

## **Is Carrier Choice Different for 3PLs and other End-shippers? Some Preliminary Findings**

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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 its 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.

As companies have increasingly sought to outsource their non-essential activities, there has been a dramatic rise in the use of the services of external companies (often referred to as Third Party Logistics Companies or 3PLs) to organize transportation logistics. Little is known about the degree to which their choice of carriers differs from that of traditional end-shippers. Because this sector is expected to grow in the future and thereby to exert more influence on the way freight is shipped, understanding any differences that they might manifest in carrier choice is useful in itself, but also potentially critical in evaluating the potential for rail to increase its share of freight.

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 presents some findings of a unique shipper carrier-choice stated preference survey of shippers in the Quebec City-Windsor Corridor. The survey was conducted during the fall of 2005. It 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. One novelty of the survey data is that they allow for the testing for, and comparison of,

differences between 3PLs and other ‘end-shippers’ in terms of their carrier and mode choice behaviour.

The paper begins with background on the case-study region and its importance for transportation in the country as a whole. Following this, the paper provides a brief literature review of research on third-party logistics providers and sets the stage for the research described in this paper. It then describes the survey on which this research is based, 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 how differences between 3PLs and other end-shippers were tested for, and presents the summary results of preliminary models that were applied to 3PLs and other end-shippers separately. Some of the results of the carrier choice models are described and a discussion of what these imply for the potential for intermodal rail to increase its mode share is provided.

### The Quebec City – Windsor Corridor

The Quebec City-Windsor corridor is the strip (more or less 100-kilometre-wide) that hugs the Canada-United States border for roughly 1,100 kilometres between Quebec City, Quebec and Windsor, Ontario (see **Error! Reference source not found.**).

Figure 1 - The Quebec City - Windsor Corridor



Quebec and Ontario are the two most populous provinces of Canada containing roughly half its population. The

Corridor is home to 85 percent of the population of Quebec and Ontario, and the location of 3 of the 4 largest Canadian cities. It is also the industrial heartland of the country (Environment Canada 2002). Due to this concentration of industry and population, it is the busiest and most important trade and transportation corridor in Canada.

The Montreal-Toronto section forms the busiest segment of the Corridor. Along this corridor, road has a particularly high mode-share. Whereas road mode share of land-based freight transportation is around 40% for the country as a whole, road mode share in the Corridor was 65% in 1997 relative to 35% for rail. Moreover, road mode share in the Corridor is rising: from 61% in 1990 to 65% in 1997 (Delcan, KPMG and A.K.Socio-Technical Consultants 1999). Because of the Corridor's importance for freight transportation and the dominant role of trucking, understanding the potential to increase rail's mode-share here has important implications for the country as a whole.

### **Premium-Intermodal**

The focus of the study on which this research was based was intermodal transportation that could compete directly with truck-only freight transportation in the Corridor. The intermodal configuration referred to as 'premium-TOFC' (trailer-on-freight-car) was the only one found to meet these criteria. Premium-TOFC refers to railway service configurations that prioritize on-time reliability (through scheduled services and reduced loading and unloading times), minimize damage risk (by using smooth-ride technologies), and provide schedules that allow carriers to provide the same service to their clients as by their truck-only services (Canadian National Railway 2000, Canadian Pacific Railway 2004).

The service is referred to as *TOFC* because it involves carrying regular truck trailers as opposed to reinforced marine or domestic containers. Both Canadian National Railway (CN) and Canadian Pacific Railway (CP) introduced premium-TOFC services in the Corridor at the end of the 1990s. These services were offered between various combinations of the main Corridor destinations (Chicago, Montreal, Toronto and Windsor), but have been for the most part abandoned by CN, while CP continues to offer its service between Montreal and Toronto. As a result, the CP service called Expressway was used as the 'model'

configuration during the study and survey development. Expressway service includes two trains from Montreal to Toronto and two trains from Toronto to Montreal per day. Expressway trains have been engineered so that a trailer can be loaded or unloaded in as little as 15 minutes. At the same time, the specially engineered train cars provide load stability comparable to standard trucks trailers.

While premium-TOFC was used as the model of a service that could compete directly with trucks, the study should not be seen as a study of the potential of only premium-TOFC services, but rather as a study of the potential for premium-*intermodal* services more broadly.

### **Literature Review – 3PLs**

Third party logistics companies are businesses that provide one or many of a variety of logistics-related services. Services offered by 3PLs can include public warehousing, contract warehousing, transportation management, distribution management, freight consolidation, etc. The use of 3PLs has been increasing quickly since at least the 1980's as companies have attempted to outsource non-core activities, including transportation logistics. As a result of this growth, there has been a great deal of interest both in the academic literature as well as the business press.

For the most part, both the academic and business press has been particularly interested in the degree to which, and the reasons for which, 3PLs are used. Examples from the academic literature include Ashenbaum, Maltz and Rabinovich (2005) (a particularly wide-ranging study), Lieb and Bentz (2004) and Peters, Lieb and Randall (1998). Recent Examples from the business press include Belford (2006), Buck Consultants International (2003), eyefortransport (2005), Smyrlis (2004), Tirschwell (2004) and Ward (2004).

Whatever the focus of the particular articles, the broad conclusions are clear: more and more companies are using 3PL services, and the market potential for 3PLs is large. With respect to usage, Smyrlis (2004) reports that around 40% of Canadian companies use 3PLs for some of their transportation needs. Ashenbaum, Maltz and Rabinovich (2005) report that large US companies are increasingly using 3PLs. In particular, they report that whereas in 1991 only 38% of Fortune 500 companies used

3PLs, by 2003 83% were using them. At the same time, it seems there is still a lot of potential for growth. Tirschwell (2004) quotes one industry insider as estimating that only one quarter of the total market potential of US\$150 billion has been captured.

When it comes to quantitative behavioural modeling and in particular carrier or mode choice modeling, there is little research that has looked explicitly at any differences that might exist between 3PLs and other freight transportation decision makers. Because this paper uses a Stated Preference (SP) methodology, this literature review focuses and reports on SP studies, it should be noted, however that the following appears to be true for Revealed Preference (RP) as well as SP studies. In particular, there does not appear to be many reported attempts in the SP mode or carrier choice literature to establish whether 3PLs behave differently from than other shippers (Fowkes and Tweddle 1988, Fridstrom and Madslie 2001, Norojono and Young 2003, Shinghal and Fowkes 2002, Vellay and de Jong 2003, Wigan, Rockcliffe, Thoresen and Tsolakis 2000). One recent example which begins to explore this issue is a paper by Patterson, Ewing and Haider (2007 (Forthcoming)). The current paper seeks to investigate this question more closely.

Thus we can say that 3PLs are more and more important in terms of freight transportation decisions and thereby demand. As a result, if it is indeed the case that 3PLs behave differently from other shippers with respect to their carrier and mode choice, this has important implications for understanding future freight demand.

### **The Carrier Choice Survey**

This research is based on the results of a stated preference carrier choice survey of end-shippers in the Quebec City – Windsor Corridor. End-shipper is the term used in the study to describe a shipper that hires carriers for all of their shipments. The decision to use intermodal services will generally be that of the carrier, since it is the carrier that organizes the movements of consignments from end-shipper to receiver. Although one might expect end-shippers to be 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 intermodal services will ultimately be constrained by shipper

preferences. In effect, the end-shipper can be seen as the true backstop for the demand for intermodal services.

As a result, while many previous mode choice studies, e.g. (Vellay and de Jong 2003), have surveyed both end-shippers and own-account shippers, this survey focused exclusively on end-shippers. In particular, it was designed to establish whether a carrier's use of intermodal services would affect the end-shipper's choice of carrier. To save space, only a cursory description of the survey is provided here - a more complete description of the survey can be found in (Patterson, Ewing and Haider 2007 (Forthcoming)).

The survey itself took the form of what is called in the literature a 'contextual stated preference' or CSP survey, e.g. (Wigan, Rockliffe, Thoresen and Tsolakis 2000). In fact, there were two surveys one in English and the other in French, reflecting the primary mother tongues of respondents. The surveys had two parts. The first described the purpose of the survey and how the survey was meant to be completed. In addition, some information believed to be relevant in post analysis was sought, e.g. the proportion of the firm's shipments that were 'by-appointment', and whether the shipper employed carriers using intermodal services.

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 given to the respondent was the origin and destination, when the shipment was to arrive, whether it was 'by-appointment,' whether it was of high or low value, whether it was fragile or perishable, and its size (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.

With respect to carrier attributes, five were provided: cost, on-time reliability, damage risk, security risk and whether the carrier would send the shipment by rail for a portion of the journey. Whereas in previous mode choice studies (Norjono and Young 2003, Shinghal and Fowkes 2002, Vellay and de Jong 2003), mode has been included explicitly by asking respondents to choose between alternative modal configurations for their

shipments, in this survey, mode was considered a carrier attribute. Unlike many SP freight surveys, time required for shipping was considered a shipment's attribute, not a carrier's.

This is because discussions with shippers established that shipping times in the Corridor are standardized, e.g. a Montreal to Toronto shipment is 'overnight.' As a result, shipping time is not a basis upon which carriers are chosen as all carriers can offer the same overnight shipping. This is not the case for shipments between city pairs separated by longer distances. For example, a shipment between Toronto and Vancouver can require between 3 and 7 days. Because of this difference, a study that included longer-haul shipments between city-pairs for which travel times are not standard would require a different survey – i.e. one that included shipment travel time as a carrier characteristic. Unfortunately, it was outside of scope of this research to be able to field two surveys, and so only one survey for trips between destinations in the Corridor was used.

A list of end-shippers including manufacturers, wholesalers, retailers and third-party logistics companies (3PLs) was provided to a telephone survey company to contact and recruit respondents for the web-based survey. The list of companies came from the Dun & Bradstreet Million Dollar Database of companies in Ontario and Quebec. The survey was administered between mid-August and early December 2005. All companies in the list sent to the marketing firm were contacted (7,221). Of these, 680 agreed to participate. In the end, completed results were obtained for 392 respondents, of these 25 were 3PLs.

## **Modelling Approach**

The methodology and results reported in this paper are preliminary. As a result, rather preliminary models are reported. In particular, further analysis will involve accounting for interpersonal variation in responses through the use of random-effects mixed-logit models as well as more elaborate models. In the current analysis, the results of simplified standard conditional logit models are presented.

The modelling approach adopted was as follows. First, for all of the data (choice observations), a global conditional logit was estimated. This model was arrived at by beginning with a more general form of the model and removing insignificant

variables iteratively. In other words, the more specific global model was developed by “testing down” from a more general form of the model to the more specific model presented below.

In the second stage, testing was conducted to see if 3PLs had statistically different utility functions from other end-shippers, and hence whether they ought to be modeled separately. This was accomplished using a version of the so-called Chow test (see for example Greene (2000: 287)). It is an F-test of the joint insignificance of multiple variables identified with subsets of a population. The coefficients of these subset-specific variables are allowed to vary independently from the coefficients used for the rest of the observations. These coefficients are allowed to vary independently from the rest by interacting the explanatory variables with a dummy variable identifying the subset of observations of interest. If all the explanatory variables of the model are interacted with the dummy variable identifying the subgroup, this amounts to testing whether the subgroup is statistically significantly different from the other observations. More precisely, it is testing whether, by allowing each of the explanatory variables to be estimated separately for the subgroup, there is a statistically significant increase in the explanatory power of the model.

In this case, the test was between 3PLs and other end-shippers. As such, a test for the joint insignificance of variables interacted with a dummy variable indicating whether each respondent was from a 3PL was performed. If the test turned out to be statistically significant (i.e. the null hypothesis was rejected), it would amount to saying that there is a statistically significant increase in explanatory power by estimating a model for 3PLs independently from other end-shippers, and therefore that separate models ought to be estimated for 3PLs and other end-shippers. As this is a discrete choice analysis involving maximum likelihood estimation, instead of using an F-test the appropriate test is a likelihood-ratio test. When testing to see whether 3PLs ought to be modeled separately from other end-shippers, a Chi-square statistic of 48.95 with 21 degrees of freedom resulted. This suggests that the probability of differences in the estimated coefficients between 3PLs and end-shippers arising out of chance as being very small (0.0005%). As such, it was concluded that they should be modeled separately. A

summary of the three resulting models is presented in the following section.

### **Preliminary Findings – 3PLs vs. other End-shippers**

Table 1 provides a summary of the preliminary, simplified modelling results. Due to the space constraints, only the primary variables of interest (carrier attributes) are reported on here. Considering the global model (column 'All'), the primary results are what would be expected from economic and logistics theory. Namely, the coefficients for cost, damage risk and security risk are negative. This implies that as cost, damage risk and security risk increase, the probability of choosing a carrier decreases. At the same time, the coefficient for on-time reliability is positive. That is, as on-time reliability increases, so does the probability of choosing a given carrier. These findings are consistent not only with theory, but also with research reported in the literature review.

The last carrier attribute of interest is that for whether the shipment was identified as being intermodal. The coefficient implies that if the probability of choosing a particular carrier were was  $1/2$ , then knowledge that the carrier would send the shipment intermodally would reduce the probability of choosing the carrier to  $1/3^{\text{rd}}$  – a very strong result. Comparison of this result with other literature is complicated by the fact that this is the first time that the intermodal nature of a shipment has been considered as a carrier attribute as opposed to an explicit choice by the respondent. Nevertheless, similar results are reported in Patterson, Ewing and Haider (2007 (Forthcoming)).

Of course, what is most interesting about these results is not the global model, but rather the difference between 3PLs and other end-shippers. The first thing to notice is the fact that some variables (damage and security risk) do not come out as statistically significant and are therefore not included. Whether these variables come out as insignificant due to actual behavioural differences, or due to lack of observations, it is difficult to say. In any case, comparison between these variables is left out.

With respect to the variables that do come out as statistically significant, there are three that are particularly

interesting. The first is price. At first glance, it would seem that the 3PL coefficient on price (-7.335) would suggest that 3PLs are much more price sensitive than other end-shippers. This result needs to be mediated by the fact that the price coefficient for other end-shippers is affected by the distance\*price variable. When we compare the combined price variable for other end-shippers (Price + Dist\*Price) at the average distance of shipments in the survey, we find a coefficient value of -5.927. As a result, while the initial conclusion that 3PLs are more price-sensitive than other end-shippers seems to be right, the difference is not as large as one might first think.

With respect to on-time reliability, the coefficient for 3PLs is larger than for other end-shippers suggesting that 3PLs are more sensitive to on-time reliability than other end-shippers.

The last important result is the intermodal variable. The 3PL intermodal coefficient is twice as large as that for other end-shippers. In particular, the coefficients suggest the following. For other end-shippers, the odds of choosing a given carrier would decrease by 45% if the shipper made aware of the fact that the shipment would be sent intermodally. For a 3PL, these odds would decrease by 70%!

Relatively intuitive explanations can be proposed for the reticence towards intermodal shipping by 3PLs. Perhaps 3PLs are more reluctant to use rail because reduced performance of shipments can result in the loss of a client. As a result any pre-conceived perception about rail performance would have a magnified rail-bias for them. Similar explanations could be put forward for explaining 3PLs heightened sensitivity for on-time reliability as well as price.

Table 1 – Summary of Simplified, Preliminary Modelling Results

	<b>All Observations</b>	<b>End-shippers</b>	<b>3PLs</b>
<b>Price(ln)</b>	-4.54	-3.724	-7.335
	(7.81)**	(6.77)**	(5.24)**
<b>Dist*Price</b>	-0.002	-0.002	
	(4.52)**	(4.78)**	
<b>Ontime Reliability (OR)</b>	0.093	0.086	0.1
	(9.99)**	(8.96)**	(6.55)**

<b>Damage Risk (DR)</b>	-0.364	-0.378	
	(15.98)**	(16.07)**	
<b>Security Risk</b>	-0.1	-0.094	
	(2.92)**	(2.66)**	
<b>Intermodal</b>	-0.774	-0.59	-1.189
	(8.87)**	(14.76)**	(9.06)**
<b>Observations</b>	7074	6624	450
<b>Prob &gt; chi2 =</b>	0.000	0.000	0.000
Absolute value of z-statistics in parentheses			
* significant at 5% level; ** significant at 1% level			

The fact that 3PLs are increasing in importance with respect to freight transportation decision-making and that they seem to be particularly dubious about the use of rail, suggests further challenges to increasing rail's mode share in the future.

Before firm conclusions can be drawn, however, much more detailed analysis needs to be undertaken. This would involve not only more detailed models, but also accounting for interpersonal variation in choices across respondents. This in turn requires more flexible discrete choice models, namely a random-effects mixed logit.

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