Université de Montréal
Faculté des arts et des sciences
Département de sciences économiques

CAHIER 9413

IMPROVING A FRAGILE LINEAR LOGIT MODEL SPECIFIED FOR HIGH SPEED RAIL DEMAND ANALYSIS IN THE QUEBEC-WINDSOR CORRIDOR OF CANADA

Marc Gaudry[1] and Alexandre Le Leyzour[2]

1 Département de sciences économiques and Centre de recherche sur les transports (CRT), Université de Montréal.

2 Institut d'économie appliquée, École des Hautes Études Commerciales.

August 1994

The authors benefited from direct support of Transport Canada, as well as from basic research funded by the National Science and Engineering Research council of Canada and by the F.C.A.R. program of the Quebec Government. The Via Rail data for 1987 were gratefully made available by Peat Marwick.

C.P. 6128, succursale Centre-ville
Montréal (Québec) H3C 3J7

Télécopieur (FAX): (514) 343-5831
Courrier électronique (E-Mail): econo@tornade.ERE.Umontreal.CA

Ce cahier a également été publié au Centre de recherche sur les transports (CRT) (publication no 988) et à l'Institut d'économie appliquée de l'École des Hautes Études Commerciales (publication no IEA-94-07)

Dépôt légal - 1994
Bibliothèque nationale du Québec
Bibliothèque nationale du Canada

ISSN 0709-9231

ABSTRACT

It is important to obtain distinct and credible price and service elasticities in the analysis of competition among travel modes. In a study of the Quebec-Windsor Corridor pertaining to the 4 intercity travel modes in Canada, and carried out by independent consultants, distinct price and service elasticities were obtained for business trips, but not for other trips, using a linear exponent logit model. After reproducing these results, we first show that the existence of nonlinearity makes the business trip model extremely fragile but also makes it possible to reestablish distinct price and time coefficients for the non-business model. Secondly, we show that proper exploitation of this nonlinearity makes the formulation of a common specification for both types of trips simultaneously possible and superior to the linear formulation. Although it is well known that the Box-Cox logit model generally dominates the linear logit model, we further show, thirdly, that the Generalized Box-Cox logit yields better results still, no doubt because it provides an estimable form of the Universal logit and brings logit analysis back into the fold of classical demand analysis where additive separability of utility is not generally credible among close substitutes. This third specification, although limited in scope, shows promise as a substitute for the nested logit.

Keywords: logit, Box-Cox logit; generalized Box-Cox logit; mode choice; Quebec-Windsor Corridor; disaggregate data; business trips; non business trips; high speed rail; Canada.

. . . .

RÉSUMÉ

Dans la modélisation de la concurrence intermodale, il est important d'obtenir des résultats distincts et crédibles pour les élasticités de la demande par rapport aux prix et aux niveaux de service. Notre point de départ est une étude faite par des experts indépendants du corridor Québec-Windsor, et ayant trait aux quatre modes de transport interurbain des voyageurs au Canada, où on avait réussi à obtenir de telles élasticités distinctes pour le modèle des déplacements à motif affaires, mais pas pour les modèles des autres déplacements, grâce à un logit à forme linéaire. Après avoir reproduit ces résultats, nous montrons en premier lieu que l'existence de nonlinéarité rend le modèle pour motif affaires par trop fragile mais permet aussi de rétablir dans l'autre modèle des coefficients distincts pour le prix et le temps de tranpsort. Nous montrons en second lieu que l'exploitation de la nonlinéarité présente permet à la fois d'utiliser une formulation commune aux deux modèles et préférable à la formulation linéaire. Il n'est pas nouveau que le Box-Cox logit domine ainsi le logit linéaire mais nous réussissons en troisième lieu, en sus, à obtenir par ailleurs des résultats meilleurs encore avec le Box-Cox logit généralisé. Ce dernier représente une forme estimable du logit universel et ramène en fait l'analyse logit dans la foulée classique des systèmes de demande où il est normal de rejeter l'additivité séparable de l'utilité, en particulier entre substituts assez proches. Cette troisième formulation laisse entrevoir la possibilité d'utiliser le Box-Cox logit généralisé au lieu du logit emboîté, même si notre application n'est pas générale.

Mots-clés : logit; Box-Cox logit; Box-Cox logit généralisé; choix modal; corridor Québec-Windsor; données individuelles ou désagrégées; motif affaires; autres motifs; train à haute vitesse; Canada.

Contents

1. Introduction 1
2. Theoretical Background 2
   - 2.1 Is the representative utility function linear? 3
   - 2.2 A useful specification of the Universal logit 3
   - 2.3 Impacts on Elasticities and Values of Time 4
     - • Elasticities 4
     - • Value of time 5
   - 2.4 Estimation 5
3. Empirical Analysis 7
   - 3.1 Data and variables 7
   - 3.2 Model specifications 7
     - • Peat-Marwick specification (PM) 7
     - • Modified specification (MO) 9
     - • Enriched specification: the Generalized Box-Cox (GBC) 9
   - 3.3 Results 17
     - • The fragile Peat-Marwick model (Columns 1–2 and 7–8) 17
     - • A modified model in linear and logarithmic form (Columns 3–4 and 9–10) 18
     - • More reasonable results with Box-Cox transformations (Columns 5 and 11) 19
     - • Generalized Box-Cox logit results (Columns 6 and 12) 20
4. Some policy implications 22
5. Conclusion 23
6. References 23
7. Appendix. Additional results for business and non business models, Quebec-Windsor corridor, 1987 27

List of Tables

Table 1 List of variables 8

Table 2 The Peat-Marwick (PM), modified (MOD) and Generalized Box-Cox (GBC) specifications 10

Table 3 Results for business and non business models, Quebec-Windsor corridor, 1987 11

1. Introduction[1]

For many years, researchers have tried to specify models to explain mode choice in many transportation networks. Almost every study published in the early 1970's used binary logit or Probit models to calibrate choice models [Canadian Transport Commission (1970), Cohen *et al.* (1978)]. Later, the introduction of the Multinomial logit model allowed researchers to explain in the same econometric model more than two choices [Hensher and Johnson (1981), Grayson (1981), Ben-Akiva (1981), Wilson *et al.* (1984)]. However, the issue which is usually left aside in the literature is that of the functional form of the variables used in the indirect utility function common to all the individuals pertaining to the sample or sub-sample of a database. Usually, the form of the fixed part of the utility function is linear in the variables [Swait (1984), Abdelwahab (1990), Peat-Marwick (1990)]. This assumption can lead to an erroneous evaluation of the weight of the variables on the latent factor representing the utility. Although, some researchers considered that nonlinear formulations of variables could improve the reliability of the utility specification [Gaudry and Wills (1978), Gaudry (1981), Gaudry (1993)], notably in aggregate models, individual choice models that addressed this issue of nonlinearity are relatively scarce: early examples include Koppelman (1980) and Hensher and Johnson (1981) but the first thorough study came later [Gaudry *et al.* (1989) and Mandel *et al.* (1994)]. Despite the demonstrated power of the Box-Cox transformation to modify deeply the understanding and value of the results obtained in mode choice models, it has remained little used. The lack of easy-to-use software explains this state of affairs. We hope that the availability of self-programmed procedures, such as Gauss [Aptech Systems, inc. (1992)], or of interactive graphic user friendly programs, such as TRIO [Gaudry *et al.* (1993)] will modify this practice.

The object of this paper is to extend significantly previous demonstrations of the usefulness of nonlinear specifications. We first show that nonlinear transformations improve on a fragile linear logit model in such a way that all parameters have the expected signs and greatly increase

[1] The authors benefited from the direct support of Transport Canada, as well as from basic research funded by the National Science and Engineering Research council of Canada and by the F.C.A.R. program of the Quebec Government. The Via Rail data for 1987 were gratefully made available by Peat Marwick.

the model fit, as indicated by huge increases in the maximum likelihood function. Secondly, we also go beyond the standard Box-Cox logit model to specify a less restrictive format, called the generalized Box-Cox logit [Gaudry (1978)] that directly questions the additive separability assumptions of the linear logit model.

The first part presents the theoretical background of the nonlinear mode choice models and analyses the usefulness of this important modification. Part II discribes the specification of alternative models. Part III contains the results of the different specifications. We end with some policy implications and a conclusion.

2. Theoretical Background

In transportation economics, the most widely used model to calibrate modal choice or modal split is the linear logit model [Domencich and McFadden (1975)]. The theoretical background of the logit lies in the microeconomic concepts of consumer behavior and perfect competition between modes. The former is linked to an individual indirect utility. All prices, times and frequencies associated with all modes are known. The latter is more easily understood in considering the fact that all modes are substitutes. No complementarity of modes is allowed within the framework of the econometric model.

If we admit the *a priori* assumptions of the logit, the model can be easily derived. Suppose that an individual, say n, is rational and he chooses the alternative, i, which maximize his indirect utility from this mode (U_{in}). Then, $P_n(i) = \Pr\left(U_{in} > \max_{j \neq i} U_{jn} \right)$ where $P_n(i)$ is the probability that individual n chooses mode i and $\max_{j \neq i} U_{jn}$ is the best competing alternative j. However, the indirect utility function, U_{in}, is unknown but approximated by being spliting into two parts labelled V_{in} and ϵ_{in}: V_{in} is a deterministic part composed of network variables (i.e: cost, time and frequencies) and socioeconomic variables (i.e. income or social class); ϵ_{in} is a random component due to the researcher's ignorance of all the determinants underlying modal choice or the use of a wrong functional form. Incorporating these elements into the choice probability equation, it can be written as $P_n(i) = \Pr\left(V_{in} + \epsilon_{in} > \max_{j \neq i} V_{jn} + \epsilon_{jn} \right)$. If we also suppose that the random terms difference follows a Gumbell distribution, the probability of choosing mode i can be written:

$$P_n(i) = \frac{\exp(V_{in})}{\sum_j \exp(V_{jn})}, \tag{1}$$

which is the well known Multinomial logit model (MNL).

2.1 Is the representative utility function linear?

Usually, the determinist part of the indirect utility function V_{in}, is specified as a linear combination of its attributes. In other words, $V_{in} = \beta_0 + \sum_k \beta_k X_{ink}$ where β_0 is a constant term associated with alternative i, and $\sum_k \beta_k X_{ink}$ is a set of coefficients and variables respectively. However, this representation is oversimplified and may not represent the true specification of the variables. In order to test the linearity assumption, we can apply a monotonic power transformation parameter on any variable and then estimate this parameter jointly with the $\beta-$parameters. Some power transformations can be applied such as the Box-Tukey [Tukey (1957)] or the Box-Cox [Box and Cox (1964)]. We have chosen the Box-Cox transformation (BCT) for its simplicity as the representation of a transformed positive variable, X_{ink}:

$$X_{ink}^{(\lambda)} = \begin{cases} \frac{X_{ink}^{\lambda}-1}{\lambda} & \text{if } \lambda \neq 0 \\ \ln(X_{ink}) & \text{if } \lambda = 0. \end{cases} \tag{2}$$

The determinist component of the indirect utility function now has the following specification:

$$V_{in} = \beta_0 + \sum_k \beta_k X_{ink}^{(\lambda_{ik})}. \tag{3}$$

2.2 A useful specification of the Universal logit

Another limitation of the linear form consists in the impossibility to introduce in V_{in} some attributes of the other modes. For example, one cannot specify in alternative i the cost of another alternative. The advantage of the power transformation is to allow the calibration of the

Generalized Box-Cox logit in which attributes of alternatives $j \neq i$ can be explicitly introduced in alternative i. So, V_{in} becomes

$$V_{in} = \beta_0 + \sum_k \beta_k X_{ink}^{(\lambda_{ik})} + \sum_l \beta_l X_{jnl}^{(\lambda_{jl})}. \quad (4)$$

The above specification is in effect an estimable form of McFadden's unspecified Universal logit [McFadden (1975)] and permits to test different hypotheses concerning the relations between modes. In other words, substitution or complementarity among modes are possible, depending on signs of the β_l coefficients. If the sign of the coefficient is positive, then modes are substitutable; if negative, the modes are complementary.

2.3 Impacts on Elasticities and Values of Time

Elasticities

The elasticities in the classical logit model are defined as $E_{X_{ink}}^{P_n(i)} = [1 - P_n(i)]\beta_k X_{ink}$. The modification introduced by the Box-Cox transformation is related to the variable X_{ink} yields instead $E_{X_{ink}}^{P_n(i)} = [1 - P_n(i)]\beta_k X_{ink}^{\lambda_k}$. If we consider $P_n(i)$ as a constant, the new elasticity depends on the value of λ_k: some usual forms can be seen as special cases. If $\lambda_k = 1$, the elasticity of the linear logit is obtained; if $\lambda_k = 0$, the logarithmic transformation of the variable implies an elasticity equal to $E_{X_{ink}}^{P_n(i)} = [1 - P_n(i)]\beta_k$.

The more appropriate elasticity is the weighted aggregate elasticity [Ben-Akiva and Lerman (1985)], which in the nonlinear case is

$$E_{X_{ik}}^{P(i)} = \beta_k \sum_n P_n(i)[1 - P_n(i)] X_{ink}^{\lambda_k} / \sum_n P_n(i). \quad (5)$$

The previous representation of the elasticities only applies to the standard logit and Box-Cox logit models. The weighted aggregate elasticity of the Generalized Box-Cox logit model model is:

$$E_{X_{ik}}^{P(i)} = \sum_n P_n(i) \left[\frac{\partial V_{in}}{\partial X_{ink}} - \sum_j P_n(j) \frac{\partial V_{jn}}{\partial X_{ink}} \right] X_{ink}^{\lambda_k} / \sum_n P_n(i). \quad (6)$$

Value of time

Economists are often interested by the concept of marginal rate of substitution. In transportation, the most calculated rate of substitution is the value of time (VOT) measuring the revealed trade-off between cost and travel time. With a linear logit model, estimates of value of time will be the same across the modes and equal the ratio of the travel time and cost coefficients. The use of Box-Cox transformation implies a more realistic expression

$$VOT = \frac{\beta_{Time} Time^{\lambda_{time}-1}}{\beta_{Cost} Cost^{\lambda_{cost}-1}}. \tag{7}$$

where values will differ across modes if their time and cost characteristics are not equal even if the BCT are constrained equal. In the generalized Box-Cox logit, there arises an ambiguity, because the value of time defined by (6) now depends on whether one is interested in the ratios of substitution defined on representative utilities

$$\frac{\partial V_{in}}{\partial Cost} / \frac{\partial V_{in}}{\partial Time} \tag{8}$$

or on choice probabilities

$$\frac{\partial P_n(i)}{\partial Cost} / \frac{\partial P_n(i)}{\partial Time}. \tag{9}$$

Although the derivatives are different, the ratios are identical [Gaudry *et al.* (1993)] if a particular cost or time variable can appear in more than one representative utility function. The TRIO program that we used computes the marginal rates of substitution in terms of choice probabilities and takes due account of the possible presence of any variable in more than one representative utility function.

2.4 Estimation

To estimate the parameters, the log-likelihood method is used. The likelihood of observing a random sample of size N, is the product of the choice probabilities associated with G subsets of observations, in which the first set includes G_1 individuals observed to have chosen alternative

1, the next one G_2 individuals having chosen alternative 2, and so on, all observations being independent:

$$L = \prod_{n=1}^{G_1} P_n(1) \prod_{n=G_1+1}^{G2} P_n(2) \cdots \prod_{n=G_1+\ldots+G_{M-1}+1}^{G} P_n(M). \qquad (10)$$

This expression can be simplified by defining a dummy variable, d_{in} equal to 1 if individual n has chosen alternative $i \in C_n$ where C_n is the alternative choice set of individual n and 0 otherwise:

$$L = \prod_{n=1}^{G} \prod_{i \in C_n} P_n(i)^{d_{in}}. \qquad (11)$$

The corresponding log-likelihood function can now be written as:

$$\ln L = \sum_{n=1}^{G} \sum_{i \in C_n} d_{in} P_n(i). \qquad (12)$$

However as specified, this log-likelihood cannot be used with our stratified sample. One estimation procedure, developed by Manski and Lerman (1977) is called Weighted Exogenous Sampling Maximum Likelihood (WESML). The use of this method is needed because these authors showed that the classical maximum likelihood procedure for random samples would yield inconsistent estimates. The WESML estimator which is consistent and asymptotically normal is obtained by weighting each observation's contribution to the log-likelihood function with known positive constants $w(i) = Q(i)/H(i)$, where $Q(i)$ is the proportion of the population choosing alternative i and $H(i)$ is the analogous proportion for the choice-based sample. The log-likelihood function is now:

$$\ln L = \sum_{n=1}^{G} \sum_{i \in C_n} d_{in} w(i) P_n(i). \qquad (13)$$

In TRIO, the maximization of the likelihood function of this nonlinear model is made by Davidon-Fletcher-Powel algorithm [Fletcher and Powell (1963)].

3. Empirical Analysis

3.1 Data and variables

The database used in this study was originally produced by the Canadian passenger railway company Via Rail in 1987 for the Quebec-Windsor corridor. Over 12,000 individuals are included and the database was split into two main travel purposes. The first includes exclusively business travellers (4402 individuals) and the second one includes all other travellers (8535 individuals). The structure of the database shows that car is the most used mode for both purposes (almost 90%). Rail et Bus are the least chosen modes when somebody travels in the corridor (3% and 1% respectively). The last mode, Air, is heterogenous in respect of the purpose: for business travellers, Air comes second behind Car (10.1%) but for the other purposes, Air (3.3%)comes third behind Car (91%) and Rail (4%).

The variables used in this paper are presented in table 1. The large number of variables is due to the fact that two types of specifications are used. we first present the Network variables and then the socioeconomic variables.

3.2 Model specifications

Peat-Marwick specification (PM)

The first specification proposed in this study uses the model presented by Peat-Marwick (1990). We reestimated their model for business and non business purposes. The specification of the determinist part of the utility function is:

$$\begin{aligned}
V_{Rail} &= \beta_{10} + \beta_1 CTT_R + \beta_2 RTHI_R + \beta_3 RTLI_R + \beta_4 ATHI_R + \beta_5 ATLI_R + \beta_6 FR_R + \beta_7 LARGE \\
V_{Air} &= \beta_{20} + \beta_1 CTT_A + \beta_2 RTHI_A + \beta_3 RTLI_A + \beta_4 ATHI_A + \beta_5 ATLI_A + \beta_6 FR_A + \beta_8 LARGE \\
V_{Bus} &= \beta_{30} + \beta_1 CTT_B + \beta_2 RTHI_B + \beta_3 RTLI_B + \beta_4 ATHI_B + \beta_5 ATLI_B + \beta_6 FR_B + \beta_9 LARGE \\
V_{Car} &= \beta_1 CTT_C + \beta_2 RTHI_C + \beta_3 RTLI_C
\end{aligned} \tag{14}$$

Table 1. List of variables

Codes	Network variable description
i_CTT	Trip total cost for the for modes. It incorporates travel cost and access cost (nul for auto mode). Variable measured in 1987 canadian dollars.
i_GC	Generalized cost used as a level of service variable for non business purpose. It includes cost and all times variables weighted by half of the business value of time. Variable measured in 1987 canadian dollars. i_GC= i_C+ (12.7/60)*(0.25*(6.9*i_ATHI1+ i_RTHI1) + 2.9*i_ATHI1+ i_RTHI1)
i_RTT	Travel time for all four modes. It includes travel time and transfer time. Variable measured in minutes.
i_RTHI1	Travel time as specified above for all four modes. Segmentation is made for travellers with high income (30,000 C$ and up). Variable measured in minutes.
i_RTLI1	Travel time as specified above for all four modes. Segmentation is made for travellers with low income (up to 30,000 C$). Variable measured in minutes.
i_TTT	Door-to-door travel time for all modes. It includes travel time as specified above and access time as specified below. Variable measured in minutes.
i_ATT	Access time for all three public modes (Rail, Plane and Bus). It incorporates access time, egress time and waiting time in the terminal. Variable measured in minutes.
i_ATHI1	Access time as specified above for high income travellers. Variable measured in minutes.
i_ATLI1	Access time as specified above for low income travellers. Variable measured in minutes.
i_FR	Departure frequency for public modes (Rail, Plane and Bus). Variable measured by daily number of departures
	Socioeconomic variable description
INC	Individual yearly gross income. Variable measured in 1987 canadian dollars.
LARGE	Variable equal to 2 if the origin and the destination of travel are in a large city (Toronto, Ottawa or Montreal), 1 if the origin or the destination are in a large city, 0 otherwise.
GROUP	Binary variable equal to 1 if a travel is done by a group, 0 otherwise.

where it is clear that all time variables are split into two groups according to income. This assumes that travellers having a relatively high and low income have heterogeneous reactions with respect to time variables. However, the cost reaction is assumed to be the same for all the individuals. Such segmentation deals with mispecification problems and could also have been applied to the cost variable. The estimation of the model was first made under a linear hypothesis and then by applying Box-Cox transformations.

Modified specification (MO)

The second model, more robust, uses a different specification of the variables. Firstly, the segmentation of the time variables by income variable has been removed and an income term considered independently. Secondly, the time variables were summed to define a "door-to-door" travel time for the public modes. Cost and frequency variables remained unchanged.

Furthermore, keeping in mind that models must be compared we decided to have the same specification for the business and non business models. Equation 15 displays the reference model operational specification. The only difference between models for different trip purposes is the addition of a group variable in the non business purpose in order to reflect the fact that, when groups travel, the probability of using car is higher (Peat-Marwick 1990).

$$
\begin{aligned}
V_{Rail} &= \beta_0 + \beta_1 CTT_R^{(\lambda_1)} + \beta_2 TTT_R^{(\lambda_2)} + \beta_3 FR_R^{(\lambda_3)} + \beta_4 INCOME^{(\lambda_4)} + \beta_7 LARGE \\
V_{Air} &= \beta_0 + \beta_1 CTT_A^{(\lambda_1)} + \beta_2 TTT_A^{(\lambda_2)} + \beta_3 FR_A^{(\lambda_3)} + \beta_5 INCOME^{(\lambda_4)} + \beta_8 LARGE \\
V_{Bus} &= \beta_0 + \beta_1 CTT_B^{(\lambda_1)} + \beta_2 TTT_B^{(\lambda_2)} + \beta_3 FR_B^{(\lambda_3)} + \beta_6 INCOME^{(\lambda_4)} + \beta_9 LARGE \\
V_{Car} &= \beta_1 CTT_C^{(\lambda_1)} + \beta_2 TTT_C^{(\lambda_2)}
\end{aligned}
\tag{15}
$$

Enriched specification: the Generalized Box-Cox (GBC)

The generalized Box-Cox specification [Gaudry (1978)] includes the car in-vehicule time (run time) variable added to the utility functions of the other three modes. Because this variable has its own BCT, which is distinct from the other BCT of the model, there is no underindentification problem of its coefficient. The form is

$$
\begin{aligned}
V_{Rail} &= \ldots + \beta_{10} TTT_C^{(\lambda_s)} + \ldots \\
V_{Air} &= \ldots + \beta_{10} TTT_C^{(\lambda_s)} + \ldots \\
V_{Bus} &= \ldots + \beta_{10} TTT_C^{(\lambda_s)} + \ldots \\
V_{Car} &= \ldots
\end{aligned} \tag{16}
$$

where only the additional variable has been shown.

The three specifications are shown in summary form in table 2.

Table 2. The Peat-Marwick (PM), modified (MOD) and Generalized Box-Cox (GBC) specifications

	Business	Non Business
PM	$V_i = (CTT_i, RTT_i^*, ATT_i^*, FR_i, LARGE, -)$	$V_i = (CG_i, -, FR_i, LARGE, GROUP, -)$
MOD	$V_i = (CTT_i, \mathrm{TTT}_i, -, FR_i, LARGE, \mathrm{INC})$	$V_i = (CTT_i, \mathrm{TTT}_i, -, FR_i, LARGE, GROUP, \mathrm{INC})$
GBC	$V_i = (CTT_i, TTT_i^*, \mathrm{TTT_C}, FR_i, LARGE, \mathrm{INC})$	$V_i = (CTT_i, TTT_i^*, \mathrm{TTT_C}, FR_i, LARGE, GROUP, \mathrm{INC})$

* Segmented by income

In all the specifications, the network variable coefficients are constrained to be generic and the socioeconomic variables coefficients are unconstrained to reflect the heterogeneity of decisions with respect to income and origin or/and destination of a travel. When a BCT is used on a variable that contains observations equal to zero, TRIO automatically generates an associated dummy variable that preserves the invariance of the BCT and is shown in Table 3.

Table 3. Results for business and non business models, Quebec-Windsor corridor, 1987

I. M.A. ELASTICITIES		1	2	3	4	5	6	7	8	9	10	11	12
M.A. MHS: RAI_CTT	VARIANT =	PHREF	PHREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PHNBUS	PHNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
(COND. T-STATISTIC)	VERSION =	70	76	8	2	18	46	15	16	43	44	48	105
	DEP.VAR. =	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
ALTERNATIVE 1 : RAIL (RAIL)													
NETWORK VARIABLES													
TOTAL COST, RAIL	RAI_CTT	-1.314	-2.437	-.907	-3.721	-2.171	-1.215			.341	-1.168	-.939	-.301
(RUN AND ACCESS COST)		.10E+01	[illegible]	.10E+01	.10E+01	.10E+01	.10E+01			.10E+01	.10E+01	.10E+01	.10E+01
	(1)	(-5.21)	(-6.49)	(-3.66)	(-7.62)	(-7.23)	(-2.85)			(2.45)	(-5.18)	(-4.96)	(-2.58)
		(GE)	L [illegible](GE)	L 1(GE)	L 1(GE)	L 4(GE)	L 4(GE)			L 1(GE)	L 1(GE)	L 4(GE)	L 2(GE)
GENERALIZED COST, RAIL	RAI_GC							-3.367	-4.528				
								-	-				
	(1)							(-18.85)	(-22.54)				
								(GE)	L 1(GE)				
TOTAL	RAI_TTC			-3.002	-.828	-1.662	-1.938			-1.106	-.719	-.517	-.354
TRAVEL TIME, RAIL				.51E+00	.41E-01	.12E+00	.28E+00			-.37E+00	.58E-01	.52E-01	.12E+00
	(1)			(-10.19)	(-1.69)	(-5.91)	(-4.31)			(-6.26)	(-2.97)	(-2.13)	(-4.10)
				L 1(GE)	L 1(GE)	L 3(GE)	L 3(GE)			L 1(GE)	L 1(GE)	L 3(GE)	L 3(GE)
RUN TIME, RAIL	RAI_RTHI	-1.487	-.877										
(INCOME>30,000$)		.42E+00	.71E-01										
	(1)	(-10.24)	(-5.32)										
		(GE)	L 2(GE)										
RUN TIME, RAIL	RAI_RTLI	-.140	.209										
(INCOME<30,000$)		.12E+00	-.13E-02										
	(1)	(-2.05)	(.12)										
		(GE)	L 2(GE)										
ACCESS TIME,	RAI_ATHI	-2.178	-1.789										
RAIL (INCOME>30,000$)		.12E+01	.33E+00										
	(1)	(-9.83)	(-8.02)										
		(GE)	L 2(GE)										
ACCESS TIME,	RAI_ATLI	-.492	-.584										
RAIL (INCOME<30,000$)		.81E+00	.18E+00										
	(1)	(-5.92)	(-3.79)										
		(GE)	L 2(GE)										
FREQUENCY, RAIL	RAI_FR	.437	.192	.345	1.077	.129	.192	.348	.235	.328	.509	.264	.391
		-.31E+01	-.72E+00	-.36E+01	-.31E+01	-.53E+00	-.15E+01	-	-	.39E+01	-.19E+01	-.11E+01	-.75E+01
	(1)	(13.44)	(12.89)	(12.02)	(10.76)	(11.67)	(11.88)	(14.51)	(12.92)	(12.14)	(9.85)	(12.78)	(14.05)
		(GE)	L 3(GE)	L 1(GE)	L 1(GE)	L 1(GE)	L 1(GE)	(GE)	L 2(GE)	L 1(GE)	L 1(GE)	L 1(GE)	L 5(GE)
RUN TIME, CAR	CAR_RT						1.452						1.108
							-.28E+00						-.46E+00
	(1)						(4.59)						(13.67)
							L 5(GE)						L 4(GE)

Table 3. (Continued) Results for business and non business models, Quebec-Windsor corridor, 1987

I. W.A. ELASTICITIES W.A. MRS: AIR_CTT (COND. T-STATISTIC)	VARIANT = VERSION = DEP.VAR. =	1 PMREF 70 MODE	2 PMREF 76 MODE	3 BENBUS1 8 MODE	4 BENBUS1 2 MODE	5 BENBUS1 18 MODE	6 BENBUS1 46 MODE	7 PMNBUS 15 MODE	8 PMNBUS 16 MODE	9 BENNBUS 43 MODE	10 BENNBUS 44 MODE	11 BENNBUS 48 MODE	12 BENNBUS 105 MODE
Socioeconomic variables													
BINARY VARIABLE FOR ORIGIN OR END OF TRAVEL IN BIG CITY	LARGEC1 (1)	1.421 -.36E+02 (7.45) (SP)	1.328 -.18E+02 (6.94) (SP)	1.589 -.58E+02 (8.95) (SP)	1.187 -.11E+02 (7.84) (SP)	1.507 -.22E+02 (8.63) (SP)	1.537 -.41E+02 (8.89) (SP)	1.344 - (17.69) (SP)	1.145 - (15.69) (SP)	1.401 .69E+02 (18.72) (SP)	1.274 -.17E+02 (17.50) (SP)	1.251 -.22E+02 (17.07) (SP)	1.137 -.78E+02 (16.46) (SP)
BINARY VARIABLE FOR GROUP TRAVELS	GROUP (1)							-.985 - (-16.70) (GE)	-1.061 - (-17.86) (GE)	-.991 -.50E+02 (-16.46) (GE)	-1.004 .14E+02 (-16.66) (GE)	-1.020 .18E+02 (-16.83) (GE)	-1.026 .70E+02 (-17.07) (GE)
YEARLY INCOME	INCOME (1)			-.809 .70E-03 (-2.61) (SP)	-.922 .20E-03 (-2.70) (SP)	-.709 .32E-03 (-2.99) L 2(SP)	-.752 .65E-03 (-3.00) L 2(SP)			-.454 -.53E-03 (-6.56) L 1(SP)	-.430 .33E-03 (-9.03) L 1(SP)	-.446 .27E-03 (-7.82) L 2(SP)	-.440 .12E-02 (-7.71) L 1(SP)
ASSOCIATED DUMMIES GROUP													
RUN TIME, RAIL (INCOME<30,000$)	RAI_RTLI1 (1)		.988 -.17E+02 (1.89) (GE)										
REGRESSION CONSTANT	CONSTANT (1)	- - (-5.83)	- - (-8.79)	- - (-10.17)	- - (-12.33)	- - (-1.03)	- - (-1.10)	- - (-13.38)	- - (-3.59)	- - (-22.39)	- - (3.78)	- - (-7.56)	- - (-12.94)
ALTERNATIVE 2 : AIR (AVION)													
NETWORK VARIABLES													
TOTAL COST, AIR (RUN AND ACCESS COST)	AIR_CTT (2)	-1.724 .10E+01 (-5.21) (GE)	-1.212 .10E+01 (-6.49) L 1(GE)	-1.221 .10E+01 (-3.66) L 1(GE)	-1.827 .10E+01 (-7.62) L 1(GE)	-1.126 .10E+01 (-7.23) L 4(GE)	-.325 .10E+01 (-2.85) L 4(GE)			1.415 .10E+01 (2.45) L 1(GE)	-1.177 .10E+01 (-5.18) L 1(GE)	-.571 .10E+01 (-4.96) L 4(GE)	-.204 .10E+01 (-2.38) L 2(GE)
GENERALIZED COST, AIR	AIR_GC (2)							-6.660 - (-18.85) (GE)	-6.366 - (-22.54) L 1(GE)				
TOTAL TRAVEL TIME, AIR	AIR_TTT (2)			-.753 .61E+00 (-10.19) L 1(GE)	-.362 .23E+00 (-1.69) L 1(GE)	-.270 .23E+00 (-5.91) L 3(GE)	-.520 .17E+01 (-4.31) L 3(GE)			-.800 -.32E+00 (-6.26) L 1(GE)	-.724 .37E+00 (-2.92) L 1(GE)	-.509 .55E+00 (-2.13) L 3(GE)	-.014 .43E-01 (-4.10) L 3(GE)

Table 3. (Continued) Results for business and non business models, Quebec-Windsor corridor, 1987

I. N.A. ELASTICITIES N.A. MRS: AIR_CTT (COND. T-STATISTIC)	VARIANT = VERSION = DEP.VAR. =	1 PMREF 70 MODE	2 PMREF 74 MODE	3 BENBUS1 8 MODE	4 BENBUS1 2 MODE	5 BENBUS1 18 MODE	6 BENBUS1 46 MODE	7 PMNBUS 15 MODE	8 PMNBUS 16 MODE	9 BENNBUS 43 MODE	10 BENNBUS 44 MODE	11 BENNBUS 48 MODE	12 BENNBUS 105 MODE
RUN TIME, AIR	AIR_RTH1	-.236	-.084										
(INCOME>30,000$)		.42E+00	.21E+00										
	(2)	(-10.24)	(-5.32)										
		(GE)	L 2(GE)										
RUN TIME, AIR	AIR_RTL11	-.007	.000										
(INCOME<30,000$)		.12E+00	-.48E-03										
	(2)	(-2.05)	(.12)										
		(GE)	L 2(GE)										
ACCESS TIME, AIR	AIR_ATH11	-1.202	-1.022										
(INCOME>30,000$)		.12E+01	.15E+01										
	(2)	(-9.83)	(-8.02)										
		(GE)	L 2(GE)										
ACCESS TIME, AIR	AIR_ATL11	-.093	-.124										
(INCOME<30,000$)		.81E+00	.11E+00										
	(2)	(-5.92)	(-3.79)										
		(GE)	L 2(GE)										
FREQUENCY, AIR	AIR_FR	.916	.904	.747	.471	.787	.801	2.050	2.184	1.921	.512	2.298	1.700
		-.31E+01	-.47E+01	-.36E+01	-.19E+01	-.44E+01	-.16E+02	-	-	.39E+01	-.14E+01	-.13E+02	-.26E+02
	(2)	(13.44)	(12.89)	(12.02)	(10.76)	(11.67)	(11.88)	(14.51)	(12.92)	(12.14)	(9.85)	(12.78)	(14.05)
		(GE)	L 3(GE)	L 1(GE)	L 1(GE)	L 1(GE)	L 1(GE)	(GE)	L 2(GE)	L 1(GE)	L 1(GE)	L 1(GE)	L 5(GE)
RUN TIME, CAR	CAR_RT						1.036						2.016
							-.70E+01						-.33E+01
	(2)						(4.59)						(13.67)
							L 5(GE)						L 4(GE)
Socioeconomic variables													
BINARY VARIABLE FOR ORIGIN OR END OF TRAVEL IN BIG CITY	LARGEC1	.149	.128	.272	.344	.300	.289	.368	.235	.603	.948	.505	.811
		-.11E+02	-.15E+02	-.29E+02	-.29E+02	-.27E+02	-.12E+03	-	-	.30E+02	-.53E+02	-.68E+02	-.29E+03
	(2)	(3.97)	(3.54)	(6.60)	(7.84)	(7.12)	(6.87)	(3.81)	(3.30)	(5.22)	(7.33)	(4.91)	(6.90)
		(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)
BINARY VARIABLE FOR GROUP TRAVELS	GROUP							-.953	-.949	-.965	-.992	-.980	-.934
								-	-	-.54E+02	.64E+02	.14E+03	.37E+03
	(2)							(-16.70)	(-17.86)	(-16.46)	(-16.66)	(-16.83)	(-17.07)
								(GE)	(GE)	(GE)	(GE)	(GE)	(GE)
YEARLY INCOME	INCOME			.543	.630	.441	.448			1.046	.607	.778	.762
				-.13E-02	-.12E-02	-.12E-02	-.46E-02			.16E-02	-.13E-02	-.35E-02	-.99E-02
	(2)			(4.99)	(5.22)	(5.00)	(5.05)			(4.09)	(2.53)	(3.18)	(2.83)
				(SP)	(SP)	L 2(SP)	L 2(SP)			L 1(SP)	L 1(SP)	L 2(SP)	L 1(SP)
ASSOCIATED DUMMIES GROUP													
RUN TIME, AIR	AIR_RTL11		.688										
(INCOME<30,000$)			-.48E+02										
	(2)		(1.89)										
			(GE)										
REGRESSION CONSTANT	CONSTANT	-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-
	(2)	(-.43)	(.58)	(-7.19)	(-5.47)	(-5.86)	(-7.50)	(-2.91)	(-.78)	(-14.19)	(-4.60)	(-9.80)	(-13.54)

Table 3. (Continued) Results for business and non business models, Quebec-Windsor corridor, 1987

I. W.A. ELASTICITIES W.A. MRS: BUS_CTT (COND. T-STATISTIC)		1	2	3	4	5	6	7	8	9	10	11	12
	VARIANT =	PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
	VERSION =	70	76	8	2	18	46	15	16	43	44	48	105
	DEP.VAR. =	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
ALTERNATIVE 3 : BUS (AUTOBUS)													
NETWORK VARIABLES													
TOTAL COST, BUS (RUN AND ACCESS COST)	BUS_CTT (3)	-.711 .10E+01 (-5.21) (GE)	-2.154 .10E+01 (-6.49) L 1(GE)	-.462 .10E+01 (-3.66) L 1(GE)	-3.671 .10E+01 (-7.62) L 1(GE)	-1.756 .10E+01 (-7.23) L 4(GE)	-1.382 .10E+01 (-2.85) L 4(GE)			.247 .10E+01 (2.45) L 1(GE)	-.959 .10E+01 (-5.18) L 1(GE)	-.793 .10E+01 (-4.96) L 4(GE)	-.257 .10E+01 (-2.58) L 2(GE)
GENERALIZED COST, BUS	BUS_GC (3)							-2.928 - (-18.85) (GE)	-3.932 - (-22.54) L 1(GE)				
TOTAL TRAVEL TIME, BUS	BUS_TTT (3)			-3.144 .61E+00 (-10.19) L 1(GE)	-.817 .19E-01 (-1.69) L 1(GE)	-1.719 .89E-01 (-5.91) L 3(GE)	-1.898 .12E+00 (-4.31) L 3(GE)			-.970 -.32E+00 (-6.26) L 1(GE)	-.590 .48E-01 (-2.92) L 1(GE)	-.417 .41E-01 (-2.13) L 3(GE)	-.192 .39E-01 (-4.10) L 3(GE)
RUN TIME, BUS (INCOME>30,000$)	BUS_RTHI1 (3)	-1.642 .42E+00 (-10.24) (GE)	-.914 .41E-01 (-5.32) L 2(GE)										
RUN TIME, BUS (INCOME<30,000$)	BUS_RTLI1 (3)	-.176 .12E+00 (-2.05) (GE)	.011 -.85E-02 (.12) L 2(GE)										
ACCESS TIME, BUS (INCOME>30,000$)	BUS_ATHI1 (3)	-2.247 .12E+01 (-9.83) (GE)	-1.847 .19E+00 (-8.02) L 2(GE)										
ACCESS TIME, BUS (INCOME<30,000$)	BUS_ATLI1 (3)	-.551 .81E+00 (-5.92) (GE)	-.651 .12E+00 (-3.79) L 2(GE)										
FREQUENCY, BUS	BUS_FR (3)	1.950 -.31E+01 (13.44) (GE)	1.635 -.84E+00 (12.89) L 3(GE)	1.371 -.36E+01 (12.02) L 1(GE)	1.063 -.36E+00 (10.76) L 1(GE)	1.140 -.81E+00 (11.47) L 1(GE)	1.288 -.12E+01 (11.88) L 1(GE)	.856 - (14.51) (GE)	.746 - (12.92) L 2(GE)	.713 .39E+01 (12.14) L 1(GE)	.417 -.73E+00 (9.85) L 1(GE)	.698 -.11E+01 (12.78) L 1(GE)	.727 -.40E+01 (14.05) L 5(GE)
RUN TIME, CAR	CAR_RT (3)						1.308 -.13E+00 (4.59) L 5(GE)						.732 -.29E+00 (13.67) L 4(GE)
Socioeconomic variables													
BINARY VARIABLE FOR ORIGIN OR END OF TRAVEL IN BIG CITY	LARGEC1 ------- (3)	1.221 -.31E+02 (4.02) (SP)	1.139 -.89E+01 (3.84) (SP)	1.497 -.57E+02 (5.23) (SP)	1.253 -.57E+01 (4.93) (SP)	1.460 -.14E+02 (5.16) (SP)	1.468 -.19E+02 (5.11) (SP)	1.079 - (18.23) (SP)	.953 - (17.33) (SP)	1.105 .70E+02 (19.19) (SP)	.902 -.14E+02 (16.91) (SP)	.955 -.18E+02 (17.49) (SP)	.936 -.57E+02 (17.41) (SP)

Table 3. (Continued) Results for business and non business models, Quebec-Windsor corridor, 1987

1. N.A. ELASTICITIES N.A. MRS: BUS_CTT (COND. T-STATISTIC)	VARIANT = VERSION = DEP.VAR. =	1 PNREF 70 MODE	2 PNREF 76 MODE	3 BENBUS1 8 MODE	4 BENBUS1 2 MODE	5 BENBUS1 18 MODE	6 BENBUS1 46 MODE	7 PNNBUS 15 MODE	8 PNNBUS 16 MODE	9 BENNBUS 43 MODE	10 BENNBUS 44 MODE	11 BENNBUS 48 MODE	12 BENNBUS 105 MODE
BINARY VARIABLE FOR GROUP TRAVELS	GROUP ----- (3)							-.949 - (-16.72) (GE)	-1.023 - (-17.86) (GE)	-.917 -.57E+02 (-16.46) (GE)	-.913 .14E+02 (-16.66) (GE)	-.928 .17E+02 (-16.83) (GE)	-.950 .57E+02 (-17.07) (GE)
YEARLY INCOME	INCOME (3)			-1.931 .28E-02 (-5.80) (SP)	-1.956 .35E-03 (-5.78) (SP)	-1.655 .17E-02 (-6.89) L 2(SP)	-1.677 .21E-02 (-6.93) L 2(SP)			-1.022 -.30E-02 (-19.45) L 1(SP)	-.858 .17E-02 (-22.18) L 1(SP)	-.935 .14E-02 (-21.15) L 2(SP)	-.923 .45E-02 (-21.02) L 1(SP)
ASSOCIATED DUMMIES GROUP													
RUN TIME, BUS (INCOME<30,000$)	BUS_RTLI1 --------- (3)		1.043 -.10E+02 (1.89) (GE)										
REGRESSION CONSTANT	CONSTANT (3)	- - (-9.38)	- - (-12.51)	- - (-7.01)	- - (-10.66)	- - (1.47)	- - (1.46)	- - (-10.97)	- - (-.66)	- - (-12.20)	- - (15.75)	- - (2.30)	- - (-5.21)
ALTERNATIVE 4 : CAR (AUTOMOBILE)													
NETWORK VARIABLES													
GENERALIZED COST, CAR	CAR_GC (4)							-.115 - (-18.85) (GE)	-.205 - (-22.54) L 1(GE)				
COST, CAR (RUN COST)	CAR_C (4)	-.128 .10E+01 (-5.21) (GE)	-.179 .10E+01 (-6.49) L 1(GE)	-.091 .10E+01 (-3.66) L 1(GE)	-.260 .10E+01 (-7.62) L 1(GE)	-.161 .10E+01 (-7.23) L 4(GE)	-.077 .10E+01 (-2.85) L 4(GE)			.015 .10E+01 (2.45) L 1(GE)	-.082 .10E+01 (-5.18) L 1(GE)	-.075 .10E+01 (-4.96) L 4(GE)	-.023 .10E+01 (-2.58) L 2(GE)
RUN TIME, CAR	CAR_RT (4)			-.201 .61E+00 (-10.19) L 1(GE)	-.060 .60E-01 (-1.69) L 1(GE)	-.109 .11E+00 (-5.91) L 3(GE)	-.177 .36E+00 (-4.31) L 3(GE)			-.057 -.32E+00 (-6.26) L 1(GE)	-.050 .51E-01 (-2.92) L 1(GE)	-.038 .39E-01 (-2.13) L 3(GE)	-.088 .16E+00 (-4.10) L 3(GE)
RUN TIME, CAR (INCOME>30,000$)	CAR_RTHI (4)	-.167 .42E+00 (-10.24) (GE)	-.102 .10E+00 (-5.32) L 2(GE)										
RUN TIME, CAR (INCOME<30,000$)	CAR_RTLI (4)	-.008 .12E+00 (-2.05) (GE)	.001 -.69E-03 (.12) L 2(GE)										

Table 3. (Continued) Results for business and non business models, Quebec-Windsor corridor, 1987

II. PARAMETERS		1	2	3	4	5	6	7	8	9	10	11	12
UNCOND.(T-STATISTIC=0)	VARIANT =	PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
UNCOND.(T-STATISTIC=1)	VERSION =	70	76	8	2	18	46	15	16	43	44	48	105
	DEP.VAR. =	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
BOX-COX TRANSFORMATIONS													
LAMBDA(X) - GROUP 1	LAM 1		.269	1.000	.000	1.531	1.340		.616	1.000	.000	1.180	.419
			(1.52)	FIXED	FIXED	(3.52)	(3.14)		(26.91)	FIXED	FIXED	(6.91)	(3.92)
			(-4.14)			(1.22)	(.80)		(-16.77)			(1.05)	(-5.43)
LAMBDA(X) - GROUP 2	LAM 2		1.353			.142	.185		1.225			.418	-.224
			(5.22)			(.51)	(.58)		(7.66)			(3.94)	(-.98)
			(1.34)			(-2.63)	(-2.56)		(1.40)			(-5.49)	(-5.15)
LAMBDA(X) - GROUP 3	LAM 3		1.411			1.802	.612					-.122	4.961
			(3.95)			(2.83)	(1.66)					(-.56)	(5.58)
			(1.15)			(1.26)	(-1.05)					(-5.16)	(4.46)
LAMBDA(X) - GROUP 4	LAM 4					.281	-.220					-.294	1.595
						(1.28)	(-.38)					(-2.91)	(6.83)
						(-3.28)	(-2.13)					(-12.80)	(2.55)
LAMBDA(X) - GROUP 5	LAM 5						4.943						.797
							(4.08)						(5.74)
							(3.26)						(-1.46)

III.GENERAL STATISTICS		1	2	3	4	5	6	7	8	9	10	11	12
	VARIANT =	PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
	VERSION =	70	76	8	2	18	46	15	16	43	44	48	105
	DEP.VAR. =	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
LOG-LIKELIHOOD	-FINAL VALUE	-1061.30	-1044.90	-1060.85	-1095.74	-1058.38	-1049.88	-4008.85	-3912.29	-3934.89	-3874.47	-3835.19	-3753.66
	-INITIAL VALUE	-1923.80	-1045.53	-1923.80	-1923.80	-1064.49	-1056.38	-4932.74	-4011.29	-4932.74	-4932.74	-3867.15	-3756.11
	-WITH CONSTANTS ONLY	-1923.80	-1923.80	-1923.80	-1923.80	-1923.80	-1923.80	-4932.74	-4932.74	-4932.74	-4932.74	-4932.74	-4932.74
	-RATIO TEST	1724.996	1757.004	1709.902	1656.132	1730.840	1747.853	1847.703	2040.917	1995.703	2116.552	2195.110	2358.175
RHO-SQUARED		.448	.457	.444	.430	.450	.454	.187	.207	.202	.215	.223	.239
RHO-SQUARED BAR	-AKAIKE	.442	.449	.438	.424	.442	.445	.185	.205	.200	.212	.219	.235
	-HOROWITZ	.445	.453	.441	.427	.446	.450	.186	.206	.201	.213	.221	.237
	-BENSSEN AND JOHNSON	.448	.456	.444	.430	.449	.453	.187	.206	.202	.214	.222	.238
PER CENT RIGHT		74.786	75.527	75.203	74.253	76.014	76.037	55.602	55.724	55.773	55.968	55.846	56.775
SAMPLE	-NUMBER OF ALTERNATIVES	4	4	4	4	4	4	4	4	4	4	4	4
	-NUMBER OF OBSERVATIONS	4402	4402	4402	4402	4402	4402	8536	8536	8536	8536	8536	8536
	-FIRST OBSERVATION	1	1	1	1	1	1	4403	4403	4403	4403	4403	4403
	-LAST OBSERVATION	4402	4402	4402	4402	4402	4402	12938	12938	12938	12938	12938	12938
	-AVAILABLE OBSERVATIONS	4315	4315	4315	4315	4315	4315	8185	8185	8185	8185	8185	8185
	1 RAIL	4291	4291	4291	4291	4291	4291	8229	8229	8229	8229	8229	8229
	2 AIR	3624	3624	3624	3624	3624	3624	5902	5902	5902	5902	5902	5902
	3 BUS	3264	3264	3264	3264	3264	3264	5668	5668	5668	5668	5668	5668
	4 CAR	4390	4390	4390	4390	4390	4390	8452	8452	8452	8452	8452	8452
NUMBER OF ESTIMATED PARAMETERS													
-BETAS	.VARIABLES	9	9	9	9	9	10	6	6	10	10	10	11
	.CONSTANTS	3	3	3	3	3	3	3	3	3	3	3	3
	.ASSOCIATED DUMMIES	0	1	0	0	0	0	0	0	0	0	0	0
-BOX-COX TRANSFORMATIONS		0	3	0	0	4	5	0	2	0	0	4	5

3.3 Results

The results of the different specifications are shown in the **Tablex** table generated by TRIO and listed as Table 3 where the first six Columns pertain to business trips and the last six Columns correspond to non business trip model specifications. The table consists of three parts. In part I, one finds elasticities, marginal rate of substitution (VOT) and t-statistics computed conditionally upon the value of the BCT. The second part pertains to BCT and the third to general statistics. The reader interested in further details may consult the Appendix where are also listed regression coefficients and own and cross changes in probability points. This last statistic makes it possible to read the change in the number of probability points associated with a doubling in the explanatory variable: many researchers prefer it to the elasticity because, in a logit model, the dependent variable is already a percentage. The last item of information included in Part I of both Table 3 and the Appendix is a reminder, under each variable, of whether the regression coefficient was constrained to be generic (GE) or allowed to be specific (SP), and of the identity index of the BCT applied to the variable. As the modeling effort was carried out with High Speed Rail forecasts in mind, we shall concentrate our comments on results for the Rail mode.

The fragile Peat-Marwick model (Columns 1–2 and 7–8)

The first two Columns displaying the Peat-Marwick model for the business purpose, show that the introduction of Box-Cox transformations increases the log likelihood function significantly. Weighted aggregate elasticities have also been modified. Column 1 revealed that cost and time elasticities are somewhat equivalent for the high income category while Column 2 seems to reverse this conclusion in the way that the cost elasticity is more than twice the time elasticity for high income. The results concerning the low income category are also different following the introduction of BCT. The elasticity of time for linear model is coherent with a priori expectations (i.e. negative significant sign and lower than high income category) and lower than the cost cost elasticity but this running time elasticity for low income category becomes positive when BCT are used (i.e. .009 for Rail mode). Fortunately, it is non significant. However, this is a disappointing result because, even if an individual has a low income, for the business trip purpose time is not a negligeable input in the decision to travel.

The non business model presented by Peat-Marwick is not of a great interest (Columns 7 and 8) because all cost and time were aggregated in a generalized cost variable. The sign of the generalized cost is negative as expected and nonlinearity was strong because the Box-Cox parameter of the generalized cost was 0.616. However, with this specification, we cannot observe the revealed trade-off between cost and time. Furthermore, we used the business model specification on non business data (results are not shown) and were unable to find simultaneously negative signs for the cost and time variables. This problem caused us to reformulate the Peat-Marwick model which is clearly too fragile if simple BCT increases the fit but yield incorrect signs.

A modified model in linear and logarithmic form (Columns 3–4 and 9–10)

As shown in the Table 3 (Columns 3 and 4), results are quite heterogeneous with respect to the functional form specified for the variables. When someone uses a linear or logarithmic specification for the business purpose, time and cost elasticities of the Rail choice probability are of opposed magnitude. In fact, in linear model of Column 3 the time elasticity is larger than the cost elasticity while the opposite appears in the logarithmic specification of Column 4 (-3.002 vs. -907; -.828 vs -2.171). The frequency elasticity is almost twice as large in the log model than in the linear one. However, the optimal log-likelihood values allows us to reject the log model for business purpose (-1068.85 vs. -1095.74).

The non business model produces quite different results. Column 9 shows that cost elasticity has a non anticipated positive sign. But when a logarithmic utility function is specified (Column 10) all signs are coherent with a priori expectations. The time elasticity is smaller than the cost elasticity (-.719 vs. -1.168) for the Rail mode. Furthermore, the log-likelihood values reveal that linear form has to be strongly rejected because its value is about 60 points lower than for the log form (-3934.8 vs. -3874.4). It is clear from these results that functional form has a great impact on the model results.

More reasonable results with Box-Cox transformations (Columns 5 and 11)

When λ-coefficients are not constrained to be either linear or logarithmic, this produces huge increases of the log-likelihood. For the model presented in Column 11, the log-likelihood function increased by 39 points in comparison to the model presented in Column 10. The growth is smaller for the business purpose, with only 10 points between Column 3 and Column 5. However, The λ-coefficients are all different from 1 except for the transformation applied to frequency. For the business model of Column 5, nonlinear transformations show that linearity of the variables is a strong assumption because none of the parameters are equal to one. The value of the Box-Cox transformation was 0.281 for the cost and 1.802 for the door-to-door time. For the non business model presented in Column 11, the relations between of cost or time variables and the probability of choice in the non business model are highly nonlinear (-.294 and -.122 respectively). Such differences in BCT are not surprising. Linearity means that changes in fares or service have the same impact on the utility of modes irrespective of total trip cost or time. It is reasonable to find in the sample range that, for some variables, marginal changes have diminishing marginal impact (the BCT is smaller than 1) while, for other variables, the marginal impact increases with the level of the variable (the BCT is larger than 1). Clearly, an unprobed linear form is not likely in any data set.

Further comparison of the two business models revealed that the VOT varied substantively with the number of constraints on the nonlinear transformation. In the linear business model (Column 3), the VOT for the Rail mode, after reexpressing the \$/minute values shown in the Table 3 as \$/hour was 36.60 dollars per hour while the VOT in Column 5 was only 7.20 dollars per hour. For the non business models, the Box-Cox transformation marginally lowered the VOT comparing to Column 10 to Column 11 (3.48 vs. 3.12). Furthermore, VOT for the business model of Column 5 is more than twice as large as the VOT of the non business purpose of Column 11.

In conclusion, the use of Box-Cox transformations proved to be efficient for three main reasons. Firstly, while non credible coefficients are obtained from a linear specification, credibility can be retestablished by applying nonlinear transformations on the variables of the model: this happened for the non business model with the positive cost coefficient. Secondly, elasticities vary greatly between linear and nonlinear cases, indicating that linearity assumptions can lead to incorrect conclusions. Thirdly, nonlinear transformations allow the S-shaped curve of the logit to be asymmetric with respect to a given network variable: all the models showed asymmetry with respect to the time and cost variables. These results are in keeping with those found recently in the same Quebec-Windsor Corridor with stated preference data: Deepack and Laferrière (1994) showed with a nested logit that linear results were clearly inferior to Box-Cox results and that the latter implied very different revenue forecasts for a High Speed Rail train.

Generalized Box-Cox logit results (Columns 6 and 12)

The usual linear logit model does not allow the introduction of other modal attributes into own utility functions. However, the use of Box-Cox transformations makes it possible to remove this constraint and simultaneously obviate the IIA property of the simple of Box-Cox logit forms: we therefore introduced car running time in all public alternatives. Before analyzing results, we must specify that because all individuals did not have full choice sets, only car attributes could be introduced into all other alternatives. This limited the extend to which we could extend the standard Box-Cox logit model. However, results improved significantly. Running time by car has been introduced by two different ways. First, it has been constrained to be generic across the alternatives. The assumption derived from this specification is that running time by car has the same impact of all public mode. Second, this assumption was removed allowing different β-coefficients signifying possible heterogeneous impacts of the variable on the utility functions. Selected elasticities for the generic case are presented in the Table 3.

Columns 6 and 12 show that relaxing the usual assumption of independence of irrelevant alternatives increased significantly all log-likelihood functions. For business and non business purposes, the function increased by 8.5 and 81.5 respectively only by adding one single $\beta-$parameter and an extra λ-coefficient. However, the values of the nonlinear transformations varied a fair amount when compared to those obtained under the less general forms of Columns 5 and 11 just discussed.

The biggest impact was on the cost variable. In the model of Column 5, its elasticity value was -2.171 but in the model of Column 6, it is reduced to -1.382 for the Rail mode. The time elasticity increased from -1.662 to -1.938 for the Rail mode. Furthermore, a time elasticity larger than a cost elasticity seems more credible. In fact, business trips are often paid by companies and cost is not the most important factor when making a mode choice. In the non business model shown in Column 12, time and cost elasticities indicate reductions in their values (-.354 and -.301 respectively).

The analysis of the value of time (VOT) reveals, for the business model of Column 6, a value of 0.28 dollar per minute or 16.80 dollars per hour. Comparing to Column 5, the VOT of this last model more than twice as large (16.80 vs. 7.20). In contrast, the non business model VOT is 7.46 dollars per hour, which is roughly half as large as the business value of time. The same result can be found in the non business model when the VOT shown in Column 12 is compared to the value found in Column 11 (7.46 $/h vs. 3.12 $/h).

For both models, the positive coefficient of the car running time indicate that car is a substitute modes to all public modes. In fact when run time by car increases, the probability of choosing either rail, plane or bus increases. As shown in the Appendix, if run time by car increases by one percent, the rail probability will increase by 1.452 percent and by 1.108 percent for the business and non business models respectively.

A second specification (not shown in the Table) has not been successful for both purposes: all log-likelihood functions increased significantly when we removed the constraint of generic coefficients for the running time by car variable. However, own coefficient signs of time and cost were inverted from negative to positive, which is not intuitively acceptable. This is frequent in mode choice models when the coefficients of network variables are allowed to be specific.

Frequently, analysts use a nested logit hierarchy, instead of the MNL, to account for specific patterns of correlation among the unobserved error terms associated with each alternative. As such correlations in systems of demand equations are frequently due to mispecification, and in particular to the absence of explanatory variables, it is not surprising to find that, by introducing such variables, the Generalized Box-Cox logit model yields very high increases in the quality of adjustment. In effect, the introduction of these variables make a logit system resemble a classical system of demand equations. Additive separability of utility is not a credible assumption to explain the demand for moderately close substitutes, such as transport modes. The Generalized Box-Cox logit should therefore be a strong and flexible competitor for the nested logit model.

4. Some policy implications

It is clear from the results obtained that the assumption of linearity in the variables is a strong one. In fact, how can we seriously believe that the impact of each modal attribute on the utility is a linear one? If a government takes a decision based on linear results, this decision is likely to be misguided unless the form has been shown to be correct. Our application to transportation analysis is certainly indicative of what could happen in other fields where linear logit models are used.

We saw in particular that linear forms tend to give bigger time elasticities than the ones given by a nonlinear formulation. The inverse conclusion is also true for the cost elasticities. The conclusions have further implications: if decisions were to be based on linear results, overestimation of Rail modal share would be experienced and the recovery of the initial investment could be delayed.

Moreover, the results given by the Generalized Box-Cox logit indicate that this generalization should be more often used. Usually, the specification is not considered because one has to associate a nonlinear transformation to a given variable. This model developed seems to have great advantages upon linear logit model because the independence of irrelevant alternatives assumption no longer holds. In the light of the results, we can conclude that the car mode is a substitute to public transportation (i.e: Rail, Air and Bus) and should be considered in all representative utility functions. These are not linear and they are not additive.

5. Conclusion

The first concern of this paper was to demonstrate the usefulness of nonlinear transformations applied to mode attributes in determining the decision process of individuals. Most of the published literature uses the well-known logit model as we did. However the linear specification of the relevant attributes can give disappointing results. In fact, the usual use of a unique variable of level of service (Peat-Marwick 1990) can be the result of a wrong assumption about the functional form of the attributes. We showed that a fragile logit model can be strengthened in the sense that all coefficients can be estimated and obtain signs that are in conformity with a priori expectations. In our experiments, this has been done in the non business model where linear specifications of the variables led to a wrong sign for the total time variable. The application of Box-Cox transformation removed the sign inversion. Furthermore, the cost and time elasticities were consistent with the fact that time elasticities for the business purpose were larger than the ones associated with the non business purpose. The calculated values of time were also more in keeping with the relevant literature. However, an interesting point was that the values decreased when all the models became less constrained.

The use of a generalized Box-Cox logit model allowed to make the business model more credible because the time elasticity became larger than the cost elasticity when total travel time by car was introduced in all the public transport utilities. This last specification in effect brings logit models back into the fold of microeconomic demand analysis where additive separability of utility is seen as a particulary restrictive assumption that we easily reject in this analysis.

6. References

1. **Abdelwahab, W.M.,** (1990) : "Transferability of Intercity Desaggregate Mode Choice Models in Canada", Canadian Journal of Civil Engineering, Vol.18, p. 20–26.
2. **Anscombe, F.J. et Tuckey, J.W.** (1954) : "The Criticism of Transformations", Paper presented before the American Statistical Association and Biometric Society, Montréal.
3. **Aptech Systems, inc.** (1992): The Gauss System Version 3.0, Maple Valley, WA.

4. **Ben-Akiva, Moshe** (1981) : "Issues in Transferring and Updating Travel-Behavior Models.", in New Horizons in Travel Behavior Research. P.Stopher et al.., eds. Lexington Books, Lexington.

5. **Ben-Akiva, M. et Lerman, S.R.** (1985) : Discrete Choice Analysis: Theory and Application to Travel Demand, The MIT press, Cambridge, Mass.

6. **Berndt, E.K., Hall, B.H., Hall, R.E. et Hausman, J.A,** (1974) : "Estimation and Inference in Nonlinear Structural Models.", Annals of Economic and Social Measurement, p. 653–65.

7. **Box, G.P et Cox, D.R** (1964): "An Analysis of Transformations", Journal of the Royal Statistical Society, Series B, 26, p. 211–243.

8. **Cohen, G.S., Erlbaum, N.S. et Hartgen, D.T.** (1978) : "Intercity Rail Travel Models", Transportation Research Record, #673, p. 41–58.

9. **Commission Canadienne des Transports** (1970) : "Intercity Passenger Transport Study", Ottawa: Research branch, Canadian Transport Commission, September, p.48.

10. **Deepack, E. and Laferrière, R.** (1994), "Demand Model Developments to Assess High Speed Passenger Train Markets on Windsor to Quebec city Corridor", CP Rail System, 1994.

11. **Domencich, T. and McFadden, D.** (1975) : Urban Travel Demand: A Behavioral Analysis, Noth-Holland, Amsterdam.

12. **Fletcher, R. and Powell, M.J.D.** (1963), "A Rapidly Convergent Descent Method for Minimization", Computer Journal, 6, 163-168.

13. **Gaudry, M.J.I.** (1978) : "A Generalized LOGIT Mode Choice Model.", publication CRT #98, Centre de Recherche sur les Transports, Université de Montréal, p.20.

14. **Gaudry M.J.I. and Wills, M.J.** (1978): "Estimating the Functional Forms of Travel Demand Models.", Transportation Research B, Vol 12, p. 257–289.

15. **Gaudry, M.J.I.** (1981): "The Inverse Power Transformation Logit and Dogit Mode Choice Models", Transportation Research B, 13, 2, p.105–112.

16. **Gaudry, M.J.I.** (1985) : "Modèles de Demande Agrégés et Désagrégés à Forme Variable: Résultats sur Montréal et Paris", Transports, 304, p. 288–293.

17. **Gaudry M.J.I., Jara-Diaz, S.R. and Ortuzar, J. de D.** (1989): Value of Time Sensitivity to Model Specification", Transportation Research B, 23, 2, p. 151–158.

18. **Gaudry, M.J.I.** (1993) : "Asymetric Shape and Variable Tail Tickness in Multinomial Probabilistic Response: Three Model Type Families in a Quasi-Direct Format Application to Intercity Travel Demand with Aggregate Canadian Data", publication CRT #893, Centre de Recherche sur les Transports, Université de Montréal, p.22.

19. **Gaudry, M., Dagenais, M., Laferrière, R. and Liem, T.C** (1993): "TRIO Model Types, Version 1.0", publication CRT #904, Centre de Recherche sur les Transports, Université de Montréal, April.

20. **Grayson, A.** (1981) : "Disaggregate model of Mode Choice in Intercity Travel", Transportation Research Record, #835, p. 36–42.

21. **Hensher, D.A. and Johnson, L.W.** (1981): Applied Discrete-Choice Modelling, Croom Helm, London.

22. **Hensher, D.A. and Johnson, L.W.** (1981): "Behavioral Response and Form of the Representative Component of the indirect Utility Function in Travel Mode Choice", Regional Science and Urban Economics, 11, p. 559–572.

23. **Kanafani, A.** (1983) : "Transportation Demand Analysis", Series in Transportation, McGraw-Hill eds., New York.

24. **Koppelman, F.** (1980) : "Nonlinear Utility Functions in Models of Travel Choice Behavior", The Transportation Center , Northwestern University, mimeo, May.

25. **Mandel, B., Gaudry, M.J.I. et Rothengatter, W.** (1994) :"Linear or Nonlinear Utitlity Functions in Logit Models? The impact on German High Speed Rail Demand Forecasts.", Transportation Research B, 28, 2, p. 91–101.

26. **Manski, C.F. and Lerman, S.R.** (1977), "The Estimation of Choice Probabilities from Choice-Based Samples", Econometrica, 45, 1977-1988.

27. **McFadden, D.** (1975): "On independence, Structure and Simultaneity in Transportation Demand Analysis", Working Paper 7511, Urban Travel Demand Forcasting Project, Institute of Transportation Studies, University of California, Berkeley.

28. **Peat-Marwick** (1990): "Analysis of the Market Demand for High Speed Rail in the Québec/Ontario Corridor", Final report presented to the Québec/Windsor Corridor High Speed Rail Task Force, KPMG.

29. **Rea, J.C., Wills, M.J. et Platts, J.B.** (1977) : "CANPASS: A Strategic Planning Capability for Intercity Passenger Transportation", Strategic Planning Group, Transport Canada, p.29.

30. **Rea, J.C., Wills, M.J. et Platts, J.B.** (1978) : " Intercity Passenger Transportation in Canada", Economic and Regional Analysis Directorate, Strategic Planning Group, Transport Canada, p.20.

31. **Spitzer, J.J.** (1978) : "A Monte Carlo investigation of the Box-Cox Transformation in Small Samples", Journal of the American Statistical Association, 73, p. 488–495.

32. **Swait J**, (1984) : "A model system of individual travel behavior for a Brazilian city", in Transportation Decision Making 2, p. 451–480.

33. **Tukey, J.W.** (1957) : "On the Comparative Anatomy of Transformation", Annals of Mathematical Statistics, 28 p. 602–632.

34. **Wilson, F.R., Damodaran, S. et Innes, J.D.** (1990) : "Disaggregate Mode Choice Models for Intercity Passenger Travel in Canada",Canadian Journal of Civil Engineering, Vol 17, p. 184–91.

35. **Zarembka, P.C.** (1974) ; "Transformation of Variables in Econometrics", in Frontiers in Econometrics, Academic Press, New York, p. 81–104.

7. Appendix. Additional results for business and non business models, Quebec-Windsor corridor, 1987

Additional results for business and non business models, Quebec-Windsor corridor, 1987

I. BETA W.A. ELASTICITIES W.A. MRS: RAI_CTT (COND. T-STATISTIC) W.A. CHANGE IN P(I)	VARIANT = VERSION = DEP.VAR. =		1 PHREF 70 MODE	2 PHREF 76 MODE	3 BENBUS1 8 MODE	4 BENBUS1 2 MODE	5 BENBUS1 18 MODE	6 BENBUS1 46 MODE	7 PHNBUS 15 MODE	8 PHNBUS 16 MODE	9 BENNBUS 43 MODE	10 BENNBUS 44 MODE	11 BENNBUS 48 MODE	12 BENNBUS 105 MODE
ALTERNATIVE 1 : RAIL (RAIL)														
NETWORK VARIABLES														
TOTAL COST, RAIL	RAI_CTT		-.33E-01	-.97E+00	-.22E-01	-.40E+01	-.81E+00	-.30E+01			.17E-01	-.13E+01	-.25E+01	-.48E-[illegible]
(RUN AND ACCESS COST)			-1.314	-2.402	-.907	-3.721	-2.171	-1.215			.341	-1.168	-.939	-.321
	(1)		.10E+01	.10E+01	.10E+01	.10E+01	.10E+01	.10E+01			.10E+01	.10E+01	.10E+01	.10E+01
			(-5.21)	(-6.49)	(-3.66)	(-7.62)	(-7.23)	(-2.85)			(2.45)	(-5.18)	(-4.96)	(-2.58)
		1	-.085	-.161	-.056	-.285	-.139	-.076			.024	-.084	-.062	-.232
		2	.037	.052	.025	.106	.041	.023			-.009	.010	.010	.026
		3	.004	.007	.011	.049	.029	.014			-.007	.030	.022	.027
		4	.023	.046	.016	.060	.040	.023			-.007	.024	.020	.026
			(GE) L	1(GE) L	1(GE) L	1(GE) L	4(GE) L	4(GE)			L 1(GE)	L 1(GE)	L 4(GE)	L 2(GE)
GENERALISED COST, RAIL	RAI_GC								-.48E-01	-.33E+00				
									-3.387	-4.528				
	(1)								-	-				
									(-18.05)	(-22.54)				
		1							-.228	-.344				
		2							.054	.117				
		3							.038	.084				
		4							.070	.092				
									(GE) L	1(GE)				
TOTAL TRAVEL TIME, RAIL	RAI_TTT				-.14E-01	-.90E+00	-.82E-04	-.71E-01			-.53E-02	-.78E+00	-.11E+01	-.74E-13
					-3.002	-.828	-1.462	-1.938			-1.106	-.719	-.317	-.354
	(1)				.61E+00	.41E-01	.12E+00	.28E+00			-.32E+00	.58E-01	.32E-01	.12E+00
					(-10.19)	(-1.69)	(-3.91)	(-4.31)			(-6.26)	(-2.97)	(-2.13)	(-4.30)
		1			-.183	-.064	-.186	-.124			-.075	-.052	-.035	-.053
		2			.085	.024	.057	.055			.022	.086	.007	.025
		3			.039	.011	.027	.024			.023	.018	.012	.007
		4			.051	.013	.026	.033			.023	.015	.011	.006
					L 1(GE)	L 1(GE)	L 3(GE)	L 3(GE)			L 1(GE)	L 1(GE)	L 3(GE)	L 3(GE)
RUN TIME, RAIL	RAI_RTH1		-.14E-01	-.12E-02										
(INCOME>30,000$)			-1.487	-.877										
	(1)		.42E+00	.71E-01										
			(-10.24)	(-5.32)										
		1	-.079	-.044										
		2	.058	.029										
		3	.003	.001										
		4	.024	.013										
			(GE) L	2(GE)										

(Continued) Additional results for business and non business models, Quebec-Windsor corridor, 1987

I. BETA N.A. ELASTICITIES N.A. MRS: RAI_CTT (COND. T-STATISTIC) N.A. CHANGE IN P(I)			1	2	3	4	5	6	7	8	9	10	11	12
	VARIANT =		PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
	VERSION =		70	76	8	2	18	46	15	16	43	44	48	105
	DEP.VAR. =		MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
RUN TIME, RAIL (INCOME<30,000$)	RAI_RTL11		-.38E-02	.36E-04										
			-.140	.009										
	(1)		.12E+00	-.13E-02										
			(-2.05)	(.12)										
		1	-.014	.001										
		2	.002	-.000										
		3	.001	-.000										
		4	.002	-.000										
			(GE) L	2(GE)										
ACCESS TIME, RAIL (INCOME>30,000$)	RAI_ATH11		-.40E-01	-.70E-02										
			-2.178	-1.789										
	(1)		.12E+01	.33E+00										
			(-9.83)	(-8.02)										
		1	-.117	-.096										
		2	.049	.040										
		3	.004	.004										
		4	.041	.034										
			(GE) L	2(GE)										
ACCESS TIME, RAIL (INCOME<30,000$)	RAI_ATL11		-.26E-01	-.70E-02										
			-.492	-.584										
	(1)		.81E+00	.18E+00										
			(-5.92)	(-3.79)										
		1	-.041	-.051										
		2	.004	.006										
		3	.003	.003										
		4	.010	.011										
			(GE) L	2(GE)										
FREQUENCY, RAIL	RAI_FR		.10E+00	.26E-01	.80E-01	.12E+01	.14E-01	.28E-01	.73E-01	.34E-01	.66E-01	.55E+00	.40E-01	.12E+00
			.437	.192	.345	1.077	.129	.192	.348	.235	.328	.509	.264	.391
	(1)		-.31E+01	-.72E+00	-.36E+01	-.31E+01	-.52E+00	-.15E+01	-	-	.39E+01	-.19E+01	-.11E+01	-.75E+01
			(13.44)	(12.89)	(12.02)	(10.76)	(11.67)	(11.88)	(14.51)	(12.92)	(12.14)	(9.85)	(12.78)	(14.05)
		1	.030	.013	.022	.083	.008	.012	.025	.018	.071	.036	.018	.029
		2	-.007	-.003	-.006	-.031	-.002	-.003	-.003	-.003	-.003	-.005	-.003	-.008
		3	-.001	-.001	-.003	-.014	-.001	-.002	-.006	-.004	-.006	-.013	-.006	-.009
		4	-.009	-.004	-.007	-.017	-.003	-.004	-.007	-.005	-.007	-.010	-.006	-.008
			(GE) L	3(GE) L	1(GE) L	1(GE) L	1(GE) L	1(GE)	(GE) L	2(GE) L	1(GE) L	1(GE) L	1(GE) L	5(GE)
RUN TIME, CAR	CAR_RT							.50E-12						.28E-03
								1.452						1.108
	(1)							-.28E+00						-.46E+00
								(4.59)						(13.67)
		1						.098						.119
		2						.530						.294
		3						.135						.154
		4						-.095						-.043
								L 5(GE)						L 4(GE)

(Continued) Additional results for business and non business models, Quebec-Windsor corridor, 1987

I. BETA / W.A. ELASTICITIES / W.A. MRS: RAI_CTT / (COND. T-STATISTIC) / W.A. CHANGE IN P(I)			1	2	3	4	5	6	7	8	9	10	11	12
	VARIANT =		PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
	VERSION =		70	76	8	2	18	46	15	16	43	44	48	105
	DEP.VAR. =		MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
Socioeconomic variables														
BINARY VARIABLE FOR ORIGIN OR END OF TRAVEL IN BIG CITY	LARGECI ------- (1)		.13E+01	.12E+01	.15E+01	.13E+01	.15E+01	.15E+01	.14E+01	.12E+01	.15E+01	.14E+01	.13E+01	.13E+01
			1.471	1.328	1.589	1.187	1.507	1.537	1.344	1.145	1.401	1.274	1.251	1.137
			-.36E+02	-.18E+02	-.58E+02	-.11E+02	-.22E+02	-.41E+02	-	-	.69E+02	-.17E+02	-.22E+02	-.78E+02
			(7.45)	(6.94)	(8.95)	(7.84)	(8.63)	(8.89)	(17.69)	(15.69)	(18.72)	(17.50)	(17.07)	(16.46)
		1	.114	.105	.125	.105	.120	.121	.118	.107	.116	.115	.109	.108
		2	.063	.053	.121	.150	.134	.125	.051	.037	.077	.076	.063	.101
		3	.046	.041	.119	.107	.105	.107	.196	.188	.239	.187	.206	.204
		4	-.084	-.078	-.104	-.089	-.105	-.105	-.151	-.128	-.163	-.138	-.137	-.132
			(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)
BINARY VARIABLE FOR GROUP TRAVELS	GROUP ----- (1)								-.11E+01	-.12E+01	-.11E+01	-.12E+01	-.12E+01	-.12E+01
									-.985	-1.061	-.991	-1.004	-1.020	-1.026
									-	-	-.50E+02	.14E+07	.18E+02	.70E+02
									(-16.70)	(-17.86)	(-16.46)	(-16.56)	(-16.83)	(-17.07)
		1							-.037	-.041	-.033	-.037	-.036	-.045
		2							-.068	-.105	-.063	-.039	-.067	-.080
		3							-.093	-.104	-.107	-.111	-.115	-.121
		4							.044	.046	.043	.043	.043	.043
									(GE)	(GE)	(GE)	(GE)	(GE)	(GE)
YEARLY INCOME	INCOME (1)				-.15E-04	-.16E-04	-.11E+00	-.91E-01			-.18E-04	-.62E+00	-.85E-02	-.84E-02
					-.809	-.922	-.709	-.752			-.454	-.430	-.446	-.440
					.70E-03	.20E-03	.32E-03	.65E-03			-.53E-03	.33E-03	.27E-03	.12E-02
					(-2.61)	(-2.70)	(-2.99)	(-3.00)			(-6.56)	(-9.03)	(-7.82)	(-7.71)
		1			-.044	-.061	-.041	-.044			-.021	-.025	-.023	-.028
		2			.230	.267	.181	.185			.120	.043	.089	.098
		3			-.103	-.108	-.108	-.106			-.135	-.157	-.148	-.151
		4			-.005	-.011	-.003	-.003			.049	.041	.045	.044
					(SP)	(SP) 1	2(SP) 1	2(SP)			1 1(SP) 1	1(SP) 1	2(SP) 1	1(SP)
ASSOCIATED DUMMIES GROUP														
RUN TIME, RAIL (INCOME<30,000$)	RAI_RTL11 --------- (1)			.11E+01										
				.988										
				-.17E+02										
				(1.89)										
		1		.092										
		2		-.045										
		3		-.005										
		4		-.034										
				(GE)										
REGRESSION CONSTANT	CONSTANT (1)		-.22E+01	-.29E+01	-.35E+01	-.52E+01	-.11E+01	-.12E+01	-.20E+01	-.45E+00	-.34E+01	.27E+01	-.16E+01	-.35E+01
			-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-
			(-5.83)	(-8.79)	(-10.17)	(-12.33)	(-1.03)	(-1.18)	(-13.38)	(-2.59)	(-22.39)	(3.78)	(-7.56)	(-12.94)
			-	-	-	-	-	-	-	-	-	-	-	-

(Continued) Additional results for business and non business models, Quebec-Windsor corridor, 1987

1. BETA
   W.A. ELASTICITIES
   W.A. MRS: AIR_CTT
   (COND. T-STATISTIC)
   W.A. CHANGE IN P(I)

			1	2	3	4	5	6	7	8	9	10	11	12
	VARIANT =		PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
	VERSION =		70	76	8	2	18	46	15	16	43	44	48	105
	DEP.VAR. =		MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
ALTERNATIVE 2 : AIR (AVION)														
NETWORK VARIABLES														
TOTAL COST, AIR (RUN AND ACCESS COST)	AIR_CTT (2)		-.33E-01	-.97E+00	-.22E-01	-.40E+01	-.81E+00	-.30E+01			.17E-01	-.13E+01	-.25E+01	-.68E+00
			-1.724	-1.212	-1.231	-1.627	-1.126	-.325			1.415	-1.177	-.571	-.204
			.10E+01	.10E+01	.10E+01	.10E+01	.10E+01	.10E+01			.10E+01	.10E+01	.10E+01	.10E+01
			(-5.21)	(-6.49)	(-3.66)	(-7.62)	(-7.23)	(-2.85)			(2.45)	(-5.38)	(-4.96)	(-2.58)
		1	.054	.035	.033	.070	.030	.011			-.004	.004	.002	.002
		2	-.747	-.501	-.537	-.645	-.463	-.128			.150	-.076	-.058	-.023
		3	.016	.010	.027	.041	.015	.004			-.003	.005	.002	.001
		4	.097	.071	.070	.095	.067	.020			-.008	.006	.003	.001
			(GE)	L 1(GE)	L 1(GE)	L 1(GE)	L 4(GE)	L 4(GE)			L 1(GE)	L 1(GE)	L 4(GE)	L 7(GE)
GENRALIZED COST, AIR	AIR_GC (2)								-.48E-01	-.33E+00				
									-6.660	-6.366				
									-	-				
									(-18.85)	(-22.54)				
		1							.014	.024				
		2							-.739	-.963				
		3							.018	.023				
		4							.036	.029				
									(GE)	L 1(GE)				
TOTAL TRAVEL TIME, AIR	AIR_TTT (2)				-.14E-01	-.90E+00	-.83E-04	-.71E-01			-.53E-02	-.78E+00	-.11E+01	-.76E-13
					-.753	-.362	-.270	-.520			-.800	-.724	-.509	-.014
					.61E+00	.23E+00	.25E+00	.17E+01			-.32E+00	.37E+00	.55E+00	.43E-01
					(-10.19)	(-1.69)	(-5.91)	(-4.31)			(-6.26)	(-2.92)	(-2.13)	(-4.10)
		1			.019	.016	.006	.018			.002	.002	.002	.000
		2			-.321	-.144	-.119	-.217			-.079	-.047	-.053	-.002
		3			.015	.009	.003	.006			.002	.003	.002	.000
		4			.044	.021	.015	.030			.005	.004	.003	.000
					L 1(GE)	L 1(GE)	L 3(GE)	L 3(GE)			L 1(GE)	L 1(GE)	L 3(GE)	L 3(GE)
RUN TIME, AIR (INCOME>30,000$)	AIR_RTSI1 (2)		-.14E-01	-.12E-02										
			-.236	-.084										
			.42E+00	.21E+00										
			(-10.24)	(-5.32)										
		1	.005	.002										
		2	-.111	-.041										
		3	.002	.000										
		4	.013	.004										
			(GE)	L 2(GE)										
RUN TIME, AIR (INCOME<30,000$)	AIR_RTLI1 (2)		-.38E-02	.36E-04										
			-.007	.000										
			.12E+00	-.48E-03										
			(-2.85)	(.12)										
		1	.001	-.000										
		2	-.002	.000										
		3	.000	-.000										
		4	.000	-.000										
			(GE)	L 2(GE)										

(Continued) Additional results for business and non business models, Quebec-Windsor corridor, 1987

1. BETA N.A. ELASTICITIES N.A. MRS: AIR_CTT (COND. T-STATISTIC) N.A. CHANGE IN P(I)			1	2	3	4	5	6	7	8	9	10	11	12
	VARIANT =		PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
	VERSION =		70	76	8	2	18	46	15	16	43	44	48	105
	DEP.VAR. =		MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
ACCESS TIME, AIR (INCOME>30,000$)	AIR_ATE11		-.40E-01	-.70E-02										
			-1.202	-1.022										
	(2)		.12E+01	.15E+01										
			(-9.83)	(-8.02)										
		1	.024	.020										
		2	-.521	-.448										
		3	.009	.006										
		4	.070	.059										
			(GE) L	2(GE)										
ACCESS TIME, AIR (INCOME<30,000$)	AIR_ATL11		-.26E-01	-.70E-02										
			-.093	-.126										
	(2)		.81E+00	.11E+00										
			(-5.92)	(-3.79)										
		1	.010	.012										
		2	-.023	-.033										
		3	.002	.003										
		4	.006	.008										
			(GE) L	2(GE)										
FREQUENCY, AIR	AIR_FR		.10E+00	.29E-01	.80E-01	.12E+01	.14E-01	.28E-01	.73E-01	.34E-01	.66E-01	.55E+00	.40E-01	.12E+00
			.916	.904	.747	.471	.787	.801	2.050	2.184	1.921	.512	2.298	1.700
	(2)		-.31E+01	-.47E+01	-.36E+01	-.19E+01	-.44E+01	-.16E+02	-	-	.39E+01	-.14E+01	-.13E+02	-.26E+02
			(13.44)	(12.89)	(12.02)	(10.76)	(11.67)	(11.88)	(14.51)	(12.92)	(12.14)	(9.85)	(12.78)	(14.05)
		1	-.035	-.034	-.023	-.020	-.024	-.027	-.005	-.010	-.007	-.002	-.010	-.015
		2	.478	.516	.396	.187	.460	.452	.267	.392	.238	.033	.302	.226
		3	-.006	-.005	-.012	-.012	-.009	-.007	-.005	-.008	-.004	-.002	-.008	-.008
		4	-.043	-.037	-.034	-.028	-.032	-.034	-.011	-.009	-.010	-.003	-.011	-.007
			(GE) L	3(GE) L	1(GE) L	1(GE) L	1(GE) L	1(GE)	(GE) L	2(GE) L	1(GE) L	1(GE) L	1(GE) L	5(GE)
RUN TIME, CAR	CAR_RT							.58E-12						.28E-03
								1.036						2.016
	(2)							-.30E+01						-.33E+01
								(4.59)						(13.67)
		1						.098						.119
		2						.530						.294
		3						.135						.154
		4						-.085						-.063
								L 5(GE)						L 4(GE)
Socioeconomic variables														
BINARY VARIABLE FOR ORIGIN OR END OF TRAVEL IN BIG CITY	LARGEC1		.56E+00	.52E+00	.85E+00	.94E+00	.93E+00	.94E+00	.57E+00	.52E+00	.77E+00	.10E+01	.72E+00	.11E+01
	-------		.149	.138	.272	.344	.300	.289	.368	.235	.603	.948	.505	.811
	(2)		-.11E+02	-.15E+02	-.29E+02	-.29E+02	-.37E+02	-.12E+03	-	-	.30E+02	-.53E+02	-.68E+02	-.29E+03
			(3.97)	(3.54)	(6.60)	(7.84)	(7.12)	(6.87)	(3.81)	(3.30)	(5.22)	(7.33)	(4.91)	(6.90)
		1	.132	.116	.148	.112	.135	.135	.179	.145	.170	.157	.146	.137
		2	.063	.053	.121	.150	.134	.135	.051	.037	.077	.076	.063	.101
		3	.048	.042	.126	.109	.111	.114	.271	.236	.234	.231	.257	.253
		4	-.111	-.103	-.137	-.118	-.138	-.137	-.251	-.217	-.273	-.236	-.223	-.227
			(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)

(Continued) Additional results for business and non business models, Quebec-Windsor corridor, 1987

			1	2	3	4	5	6	7	8	9	10	11	12
1. BETA	VARIANT =		PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
W.A. ELASTICITIES	VERSION =		70	76	8	2	18	46	15	16	43	44	48	105
W.A. MRS: AIR_CTT	DEP.VAR. =		MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
(COND. T-STATISTIC)														
W.A. CHANGE IN P(I)														
									-.11E+01	-.12E+01	-.11E+01	-.12E+01	-.12E+01	-.12E+01
BINARY VARIABLE	GROUP								-.953	-.949	-.965	-.992	-.980	-.934
FOR GROUP TRAVELS	-----								-	-	-.54E+02	.64E+02	.14E+03	.37E+03
	(2)								(-16.70)	(-17.86)	(-16.46)	(-16.66)	(-16.83)	(-17.07)
		1							-.057	-.056	-.050	-.053	-.049	-.057
		2							-.068	-.105	-.063	-.039	-.067	-.079
		3							-.128	-.131	-.151	-.137	-.143	-.148
		4							.079	.084	.077	.077	.078	.078
									(GE)	(GE)	(GE)	(GE)	(GE)	(GE)
					.25E-04	.25E-04	.21E+00	.17E+00			.21E-04	.46E+00	.78E-02	.69E-02
YEARLY INCOME	INCOME				.543	.630	.441	.448			1.046	.607	.778	.762
					-.13E-02	-.12E-02	-.12E-02	-.46E-02			.16E-02	-.13E-02	-.35E-02	-.99E-02
	(2)				(4.99)	(5.22)	(5.00)	(5.05)			(4.09)	(2.53)	(3.18)	(2.83)
		1			-.044	-.061	-.041	-.044			-.021	-.025	-.023	-.028
		2			.230	.267	.181	.185			.120	.043	.089	.098
		3			-.103	-.108	-.108	-.106			-.135	-.157	-.148	-.151
		4			-.005	-.011	-.003	-.003			.049	.041	.045	.044
					(SP)	(SP)	L 2(SP)	L 2(SP)			L 1(SP)	L 1(SP)	L 2(SP)	L 1(SP)
ASSOCIATED DUMMIES GROUP														
				.11E+01										
RUN TIME, AIR	AIR_RTL11			.688										
(INCOME<30,000$)	---------			-.48E+02										
	(2)			(1.89)										
		1		-.017										
		2		.175										
		3		-.004										
		4		-.026										
				(GE)										
			-.32E+00	.42E+00	-.49E+01	-.41E+01	-.80E+01	-.98E+01	-.13E+01	-.25E+00	-.81E+01	-.89E+01	-.60E+01	-.83E+01
REGRESSION CONSTANT	CONSTANT		-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-
	(2)		-	-	-	-	-	-	-	(-.78)	(-14.19)	(-4.60)	(-9.80)	(-13.54)
			(-.43)	(.58)	(-7.19)	(-5.47)	(-5.86)	(-7.50)	(-3.91)	-	-	-	-	-
			-	-	-	-	-	-	-					

(Continued) Additional results for business and non business models, Quebec-Windsor corridor, 1987

I. BETA
W.A. ELASTICITIES
W.A. HRS: BUS_CTT
(COND. T-STATISTIC)
W.A. CHANGE IN P(I)

			1	2	3	4	5	6	7	8	9	10	11	12
	VARIANT =		PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
	VERSION =		70	76	8	2	18	44	15	16	43	44	48	105
	DEP.VAR. =		MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
ALTERNATIVE 3 : BUS (AUTOBUS)														
NETWORK VARIABLES														
TOTAL COST, BUS	BUS_CTT		-.33E-01	-.97E+00	-.22E-01	-.40E+01	-.83E+00	-.30E+01			.17E-01	-.13E+01	-.25E+01	-.68E+00
(RUN AND ACCESS COST)			-.711	-2.154	-.460	-3.671	-1.756	-1.382			.247	-.959	-.783	-.257
	(3)		.10E+01	.10E+01	.10E+01	.10E+01	.10E+01	.10E+01			.10E+01	.10E+01	.10E+01	.10E+01
			(-5.21)	(-6.49)	(-3.66)	(-7.62)	(-7.23)	(-2.85)			(2.45)	(-5.38)	(-4.96)	(-2.58)
		1	.001	.005	.002	.017	.008	.006			-.004	.018	.014	.005
		2	.003	.007	.001	.013	.004	.003			-.003	.011	.008	.003
		3	-.023	-.064	-.038	-.300	-.136	-.102			.046	-.182	-.150	-.050
		4	.005	.015	.003	.021	.011	.009			-.009	.034	.028	.009
			(GE) L	1(GE) L	1(GE) L	1(GE) L	4(GE) L	4(GE)			L 1(GE)	L 1(GE)	L 4(GE)	L 2(GE)
GENERALIZED COST, BUS	BUS_GC								-.48E-01	-.33E+00				
									-2.928	-3.932				
	(3)								-	-				
									(-18.85)	(-22.54)				
		1							.244	.068				
		2							.048	.104				
		3							-.431	-.625				
		4							.111	.145				
									(GE) L	1(GE)				
TOTAL TRAVEL TIME, BUS	BUS_TTT				-.14E-01	-.90E+00	-.83E-04	-.71E-01			-.53E-02	-.78E+00	-.11E+01	-.76E-13
					-3.144	-.817	-1.719	-1.898			-.970	-.590	-.417	-.192
	(3)				.61E+00	.19E-01	.89E-01	.12E+00			-.32E+00	.48E-01	.41E-01	.39E-01
					(-10.19)	(-1.69)	(-5.91)	(-4.31)			(-6.26)	(-2.92)	(-2.13)	(-4.10)
		1			.011	.004	.009	.008			.017	.011	.008	.014
		2			.010	.003	.008	.005			.011	.007	.004	.012
		3			-.261	-.067	-.147	-.148			-.181	-.112	-.080	-.047
		4			.019	.005	.010	.012			.035	.021	.015	.005
					L 1(GE)	L 1(GE)	L 3(GE)	L 3(GE)			L 1(GE)	L 1(GE)	L 3(GE)	L 3(GE)
RUN TIME, BUS	BUS_RTR11		-.14E-01	-.12E-02										
(INCOME>30,000$)			-1.642	-.914										
	(3)		.42E+00	.41E-03										
			(-10.24)	(-5.32)										
		1	.002	.001										
		2	.009	.006										
		3	-.041	-.020										
		4	.011	.006										
			(GE) L	2(GE)										

(Continued) Additional results for business and non business models, Quebec-Windsor corridor, 1987

			1	2	3	4	5	6	7	8	9	10	11	12
1. BETA	VARIANT =		PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
W.A. ELASTICITIES	VERSION =		70	76	8	7	16	46	15	16	43	44	48	105
W.A. MRS: BUS_CTT	DEP.VAR. =		MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
(COND. T-STATISTIC)														
W.A. CHANGE IN P(I)														
RUN TIME, BUS	BUS_RTLI1		-.30E-02	.36E-04										
(INCOME<30,000$)			-.176	.011										
	(3)		.12E+00	-.85E-03										
			(-2.05)	(.12)										
		1	.001	-.000										
		2	.000	-.000										
		3	-.009	.000										
		4	.001	-.000										
			(GE) L	2(GE)										
ACCESS TIME, BUS	BUS_ATHI1		-.40E-01	-.70E-02										
(INCOME>30,000$)			-7.247	-1.847										
	(3)		.12E+01	.19E+00										
			(-9.83)	(-8.02)										
		1	.002	.003										
		2	.009	.007										
		3	-.061	-.045										
		4	.015	.012										
			(GE) L	2(GE)										
ACCESS TIME, BUS	BUS_ATLI1		-.26E-01	-.70E-02										
(INCOME<30,000$)			-.551	-.651										
	(3)		.81E+00	.12E+00										
			(-5.92)	(-3.79)										
		1	.002	.002										
		2	.001	.001										
		3	-.027	-.028										
		4	.004	.004										
			(GE) L	2(GE)										
FREQUENCY, BUS	BUS_FR		.10E+00	.26E-01	.80E-01	.12E+01	.14E-01	.29E-01	.73E-01	.34E-01	.66E-01	.55E+00	.40E-01	.12E+00
			1.950	1.635	1.371	1.063	1.140	1.288	.856	.746	.713	.417	.698	.727
	(3)		-.31E+01	-.84E+00	-.36E+01	-.36E+00	-.81E+00	-.12E+01	-	-	.39E+01	-.73E+00	-.11E+01	-.40E+01
			(13.44)	(12.89)	(12.02)	(10.76)	(11.67)	(11.88)	(14.51)	(12.92)	(12.14)	(9.85)	(12.78)	(14.05)
		1	-.003	-.003	-.005	-.005	-.005	-.005	-.014	-.012	-.010	-.008	-.012	-.012
		2	-.004	-.003	-.002	-.004	-.001	-.001	-.005	-.007	-.003	-.005	-.004	-.007
		3	.068	.033	.121	.087	.100	.110	.157	.140	.153	.079	.137	.159
		4	-.013	-.011	-.009	-.006	-.007	-.008	-.031	-.027	-.025	-.015	-.024	-.025
			(GE) L	3(GE) L	1(GE) L	1(GE) L	1(GE) L	1(GE)	(GE) L	2(GE) L	1(GE) L	1(GE) L	1(GE) L	5(GE)
RUN TIME, CAR	CAR_RT							.58E-12						.28E-03
								1.508						.732
	(3)							-.13E+00						-.29E+00
								(4.59)						(13.67)
		1						.098						.119
		2						.530						.294
		3						.125						.154
		4						-.095						-.063
								L 5(GE)						L 4(GE)

(Continued) Additional results for business and non business models, Quebec-Windsor corridor, 1987

1. BETA
W.A. ELASTICITIES
W.A. MRS: BUS_CTT
(COND. T-STATISTIC)
W.A. CHANGE IN P(I)

			1	2	3	4	5	6	7	8	9	10	11	12
	VARIANT =		PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
	VERSION =		70	76	8	2	18	46	15	16	43	44	48	105
	DEP.VAR. =		MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
Socioeconomic variables														
BINARY	LARGECI		.12E+01	.11E+01	.16E+01	.14E+01	.15E+01	.15E+01	.12E-01	.11E+01	.14E+01	.12E+01	.12E+01	.12E+01
VARIABLE FOR ORIGIN	-------		1.221	1.139	1.497	1.253	1.460	1.468	1.229	.953	1.105	.902	.955	.936
OR END OF	(3)		-.31E+02	-.89E+01	-.57E+02	-.57E+01	-.14E+02	-.19E+02	-	-	.70E+02	-.14E+02	-.18E+02	-.57E+02
TRAVEL IN BIG CITY			(4.02)	(3.84)	(5.23)	(4.93)	(5.16)	(5.11)	(18.23)	(17.33)	(19.19)	(16.91)	(17.49)	(17.41)
		1	.124	.114	.137	.118	.130	.133	.173	.114	.122	.123	.117	.122
		2	.090	.077	.176	.214	.199	.185	.266	.053	.099	.093	.084	.142
		3	.046	.041	.119	.107	.105	.107	.195	.188	.239	.186	.206	.204
		4	-.093	-.086	-.115	-.098	-.115	-.115	-.158	-.134	-.171	-.146	-.144	-.139
			(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)	(SP)
BINARY VARIABLE	GROUP								-.11E+01	-.12E+01	-.11E+01	-.12E+01	-.12E+01	-.12E+01
FOR GROUP TRAVELS	-----								-.949	-1.023	-.917	-.913	-.928	-.950
	(3)								-	-	-.57E+02	.14E+02	.17E+02	.57E+02
									(-16.70)	(-17.06)	(-16.46)	(-16.66)	(-16.83)	(-17.07)
		1							-.043	-.049	-.039	-.045	-.043	-.058
		2							-.295	-.160	-.090	-.051	-.098	-.129
		3							-.293	-.104	-.107	-.110	-.114	-.121
		4							.265	.068	.064	.063	.064	.064
									(GE)	(GE)	(GE)	(GE)	(GE)	(GE)
YEARLY INCOME	INCOME				-.61E-04	-.61E-04	-.34E+00	-.37E+00			-.52E-04	-.12E+01	-.19E-01	-.19E-01
					-1.931	-1.956	-1.655	-1.677			-1.022	-.858	-.935	-.923
	(3)				.28E-02	.35E-03	.17E-02	.21E-02			-.30E-02	.17E-02	.14E-02	.45E-02
					(-5.80)	(-5.78)	(-6.89)	(-6.93)			(-19.45)	(-22.18)	(-21.15)	(-21.02)
		1			-.044	-.061	-.041	-.044			-.021	-.025	-.023	-.028
		2			.230	.267	.181	.185			.120	.043	.089	.098
		3			-.103	-.108	-.108	-.106			-.135	-.157	-.148	-.151
		4			-.005	-.011	-.003	-.003			.049	.041	.045	.044
					(SP)	(SP) L	2(SP) L	2(SP)			L 1(SP)	L 1(SP)	L 2(SP)	L 1(SP)
ASSOCIATED DUMMIES GROUP														
RUN TIME, BUS	BUS_RTLT1			.11E+01										
(INCOME<30,000$)	---------			1.043										
	(3)			-.10E+02										
				(1.89)										
		1		-.005										
		2		-.010										
		3		.047										
		4		-.016										
				(GE)										
REGRESSION CONSTANT	CONSTANT		-.50E+01	-.63E+01	-.40E+01	-.88E+01	.19E+01	.19E+01	-.17E+01	-.12E+00	-.19E+01	.87E+01	.44E+00	-.11E+01
			-	-	-	-	-	-	-	-	-	-	-	-
	(3)		-	-	-	-	-	-	-	-	-	-	-	-
			(-9.38)	(-12.51)	(-7.01)	(-10.66)	(1.47)	(1.46)	(-10.97)	(-.66)	(-12.20)	(15.75)	(2.30)	(-5.21)
			-	-	-	-	-	-	-	-	-	-	-	-

(Continued) Additional results for business and non business models, Quebec-Windsor corridor, 1987

I. BETA W.A. ELASTICITIES W.A. MRS: CAR_C (COND. T-STATISTIC) W.A. CHANGE IN P(I)			1	2	3	4	5	6	7	8	9	10	11	12
	VARIANT =		PHREF	PHREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PHNBUS	PHNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
	VERSION =		70	76	8	2	18	46	15	16	43	44	48	105
	DEP.VAR. =		MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
ALTERNATIVE 4 : CAR (AUTOMOBILE)														
NETWORK VARIABLES														
GENERALIZED COST, CAR	CAR_GC								-.48E-01	-.33E+00				
									-.115	-.205				
	(4)								-	-				
									(-18.85)	(-22.54)				
		1							.075	.161				
		2							.362	.534				
		3							.155	.323				
		4							-.091	-.158				
									(GE)	L 1(GE)				
COST, CAR (RUN COST)	CAR_C		-.33E-01	-.97E+00	-.22E-01	-.40E+01	-.81E+00	-.30E+01			.17E-01	-.13E+01	-.25E+01	-.68E+00
			-.128	-.179	-.091	-.268	-.161	-.077			.015	-.082	-.075	-.023
	(4)		.10E+01	.10E+01	.10E+01	.10E+01	.10E+01	.10E+01			.10E+01	.10E+01	.10E+01	.10E+01
			(-5.21)	(-6.49)	(-3.66)	(-7.62)	(-7.23)	(-2.85)			(2.45)	(-5.19)	(-4.96)	(-2.58)
		1	.069	.132	.046	.198	.111	.057			-.011	.062	.052	.017
		2	.356	.361	.260	.576	.341	.123			-.037	.055	.063	.021
		3	.042	.064	.072	.210	.133	.067			-.027	.147	.138	.045
		4	-.075	-.120	-.052	-.176	-.105	-.055			.012	-.064	-.060	-.018
			(GE)	L 1(GE)	L 1(GE)	L 1(GE)	L 4(GE)	L 4(GE)			L 1(GE)	L 1(GE)	L 4(GE)	L 2(GE)
RUN TIME, CAR	CAR_RT				-.14E-01	-.90E+00	-.83E-04	-.71E-01			-.53E-02	-.78E+00	-.11E+01	-.76E-13
					-.201	-.060	-.109	-.177			-.057	-.050	-.038	-.088
	(4)				.61E+00	.40E-01	.11E+00	.36E+00			-.32E+00	.51E-01	.39E-01	.16E+00
					(-10.19)	(-1.69)	(-5.91)	(-4.31)			(-6.26)	(-2.92)	(-2.13)	(-4.10)
		1			.106	.044	.054	.098			.041	.038	.027	.119
		2			.554	.117	.360	.530			.126	.034	.037	.294
		3			.169	.047	.086	.135			.098	.091	.070	.154
		4			-.116	-.039	-.056	-.095			-.044	-.039	-.029	-.063
					L 1(GE)	L 1(GE)	L 3(GE)	L 3(GE)			L 1(GE)	L 1(GE)	L 3(GE)	L 3(GE)
RUN TIME, CAR (INCOME>30,000$)	CAR_RTGI1		-.14E-01	-.12E-02										
			-.167	-.102										
	(4)		.42E+00	.10E+00										
			(-10.24)	(-5.32)										
		1	.069	.041										
		2	.499	.326										
		3	.037	.019										
		4	-.095	-.055										
			(GE)	L 2(GE)										
RUN TIME, CAR (INCOME<30,000$)	CAR_RTLI1		-.38E-02	.36E-04										
			-.008	.001										
	(4)		.12E+00	-.69E-03										
			(-2.05)	(.12)										
		1	.010	-.001										
		2	.008	-.001										
		3	.008	-.000										
		4	-.006	.000										
			(GE)	L 2(GE)										

(Continued) Additional results for business and non business models, Quebec-Windsor corridor, 1987

II. PARAMETERS UNCOND.[T-STATISTIC=0] UNCOND.[T-STATISTIC=1]	1	2	3	4	5	6	7	8	9	10	11	12
VARIANT =	PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
VERSION =	70	76	8	2	18	46	15	16	43	44	48	105
DEP.VAR. =	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
BOX-COX TRANSFORMATIONS												
LAMBDA(X) - GROUP 1 LAM 1		.269	1.000	.000	1.531	1.340		.616	1.000	.000	1.180	.419
		[1.52]	FIXED	FIXED	[3.52]	[3.14]		[26.91]	FIXED	FIXED	[6.91]	[3.92]
		[-4.14]			[1.22]	[.80]		[-16.77]			[1.05]	[-5.43]
LAMBDA(X) - GROUP 2 LAM 2		1.353			.162	.185		1.275			.418	-.234
		[5.22]			[.51]	[.58]		[7.66]			[3.94]	[-.98]
		[1.36]			[-2.63]	[-2.56]		[1.40]			[-5.49]	[-5.15]
LAMBDA(X) - GROUP 3 LAM 3		1.411			1.807	.612					-.172	4.961
		[3.95]			[2.83]	[1.66]					[-.56]	[5.58]
		[1.15]			[1.26]	[-1.05]					[-5.16]	[4.46]
LAMBDA(X) - GROUP 4 LAM 4					.281	-.220					-.294	1.595
					[1.28]	[-.38]					[-2.91]	[6.83]
					[-3.28]	[-2.13]					[-12.80]	[2.55]
LAMBDA(X) - GROUP 5 LAM 5						4.943						.797
						[4.08]						[5.74]
						[3.26]						[-1.46]

III.GENERAL STATISTICS	1	2	3	4	5	6	7	8	9	10	11	12
VARIANT =	PMREF	PMREF	BENBUS1	BENBUS1	BENBUS1	BENBUS1	PMNBUS	PMNBUS	BENNBUS	BENNBUS	BENNBUS	BENNBUS
VERSION =	70	76	8	2	18	46	15	16	43	44	48	105
DEP.VAR. =	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE	MODE
LOG-LIKELIHOOD -FINAL VALUE	-1061.30	-1044.90	-1068.85	-1095.74	-1058.38	-1049.98	-4008.89	-3912.29	-3934.89	-3874.47	-3835.19	-3753.66
-INITIAL VALUE	-1923.80	-1045.53	-1923.80	-1923.80	-1064.49	-1058.38	-4932.74	-4011.29	-4932.74	-4932.74	-3867.15	-3756.11
-WITH CONSTANTS ONLY	-1923.80	-1923.80	-1923.80	-1923.80	-1923.80	-1923.80	-4932.74	-4932.74	-4932.74	-4932.74	-4932.74	-4932.74
-RATIO TEST	1724.996	1757.804	1709.902	1656.132	1730.840	1747.853	1847.703	2040.917	1995.703	2116.552	2195.110	2358.175
RHO-SQUARED	.448	.457	.444	.430	.450	.454	.187	.207	.202	.215	.223	.239
RHO-SQUARED BAR -AKAIKE	.442	.449	.438	.424	.442	.445	.185	.205	.200	.212	.219	.235
-HORONITZ	.445	.453	.441	.427	.446	.450	.186	.206	.201	.213	.221	.237
-BENSBER AND JOHNSON	.448	.456	.444	.430	.449	.453	.187	.206	.202	.214	.222	.238
PER CENT RIGHT	74.786	75.527	75.203	74.253	76.014	76.037	55.602	55.724	55.773	55.968	55.946	56.775
SAMPLE -NUMBER OF ALTERNATIVES	4	4	4	4	4	4	4	4	4	4	4	4
-NUMBER OF OBSERVATIONS	4402	4402	4402	4402	4402	4402	8536	8536	8536	8536	8536	8536
-FIRST OBSERVATION	1	1	1	1	1	1	4403	4403	4403	4403	4403	4403
-LAST OBSERVATION	4402	4402	4402	4402	4402	4402	12938	12938	12938	12938	12938	12938
-AVAILABLE OBSERVATIONS	4315	4315	4315	4315	4315	4315	8185	8185	8185	8185	8185	8185
1 RAIL	4291	4291	4291	4291	4291	4291	8229	8229	8229	8229	8229	8229
2 AIR	3624	3624	3624	3624	3624	3624	5902	5902	5902	5902	5902	5902
3 BUS	3264	3264	3264	3264	3264	3264	5668	5668	5668	5668	5668	5668
4 CAR	4398	4398	4398	4398	4398	4398	8452	8452	8452	8452	8452	8452
NUMBER OF ESTIMATED PARAMETERS												
-BETAS .VARIABLES	9	9	9	9	9	10	6	6	10	10	10	11
.CONSTANTS	3	3	3	3	3	3	3	3	3	3	3	3
.ASSOCIATED DUMMIES	0	1	0	0	0	0	0	0	0	0	0	0
-BOX-COX TRANSFORMATIONS	0	3	0	0	4	5	0	2	0	0	4	5

Université de Montréal
Département de sciences économiques
Centre de documentation
C.P. 6128, succursale Centre-ville
Montréal (Québec)
H3C 3J7

Cahiers de recherche (Discussion papers)
1993 à aujourd'hui (1993 to date)

Si vous désirez obtenir un exemplaire, vous n'avez qu'à faire parvenir votre demande et votre paiement (5 $ l'unité) à l'adresse ci-haut mentionnée. / To obtain a copy ($ 5 each), please send your request and prepayment to the above-mentioned address.

9301 : Mercenier, Jean, "Nonuniqueness of Solutions in Applied General-Equilibrium Models with Scale Economies and Imperfect Competition : A Theoretical *Curiosum*?", 26 pages.
9302 : Lemieux, Thomas, "Unions and Wage Inequality in Canada and in the United States", 66 pages.
9303 : Lemieux, Thomas, "Estimating the Effects of Unions on Wage Inequality in a Two-Sector Model with Comparative Advantage and Non-Random Selection", 54 pages.
9304 : Harchaoui, Tarek H., "Time-Varying Risks and Returns : Evidence from Mining Industries Data", 20 pages.
9305 : Lévy-Garboua, Louis et Claude Montmarquette, "Une étude économétrique de la demande de théâtre sur données individuelles", 40 pages.
9306 : Montmarquette, Claude, Rachel Houle et Sophie Mahseredjian, "The Determinants of University Dropouts : A Longitudinal Analysis", 17 pages.
9307 : Gaudry, Marc, Benedikt Mandel et Werner Rothengatter, "A Disagregate Box-Cox Logit Mode Choice Model of Intercity Passenger Travel in Germany", 17 pages.
9308 : Fortin, Nicole M., "Borrowing Constraints and Female Labor Supply : Nonparametric and Parametric Evidence of the Impact of Mortgage Lending Rules", 38 pages.
9309 : Dionne, Georges, Robert Gagné, François Gagnon et Charles Vanasse, "Debt, Moral Hazard and Airline Safety : an Empirical Evidence", 34 pages.
9310 : Dionne, Georges, Anne Gibbens et Pierre St-Michel, "An Economic Analysis of Insurance Fraud", 40 pages.
9311 : Gaudry, Marc, "Asymmetric Shape and Variable Tail Thickness in Multinomial Probabilistic Responses to Significant Transport Service Level Changes", 26 pages.
9312 : Laferrière, Richard et Marc Gaudry, "Testing the Linear Inverse Power Transformation Logit Mode Choice Model", 29 pages.

9313 : Kollmann, Robert, "Fiscal Policy, Technology Shocks and the US Trade Balanc Deficit", 38 pages.
9314 : Ghysels, Eric, "A Time Series Model With Periodic Stochastic Regim Switching", 54 pages.
9315 : Allard, Marie, Camille Bronsard et Lise Salvas-Bronsard, "C^k-Conjugat Expectations and Duality", 22 pages.
9316 : Dudley, Leonard et Claude Montmarquette, "Government Size and Economic Convergence", 28 pages.
9317 : Bronsard, Camille, "L'histoire de l'économie mathématique racontée à Juliette", 17 pages.
9318 : Tremblay, Rodrigue, "The Quest for Competitiveness and Export-Led Growth", 16 pages.
9319 : Proulx, Pierre-Paul, "L'ALÉNA", 12 pages.
9320 : Proulx, Pierre-Paul, "Le Québec dans l'ALÉNA", 28 pages.
9321 : Dionne, Georges, Denise Desjardins, Claire Laberge-Nadeau et Urs Magg, "Medical Conditions, Risk Exposure and Truck Drivers' Accidents : an Analysis with Count Data Regression Models, 20 pages.
9322 : Ghysels, Eric, "Seasonal Adjustment and Other Data Transformations", 28 pages.
9323 : Dufour, Jean-Marie et David Tessier, "On the Relationship Between Impulse Response Analysis, Innovation Accounting and Granger Causality", 12 pages.
9324 : Dufour, Jean-Marie et Eric Renault, "Causalités à court et à long terme dans les modèles VAR et ARIMA multivariés", 68 pages.
9325 : Ghysels, Eric et Alastair Hall, "On Periodic Time Series and Testing the Unit Root Hypothesis", 36 pages.
9326 : Campbell, Bryan et Jean-Marie Dufour, "Exact Nonparametric Orthogonality and Random Walk Tests", 28 pages.
9327 : Proulx, Pierre-Paul, "Quebec in North America : from a Borderlands to a Borderless Economy : an Examination of its Trade Flows with the U.S.A. at the National and Regional Levels", 24 pages.
9328 : Proulx, Pierre-Paul, "L'ALÉNA, le Québec et la mutation de son espace économique", 36 pages.
9329 : Sprumont, Yves, "Strategyproof Collective Choice in Economic and Political Environments", 48 pages.
9330 : Cardia, Emanuela et Steve Ambler, "The Cyclical Behaviour of Wages and Profits Under Imperfect Competition", 24 pages.
9331 : Arcand, Jean-Louis L. et Elise S. Brezis, "Disequilibrium Dynamics During the Great Depression", 64 pages.
9332 : Beaudry, Paul et Michel Poitevin, "Contract Renegotiation : a Simple Framework and Implications for Organization Theory", 48 pages.
9333 : Ghysels, Eric et Alastair Hall, "On Periodic Time Series and Testing the Unit Root Hypothesis", 36 pages. (Ce cahier portait déjà le no 9325.)
9333 : Dagenais, Marcel G. et Jean-Marie Dufour, "Pitfalls of Rescaling Regression Models with Box-Cox Transformations", 16 pages.
9334 : Bonomo, Marco et René Garcia, "Disappointment Aversion as a Solution to the Equity Premium and the Risk-Free Rate Puzzles", 40 pages.

9335 : Ghysels, Eric et Offer Lieberman, "Dynamic Regression and Filtered Data Series : A Laplace Approximation to the Effects of Filtering in Small Samples", 24 pages.

9336 : Kollmann, Robert, "The Duration of Unemployment as A Signal : Implications for Labor Market Equilibrium", 19 pages.

9337 : Kollmann, Robert, "Fertility, Consumption and Bequests in a Model with Non-Dynastic Parental Altruism", 22 pages.

9401 : Mercenier, Jean et Bernardin Akitoby, "On Intertemporal General-Equilibrium Reallocation Effects of Europe's move to a Single Market", janvier 1994, 41 pages.

9402 : Gauthier, Céline et Michel Poitevin, "Using Ex Ante Payments in Self-Enforcing Risk-Sharing Contracts, février 1994, 38 pages.

9403 : Ghysels, Eric et Joanna Jasiak, "Stochastic Volatility and Time Deformation : an Application of Trading Volume and Leverage Effects, février 1994, 37 pages.

9404 : Dagenais, Marcel G. et Denyse L. Dagenais, "GMM Estimators for Linear Regression Models with Errors in the Variables", avril 1994, 33 pages.

9405 : Bronsard, C., F. Rosenwald et L. Salvas-Bronsard, "Evidence on Corporate Private Debt Finance and the Term Structure of Interest Rates", avril 1994, 42 pages.

9406 : Dinardo, John, Nicole M. Fortin et Thomas Lemieux, "Labor Market Institutions and the Distribution of Wages, 1973-1992 : A Semiparametric Approach", avril 1994, 73 pages.

9407 : Campbell, Bryan et Jean-Marie Dufour, "Exact Nonparametric Tests of Orthogonality and Random Walk in the Presence of a Drift Parameter", avril 1994, 32 pages.

9408 : Bollerslev, Tim et Eric Ghysels, "Periodic Autoregressive Conditional Heteroskedasticity", mai 1994, 29 pages.

9409 : Cardia, Emanuela, "The Effects of Government Financial Policies : Can We Assume Ricardian Equivalence?", mai 1994, 42 pages.

9410 : Kollmann, Robert, "Hidden Unemployment : A Search Theoretic Interpretation", mai 1994, 9 pages.

9411 : Kollmann, Robert, "The Correlation of Productivity Growth Across Regions and Industries in the US", juin 1994, 14 pages.

9412 : Gaudry, Marc, Benedikt Mandel et Werner Rothengatter, "Introducing Spatial Competition through an Autoregressive Contiguous Distributed (AR-C-D) Process in Intercity Generation-Distribution Models within a Quasi-Direct Format (QDF)", juin 1994, 61 pages.

9413 : Gaudry, Marc et Alexandre Le Leyzour, "Improving a Fragile Linear Logit Model Specified for High Speed Rail Demand Analysis in the Quebec-Windsor Corridor of Canada, août 1994, 39 pages.