because of ideas or stimulii from other members of the group. This is particularly helpful when trying to elicit information on decisions that people make routinely but not necessarily methodically. For example it can prove helpful in contexts such as asking commuters about their commuting mode choices since one focus group member's response can elicit responses in others. In this context it was believed that since the target population was of specialists that methodically make the types of decisions of interest to the study, that the benefits from having a group of specialists would have been marginal.

develop the web-based surveys, Sawtooth Software's SSI Web software package was used. SSI Web is designed for the development of choice-based conjoint studies to be hosted on the internet. As such, it provides functionality as a flexible web page editor that can be used to build the pages required for a comprehensive choice-based conjoint study. It also integrates functionality to produce factorial designs as part of the survey design process (see the next section for more on the design).

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. In all, sixteen people provided comments on the survey. Of particular interest in testing the survey was: whether or not it was easily understandable; whether there was enough information to select between alternative carriers; whether it was possible to complete the survey in the desired time; and whether or not the attribute values were realistic in terms of their absolute value, as well as in their value relative to attributes of the other alternatives. Based on comments received, the survey was finalized and launched.

Survey respondents were contacted by a firm specializing in telephone market research. The responsibilities of the firm were to: contact the companies in the list provided to them; determine whether or not there was a shipping manager; conduct a preliminary interview to ensure that the company was indeed within the survey population; and to ask whether or not the shipping manager would like to participate in the study. If the individual agreed, the firm would then be sent an invitation e-mail with a link to a URL and a password by which the individual could be associated with his/her responses. 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 (also Sawtooth Software) and after some automated manipulation and preparation, the data were ready to be analyzed.

4.2 Survey Population

The broad goal at the beginning of the research was to survey people involved in shipping decisions related to truckload and less-than-truckload shipments (shipments that would go on standard 53-foot trailers as opposed to in containers) originating in, and transiting through the Quebec City to Windsor Corridor. The reason for this particular population (as opposed for example, to all shipping decision makers that make decide on shipments for this corridor) is that trying to capture all decision makers making decisions about shipments in this corridor would have required surveying people from around the world, an endeavour outside of the scope of this project. As such, 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 all companies in Ontario and Quebec with more than $1 million in sales or more than 20 employees. This database contains a great deal about business establishments, ranging from information such as location, phone number, industry, etc. to more precise information such as whether the establishment is a branch location, a headquarters or a single location.

The population was narrowed and nuanced through the initial interview process while developing the survey, as well as during the preparation of the list of companies to be surveyed. In the end, the survey population included 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. Initially, a random sample of 1,600 companies was drawn weighted by the number of employees at the facility. It became clear a couple of weeks after the beginning of the survey that given the response rate, this was far from enough to obtain the desired (500) number of responses and the entire population was then used.

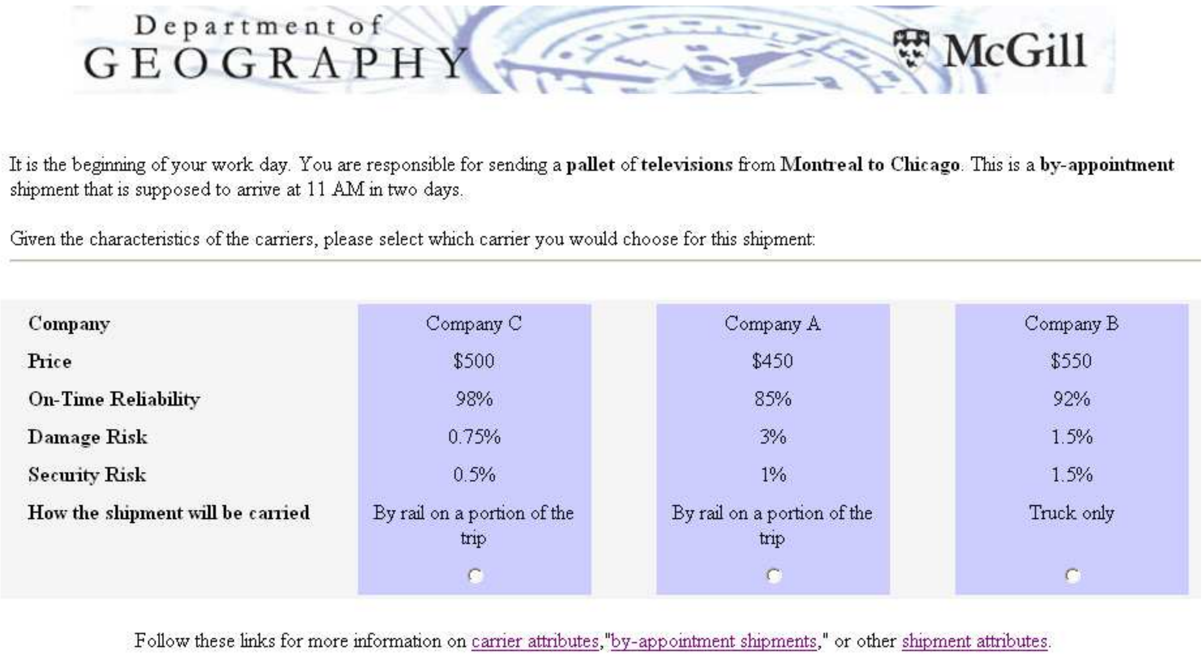
4.3 Survey Design

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 describing how the survey was intended to be completed. In addition, some information believed to be relevant in post analysis was asked (e.g. the proportion of shipments from the company that were 'by-appointment'), and whether the shipper used carriers who use TOFC.

The second part of the survey was the actual CSP, 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. The information provided was the origin and destination, 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). Information on value and fragility was not provided explicitly, but through the type of commodity that was being shipped. For example, televisions were the shipment used to represent high value, fragile goods.

The number of questions (18 per respondent) was chosen for two reasons. The first reason relates to the characteristics deemed to be necessary for the shippers to be able to make their selection between carriers. The total number of shipment attribute combinations (contexts) was seventy-two. Since that would have been far too many choice sets for any respondent to consider, it was decided to divide the seventy-two contexts between different versions of the CSP part of the survey. Recognizing that most respondents can answer effectively between 10 and 20 CSP questions (Sawtooth Software 2005;Johnson and Orme 1996;Louviere, Hensher, and Swait 2000) it was decided that four versions (with 18 questions each) of the survey with randomly selected contexts would be provided to the respondents. Another contributing factor was that Hierarchical Bayesian analysis is best performed starting with 15 choices per respondent (Sawtooth Software 2005), a form of analysis that the authors would like to be able to perform in later stages of research. Figure 3 below shows a sample CSP question from the survey.

Figure 3 - A Sample Question from the Survey



Department of GEOGRAPHY McGill

It is the beginning of your work day. You are responsible for sending a **pallet** of **televisions** from **Montreal to Chicago**. This is a **by-appointment** shipment that is supposed to arrive at 11 AM in two days.

Given the characteristics of the carriers, please select which carrier you would choose for this shipment:

Company	Company C	Company A	Company B
Price	$500	$450	$550
On-Time Reliability	98%	85%	92%
Damage Risk	0.75%	3%	1.5%
Security Risk	0.5%	1%	1.5%
How the shipment will be carried	By rail on a portion of the trip	By rail on a portion of the trip	Truck only

Follow these links for more information on carrier attributes,"by-appointment shipments," or other shipment attributes.

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

As was expected, obtaining information about prices was one of the harder elements of the design process. Due to the fact that shipping rates are so competitively sensitive, as well as the fact that there is a fair bit of variability in prices between carriers, and even between clients of the same carrier because of volume discounts, it was not possible to get 'real' shipping costs. That having been said, it was possible to obtain 'reasonable' estimates of costs owing to the Freight Carriers Association of Canada and the North American Transportation Council (FCA-NATC) 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 (low, medium and high) 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. It was expected that as cost increases, the probability of choosing a carrier would decrease.

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 likelihood of choosing a carrier was expected to increase with on-time reliability and to decrease with damage and security risk.

The last attribute was whether the carrier would send the shipment by TOFC on a portion of the journey. Whereas in previous studies separate modes have been characterized as separate alternatives, it was decided that in this study it would be considered as an attribute of the carrier. The reason for this was that in interviewing shippers it seemed that for the most part shippers were not terribly concerned with how their shipments arrived as long as they arrived on time and in the proper condition. One did note, however, that some shippers might find a benefit for public relations or environmental reasons to use TOFC. It should also be noted that the shipper in question did use a TOFC service for just this reason. 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 of the surveys was not a traditional fixed fractional factorial design. Instead, each version of the surveys had a different factorial design with 300 different attribute value combinations. The algorithm (part of SSI Web) used for choosing the attribute value combinations ensures jointly the orthogonality (maximizing the efficiency of the estimation), balance (that each attribute value is shown an equal number of times) and minimal overlap (each attribute value is shown as few time as possible in a given choice task) of attribute values. It also takes into consideration previous designs that are made so that the same designs are not produced more than once. While this type of design is not necessarily 100% efficient as is often the case with fixed factorial designs used in choice-based conjoint analysis, in the current context, with the large number of responses they were expected to be

100% efficient. Moreover, these designs allow the flexibility to estimate higher order effects (Chrzan and Orme 2000;Sawtooth Software 2005).

5. Survey and Model 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 4 - Results from Global Multinomial Logit

Variable	Coefficient	Exp(B)	Std. Error	Z - Value	P -Value
Cost (ln)	-4.19		0.17	-24.65	0.00
On-time Reliability	0.11	1.12	0.00	40.69	0.00
Damage Risk	-0.40	0.67	0.02	-21.92	0.00
Security Risk	-0.10	0.91	0.03	-2.99	0.00
TOFC	-0.71	0.49	0.03	-23.95	0.00
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.

6. 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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