Discrete Choice Modelling: How good is the model?

Model Selection and Goodness of fit

NZ Freight Shipper's Mode Choice and Modal Shift Behaviour

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Discrete Choice Modelling

- Transport consumer behavior exhibits substantial heterogeneity (Variations in travel behaviors)
  1. Want to understand causes of those variations
  2. Want to identify how to change travel behaviors (need elasticity values)
- Discrete choice modelling enables us to capture travel behavior and mode choice in particular
- When introducing a new transport service (e.g. Public transport, Cycle path, BRT, Light rail and etc.), it is particularly important;
  - Service positioning and advertisement
  - Level of service (e.g. service frequency)
  - Optimal price (e.g. WTP and WTA)

New Trends in Discrete Choice Modelling

Increasing Complexity

- In the early stages, Multinomial Logit (MNL) model: the simplest and most popular
  - In the logit model, the utility of person *i* for alternative *j* is

$$U_{ij} = \beta X_{ij} + \varepsilon_{ij}$$

- Over the last 10 years, Mixed Logit (MXL) model replaced ML model

$$U_{ij} = \beta_i X_{ij} + \varepsilon_{ij}$$

- Now, Generalized Mixed Logit (GMXL) Model

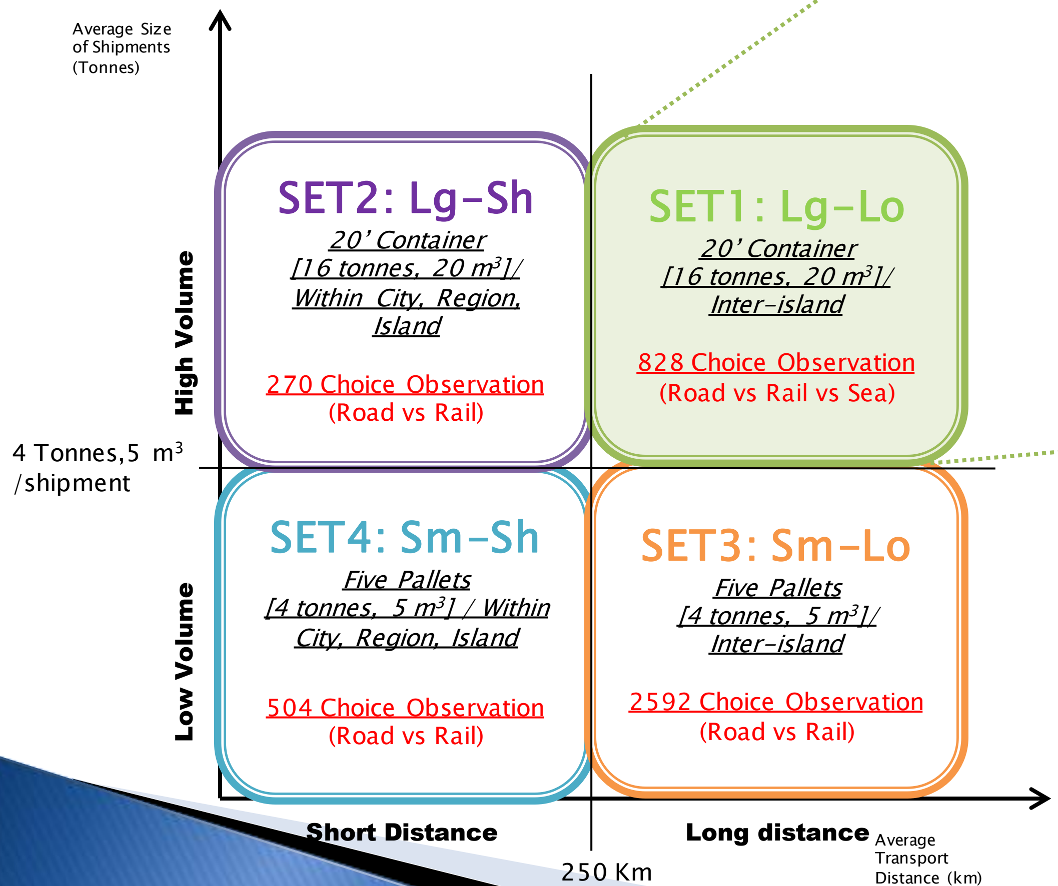
(Fiebig et al. 2009)

$$U_{ijt} = [\sigma_i \beta + \gamma \eta_i + (1-\gamma)\sigma_i \eta_i] X_{ijt} + \varepsilon_{ijt}$$

NZ Freight Shipper Survey

- Stated Preference (SP) Survey (2012)
  - 233 NZ freight Shippers
  - 4,194 Choice experiments
- Four business divisions
  - primary sector
  - manufacturers
  - retailers/wholesalers and
  - freight logistics providers
- Ten industry sectors
- Analysed by MNL, ML, GMXL and Latent Class (LC) model

Respondent Grouping Systems



Transport Options / Attributes	By truck only	By truck & Sea	By truck & Rail
Transport Cost	$3766	$1534 $1704 $1874	$2135 $2372 $2609
Transport Time	24 hrs	72, 84, 96 hrs	36, 48, 60 hrs
On-time Reliability	100%	80, 85, 90%	85, 90, 95%
Service Frequency	–	5, 7 per week	2, 4 per day

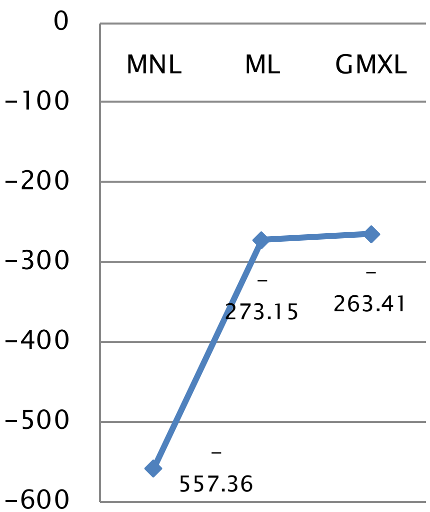
Attributes and Levels (Choice Set 1*)

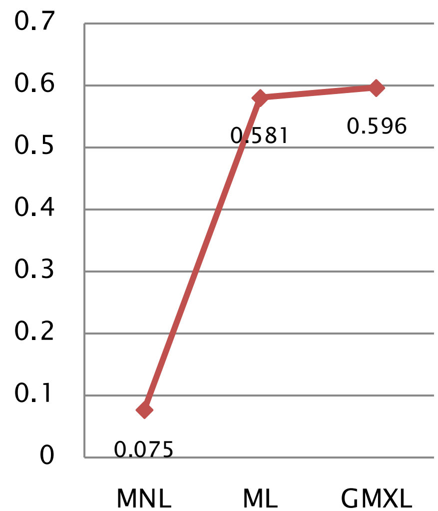
* Conditions given : Door-to-Door service, Inter-island (e.g. Auckland to Christchurch) transport with Full Container Load (FCL: 16 tonnes)

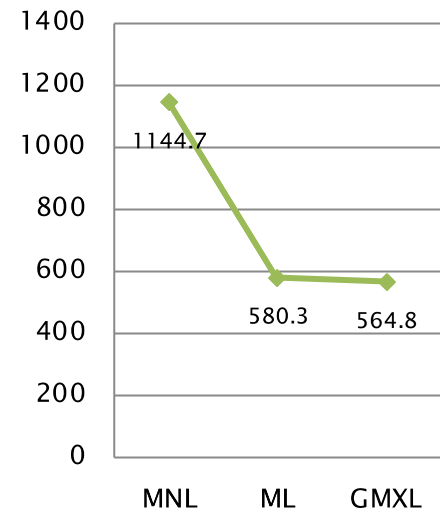
Goodness-of-Fit (Overall)

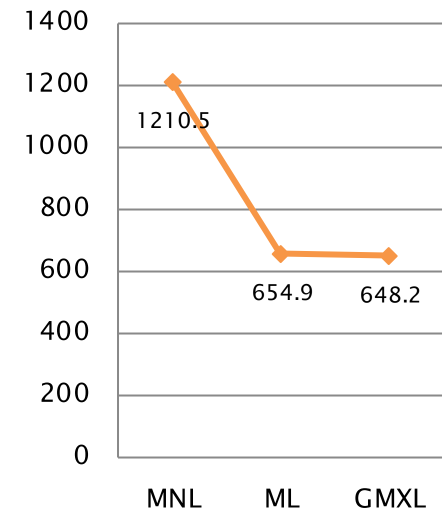
Preferred Measures:

- Lower Log-likelihood, AIC and BIC (Akaike and Bayesian Information Criterion)
- Higher Pseudo R^2









Log Likelihood	Pseudo R2	AIC	BIC
MNL	MNL	MNL	MNL
ML	ML	ML	ML
GMXL√	GMXL√	GMXL√	GMXL√

Summary of Model Results (Choice Set 1*)

	MNL§		ML		GMXL	
Attributes	Coeff.	S. E.	Coeff.	S. E.	Coeff.	S. E.
			Random parameters: Mean			
TIME	**−0.022*****	0.007	−0.006	0.017	−0.098	0.089
FREQ	**0.197***	0.118	**0.489****	0.214	1.377	0.869
			Non-random parameters			
COST	**−0.002*****	0.001	**−0.004*****	0.001	**−0.004*****	0.001
RELIAB	0.018	0.015	**0.090*****	0.026	0.085	0.140
ASCS (Sea)	0.878	0.173	2.571	2.634	1.187	7.233
ASCR (Rail)	−0.227	0.873	0.989	2.159	−0.902	7.800
TIME*NTRUCK	**0.006***	0.003	**0.033****	0.015	**0.072****	0.036
SLIFE (Sea)	**−0.797*****	0.293	0.450	1.320	1.403	3.945
LTSP (Sea)	**0.775*****	0.254	**1.744***	0.990	−1.439	3.308
NTSP (Rail)	**−0.685***	0.407	−1.101	1.905	2.256	8.466
EVOL (Rail)	**−0.677***	0.408	−0.432	1.114	9.056	15.91
LTSP (Rail)	**0.742*****	0.276	1.111	0.801	−1.437	2.308
			Random parameters: Standard Deviation			
TIME	−	−	**0.129*****	0.017	0.068	0.054
FREQ	−	−	**0.967*****	0.127	1.552	1.145
Variance parameter in scale (τ)					0.878**	0.389
Weighting parameter (γ)					0.000	0.478
Sample mean (σ)					0.695	0.885
Model Statistics						
Log Likelihood		−557.36		−273.15		**−263.41**
Pseudo R^2		0.075		0.581		**0.596**
AIC		1144.7		580.3		**564.8**
BIC		1210.5		654.9		648.2
Observations		828		828		828

Main Effects (Mean)

ASCs

Interaction Effects

Main Effects (SD)

Model Statistics

§MNL: All non-random parameters, *** $p<0.01$, ** $p<0.05$, *$p<0.1$

Policy Implication

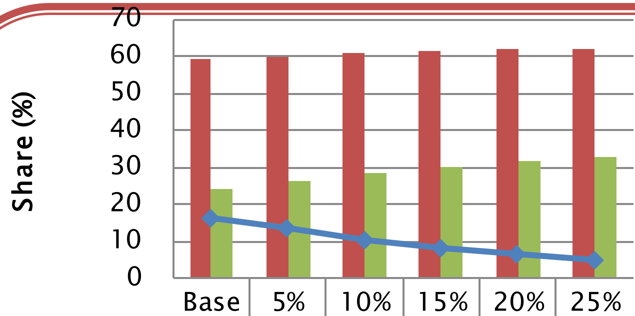
- Estimated Current Mode Shares for Inter-Island Domestic Freight Movement
- Three-Mode Competition (Road vs Rail vs Sea)

	Road	Rail	Sea
Richard Paling Consulting (2008): Inter-island	12.4%	56.8%	30.8%
Rockpoint (2009) : Auckland – Christchurch	19.0%	38.0%	43.0%
This Study (2014) : based on Mixed Logit estimation	16.5%	59.1%	24.4%

- Scenarios
  - Increase Road Transport Cost
  - Decrease Sea & Rail Cost
  - Decrease Sea & Rail Transport Time
  - Increase Sea & Rail Reliability

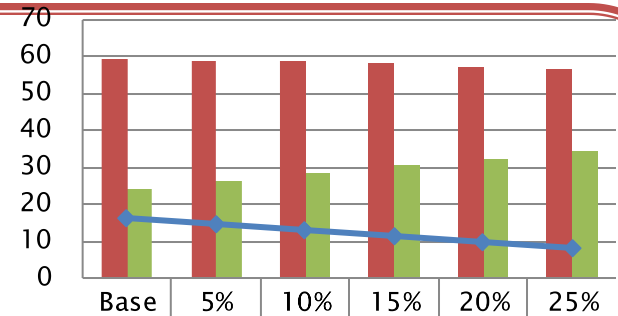
Policy Implications and Modal Shift

Estimations for Road, Sea, and Rail



	Base	5%	10%	15%	20%	25%
Sea	59.14	60.14	60.93	61.52	61.95	62.26
Rail	24.33	26.43	28.38	30.13	31.64	32.88
Road	16.53	13.42	10.69	8.35	6.41	4.86

Scenario 1 :
Increase Road Cost

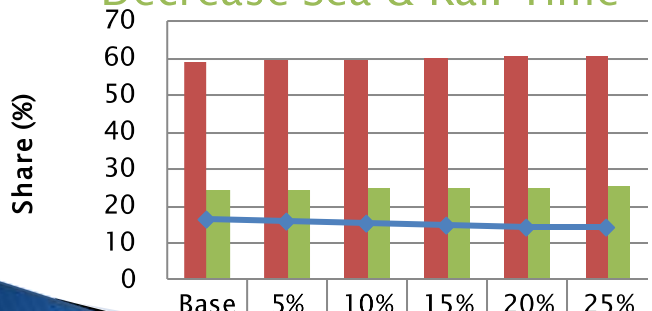


	Base	5%	10%	15%	20%	25%
Sea	59.14	58.93	58.57	58.09	57.48	56.75
Rail	24.33	26.33	28.38	30.48	32.61	34.72
Road	16.53	14.75	13.04	11.43	9.92	8.53

Scenario 2 :
Decrease Sea & Rail Cost

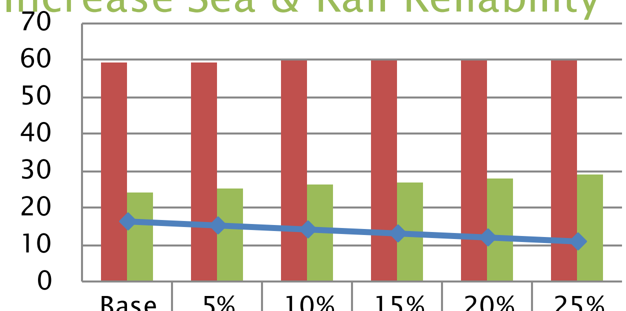
- Long-term Policy

Scenario 3 :
Decrease Sea & Rail Time



	Base	5%	10%	15%	20%	25%
Sea	59.14	59.44	59.74	60.05	60.36	60.67
Rail	24.33	24.59	24.74	[illegible]	25.06	25.17
Road	16.53	16.02	15.52	15.04	[illegible]	[illegible]

Scenario 4 :
Increase Sea & Rail Reliability



	Base	5%	10%	15%	20%	25%
Sea	59.14	59.41	59.64	59.83	59.98	60.10
Rail	24.33	25.27	26.19	27.09	27.96	28.80
Road	16.53	15.32	14.17	13.09	12.06	11.10

- Short-term Policy

Conclusions

- In choice modelling, there is growing interest in incorporating preference heterogeneity and scale heterogeneity
- GMXL model may provide better model fit than ML model and can better explain
  - the behavior of extreme transport users who exhibit near lexicographic preference (i.e. people who care greatly about particular attributes)
  - the behavior of highly random customers whose choices are relatively insensitive to service attributes (i.e. people who have small attribute weights or a large scale of the error term)

New research topic?

Modal shift research to sustainable transport modes

Urban freight transport demand model