Wellington Transport Strategy Model

TN17.1 Distribution and Mode Choice Report Final

Beca

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Final

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prepared for

Greater Wellington – The Regional Council

By

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Contents

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1. Introduction

The WTSM trip distribution and mode choice models estimate the trip matrices by mode and purpose from the trip ends and network generalised costs. They have been calibrated as 24 hour demand models, in production/attraction format.

Section 2 of this report provides details on the data used in calibration and the statistical approach to model calibration.

The model development involved testing alternative mode choice and distribution hierarchies. As a result the model for home based shopping is a simultaneous distribution and mode choice model while for all other purposes pre-distribution mode choice was the most consistent with the data. All models are also segmented by an appropriate measure of car availability.

This report details the calibration of these models and presents the results for each trip purpose:

- home based work (Section 3),
- home based education (Section 4)
- home based shopping (Section 5)
- home based other (Section 6),
- non home based other (Section 7), and
- employer's business (Section 8).

It was also necessary to consider the best treatment of the slow modes of transport which, being of very short distance, are difficult to represent with accuracy in a strategic model. They are specifically included with car and public transport in the distribution and mode choice models using procedures discussed in detail in Appendix C and also summarily described in the chapters for each purpose.

2. Preliminaries

2.1 Introduction

This section provides some background details relating to the model calibrations. It covers:

- trip matrices,
- generalised costs,
- geographic segmentations,
- statistical methods, model structures and the calibration programme.

2.2 Trip Matrices

Model calibration was based on observed 24 hour trip matrices by mode, purpose and car availability segment. These car availability segments are defined as:

- Captive – 0 cars,
- Competition – 0 < cars < number of adults in household,
- Choice – cars ≥ number of adults in household.

These matrices were best estimates derived from a combination of the household, rail, school and external car surveys (as described in the trip end report). The table below illustrates the expanded trip totals for each of the three modes (car/pt/slow), by car availability and trip purpose. Where car availability segments have been merged due to small sample size or because they have similar travel behaviour characteristics this is shown in the table.

Table 2-1 Expanded Trips - by purpose, mode and car availability

Purpose	Car			PT			Slow		
	Captive	Comp	Choice	Captive	Comp	Choice	Captive	Comp	Choice
HBW	1,326	75,215	110,733	3,568	25,618	11,540	6,272	15,871	6,735
HBEd	623	37,591		3,401	26,082		4,020	19,349	
HBSh	6,828	236,838		7,548	6,633		15,638	28,140	
HBO	7,678	283,856		2,038	6,076		13,223	55,526	
NHBO	7,474	328,057		2,184	7,409		20,827	114,829	
EB	134,575			1,365			17,873		

Note: Comp refers to competition.

2.3 Generalised Costs

The generalised cost specification is documented in the Preliminary Studies Report (2002) and reproduced as Appendix A in this report.

The generalised costs of travel are extracted from the AM and interpeak road and public transport networks. For the model calibration, an appropriate average 24hr generalised cost matrix was calculated for each mode, segment and trip purpose by combining the AM and interpeak cost matrices in proportion to the amount of travel in the peaks and other time periods.

Intrazonal costs, which cannot be derived directly from the transport networks, were computed for each zone as the minimum of:

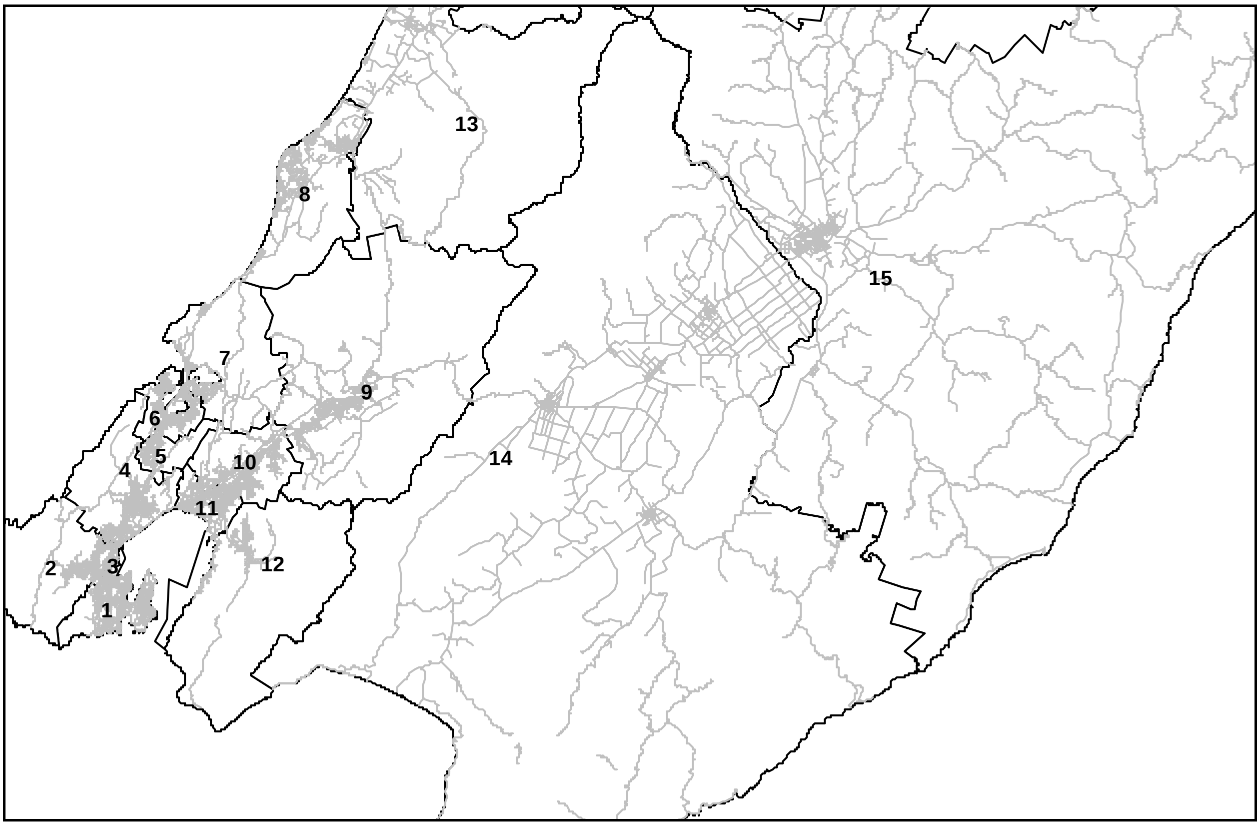
- 5 minutes for car trips and 10 minutes for PT trips, and
- the minimum interzonal cost for journeys to/from the zone.

This approach corresponds with standard international practice. We have ensured an overall correct level of intrazonal trips for each purpose and segment through the estimation of intrazonal constants in the calibration.

2.4 Geographic Segmentations

The standard geographic segmentation is based on 16 sectors system, the 225 internal zones being aggregated into 15 sectors, and the three external zones comprising sector 16. The map in Figure 2-1 illustrates the sector system.

Figure 2-1 WTSM 16 Sector System



The table below shows which TLA each sector resides in. In some instances, a sector crosses a TLA boundary, but generally this is limited only to a handful of zones, and the TLA has been allocated based on the majority of zones.

■ **Table 2-2 Sector to TLA Conversion**

Sector	TLA	Sector	TLA
1	Wellington City	9	Upper Hutt City
2	Wellington City	10	Lower Hutt City
3	Wellington City	11	Lower Hutt City
4	Wellington City	12	Lower Hutt City
5	Wellington City	13	Kapiti Coast District
6	Porirua City	14	Carterton/South Wairarapa
7	Porirua City	15	Carterton/South Wairarapa
8	Kapiti Coast District	16	External

This sector system has been used primarily for reporting and checking purposes. In the calibration, we have usually distinguished the CBD (sector 3), and urban (sectors 1-7 and 9-12) from rural sectors (sectors 8, 13-16) leading to the maximum set of possible person and geographic segmentations illustrated in Table 2-3 below.

■ **Table 2-3 The Basic Model Segmentation**

Sector	Captive PT	Competition		Choice	
		Car	PT	Car	PT
Intrasector Rural					
Intrasector Urban					
Intra TLA					
Other					
CBD Attraction					

Note: slow modes are initially combined with either PT or car, as specified for each trip purpose in later sections.

2.5 Statistical Methods, Model Structures and the Calibration Programme

The mode choice models have been estimated using LIMDEP while the distribution models (and simultaneous distribution/mode choice models) have been calibrated using SKM's custom written software (in Delphi) based on maximum likelihood techniques.

The typical output for each model includes an estimate of the t-statistics for each parameter. As the statistics reported are for the expanded sample, they exaggerate the model fit. The appropriate adjustment factor is the square root of the overall sampling factor (ie $\sqrt{40}$), or 6 in this case. This scales the t-statistic to what we would obtain from the unexpanded sample. Rather than adjusting each t-statistic, we have instead adopted a critical t-value of 12 (which is simply 6 times the usual criterion of 2) in testing for the significance of model parameters at the 95% level.

In addition to the above test, we have provided further information on calibration performance, for the distribution models in the form of observed versus modelled cost distributions, and observed versus modelled sector to sector trips, while for the mode choice models as observed versus modelled mode shares by production sector. These graphical comparisons are provided for each purpose and segment separately and indicate clearly the model fit. Furthermore we have also provided a tabular summary for each purpose in Appendix D.

For the plots of modelled and observed trips by purpose and segment, we have annotated a 95% confidence range. This range is derived from the average sampling

factor and decreases in percentage terms as the observed trips increase. Mathematically it is expressed as:
Insert formula here.

This 95% confidence range highlights a further issue, model fit for small sector to sector totals. The range on the performance plots indicates the confidence range around the observed totals. If the modelled totals fall within this range, the observed and modelled are not statistically different. In a number of cases the model fit for very small totals falls outside the 95% range. While we have endeavoured to ensure a robust model fit across all of the data, we have concentrated on improving the fit for the larger movements, reflecting the lesser importance of the smaller totals in the context of the strategic model.

Additionally the performance plots provided throughout this report have different scales, and care must be taken when interpreting the fit. While in some instances the apparent model 'misfit' for small segments appears large, if these were compared to the larger segments on a similar scale, the performance is actually better. Uniform scales have not been adopted to enable the most amount of information to be drawn from the performance plots.

The final models reported herein are the culmination of a work programme which involved calibrating different model structures for each purpose to establish the optimum fit to the data and to meet theoretical requirements on the relative sizes of model parameters in a hierarchical choice model. Appendix B gives the mathematical specifications of pre-distribution mode choice, post-distribution mode choice and simultaneous distribution and mode choice models.

These tests involved calibrating both pre- and post-distribution mode choice model structures. Our hierarchy test required the cost parameters to increase in magnitude the further they were applied down the model hierarchy tree. Thus for pre-distribution mode choice we required a larger distribution parameter for each purpose and vice versa for the post-distribution hierarchy. While every model test did not converge, those that were successful did indicate that the pre-distribution structure was preferred for all trip purposes except HBW. For the home based work purpose it was not possible to calibrate either pre- or post-distribution mode choice model structures that were completely satisfactory (in terms of parameter size and sign, and model fit), and the preferred model structure for this purpose is therefore a simultaneous distribution/mode choice model.

Included in this preliminary work was an analysis of how best to address the slow modes in the model structure, which is reported in Appendix C. A number of approaches were investigated, with the final models combining the slow modes with either car or public transport trips (by purpose and segment) as seemed most appropriate from the data . Where we combined trips, the relevant motorised (eg car or public transport) costs were used for trip distribution and the slow mode trips subsequently extracted, the proportion being a function of trip distance.

3. Home Based Work

3.1 Structure

We have adopted a simultaneous mode choice and distribution model (as illustrated in Figure 3-1) for home based work trips in 3 segments: captive (no cars), competition (more adults than cars) and choice (a car for every adult).

For the choice and competition segments, the model estimates separate trip matrices for car and public transport trips. In the case of captive there is no mode choice model, and an all-mode trip matrix is output; fixed factors subsequently allocate the trips between slow modes, public transport and car (there is a small proportion of captive car trips).

Slow mode trips are combined in the modelling with car for the competition segment, and with public transport for the choice and captive segment. They are subsequently removed using fixed factors related to trip distance.

3.2 Specification

Table 3-1 and Table 3-2 summarise the calibrated model constants and parameter values respectively, which vary by segment, mode and geographical area (See Appendix B for the mathematical specification). Key features of these two tables are as follows:

- for both the competition and choice segments the modal constant applied to the car mode is positive, indicating a preference for car for these segments;
- generally the cost parameters are higher for car compared to public transport (this is probably related to the lower level of generalised trip costs for this mode);
- the CBD cost parameters are usually lower than for the other sectors reflecting the much longer public transport trips attracted to the CBD;
- the order of magnitude of the cost parameters[1] is broadly as would be expected from international experience.

Table 3-1 HBW Sector System - Constants

<table>
<tr><th>Constant</th><th>Captive</th><th>Competition Car Slow</th><th>Competition PT</th><th>Choice Car</th><th>Choice PT Slow</th></tr>
<tr><td>Modal Constant</td><td>NA</td><td>1.754</td><td>0</td><td>0.762</td><td>0</td></tr>
<tr><td>Intrazonal</td><td>-0.0984</td><td>0.708</td><td>-4.240</td><td>0.387</td><td>0.512</td></tr>
<tr><td>Intrasector Rural</td><td rowspan="3">0.763</td><td>1.535</td><td rowspan="3">0.725</td><td rowspan="2">1.569</td><td rowspan="2">0.416</td></tr>
<tr><td>Intrasector Urban</td><td>1.892</td></tr>
<tr><td>Intra TLA</td><td>1.370</td><td>1.012</td><td rowspan="2">0</td></tr>
<tr><td>Other</td><td rowspan="2">0</td><td rowspan="2">0</td><td>0</td><td rowspan="2">0</td></tr>
<tr><td>CBD Attraction</td><td>1.724</td><td>1.064</td></tr>
</table>

Note. The mode choice constants are applied additively to the other constants shown in the table. For example to create the final constant applied to intrazonal competition car/slow trips we need to add 0.0708 and 1.754 to give 2.462.
Intra TLA refers to those Intra-TLA matrix cells that are intersector.

[1] Note: the units of generalised costs are minutes.

■ **Figure 3-1 Home Based Work Model Structure - Simultaneous Model**

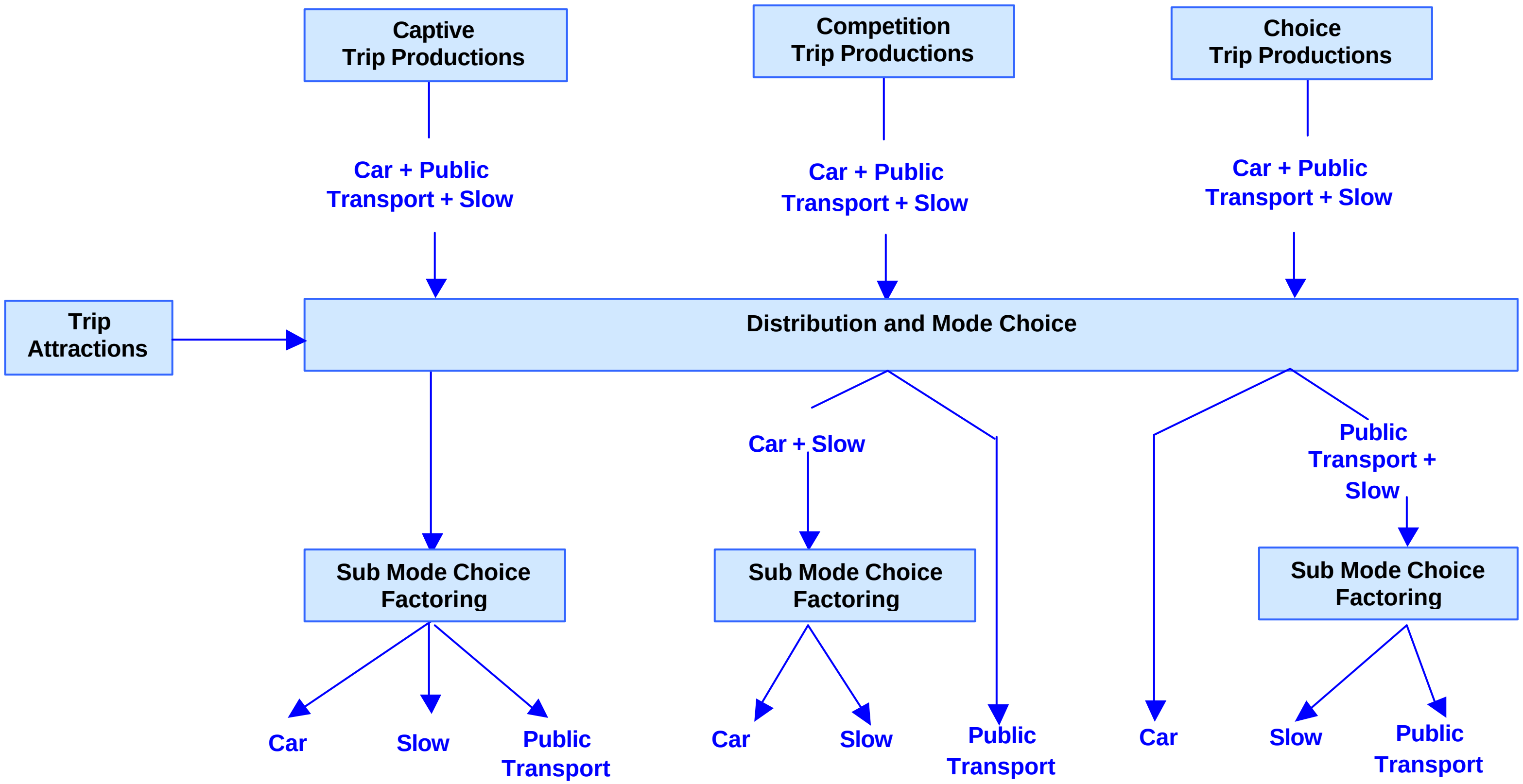


Table 3-2 HBW Sector System - Parameters

<table>
<tr><th>Sector</th><th>Captive</th><th>Competition Car Slow</th><th>Competition PT</th><th>Choice Car</th><th>Choice PT Slow</th></tr>
<tr><td>Intrasector Rural</td><td rowspan="4">-0.0303</td><td>-0.0899</td><td rowspan="4">-0.0215</td><td>-0.0802</td><td rowspan="4">-0.0273</td></tr>
<tr><td>Intrasector Urban</td><td>-0.1175</td><td>-0.0834</td></tr>
<tr><td>Intra TLA</td><td>-0.0857</td><td>-0.0587</td></tr>
<tr><td>Other</td><td rowspan="2">-0.0445</td><td rowspan="2">-0.0391</td></tr>
<tr><td>CBD Attraction</td><td>-0.0292</td><td>-0.0180</td><td>-0.0280</td></tr>
</table>

Table 3-3 and Table 3-4 provide the full statistical detail for the calibration, including parameters, t-statistics and observed and modelled trips and trip costs. They demonstrate the strong statistical significance of most of the constants and parameters.

Table 3-3 HBW Calibrated Constant Values

Segment	Mode	Sector	Constant	T-stat	Observed Trips	Modelled Trips
Competition	Car/Slow	All	1.600	64.1	91086	91347
Choice	Car	All	0.889	45.0	110578	110474
Captive	All	Intra TLA	0.780	38.3	5455	5596
Competition	Car/Slow	Intrasector – Rural	1.445	47.0	11587	11511
Competition	Car/Slow	Intrasector – Urban	1.870	93.9	27780	28191
Competition	Car/Slow	Intra TLA	1.382	60.4	31545	31686
Competition	PT	Intra TLA	0.713	38.9	4395	4349
Competition	PT	CBD and CBD South	1.403	74.7	21990	21531
Choice	Car	Intrasector	1.457	86.6	41856	41839
Choice	Car	Intra TLA	0.971	45.6	35137	35096
Choice	PT/Slow	Intrasector	0.381	15.8	3467	3376
Choice	PT/Slow	CBD	0.995	43.7	12398	12528
Captive	All	Intrazonal	0.222	6.7	1167	1203
Competition	Car/Slow	Intrazonal	0.671	43.2	9843	9908
Competition	PT	Intrazonal	-119.371	-86.9	4	0
Choice	Car	Intrazonal	0.245	15.6	8820	8835
Choice	PT/Slow	Intrazonal	0.475	16.9	1572	1560

Table 3-4 HBW Calibrated Parameter Values

Segment	Mode	Sector	Cost Parameter	T-stat	Observed Trips	Modelled Trips	Observed MTC	Modelled MTC
Captive	All	CBD	-0.0292	62.8	4991	4786	47.4	47.7
		Other	-0.0303	87.8	6174	6379	48.5	47.4
		All			11165	11165	48.0	47.5
Competition	Car/Slow	Intrasector – Rural	-0.0899	63.4	11587	11511	7.3	7.2
		Intrasector – Urban	-0.1175	80.0	27780	28191	7.8	7.8
		Intra TLA	-0.0857	98.7	31545	31686	20.5	20.4
		Other	-0.0445	125.4	20174	19959	46.9	46.7
		All			91086	91346	20.8	20.6
Competition	PT	CBD	-0.0180	136.1	19399	19152	82.3	83.3
		Other	-0.0215	115.2	6220	6205	87.2	87.4
		All			25618	25357	83.5	84.3
Choice	Car	Intrasector – Rural	-0.0802	86.6	17064	17076	10.1	10.1
		Intrasector – Urban	-0.0834	65.7	24791	24763	9.4	9.4
		Intra TLA	-0.0587	74.1	35137	35096	22.8	22.8
		Other	-0.0391	222.1	33586	33538	51.6	51.8
		All			110578	110474	26.6	26.7
Choice	PT/Slow	CBD	-0.0280	111.4	5877	5851	67.6	67.8
		Other	-0.0273	174.0	12398	12528	82.4	82.6
		All			18275	18379	77.6	77.9
All	**All**	**All**			**256722**	**256721**	**34.8**	**34.8**

MTC: mean trip cost (generalised).

3.3 Calibration Performance

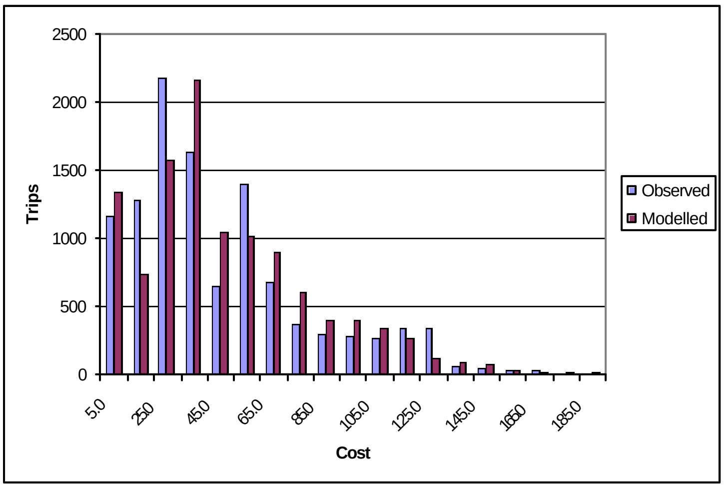
Figure 3-2 to Figure 3-7 illustrate the fit of the calibrated model to the observed and modelled trip cost distributions for the five segments individually and together[2]. Their general features are as follows:

- in general, and particularly for the larger segments, the trip cost distribution fits are good, with some variation for the captive and public transport competition segments;
- combining the segments, the overall fit is very good, as shown in Figure 3-7.

Figure 3-8 to Figure 3-12, demonstrate the fit of the model for the 16 sectors, plotting predicted trips against observed trips for each segment; the 95% confidence bands are also shown. The key features are as follows:

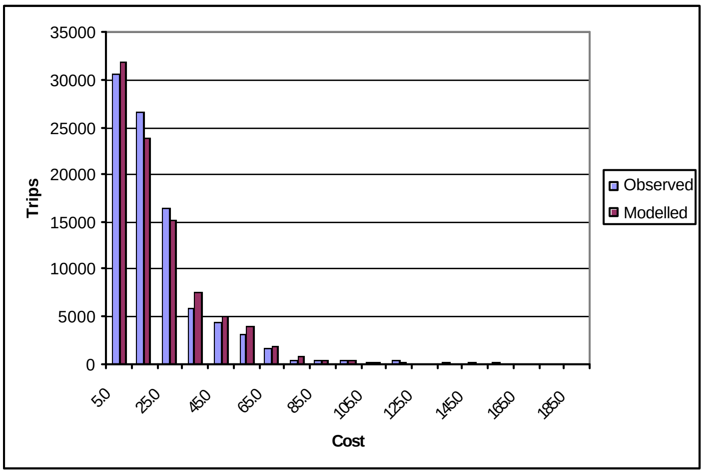
- in general the majority of sector to sector movements fall well within the confidence bands, but there are a number of outliers, particularly for the public transport segments;
- the competition and choice car segments show a particularly good fit to the observed trips at this level of aggregation.

Figure 3-2 HBW Captive Trip Cost Distribution

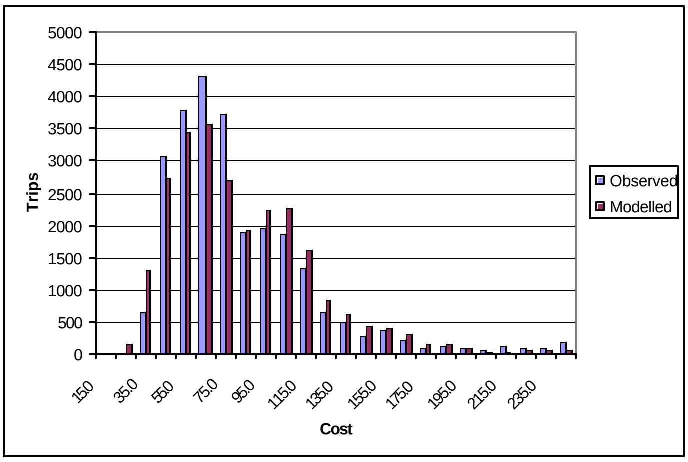


[2] Note that these figures have differing scales.

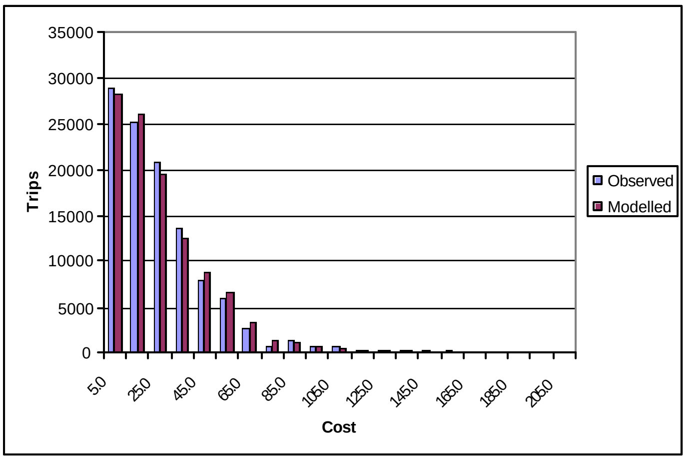
■ Figure 3-3 HBW Competition Car/Slow Trip Cost Distribution



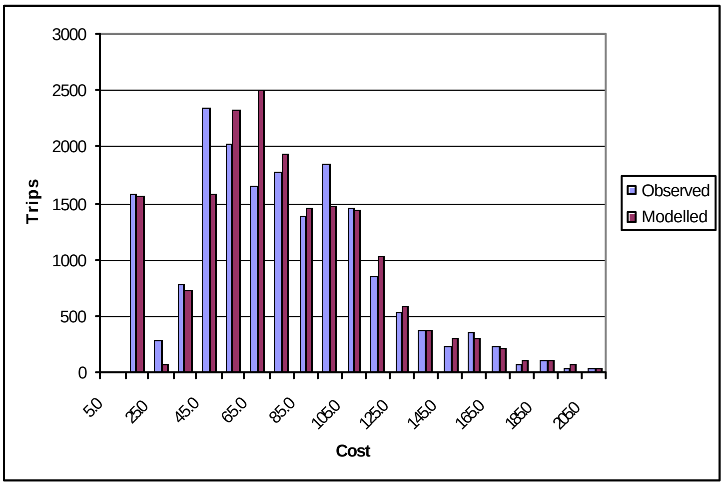
■ Figure 3-4 HBW Competition PT Trip Cost Distribution



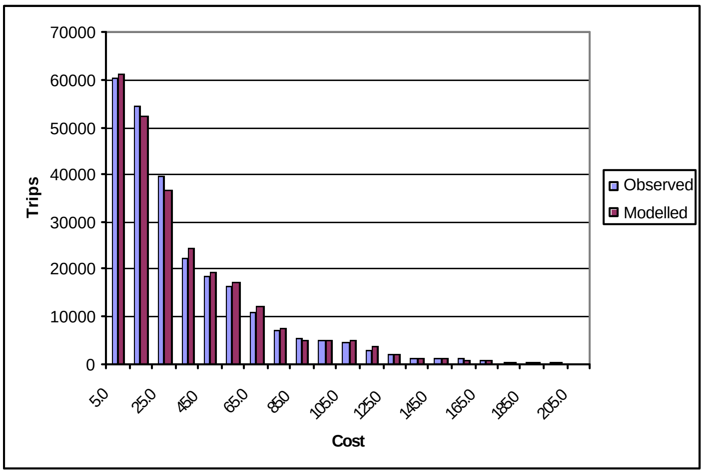
■ Figure 3-5 HBW Choice Car Trip Cost Distribution



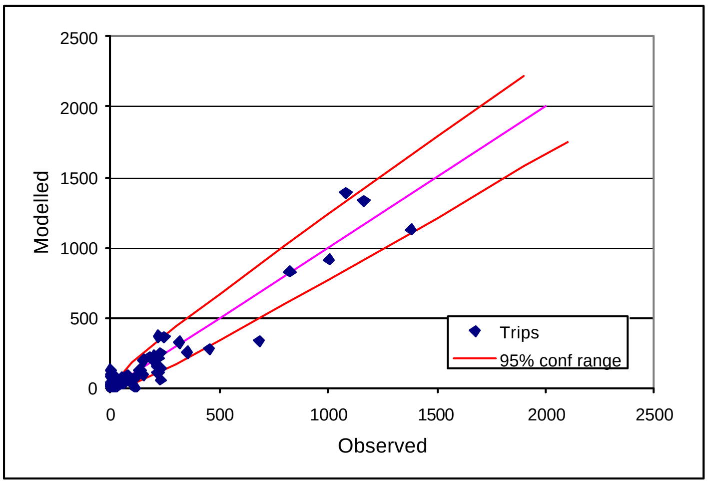
■ **Figure 3-6 HBW Choice PT/Slow Trip Cost Distribution**



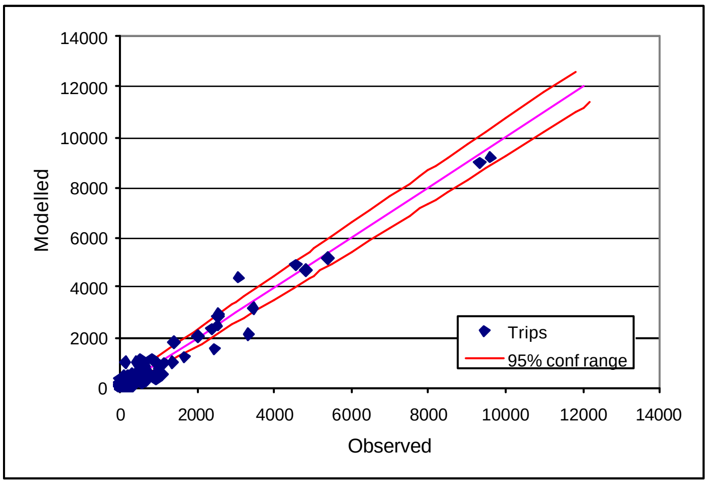
■ **Figure 3-7 HBW All Trip Cost Distribution**



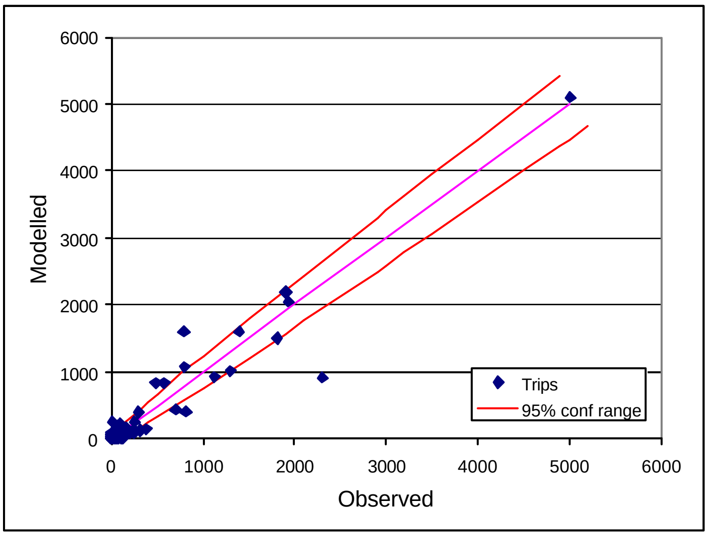
■ **Figure 3-8 HBW Captive Observed vs Modelled Trips**



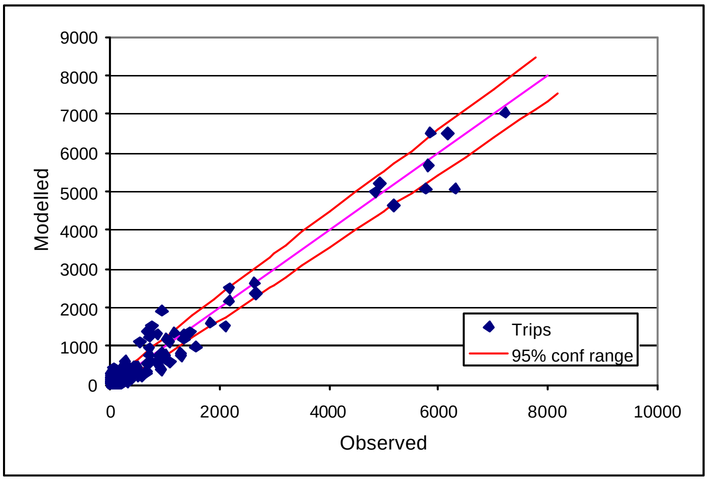
■ **Figure 3-9 HBW Competition Car/Slow Observed vs Modelled Trips**



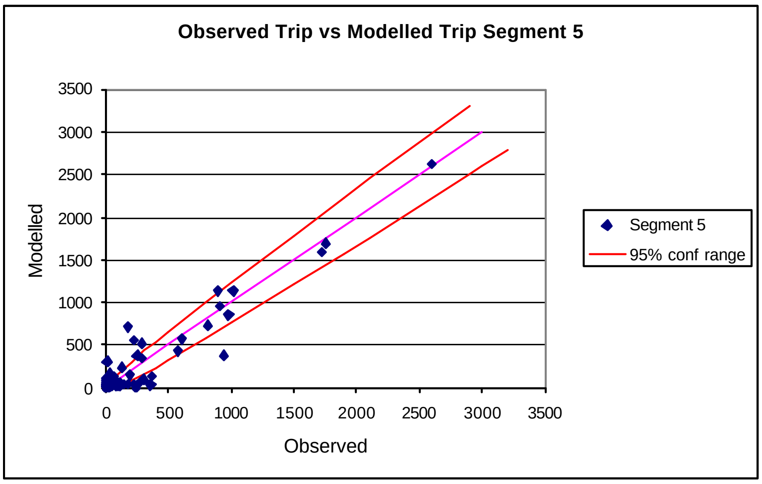
■ **Figure 3-10 HBW Competition PT Observed vs Modelled Trips**



■ **Figure 3-11 HBW Choice Car Observed vs Modelled Trips**



■ **Figure 3-12 HBW Choice PT/Slow Observed vs Modelled Trips**



3.4 Slow Modes

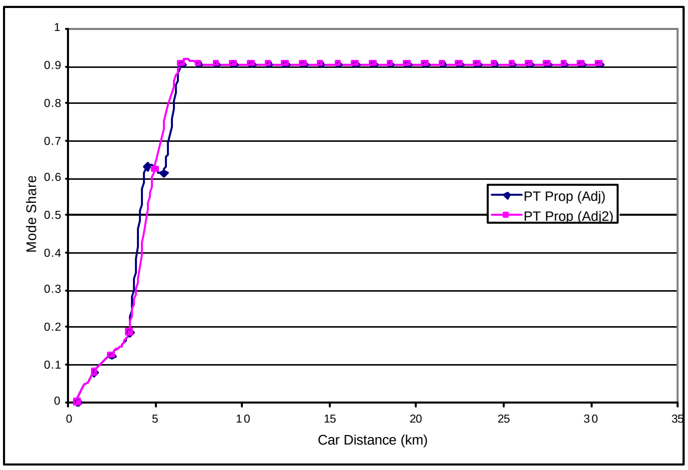
Where slow mode and mechanised (car or public transport) mode trips have been combined in the distribution/mode choice model, slow mode trips have been subsequently factored out of the final synthesised matrices based on the observed share (as a function of distance travelled[3]).

For the combined mechanised[4] and slow mode trips, Figure 3-13 to Figure 3-15 shows how the observed proportion of mechanised trips varies with distance. These observed curves were smoothed in application in the model, as shown in the figures. Intrazonals were allocated a separate, overall average mechanised mode share.

In the case of the captive segment, the mechanised mode included both public transport and car trips and separate proportions were calculated for each.

As is evident from the figures, most slow mode trips (by walk and cycle) are over short distances.

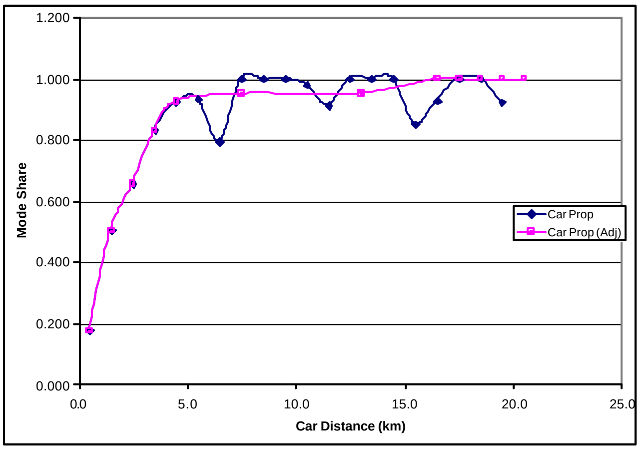
■ **Figure 3-13 HBW Captive Slow Mode Factor**



Auto Dist	Car Prop	PT Prop (Adj)
0 - 1	0.095	0.000
1 - 2	0.095	0.079
2 - 3	0.095	0.125
3 - 4	0.095	0.187
4 - 5	0.095	0.622
5 - 6	0.095	0.622
6 - 7	0.095	0.905
7 - 8	0.095	0.905
8 - 9	0.095	0.905
9 - 10	0.095	0.905
10 - 11	0.095	0.905
11 - 12	0.095	0.905
12 - 13	0.095	0.905
13 - 14	0.095	0.905
14 - 15	0.095	0.905
15 - 16	0.095	0.905
16 - 17	0.095	0.905
17 - 18	0.095	0.905
18 - 19	0.095	0.905
19 - 20	0.095	0.905
>20	0.095	0.905
Intrazonal	0.318	0.000

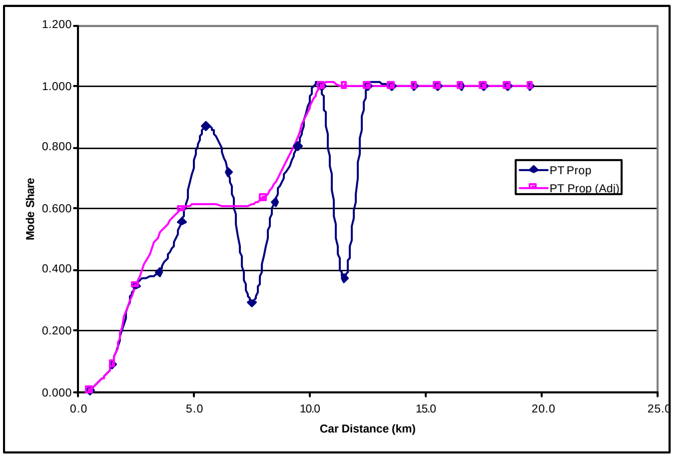
[3] Measured along the road network.
[4] Car or public transport, whichever is appropriate for that particular segment.

Figure 3-14 HBW Competition Slow Mode Factor



Auto Dist	Car Prop (Adj)
0 - 1	0.177
1 - 2	0.504
2 - 3	0.655
3 - 4	0.832
4 - 5	0.925
5 - 6	0.950
6 - 7	0.950
7 - 8	0.950
8 - 9	0.950
9 - 10	0.950
10 - 11	0.951
11 - 12	0.951
12 - 13	0.951
13 - 14	0.951
14 - 15	0.951
15 - 16	0.951
16 - 17	1.000
17 - 18	1.000
18 - 19	1.000
19 - 20	1.000
>20	1.000
Intrazonal	0.685

Figure 3-15 HBW Choice Slow Mode Factor



Auto Dist	PT Prop (Adj)
0 - 1	0.005
1 - 2	0.092
2 - 3	0.349
3 - 4	0.599
4 - 5	0.599
5 - 6	0.599
6 - 7	0.636
7 - 8	0.636
8 - 9	0.636
9 - 10	0.636
10 - 11	1.000
11 - 12	1.000
12 - 13	1.000
13 - 14	1.000
14 - 15	1.000
15 - 16	1.000
16 - 17	1.000
17 - 18	1.000
18 - 19	1.000
19 - 20	1.000
>20	1.000
Intrazonal	0.001

4. Home Based Education

4.1 Structure

We have adopted a pre-distribution mode choice structure as shown in Figure 4-1. This model has two segments: captive and ‘combined choice’ (which combines the choice and competition segments). Combined choice trip productions are first split into car and public transport/slow trips in the mode choice model.

These modally split trip productions are then input to the distribution model, along with captive trips and the overall zonal trip attractions. The final output of the distribution model is three trip matrices, captive public transport/slow, combined choice car and combined choice public transport/slow trips[5].

Slow mode trips are combined with public transport for both the captive and combined choice segments in the trip distribution output and are subsequently removed using fixed factors related to trip distance.

4.2 Distribution Model

4.2.1 Specification

Table 4-1 and Table 4-2 detail the model parameter values and constants for each mode, segment and geographical area. Key features of these tables are:

- the CBD constants are quite large, indicating a general preference for travel to the CBD by public transport,
- for combined choice car trips, the intrasector and intra TLA constants are large, indicating a relatively high proportion of such shorter trips,
- generally the parameters are larger for the car segment (this probably reflects smaller generalised car costs),
- the captive and combined choice PT segments have very similar parameters.

Table 4-1 HBEd Sector System - Constants

<table>
<tr><th>Sector</th><th>Captive</th><th>Combined Choice Car</th><th>Combined Choice PT Slow</th></tr>
<tr><td>Intrazonal</td><td>0.764</td><td>0.135</td><td>0.731</td></tr>
<tr><td>Intrasector Rural</td><td rowspan="2">2.016</td><td>1.883</td><td rowspan="2">1.698</td></tr>
<tr><td>Intrasector Urban</td><td>4.105</td></tr>
<tr><td>Intra TLA</td><td>0.583</td><td>3.707</td><td>0.884</td></tr>
<tr><td>Other</td><td>0</td><td rowspan="2">0</td><td>0</td></tr>
<tr><td>CBD Attraction</td><td>3.511</td><td>2.919</td></tr>
</table>

Table 4-2 HBEd Sector System - Parameters

<table>
<tr><th>Sector</th><th>Captive</th><th>Combined Choice Car</th><th>Combined Choice PT Slow</th></tr>
<tr><td>Intrasector Rural</td><td rowspan="4">-0.0230</td><td>-0.0221</td><td rowspan="4">-0.0246</td></tr>
<tr><td>Intrasector Urban</td><td>-0.2285</td></tr>
<tr><td>Intra TLA</td><td>-0.1938</td></tr>
<tr><td>Other</td><td rowspan="2">-0.0471</td></tr>
<tr><td>CBD Attraction</td><td>-0.0423</td><td>-0.0523</td></tr>
</table>

[5] We have not distinguished the very small number of observed car trips in the captive segment.

■ **Figure 4-1 Home Based Education Model Structure**

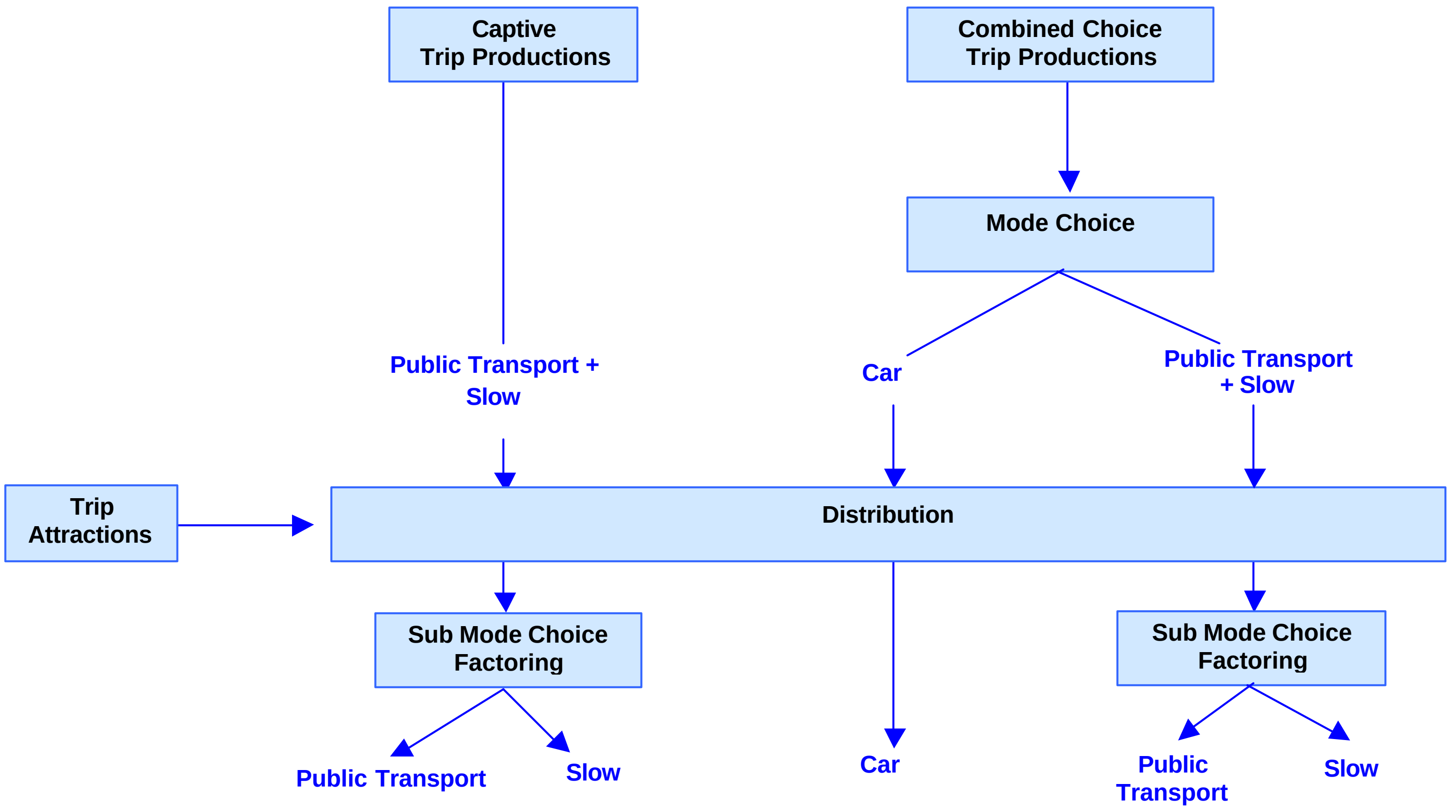


Table 4-3 and Table 4-4 provide the full statistical detail for calibration, including parameters, t-statistics and observed and modelled trips and trip costs. They demonstrate the strong statistical significance of most model constants and parameters.

- **Table 4-3 HBEd Calibrated Constant Values**

Segment	Sector	Constant	T-stat	Observed Trips	Modelled Trips
Captive	Intra Sector	2.016	41.2	5052	5049
Captive	Intra TLA	0.583	9.7	895	896
Captive	CBD	3.511	42.9	1505	1505
Combined Choice Car	Intrasector – Rural	1.883	30.9	5847	5823
Combined Choice Car	Intrasector – Urban	4.105	109.1	19448	19448
Combined Choice Car	Intra TLA	3.707	76.9	8043	8047
Combined Choice PT/Slow	Intrasector	1.698	73.7	27889	27853
Combined Choice PT/Slow	Intra TLA	0.884	38.1	8277	8275
Combined Choice PT/Slow	CBD	2.919	60.0	3567	3574
Captive	Intrazonal	0.764	13.3	1387	1387
Combined Choice Car	Intrazonal	0.135	6.2	5065	5057
Combined Choice PT/Slow	Intrazonal	0.731	29.2	8856	8842

- **Table 4-4 HBEd Calibrated Parameter Values**

Segment	Sector	Cost Parameter	T-stat	Observed Trips	Modelled Trips	Observed MTC	Modelled MTC
Captive	CBD	-0.0423	55.3	1505	1505	72.2	72.2
	Other	-0.0230	45.1	6483	6482	67.6	67.7
	All			7988	7987	68.5	21.6
Combined Choice Car	Intrasector – Rural	-0.0221	12.7	5847	5823	8.6	8.5
	Intrasector – Urban	-0.2285	82.9	19448	19448	6.3	6.3
	Intra TLA	-0.1938	73.6	8043	8047	11.6	11.6
	Other	-0.0471	70.8	4252	4272	39.6	40.2
	All			37590	37590	11.6	11.6
Combined Choice PT/Slow	CBD	-0.0523	101.2	3567	3574	65.5	65.6
	Other	-0.0246	104.3	41864	41847	70.1	70.3
	All			45431	45422	69.8	70.0
All	**All**			**91008**	**90999**	**45.6**	**45.7**

MTC: mean trip cost (generalised).

4.2.2 Calibration Performance

Figure 4-2 to Figure 4-5 illustrate the fit of the calibrated model to the observed and modelled trip cost distributions for the three segments individually and together. Their general features are as follows:

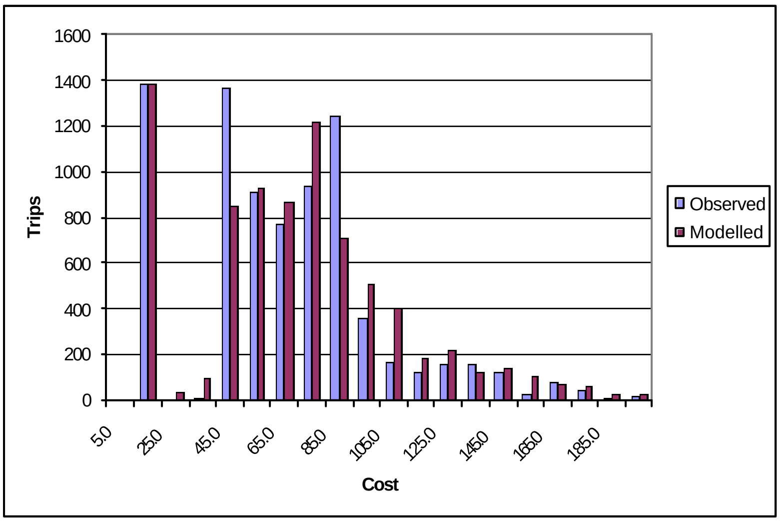
- overall the fit is very good as shown in Figure 4-5,
- for the large combined combined choice car segment the trip distribution fit is good, however there is some variation for the public transport segments, most noticeably in the shorter trips.

Figure 4-6 to Figure 4-8 demonstrate the fit of the model at a 16 sector to sector level, plotting predicted trips against observed trips for each segment. The 95% confidence bands are also demonstrated on the plots. The key features are:

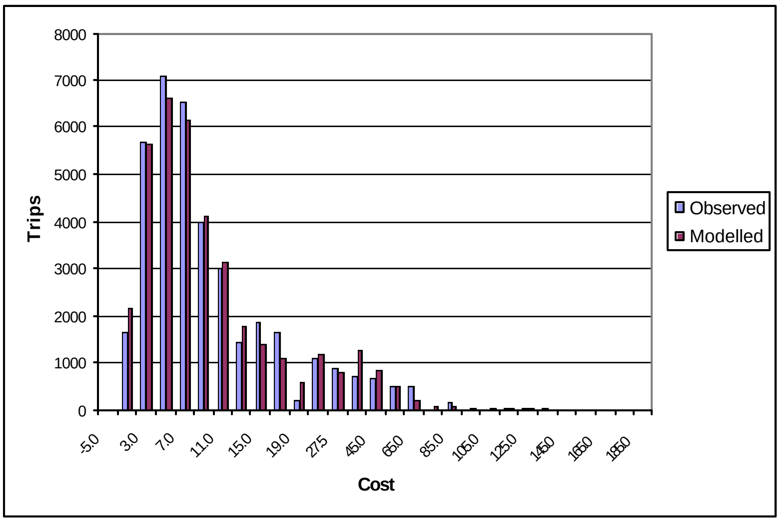
- generally the majority of the points lie within the 95% confidence range,
- the public transport segments have a few outliers, but they are small in absolute terms.

While it appears the fit for the HBEd captive segment is poor relative to the other segments, the captive segment only represents approximately 10% of the total education trips. The education matrix is very sparse, with only a smaller number of discreet attractors. This is particularly the case for tertiary attracted trips. Generally conventional gravity models have difficulty in accurately reflecting this discreet distribution of trips and while a more sophisticated approach may improve the model performance, it was rejected, as the size of this segment did not justify the additional cost.

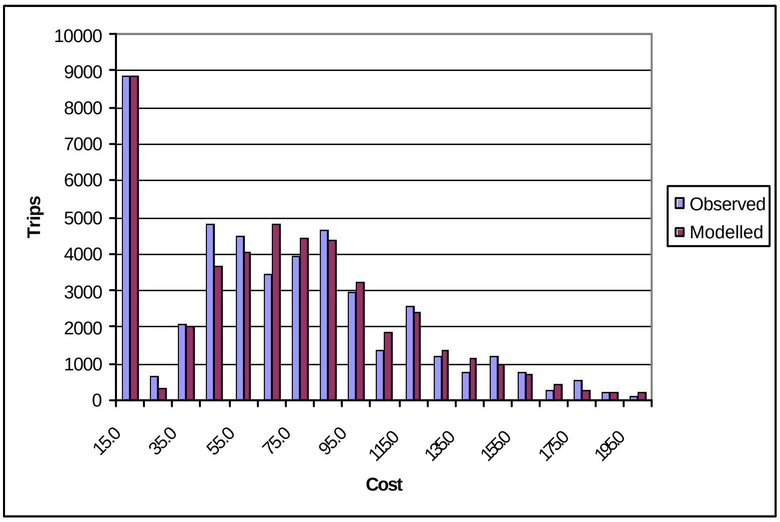
- **Figure 4-2 HBEd Captive Trip Cost Distribution**



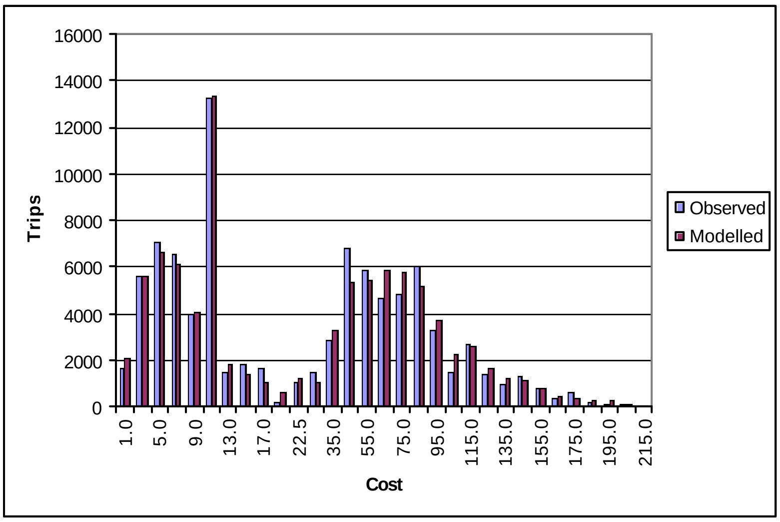
- **Figure 4-3 HBEd Combined Choice Car Trip Cost Distribution**



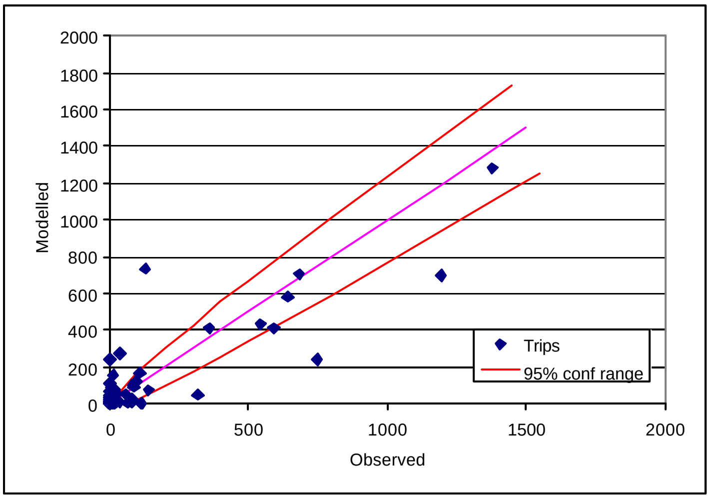
■ Figure 4-4 HBEd Combined Choice PT/Slow Trip Cost Distribution



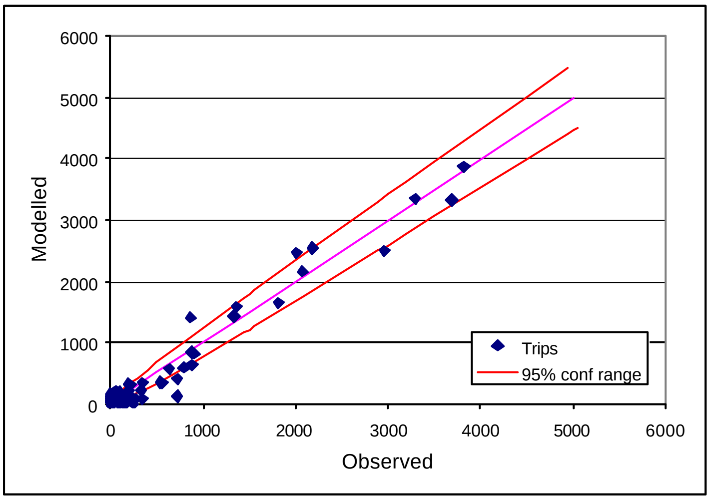
■ Figure 4-5 HBEd All Trip Cost Distribution



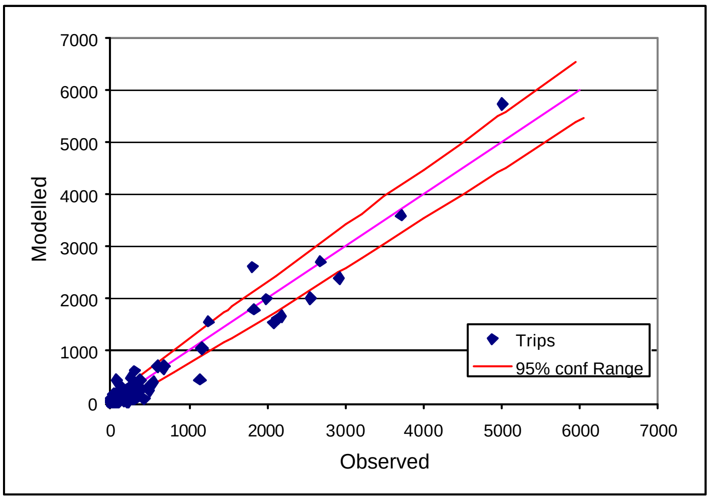
■ Figure 4-6 HBEd Captive Observed vs Modelled Trips



■ **Figure 4-7 HBEd Combined Choice Car Observed vs Modelled Trips**



■ **Figure 4-8 HBEd Combined Choice PT/Slow Observed vs Modelled Trips**



4.3 Mode Choice Model

4.3.1 Specification

The trip end (production) mode choice model has been calibrated for the combined choice segment, to produce car and public transport/slow trips.

The final calibrated parameters are shown in Table 4-5. The t-statistics indicate the good statistical fit of the model. The key findings are:

- both of the cost parameters are negative and less than 1 in absolute value; these are requirements for a pre-distribution mode choice model to be appropriate,
- the car cost parameter is larger than the public transport cost parameter,

- the public transport modal constant is positive, reflecting the high usage of public transport for education trips mainly to Wellington city, whereas the reverse is true for the other TLAs.

Table 4-5 HBEd Mode Choice Parameter Values and Constants

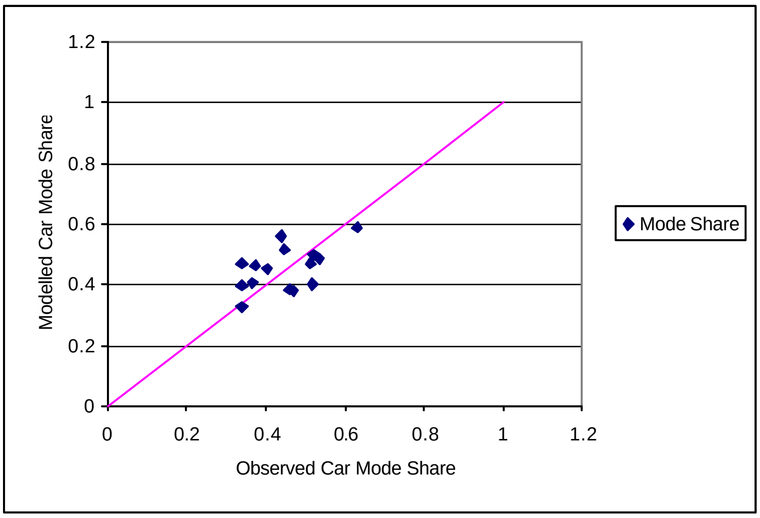
Parameter / Constant	Value	T-statistic
Car Cost Parameter (BCAR)	-0.3412	-24.1
PT Modal Constant (APT)	0.9435	31.9
PT Cost Parameter (BPT)	-0.2303	-15.9
TLA Constant 1 (Carterton, Masterton, South Wairarapa)	-1.1806	-36.7
TLA Constant 2 (Kapiti Coast, Lower Hutt, Porirua)	-0.4715	-28.2

4.3.2 Calibration Performance

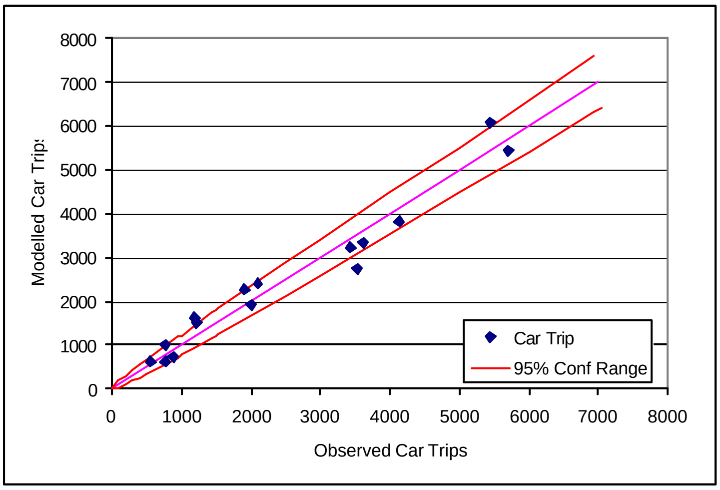
Figure 4-9 to Figure 4-11 demonstrate the fit of the mode choice model for the combined choice HBEd model. The key observations are:

- the predicted versus observed mode share as shown in Figure 4-9 is reasonable,
- this reasonable fit is replicated in the observed versus modelled figures for trips in each sector by mode in Figure 4-10 and Figure 4-11, where the majority of the points lie within the 95% confidence ranges.

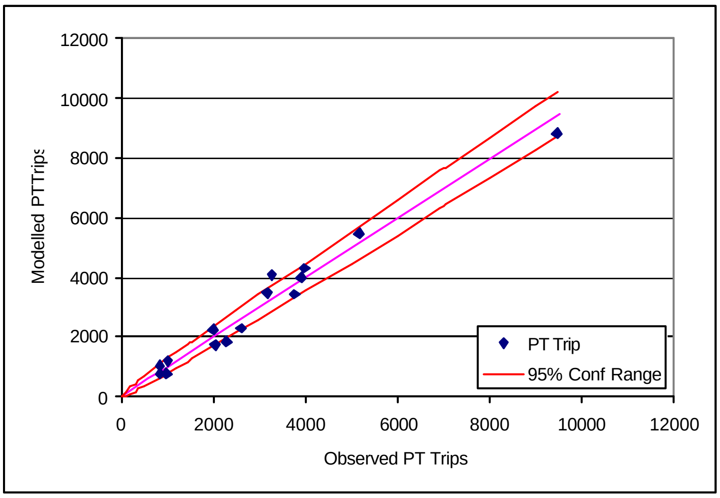
Figure 4-9 HBEd Combined Choice Observed vs Modelled Car Proportions



- **Figure 4-10 HBEd Combined Choice Observed vs Modelled Car Trips**



- **Figure 4-11 HBEd Combined Choice Observed vs Modelled PT Trips**



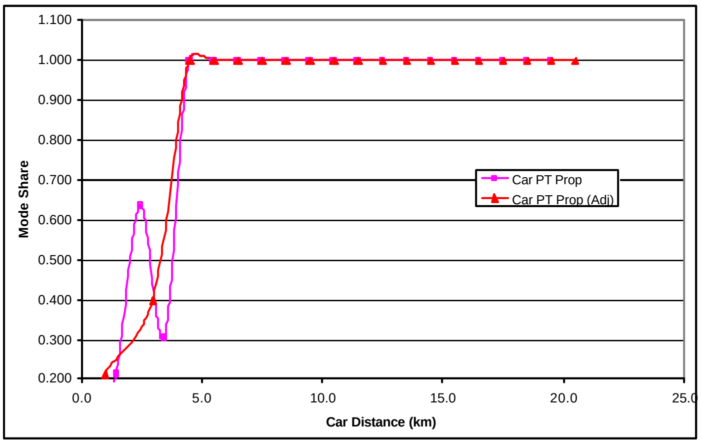
4.4 Slow Mode Factors

Where slow mode and public transport mode trips have been combined in the distribution/mode choice model, slow mode trips have been subsequently factored out of the final synthesised matrices based on the observed share (as a function of distance travelled[6]).

Figure 4-12 and
Figure 4-13 show how the observed proportions of public transport trips out of the combined public transport and slow mode total varies with distance. These observed curves were smoothed in application in the model, as shown in the figures. Intrazonals were allocated a separate, average slow mode share.

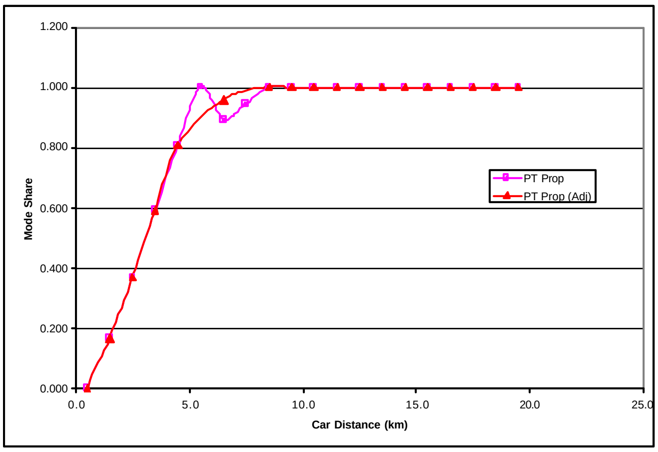
[6] Measured along the road network.

■ Figure 4-12 HBEd Captive Slow Mode Factor



Auto Dist	CarPT Prop (Adj)
0 - 1	0.212
1 - 2	0.212
2 - 3	0.395
3 - 4	0.395
4 - 5	1.000
5 - 6	1.000
6 - 7	1.000
7 - 8	1.000
8 - 9	1.000
9 - 10	1.000
10 - 11	1.000
11 - 12	1.000
12 - 13	1.000
13 - 14	1.000
14 - 15	1.000
15 - 16	1.000
16 - 17	1.000
17 - 18	1.000
18 - 19	1.000
19 - 20	1.000
>20	1.000
Intrazonal	0.018

■ Figure 4-13 HBEd Combined Choice Slow Mode Factor



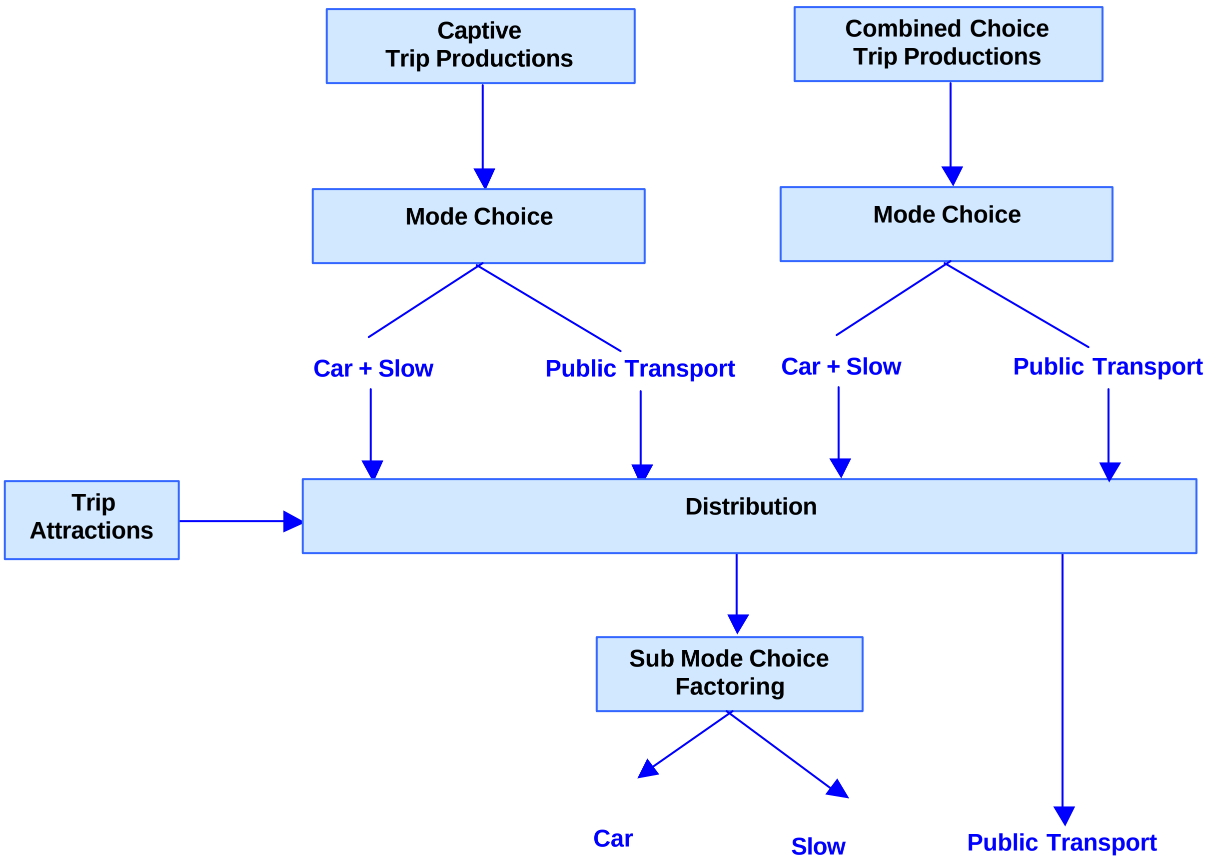
Auto Dist	PT Prop (Adj)
0 - 1	0.000
1 - 2	0.167
2 - 3	0.370
3 - 4	0.591
4 - 5	0.807
5 - 6	0.957
6 - 7	0.957
7 - 8	0.957
8 - 9	1.000
9 - 10	1.000
10 - 11	1.000
11 - 12	1.000
12 - 13	1.000
13 - 14	1.000
14 - 15	1.000
15 - 16	1.000
16 - 17	1.000
17 - 18	1.000
18 - 19	1.000
19 - 20	1.000
>20	1.000
Intrazonal	0.037

5. Home Based Shopping

5.1 Structure

The structure shown in Figure 5-1 has been adopted for the home based shopping model. This is a pre-distribution mode choice model structure. We have calibrated a trip end mode choice model to produce public transport and car/slow trips by zone for the captive and combined choice segments. The car trips for each car availability segment have then be combined, as have the public transport trips prior to input to the distribution model (which is segmented by mode of transport).

■ **Figure 5-1 Home Based Shopping Model Structure**



5.2 Distribution Model

5.2.1 Specification

Table 5-1 and
Table 5-2 give the calibrated distribution constants and parameters. The key results are:

- the car (& slow) parameters are larger than the public transport parameters;
- parameters are larger for the shorter trips, eg intrasector and intra TLA trips;

- the constants for the car segment are quite large, particularly for intrasector urban, indicating the relative attractiveness of this mode of transport;
- the intrazonal constant for public transport is negative, there being very few public transport intrazonal trips in the observed data.

Table 5-1 HBSh Sector System - Constants

Sector	Car / Slow	PT
Intrazonal	0.349	-1.455
Intrasector Rural	1.914	1.564
Intrasector Urban	4.183	
Intra TLA	2.958	1.177
Other	0	0
CBD Attraction		1.093

Table 5-2 HBSh Sector System - Parameters

Sector	Car / Slow	PT
Intrasector Rural	-0.1089	-0.0408
Intrasector Urban	-0.2491	
Intra TLA	-0.1533	
Other	-0.0558	
CBD Attraction		

Table 5-3 and Table 5-4 detail the full statistical results for the final calibrated model, including parameters, t-statistics and mean trip costs observed and modelled.

Table 5-3 HBSh Calibrated Constant Values

Segment	Sector	Constant	T-stat	Observed Trips	Modelled Trips
Car/Slow	Intrasector Rural	1.914	71.3	52237	52134
Car/Slow	Intrasector – Urban	4.183	217.0	158504	158480
Car/Slow	Intra TLA	2.958	134.8	53209	53265
PT	Intra Sector	1.564	28.1	6501	6496
PT	Intra TLA	1.177	21.2	3191	3189
PT	CBD	1.093	20.2	3915	3930
Car/Slow	Intrazonal	0.349	39.6	60157	60113
PT	Intrazonal	-1.455	-30.9	674	672

Table 5-4 HBSh Calibrated Parameter Values

Segment	Sector	Cost Parameter	T-stat	Observed Trips	Modelled Trips	Observed MTC	Modelled MTC
Car/Slow	Intrasector – Rural	-0.1089	99.0	52237	52134	7.7	7.7
	Intrasector – Urban	-0.2491	216.2	158504	158479	5.8	5.8
	Intra TLA	-0.1533	194.9	53209	53265	15.0	15.0
	Other	-0.0558	150.5	23106	23177	40.6	40.8
	All			287056	287056	10.7	10.7
PT	All	-0.0408	85.6	14181	14180	63.0	63.1
All	**All**			**301237**	**301236**	**13.1**	**13.1**

5.2.2 Calibration Performance

Figure 5-2 to Figure 5-4 illustrate the modelled and observed cost distributions for car (& slow), public transport and all-mode trips respectively.

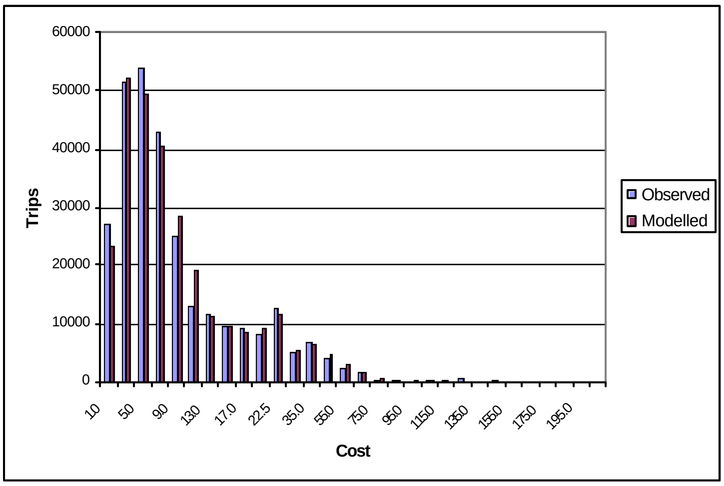
The key findings are:

- the modelled car trip cost distribution is a very good fit to the observed,
- the public transport trip cost distribution fit is also good, allowing for the small trip numbers involved, and
- the overall fit to the observed trip cost distribution is very good.

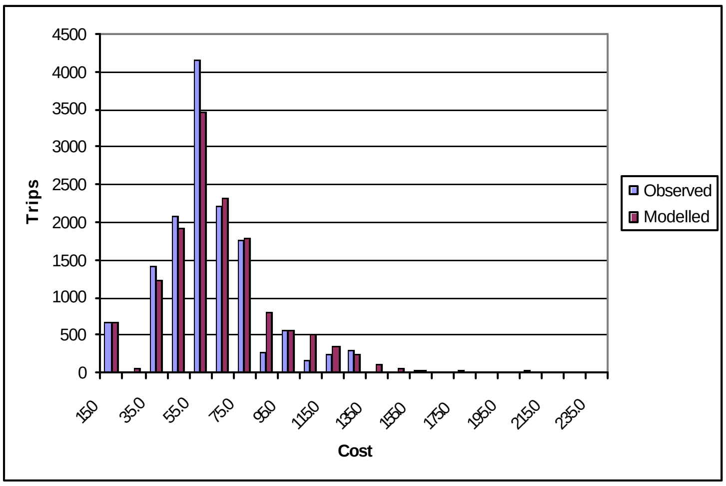
Figure 5-5 and Figure 5-6 demonstrate the fit of the modelled trips to the observed trips in an aggregate 16 sector to sector format. The 95% confidence limits are also shown on the plots. The key results are:

- generally the fit is very good, particularly for the car (& slow) segment,
- the public transport fit, while still good, has a number of points that lie just outside the 95% confidence range.

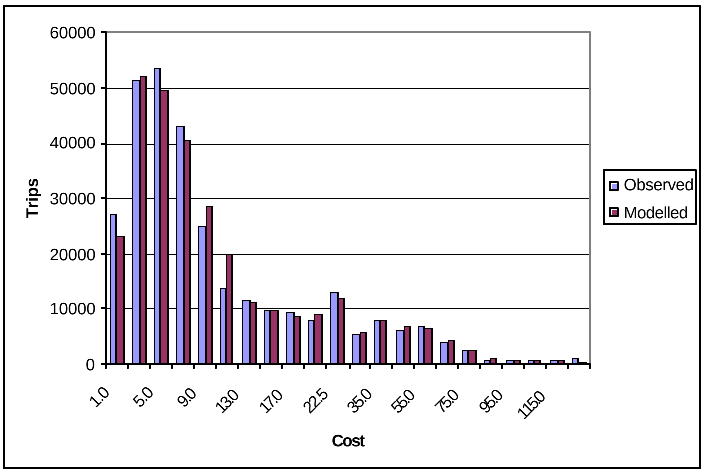
■ **Figure 5-2 HBSh Car/Slow Trip Cost Distribution**



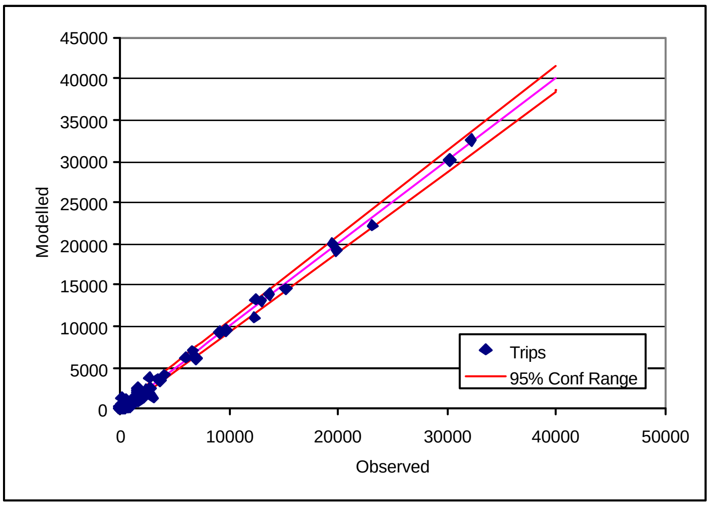
■ **Figure 5-3 HBSh PT Trip Cost Distribution**



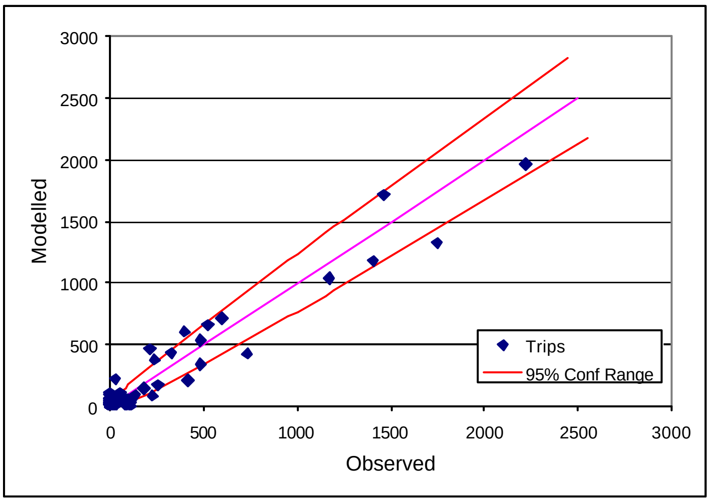
■ **Figure 5-4 HBSh All Trip Cost Distribution**



■ **Figure 5-5 HBSh Car/Slow Observed vs Modelled Trips**



■ **Figure 5-6 HBSh PT Observed vs Modelled Trips**



5.3 Mode Choice Model

5.3.1 Specification

A production zone mode choice model has been calibrated, to estimate the split between car/slow and public transport trips. The model has been segmetned by car availability, with the captive and combined choice segmetns sharing the cost parameters and TLA constants, but differing though an additional mode choice constant, CCAPT, applicable to the car mode for the captive segment.

Table 5-5 provides the calibration results for the Home Based Shopping mode choice model.

The key results are:

- both parameters are negative and less than 1 in absolute value, as required for the model hierarchy;
- the two cost parameters of -0.4546 and -0.5201 are quite similar for car and pt respectively;
- the negative mode constants for the three TLA groups indicates that the public transport mode shares for these groups is less than Wellington TLA;
- a large positive CCAPT constant indicates a strong preference for car for the captive segment;
- all parameters are statistically significant with t-statistics greater than 12.

■ **Table 5-5 HBSh Parameter Values and Constants**

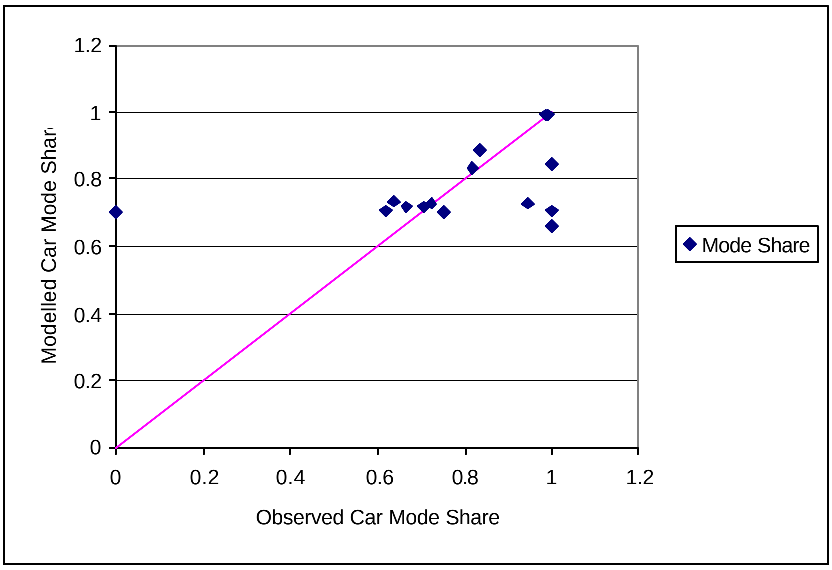
Paramete / Constantr	Value	T-statistic
Car Cost Parameter (BCAR)	-0.4546	-15.9
Captive Constant (CCAPT)	2.489	-134.0
PT Modal Constant (APT)	1.9614	-19.6
PT Cost Parameter (BPT)	-0.5201	-14.9
TLA Constant 1 (Carterton, Masterton, South Wairarapa)	-4.2147	-23.3
TLA Constant 2 (Kapiti Coast, Upper Hutt)	-1.0701	-30.8

5.3.2 Calibration Performance

Figure 5-7 and Figure 5-8 below illustrate the fit of the predicted mode shares to the observed at the 16 sector level for the captive and combined choice segments. The key observations are:

- the mode shares for the combined choice segment indicate a very high car mode share in the observed data that is well predicted by the model for each of the 16 sectors.

■ **Figure 5-7 HBSH Captive Observed vs Modelled Car Proportions**



■ **Figure 5-8 HBSH Combined Choice Observed vs Modelled Car Proportions**

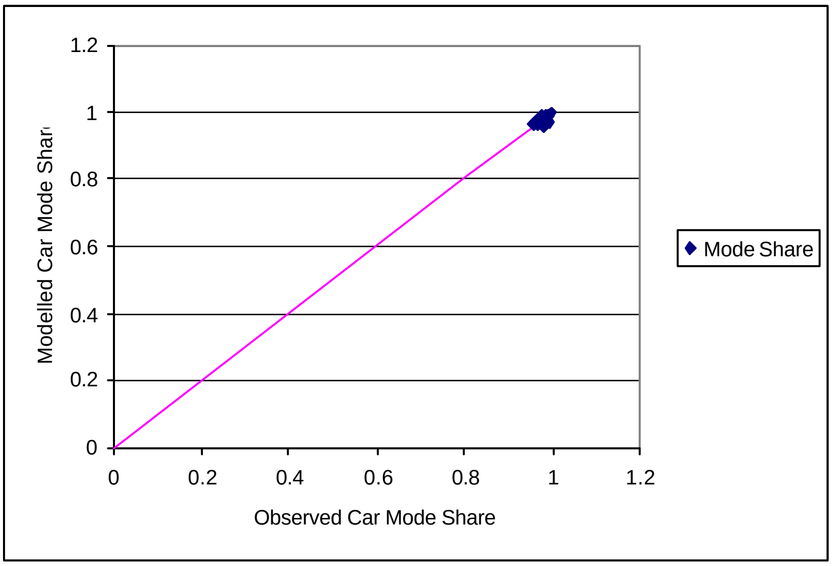
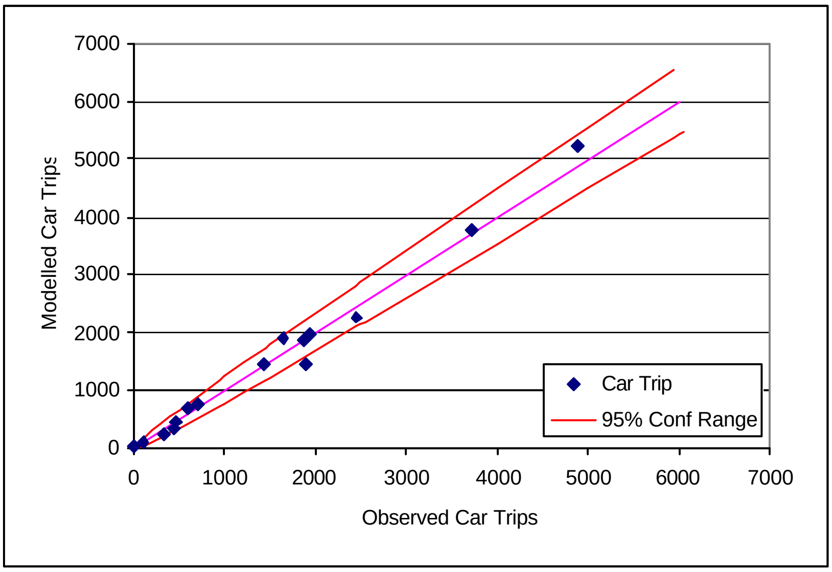


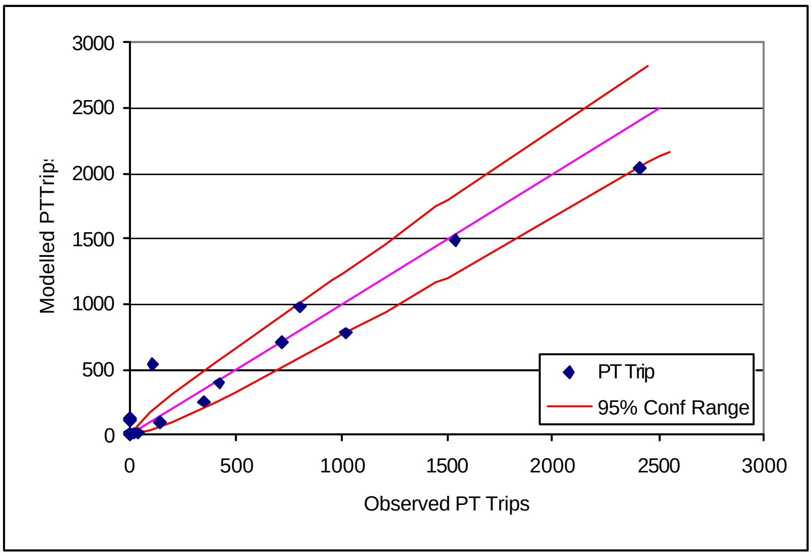
Figure 5-9 through to Figure 5-12 illustrate the predicted trips for each segment and mode against the observed trips. The findings are:

- Generally the fits shown are very good, particularly for combined choice car/slow trips, and
- the few outliers evident in the public transport plots are for very small trip numbers, and do not influence the overall good fit of this model.

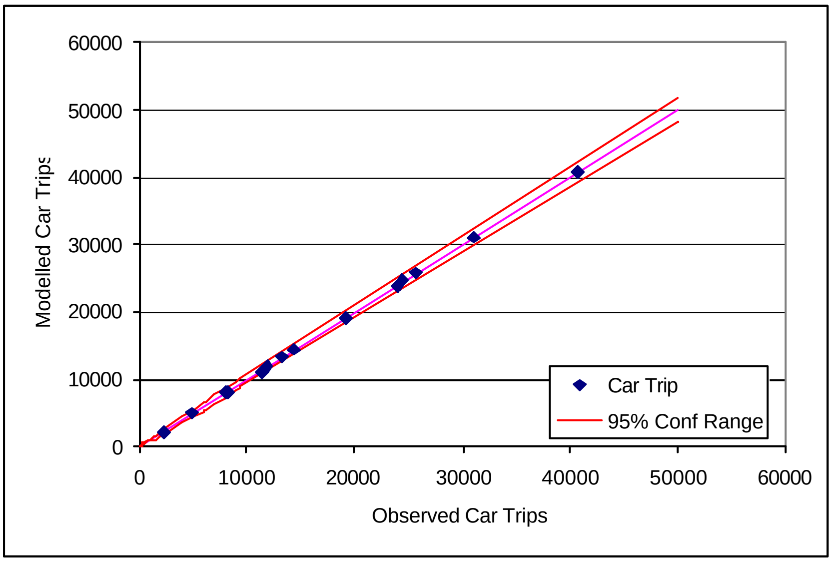
■ Figure 5-9 HBSH Captive Observed vs Modelled Car Trips



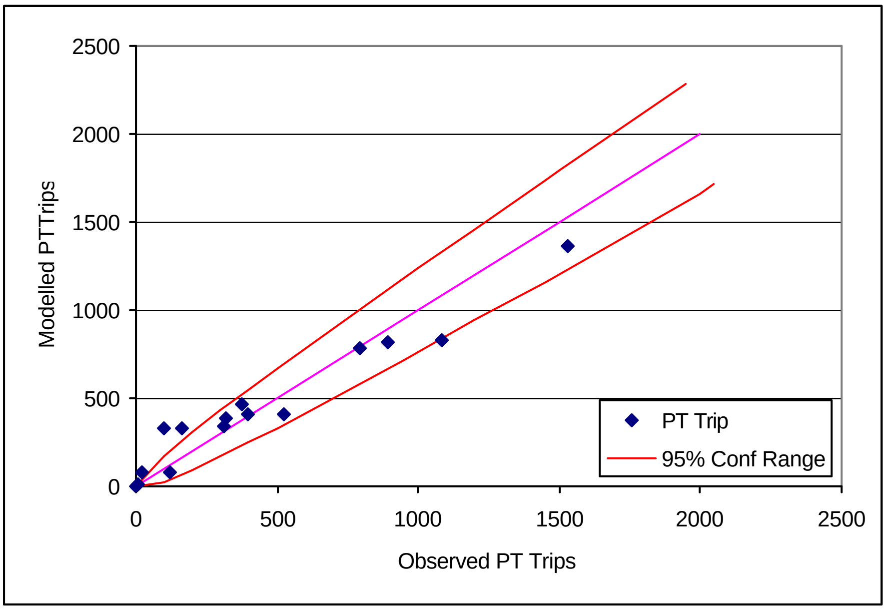
■ Figure 5-10 HBSH Captive Observed vs Modelled PT Trips



■ **Figure 5-11 HBSH Combined Choice Observed vs Modelled Car Trips**



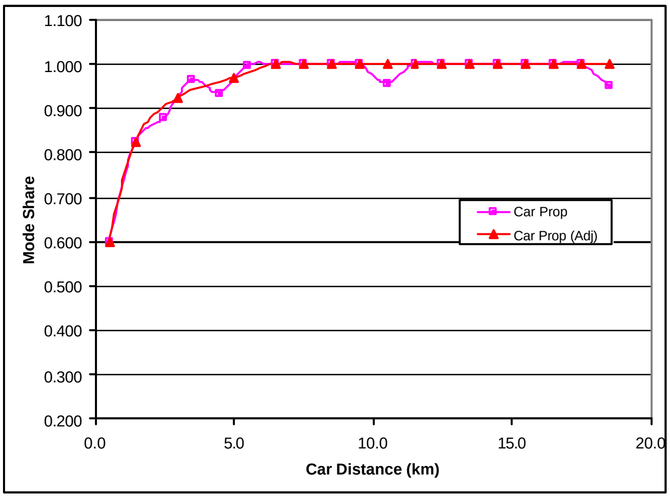
■ **Figure 5-12 HBSH Combined Choice Observed vs Modelled PT Trips**



5.4 Slow Mode Factors

As for the other purposes where slow mode and car trips have been combined for the distribution and mode choice models, slow mode trips have been extracted from the synthesised trip matrix based on factors that are a function of trip distance. Figure 5-13 reports the slow mode factors that have been calculated for the home based shopping model. This observed curve was smoothed in application in the model, as shown in the figure, and intrazonals were allocated a separate, average slow mode share.

■ Figure 5-13 HBSh Slow Mode Factor



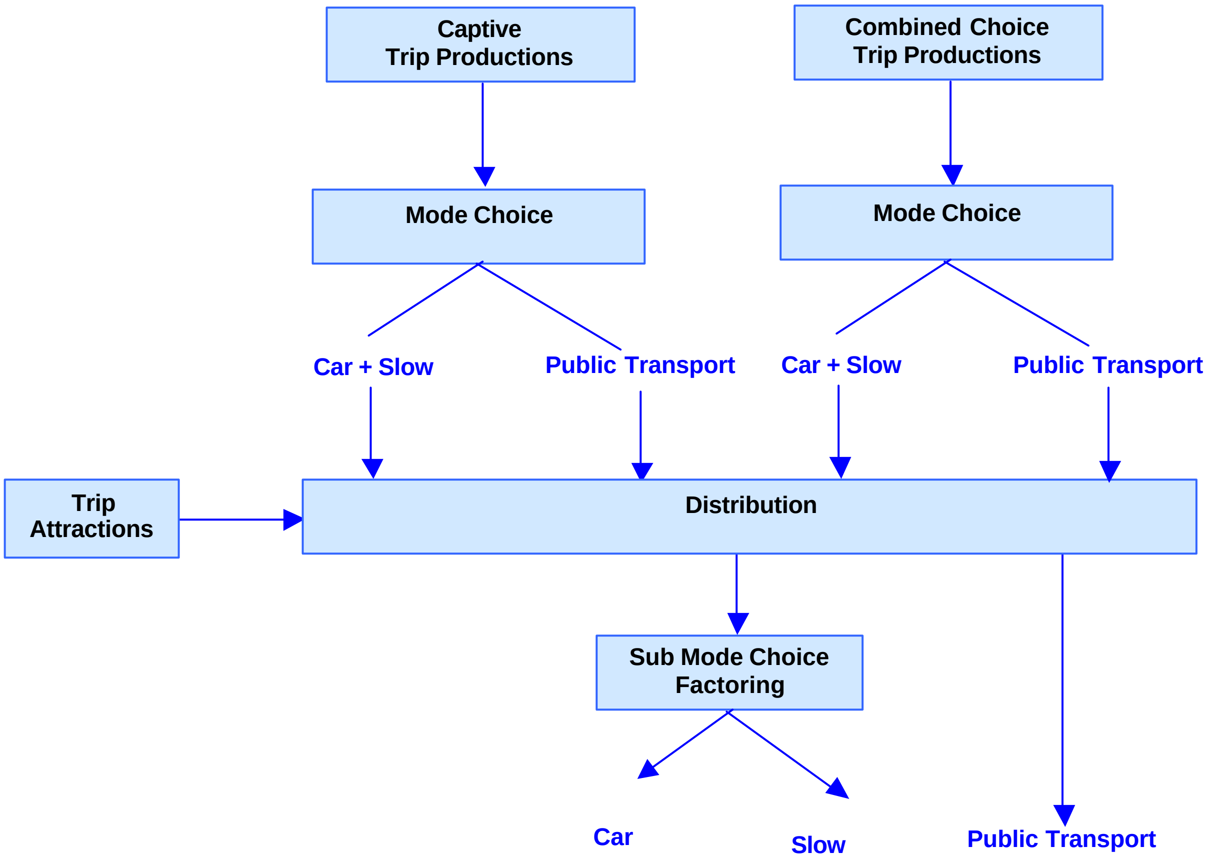
Auto Dist	Car Prop (Adj)
0 - 1	0.598
1 - 2	0.826
2 - 3	0.924
3 - 4	0.924
4 - 5	0.969
5 - 6	0.969
6 - 7	1.000
7 - 8	1.000
8 - 9	1.000
9 - 10	1.000
10 - 11	1.000
11 - 12	1.000
12 - 13	1.000
13 - 14	1.000
14 - 15	1.000
15 - 16	1.000
16 - 17	1.000
17 - 18	1.000
18 - 19	1.000
19 - 20	1.000
>20	1.000
Intrazonal	0.618

6. Home Based Other

6.1 Structure

The model hierarchy structure for home based other is identical to that for home based shopping. It is a pre-distribution model structure with the distribution models segmented by mode (car/slow and public transport), and the trip production mode choice model segmented by car availability (captive, combined choice).

■ **Figure 6-1 Home Based Other Model Structure**



6.2 Distribution Model

6.2.1 Specification

Table 6-1 and Table 6-2 summarise the calibrated constants and parameters for each sector and segment of the distribution model. The key features are:

- Except for trips to the CBD, the public transport parameters are small, indicating that the mode share is relatively insensitive to trip cost;
- the parameter values for the combined car/slow mode sectors are larger, particularly the intrasector and intra TLA sectors, indicating a preference for shorter journeys.

■ **Table 6-1 HBO Sector System - Constants**

<table>
<tr><th>Sector</th><th>Car / Slow</th><th>PT</th></tr>
<tr><td>Intrazonal</td><td>0.4838</td><td>-3.3135</td></tr>
<tr><td>Intrasector Rural</td><td>2.6630</td><td rowspan="2">4.5335</td></tr>
<tr><td>Intrasector Urban</td><td>4.0165</td></tr>
<tr><td>Intra TLA</td><td>3.0106</td><td rowspan="2">0</td></tr>
<tr><td>Other</td><td rowspan="2">0</td></tr>
<tr><td>CBD Attraction</td><td>4.5440</td></tr>
</table>

■ **Table 6-2 HBO Sector System - Parameters**

<table>
<tr><th>Sector</th><th>Car / Slow</th><th>PT</th></tr>
<tr><td>Intrasector Rural</td><td>-0.1056</td><td rowspan="2">-0.0351</td></tr>
<tr><td>Intrasector Urban</td><td>-0.2017</td></tr>
<tr><td>Intra TLA</td><td>-0.1330</td><td rowspan="2">-0.0083</td></tr>
<tr><td>Other</td><td rowspan="2">-0.0372</td></tr>
<tr><td>CBD Attraction</td><td>-0.0316</td></tr>
</table>

Table 6-3 and Table 6-4 provide the full detail of the calibrated constants and parameters, including t-statistics and observed and modelled mean trip costs. All t-statistics indicate that the parameters are significant (t-stats > 12).

■ **Table 6-3 HBO Calibrated Constant Values**

Segment	Sector	Constant	T-stat	Observed Trips	Modelled Trips
Car/Slow	Intrasector Rural	2.6630	136.3	61072	60993
Car/Slow	Intrasector – Urban	4.0165	308.0	196426	196388
Car/Slow	Intra TLA	3.0106	208.9	63136	63171
PT	Intra Sector	4.5335	57.7	3155	3147
PT	CBD	4.5440	51.2	3778	3791
Car/Slow	Intrazonal	0.4838	78.6	91719	91631
PT	Intrazonal	-3.3135	-28.2	76	75

■ **Table 6-4 HBO Calibrated Parameter Values**

Segment	Sector	Cost Parameter	T-stat	Observed Trips	Modelled Trips	Observed MTC	Modelled MTC
Car/Slow	Intrasector – Rural	-0.1056	151.0	61072	60993	8.2	8.2
	Intrasector – Urban	-0.2017	272.3	196426	196388	5.9	5.9
	Intra TLA	-0.1330	241.1	63136	63171	15.3	15.3
	Other	-0.0372	175.4	38182	38263	49.3	49.3
	All			358816	358816	12.5	12.6
PT	Intrasector	-0.0351	47.1	3155	3147	65.4	65.3
	CBD	-0.0316	39.7	3778	3791	75.1	75.3
	Other	-0.0083	28.2	1181	1176	173.7	173.0
	All			8114	8114	85.7	85.6
All	**All**			**366929**	**366929**	**14.2**	**14.2**

6.2.2 Calibration Performance

Figure 6-2 to Figure 6-4 illustrate the fit of the trip cost distributions for the observed and synthesised matrices. The key results are:

- the fit for the car/slow segment is particularly good,

- the public transport distribution shows that we under predict the short (low cost) trips, but these trip numbers are extremely small compared with those for car;
- the overall fit, as shown in Figure 6-4 indicates a very good fit overall.

Figure 6-5 and Figure 6-6 demonstrate the fit of the modelled trips against observed trips at a 16 sector to sector level. The 95% confidence limits are also shown. The findings are:

- the car/slow segment in particular shows a good fit, with most data being well within the 95% confidence limits;
- the fit of the public transport segment is not as good as that for car, but those cells with the largest errors in the public transport comparison are small.

Figure 6-2 HBO Car/Slow Trip Cost Distribution

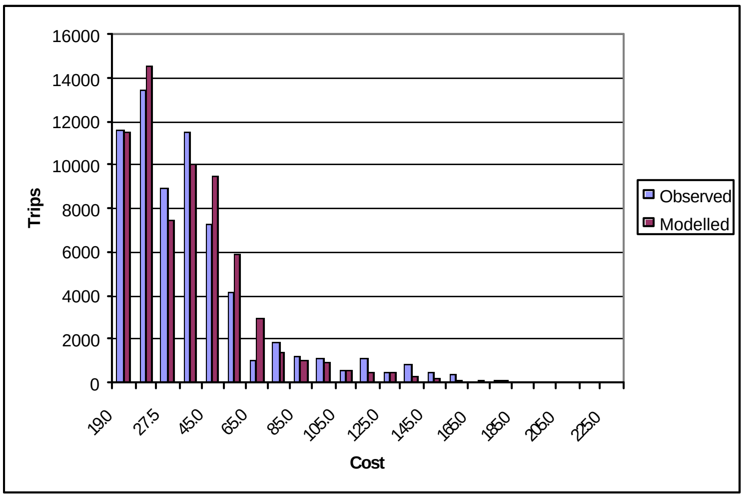
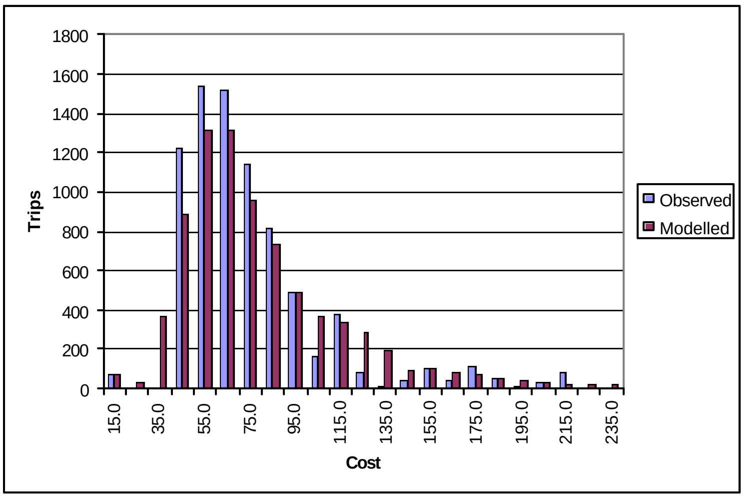
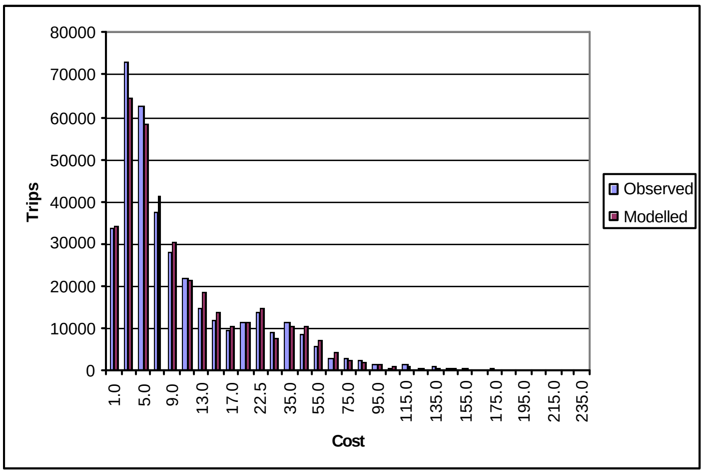


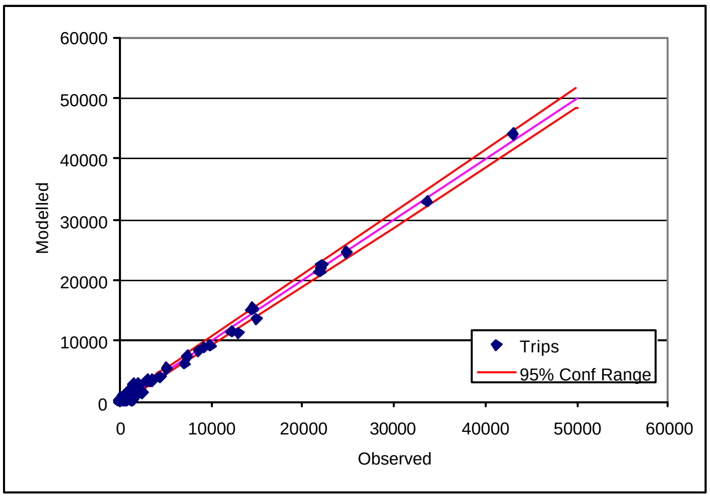
Figure 6-3 HBO PT Trip Cost Distribution



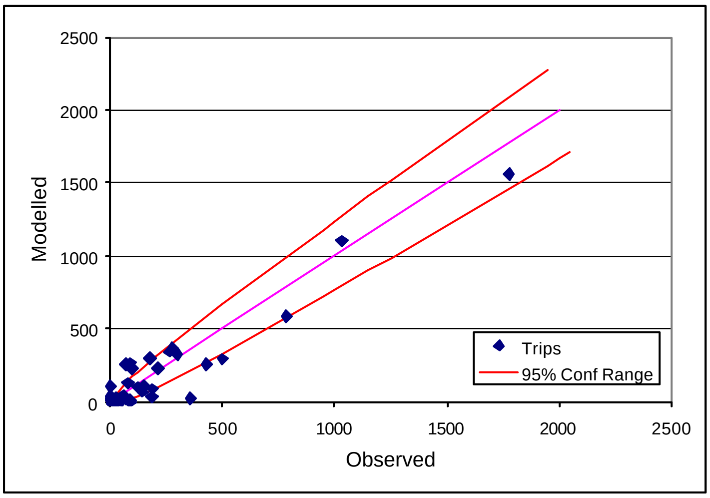
■ **Figure 6-4 HBO All Trip Cost Distribution**



■ **Figure 6-5 HBO Car/Slow Observed vs Modelled Trips**



■ **Figure 6-6 HBO PT Observed vs Modelled Trips**



6.3 Mode Choice Model

6.3.1 Specification

The specification for the production zone mode choice model is similar to that for the home based shopping model except that we have jointly calibrated the captive and combined choice segments such that they have the same parameters, but different modal constants.

The final calibrated constants and parameters are shown below in Table 6-5. The key results are:

- the two cost parameters are significant, negative and less than 1 in absolute value as required for the model hierarchy,
- the mode choice constant attached to public transport is negative as expected,
- the captive constant is also negative, indicating a higher public transport share in the captive market, as expected,
- the modal constant for the Wellington TLA differs from the rest of the region, indicating a higher level of public transport use in this TLA.

Table 6-5 HBO Calibrated Parameter Values and Constants

Parameter	Value	T-statistic
Car Cost Parameter (BCAR)	-0.7530	-20.8
Captive Constant (CCAPT)	-1.7867	-65.6
PT Modal Constant (APT)	-4.4316	-201.0
PT Cost Parameter (BPT)	-0.6830	-17.9
TLA Constant 1 (Wellington)	0.5022	15.2

6.3.2 Calibration Performance

Figure 6-7 and Figure 6-8 illustrate the fit of the car mode share to the observed data for the captive and combined choice segments at the 16 sector level. The key results are:

- the fit for the combined choice segment is particularly good, with most of the observations close to 100%.
- the fit is less good for the captive segment, but is within acceptable limits.

Figure 6-9 to Figure 6-12 demonstrate the fit of the modelled at sector level for both the captive and combined choice segments for car and public transport. The key observations from these plots are:

- the two car plots show a very good fit, with all observations well within the 95% confidence limits,
- the fit for public transport is less good, but the trip numbers are very small relative to car.

Figure 6-7 HBO Captive Observed vs Modelled Car Proportions

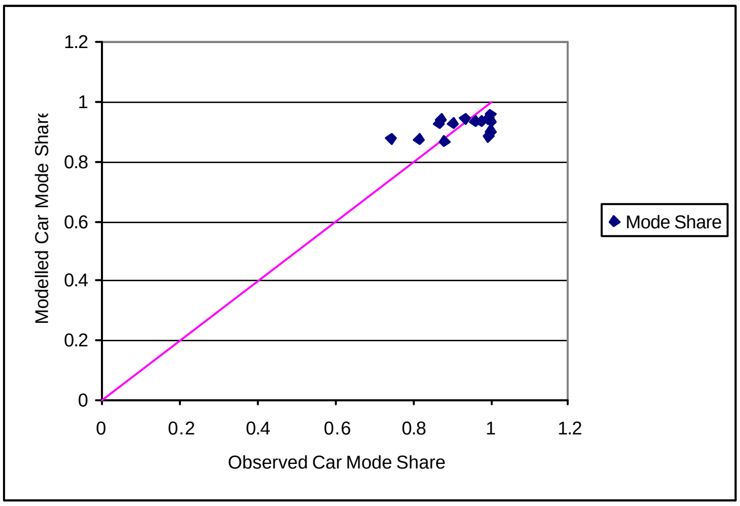


Figure 6-8 HBO Combined Choice Observed vs Modelled Car Proportion

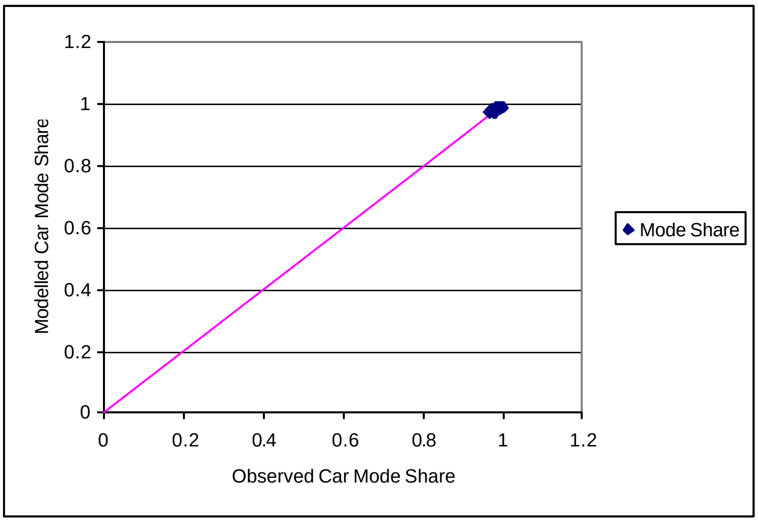
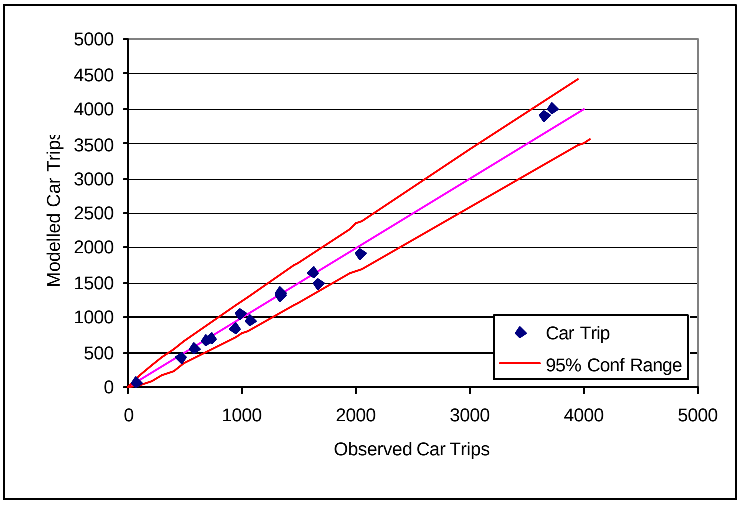
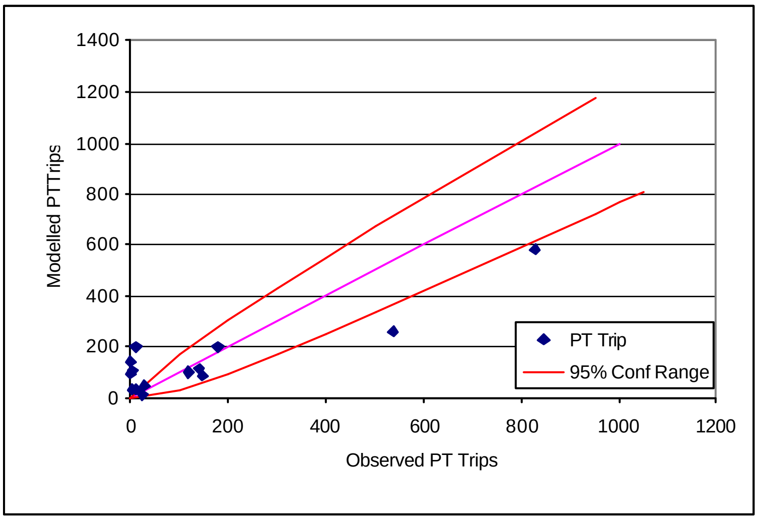


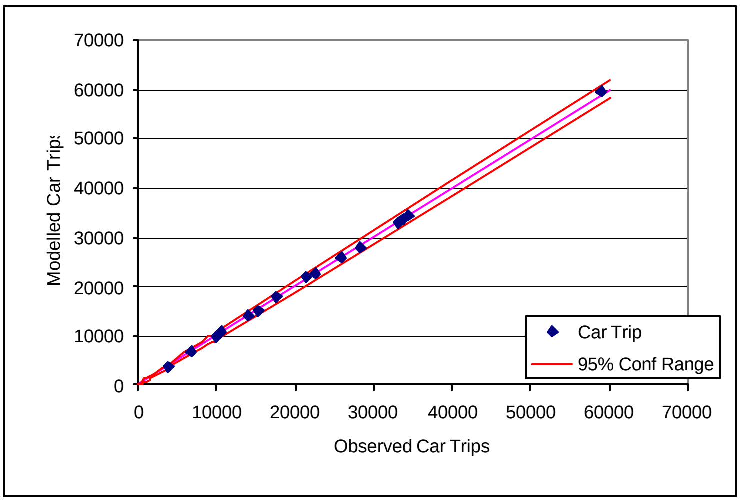
Figure 6-9 HBO Captive Observed vs Modelled Car Trips



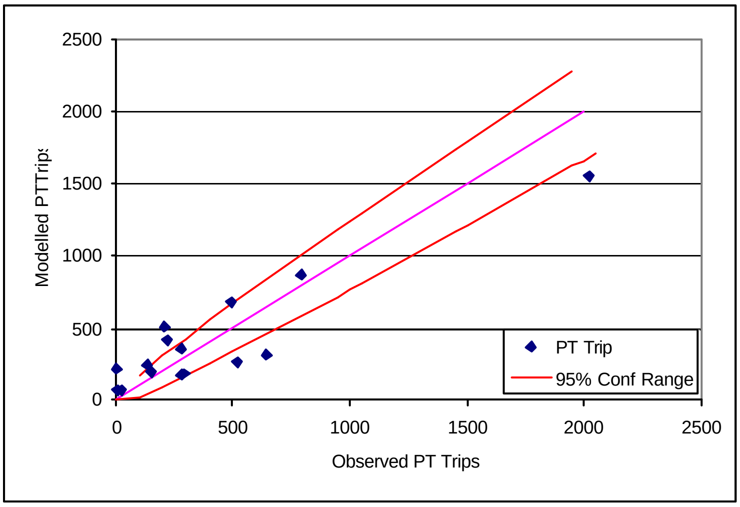
■ Figure 6-10 HBO Captive Observed vs Modelled PT Trips



■ Figure 6-11 HBO Combined Choice Observed vs Modelled Car Trips



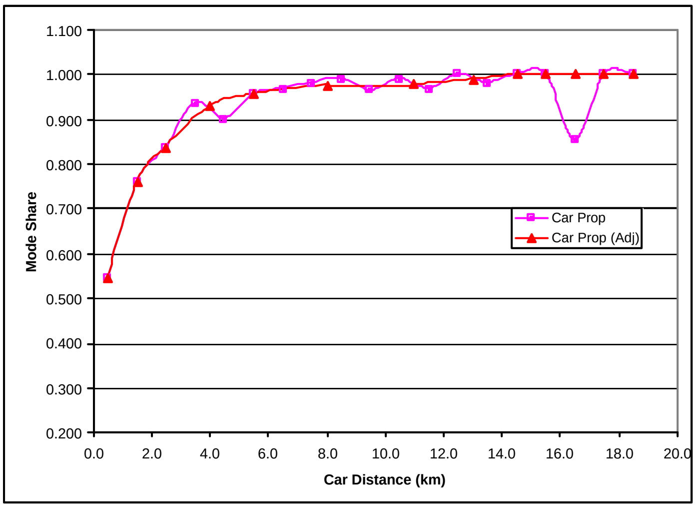
■ Figure 6-12 HBO Combined Choice Observed vs Modelled PT Trips



6.4 Slow Mode Factors

Where slow mode and car trips have been combined for the distribution model, slow mode trips have been extracted from the synthesised trip matrix based on factors that are a function of trip distance. Figure 6-13 details the slow mode factors that have been calculated for the home based other model. This observed curve was smoothed in application in the model, as shown in the figure, and intrazonals were allocated a separate, average slow mode share.

Figure 6-13 HBO Slow Mode Factor



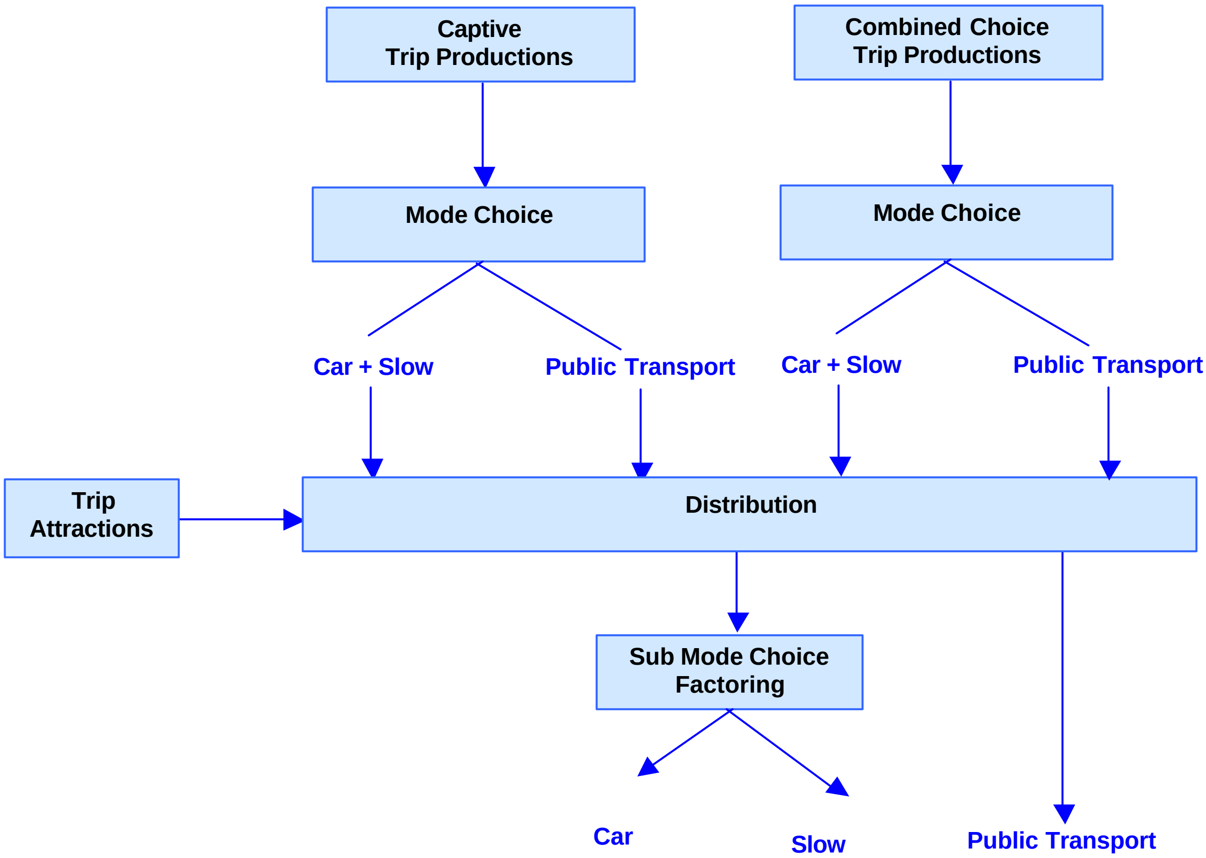
Auto Dist	Car Prop (Adj)
0 - 1	0.547
1 - 2	0.759
2 - 3	0.839
3 - 4	0.928
4 - 5	0.928
5 - 6	0.956
6 - 7	0.975
7 - 8	0.975
8 - 9	0.975
9 - 10	0.975
10 - 11	0.977
11 - 12	0.977
12 - 13	0.989
13 - 14	0.989
14 - 15	1.000
15 - 16	1.000
16 - 17	1.000
17 - 18	1.000
18 - 19	1.000
19 - 20	1.000
>20	1.000
Intrazonal	0.570

7. Non Home Based Other

7.1 Structure

The final model structure is identical to that for the home based shopping and home based other models. That is, we have adopted a pre-distribution model structure with the distribution models segmented by mode (car/slow and public transport), and the production zone mode choice model segmented by car availability (captive, combined choice).

■ **Figure 7-1 Non Home Based Model Structure**



7.2 Distribution Model

7.2.1 Specification

Table 7-1and Table 7-2 summarise the calibrated constants and cost parameters for the non home based other model. The key results are:

- ❑ the intrazonal constant for public transport is negative and very large in absolute value, reflecting the fact that there are no observed intrazonal trips for public transport;

- the constants for the intrasector and intra TLA car/slow sectors are positive and quite large, suggesting a preference for short car trips;
- in general the cost parameters for car/slow trips are larger than those for public transport.

Table 7-1 NHBO Sector System - Constants

<table>
<tr><th>Sector</th><th>Car / Slow</th><th>PT</th></tr>
<tr><td>Intrazonal</td><td>0.217</td><td>-29.809</td></tr>
<tr><td>Intrasector Rural</td><td>1.861</td><td rowspan="2">0</td></tr>
<tr><td>Intrasector Urban</td><td>3.467</td></tr>
<tr><td>Intra TLA</td><td>2.558</td><td rowspan="2">0</td></tr>
<tr><td>Other</td><td rowspan="2">0</td></tr>
<tr><td>CBD Attraction</td><td>-1.616</td></tr>
</table>

Table 7-2 NHBO Sector System - Parameters

<table>
<tr><th>Sector</th><th>Car / Slow</th><th>PT</th></tr>
<tr><td>Intrasector Rural</td><td>-0.0841</td><td rowspan="4">-0.0290</td></tr>
<tr><td>Intrasector Urban</td><td>-0.1969</td></tr>
<tr><td>Intra TLA</td><td>-0.1354</td></tr>
<tr><td>Other</td><td rowspan="2">-0.0421</td></tr>
<tr><td>CBD Attraction</td><td>-0.0084</td></tr>
</table>

Table 7-3 and Table 7-4 provide the full statistical results for the non home based calibration. These tables include constants and parameters, as well as t-statistics and both observed and modelled mean trip costs. With the exception of the intrazonal public transport constant all parameters and constants have significant t-statistics (greater than 12).

Table 7-3 NHBO Calibrated Constant Values

Segment	Sector	Constant	T-stat	Observed Trips	Modelled Trips
Car/Slow	Intrasector Rural	1.861	96.6	74181	74077
Car/Slow	Intrasector – Urban	3.467	299.8	264902	265087
Car/Slow	Intra TLA	2.558	195.7	87746	87856
PT	Intra Sector	0	0	0	0
PT	Intra TLA	0	0	0	0
PT	CBD	-1.616	-34.0	2594	2624
Car/Slow	Intrazonal	0.217	44.1	116970	116915
PT	Intrazonal	-29.809	-0.1	0	0

Table 7-4 NHBO Calibrated Parameter Values

Segment	Sector	Cost Parameter	T-stat	Observed Trips	Modelled Trips	Observed MTC	Modelled MTC
Car/Slow	Intrasector – Rural	-0.0841	111.3	74181	74077	6.4	6.5
	Intrasector – Urban	-0.1969	257.6	264902	265087	5.2	5.2
	Intra TLA	-0.1354	247.1	87746	87856	13.1	13.1
	Other	-0.0421	188.2	43624	43432	43.6	43.4
	All			470452	470452	10.4	10.4
PT	CBD	-0.0084	14.6	2594	2624	66.6	67.4
	Other	-0.0290	82.6	6998	6968	78.2	78.0
	All			9593	9593	75.0	75.1
All	**All**			**480045**	**480044**	**11.7**	**11.7**

7.2.2 Calibration Performance

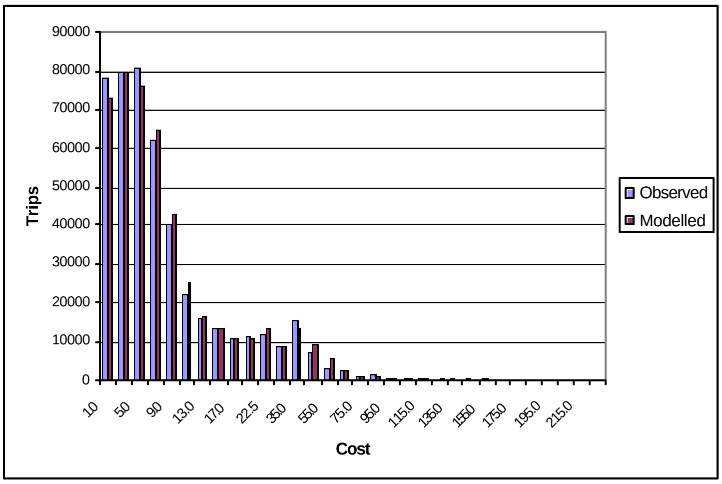
Figure 7-2 to Figure 7-4 details the modelled versus observed trip cost distributions for the car/slow, public transport and total trips respectively. The key observations are:

- while the public transport fit appears less than that for the car/slow mode, overall the fit is very good,
- the differences evident in the public transport fit are on relatively small trip numbers,
- the overall cost distribution fit to the observed is very good.

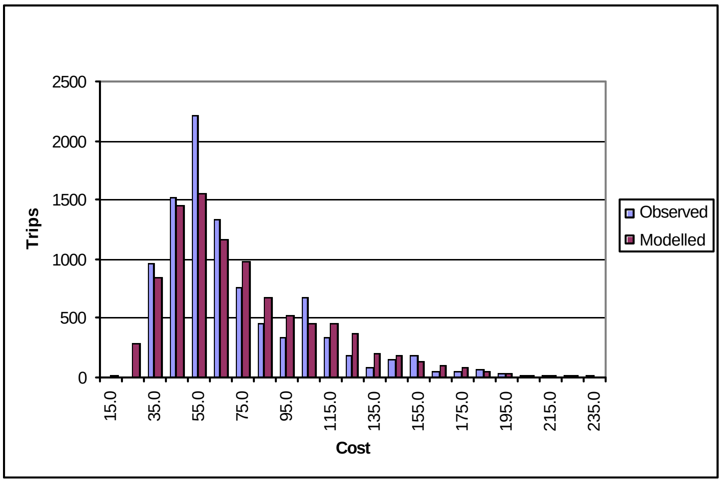
Figure 7-5 and Figure 7-6 demonstrate the modelled versus observed car/slow and public transport trips for non home based other at a 16 sector to sector level. The results can be summarised as:

- the car (& slow) fit in particular is very good,
- the fit for public transport trips is less good but there are few such trips, and the majority of sectors fall within the 95% confidence range.

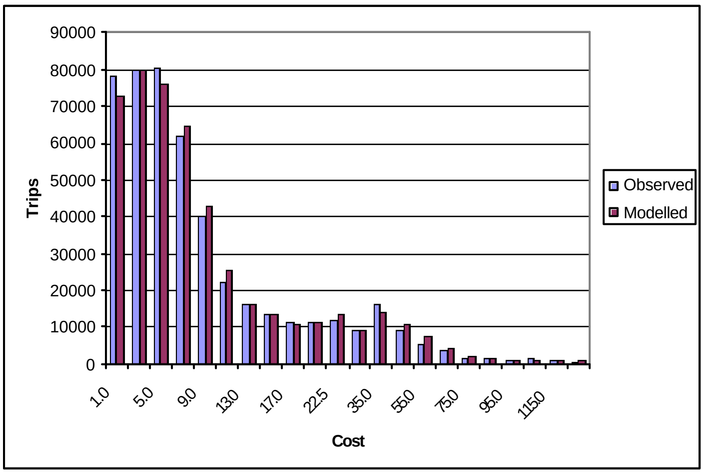
■ **Figure 7-2 NHBO Car/Slow Trip Cost Distribution**



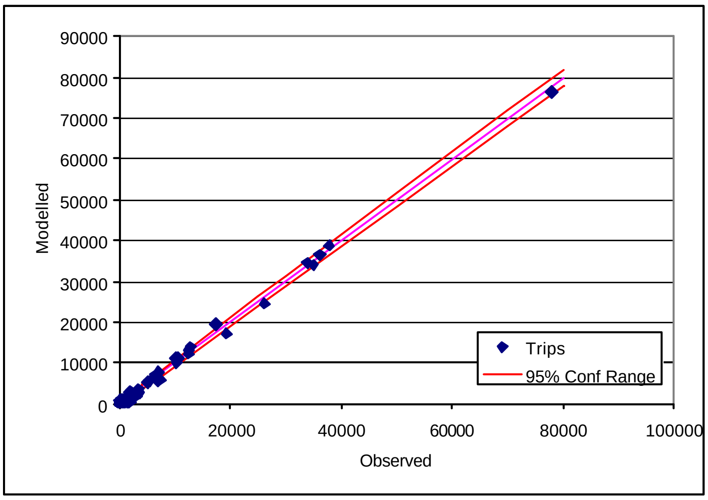
■ **Figure 7-3 NHBO PT Trip Cost Distribution**



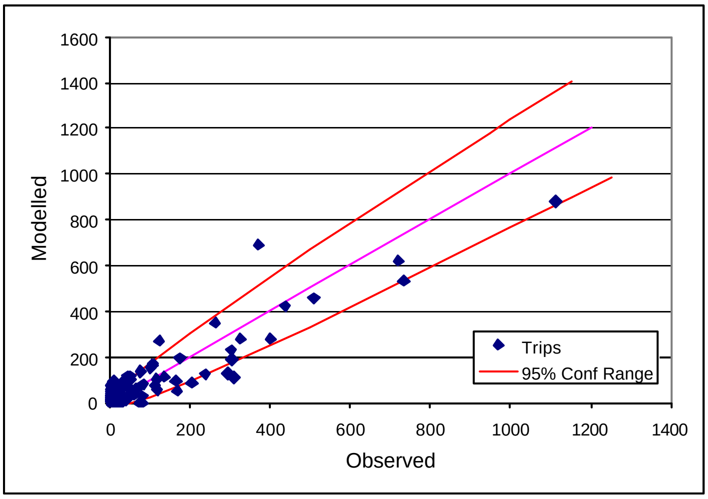
■ **Figure 7-4 NHBO All Trip Cost Distribution**



■ **Figure 7-5 NHBO Car/Slow Observed vs Modelled Trips**



■ **Figure 7-6 NHBO PT Observed vs Modelled Trips**



7.3 Mode Choice Model

7.3.1 Specification

The model structure is identical to that for the home based other model, with the car availability segments jointly calibrated in the mode choice model.

Table 7-5 presents the calibrated model constants and cost parameters. The key results are:

- the public transport cost parameter is larger than the car cost parameter, suggesting that the mode share is quite sensitive to public transport cost;
- the modal constant attached to public transport is negative, reflecting an overall preference for car;
- the captive mode choice constant is also negative, as expected indicating a higher public transport share for this segment;
- the constant for the TLA's of Carterton, Masterton, South Wiararapa and Upper Hutt is negative, suggesting a larger car mode share in these areas; the same is true to a lesser extent of Kaptiti Coast, Lower Hutt and Porirua (in comparison with Wellington TLA);
- the t-statistics for a number of parameters were not as large as required, but the parameters appear sensible and have been adopted.

Table 7-5 NHBO Calibrated Parameter Values and Constants

Parameter	Value	T-statistic
Car Cost Parameter (BCAR)	-0.2692	-6.3
Captive Constant (CCAPT)	-1.5255	-60.0
PT Modal Constant (APT)	-2.2128	-15.1
PT Cost Parameter (BPT)	-0.4941	-10.5
TLA Constant 1 (Carterton, Masterton, South Wairarapa, Upper Hutt)	-1.6470	-26.3
TLA Constant 2 (Kapiti Coast, Lower Hutt, Porirua)	-0.4822	-18.0

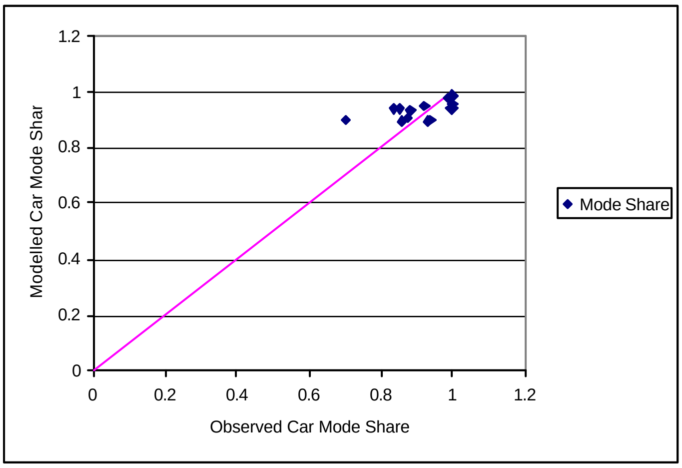
7.3.2 Calibration Performance

Figure 7-7 and Figure 7-8 demonstrate the fit of the modelled car share against the observed car share at a sector level for both the captive and combined choice segments. In general the fit is reasonable, with one or two outliers in each segment.

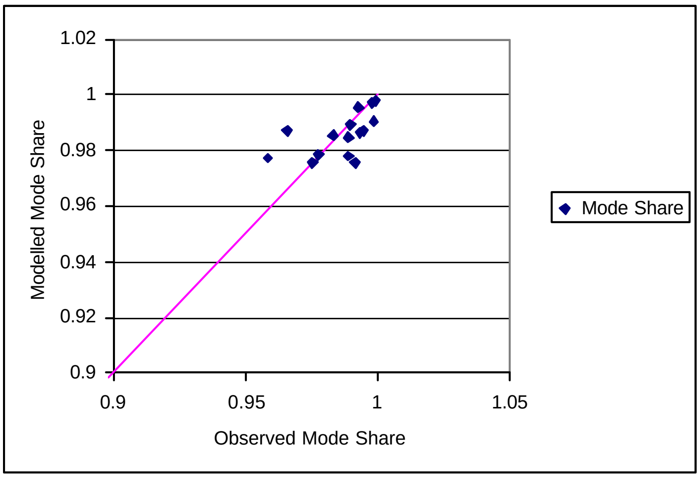
Figure 7-9 to Figure 7-12 illustrate the fit of the modelled trips at sector level for both the captive and combined choice segments for car and public transport. The key observations from these plots are:

- generally the fit is very good, particularly for the car segments,
- the public transport segments show a reasonable match between modelled and observed trips at the sector level, with a few outliers for some of the smaller sectors.

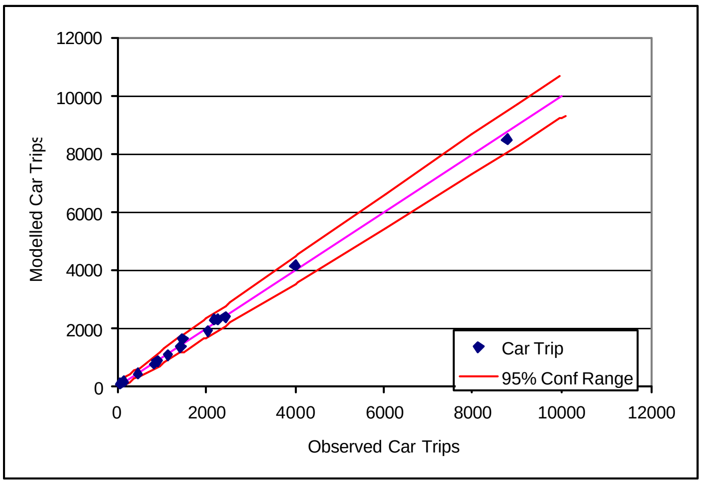
■ Figure 7-7 NHBO Captive Observed vs Modelled Car Proportions



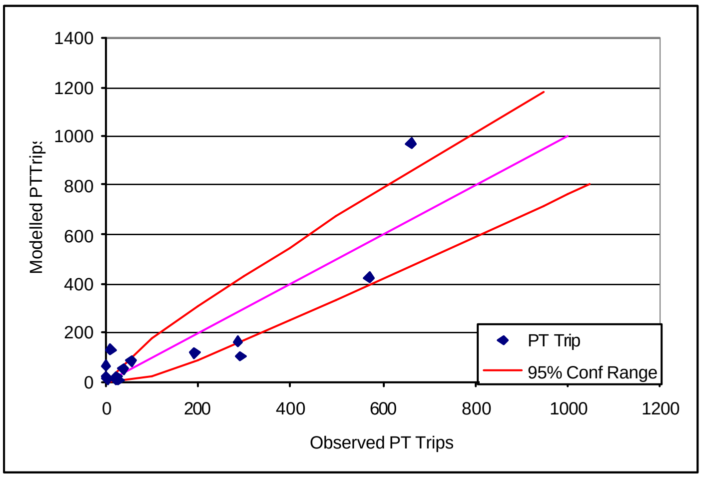
■ Figure 7-8 NHBO Combined Choice Observed vs Modelled Car Proportion



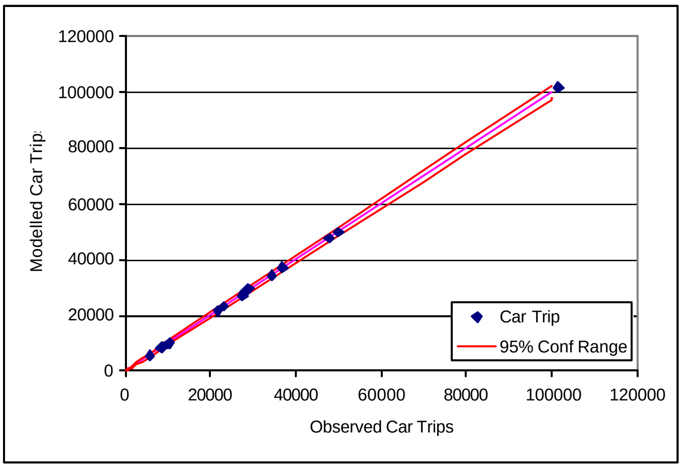
■ Figure 7-9 NHBO Captive Observed vs Modelled Car Trips



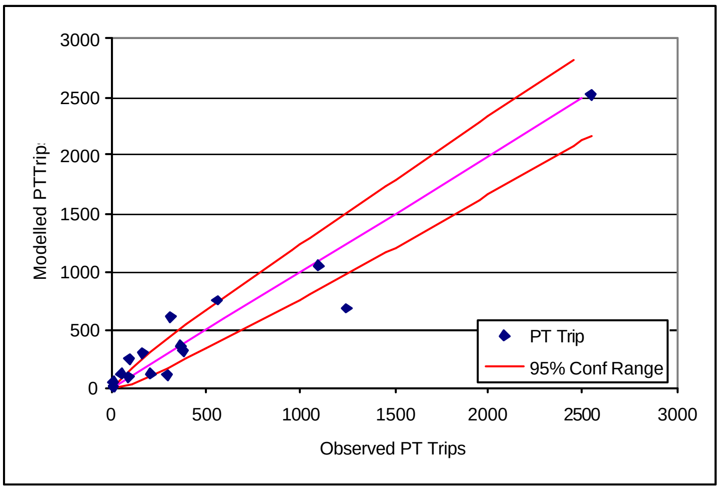
■ **Figure 7-10 NHBO Captive Observed vs Modelled PT Trips**



■ **Figure 7-11 NHBO Combined Choice Observed vs Modelled Car Trips**



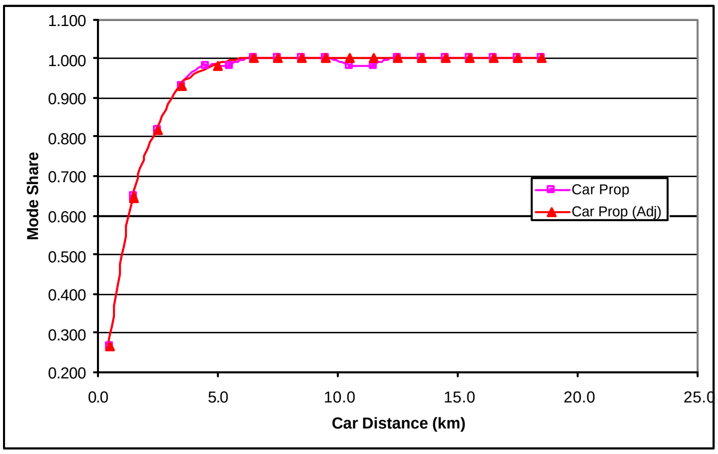
■ **Figure 7-12 NHBO Combined Choice Observed vs Modelled PT Trips**



7.4 Slow Mode Factors

Where slow mode and car trips have been combined for the distribution model, slow mode trips have been extracted from the synthesised trip matrix based on factors that are a function of trip distance. Figure 7-13 details the slow mode factors that have been calculated for the non home based other model. This observed curve was smoothed in application in the model, as shown in the figure and intrazonals were allocated a separate, average slow mode share.

■ **Figure 7-13 NHBO Slow Mode Factor**



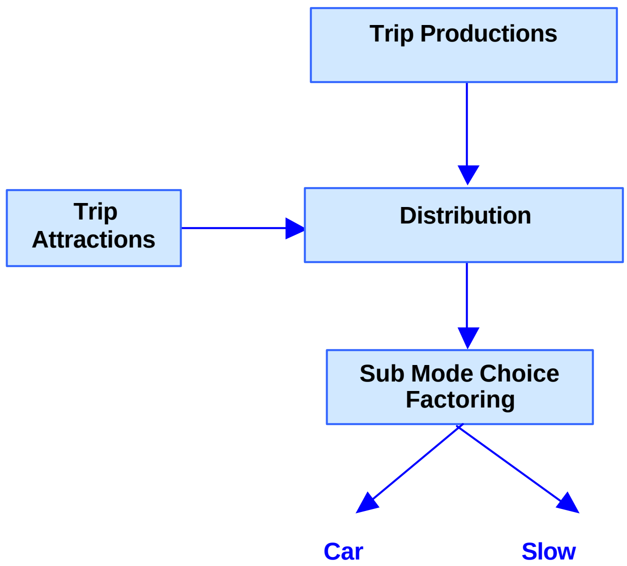
Auto Dist	Car Prop (Adj)
0 - 1	0.267
1 - 2	0.646
2 - 3	0.816
3 - 4	0.930
4 - 5	0.981
5 - 6	0.981
6 - 7	1.000
7 - 8	1.000
8 - 9	1.000
9 - 10	1.000
10 - 11	1.000
11 - 12	1.000
12 - 13	1.000
13 - 14	1.000
14 - 15	1.000
15 - 16	1.000
16 - 17	1.000
17 - 18	1.000
18 - 19	1.000
19 - 20	1.000
>20	1.000
Intrazonal	0.542

8. Employers Business

8.1 Structure

With the level of public transport trip making being insignificant (less than 1% of trips are made by public transport), there is no representation of mode choice and all travel is by car or the slow modes. As we only have one main mode, the model is a distribution model with a sub mode choice factoring process. This is illustrated in Figure 8-1.

■ **Figure 8-1 Employers Business Model Structure**



8.2 Distribution Model

8.2.1 Specification

The calibrated parameters and constants are shown in Table 8-1 and Table 8-2. The calibrated distribution constants and cost parameters are all statistically significant with t-stats greater than 25.

■ **Table 8-1 EB Calibrated Constant Values**

Segment	Sector	Constant	T-stat	Observed Trips	Modelled Trips
All	Intrasector Rural	0.7929	29.6	16761	16740
All	Intrasector – Urban	2.3822	139.3	71406	71435
All	Intra TLA	1.7772	91.4	37492	37507
All	Intrazonal	0.4063	38.7	23060	23056

■ **Table 8-2 EB Calibrated Parameter Values**

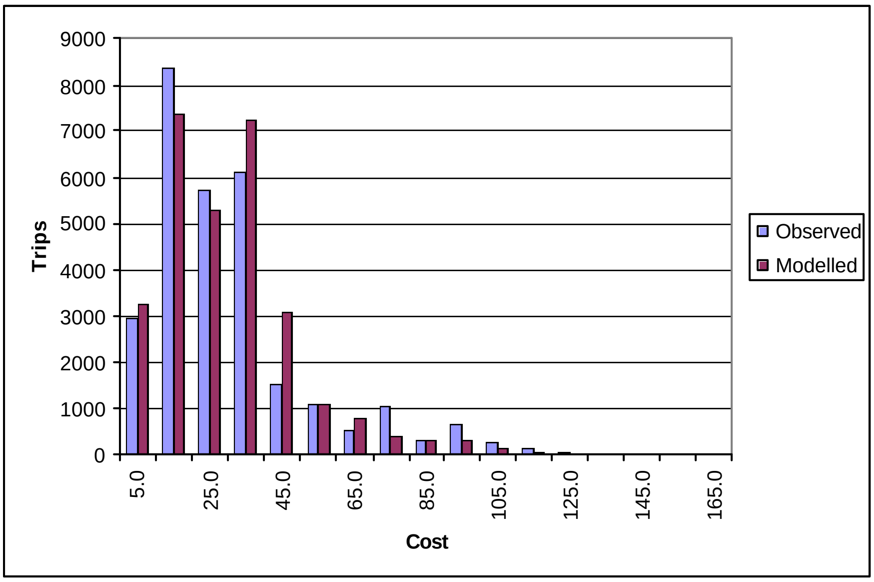
Segment	Sector	Cost Parameter	T-stat	Observed Trips	Modelled Trips	Observed MTC	Modelled MTC
All	Intrasector – Rural	-0.0383	32.1	16761	16740	8.4	8.4
	Intrasector – Urban	-0.1887	119.5	71406	71435	4.5	4.5
	Intra TLA	-0.1434	130.2	37492	37507	10.4	10.4
	Other	-0.0530	145.4	28112	28090	32.5	32.4
	All			**153771**	**153771**	**11.5**	**11.5**

8.2.2 Calibration Performance

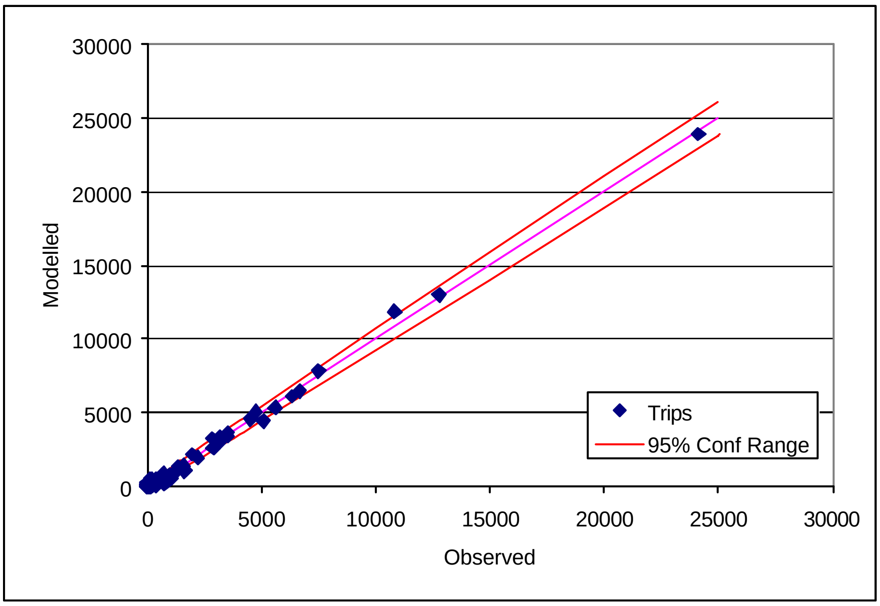
Figure 8-2 demonstrates the fit of the modelled trip cost distribution against that observed. This figure suggests that we have slightly underestimated the shortest trip costs, while slightly overestimating those trips between 20 and 50 minutes.

Figure 8-3 details the fit of the modelled versus observed trips for this purpose at a 16 sector to sector level. This fit appears to be very good, with all data points above 2500 well within the 95% confidence limits and the majority of points lower than this also within the range.

- **Figure 8-2 Trip Cost Distribution**



- **Figure 8-3 EB Observed vs Modelled Trips**

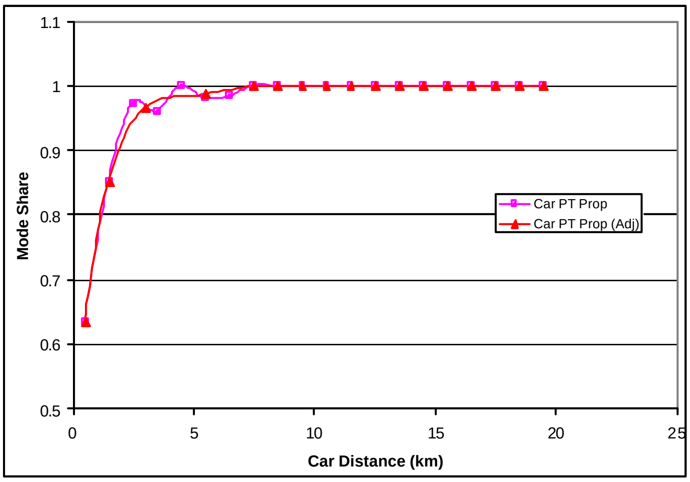


8.3 Slow Mode Factors

As for the other purposes, where slow mode and car trips have been combined for the distribution model, slow mode trips have been extracted from the synthesised trip matrix based on factors that are a function of trip distance. Figure 8-4 details the slow mode factors that have been calculated for the employers business model.

This observed curve was smoothed in application in the model, as shown in the figure. Intrazonals were allocated a separate, average slow mode share.

- **Figure 8-4 EB Slow Mode Factor**



Auto Dist	Car Prop (Adj)
0 - 1	0.633
1 - 2	0.850
2 - 3	0.966
3 - 4	0.966
4 - 5	0.987
5 - 6	0.987
6 - 7	0.987
7 - 8	1.000
8 - 9	1.000
9 - 10	1.000
10 - 11	1.000
11 - 12	1.000
12 - 13	1.000
13 - 14	1.000
14 - 15	1.000
15 - 16	1.000
16 - 17	1.000
17 - 18	1.000
18 - 19	1.000
19 - 20	1.000
>20	1.000
Intrazonal	0.672

Appendix A Generalised Cost Calculations

The description of the generalised cost calculations for distribution and mode choice modelling are provided below. These calculations are modified slightly for routeing in the assignment models.

A.1 Values of Time

The values of time are the latest Transfund perceived values as documented in the 2002 update to the Transfund Project Evaluation Manual.[7]. The model requires average values for persons of a particular segment. These values can very by mode, but only if this reflects some perceived comfort difference. Because the differences in the Transfund modal values also encompass differences between the types of people using each mode, they cannot necessarily be used directly. Note that, apart from trip purpose, we have also segmented by car availability for a number of purposes. We have also considered crowding, reliability and congestion effects where applicable.

The table below documents the adopted values; they incorporate the following assumptions:

- for each purpose and segment, the values of time are the average for the mode shares observed in 2002 of car and van/ute driver, car and van/ute passenger and public transport values of time; walk and cycle trips have been ignored because they are short distance essentially local/intrazonal;
- the PT VoTs assume 10% standing for HBW trips (which all occur in the peaks);
- congestion and reliability values of time for cars are not included – while they have been established for evaluation purposes, there are no immediate proposals for including them in behavioural modelling (or assignment);
- we have combined HBSh, HBSo, HBO and NHBO trips which have similar values of time.

Concerning the variations in values of time:

- apart from EB, the higher HBW values reflect the findings of the recent Transfund research;
- HBEd is lower because of the higher public transport usage, to which a lower VOT applies;
- captive is also lower because of the higher use of public transport.

Table A-1 WTSM Values of Time (cents/min in 2002)

Purpose	Segment	
	Captive	Choice/ Competition
EB	36.2	39.2
HBW	10.3	13.6
HBEd	6.5	10.2
Other	8.5	12.1

[7] For business trips the Transfund values are simply increased by 2001/2 earnings growth of 2.25%; for other purposes, they are also increased by 15%to give market values.

A.2 Vehicle Driver and Passenger

The generalised cost attributes are time, operating cost, parking charges and tolls:

- the 3 cost items have been divided by the values of time (see Table A-1.);
- operating costs (see Table A-2):
  - these are based on the NZVOC model;
  - for non-work travel they refer only to fuel cost but include GST;
  - for business car and commercial vehicle (CV) trips, the full operating costs have be used (with GST assumed to be refunded and therefore excluded);
- the parking charges attributable to a trip have been factored by 0.5, as these charges are shared between the in and out-bound trips;
- passenger/driver: the approach in London is to divided costs by average car occupancy so that the cost represents the average cost per person and is directly comparable with public transport fares; this is the adopted approach, with its main effect being for shopping and other trips; a table of occupancies is given below.

Table A-2 Operating costs (cents/km) – emboldened figures will be used in WTSM

Mode	Purpose	
	Business	**Other**
Car	**30**	14.7
LCV	**30**	19.2
Car and LCV average (non-EB trips)*	-	**15.0**
MCV	55	21.5
HCV-I	105	42
HCV-II	160	73.5
Truck average**	**105**	**45**

*based on 6.8% non-EB vans/utes trips in the household survey

**based on 39% MCV, 26% HCV-I, 35% HCV-II from WRC classified counts

The formula is thus:

Gen cost = ivt + (parking cost/2 + operating cost + toll)/(VoT* occupancy)

- **Table A-3 Occupancy by Purpose**

Purpose	Occupancy
HBW	1.19
HBEd	2.36
HBSh	1.35
HBO (& HBSo)	1.50
NHBO	1.39
EB	1.09

Note : these occupancy values are slightly different from those presented initially in the preliminary studies.

A.3 Public Transport Passenger

The generalised cost parameters are in-vehicle time, other time (access, egress & walking times), interchange, waiting time at boarding and interchange, and fare:

- the fare has been divided by standard values of time (see Table A-1);
- other time has been weighted by 2.0.

The adopted interchange penalties are:

- 10 mins for standard interchanges,
- 8 minutes for purpose-built interchanges, and
- 5 minutes for high quality and/or planned interchanges.

These are Auckland Public Transport (APT) values and are compatible with the 5-10 minute range in the updated Transfund Project Evaluation Manual (PEM).

A review of waiting time factors is given in the tables below, an extension of what was done for the Auckland public transport model by Booz Allen and Hamilton, the first giving the disutility of waiting time and the second the benefits of improving waiting time (indirectly a measure of the sensitivity of the model to headway differences); the table includes various formulae:

- ‘standard’ in which waiting time is half the headway and is multiplied by a cost factor of 2.0;
- PDFH are disutilities derived from the UK rail passenger demand forecasting handbook;
- Wardman draws on a review by ITS Leeds;
- BAH is a Booz Allen formula;
- APT is that used in the Auckland model 2*(3+0.22*headway);
- PEM is the that most recently recommended in the PEM;
- WTSM is what is recommended for the WTSM 2*(1.5+0.25*headway).

EMME/2 is constrained in the waiting time functions that can be accepted but a linear formula of a boarding penalty (of 1.5 mins) and a factor on headways (of 0.25) is feasible. The WTSM formula is an adjustment to, and seems marginally better than, that used in the APT.

The generalised cost formula is thus:

Gen cost = ivt +I*interchange penalty +2*(access and egress time) + 2*B*(1.5+0.25* headway) + fare/VoT

Where:

I number of interchanges

B is number of services boarded (=1+I)

Note that walk, car and bus access are not distinguished, all times being

- **Table A-3 Comparison of Generalised Cost of Headway for Various Models**

weighted by 2.

Generalised Cost (mins) of Headway

Headway (mins)	Standard	PDFH	Wardman	BAH	APT	PEM	WTSM
5	5	5	3	5	8	5	6
10	10	10	6	8	10	7	8
20	20	19	12	14	15	10	13
30	30	25	17	18	19	14	18
40	40	29	22	23	24	18	23
50	50	33	27	27	28	21	28
60	60	36	32	31	32	24	33

Incremental Benefits of Reducing Headway (mins)

Headway (mins)	Standard	PDFH	Wardman	BAH	APT	PEM	WTSM
5	5	5	3	3	2	2	3
10	10	9	6	6	4	3	5
20	10	6	5	5	4	4	5
30	10	4	5	4	4	4	5
40	10	4	5	4	4	3	5
50	10	3	5	4	4	3	5

Note: the benefit is simply the difference in disutility from the next headway in the table
Eg with Wardman if the headway is reduced from 20 to 10 mins the change in
generalised costs is 6 minutes

A.4 Walk/Cycle Time

Walk and cycle costs have not been used when slow trips are the main mode. Instead, when these modes have been aggregated with either car or public transport, the mechanised mode's generalised costs have been used for the new combined mode.

Appendix B Mathematical Form of Models

B.1 Introduction

The text below decribes the mathematical form of both the mode choice and distribution models.

Note that both mode choice and distribution are undertaken at the zonal level in terms of trips and costs. We have however estimated model constants by TLA for mode choice, and generally we haven't estimated constants at this level of detail for distribution. We have estimated constants for particular movements in the distribution such as intra-sector. These constants are for ensuring overall level of trips or mode share are correct for some segment of zones, not indicating an estimation of the models at that level.

The only appropriate estimation method is using the observed trip matrix (and implicitly the observed trip ends) and calibration statistics used are appropriately on this basis.

B.2 Mode Choice

The structure of the production zone mode choice model is a simple two mode, utility maximising model.

The two utility calculations are shown below:

$$U(Car) = BCAR \times CLi \; + [CCAPT*Captive]$$

$$U(PT/Slow) = APT + BPT \times CLi + DTLA$$

where:

- The cost variable in the above equations is *CLi*. This is the unscaled cost from the distribution model, and is a centred logsum as described below. As these costs are unscaled, we require the two cost parameters, *BCAR* and *BPT*, to be negative, but less than 1 in absolute value.
- *APT* is the modal constant, attached to the PT mode, while *DTLA* is a geographic constant, that adjusts the modal constant in each TLA, included to ensure the mode share in each TLA matches that observed. Initially the calibration included a constant for each TLA, but this was refined through the estimation procedure, removing insignificant constants,
- *CCAPT* refers to an additional captive constant that is added to the car mode (for journeys as a car passenger) for the captive segment only in some of the models.

These constants serve the purpose of ensuring an overall correct level of mode share. APT ensures that the mode share over the entire sample is correct, while the geographic and captive constants ensure that the major geographic variations in mode shares are reproduced by the model.

A utility is created for each mode and zone, from which the probability of choosing each mode can be calculated as:

$$Probability_{i,segment}^{mode} = \frac{e^{U_{i,segment}^{mode}}}{\sum_{mode=car,pt} e^{U_{i,segment}^{mode}}}$$

B.3 Distribution

The distribution model structure used for the WTSM calibration is a doubly constrained gravity model. The equation below illustrates the form of the model.

$$Trips_{ij}^{k} = P_i^k O_i^k A_j D_j e^{F_{ij}^k}$$

$$with$$

$$\mathrm{F}_{ij}^{k} = Constant_{\sec tor}^{k} + l_{\sec tor}^{k} Cost_{ij}^{k}$$

where
-*i*,*j* refer to production and attraction zones respectively,
-*k* refers to the segment (usually mode, but also car availability for some models),
-P refers to production trips,
-A refers to attraction trips,
-O refers to origin balancing factors, for each zone i and each segment k,
-D refers to destination balancing factors, for each zone j,
-λ is the cost parameter, for each sector and segment k.
-*sector* refers to some level of geographic segmentation, eg cbd trips, intrasector trips etc. This model sector system is unrelated to the production / attraction sectors used for reporting purposes.

At convergence, the calibration outputs are the cost parameters and constants. The expected sign for the cost parameter is again negative. Convergence of the maximum likelihood estimation process is achieved when the change in model parameters and constants reduces below a preset threshold level (expressed as a percentage).

For each step of the calibration the current estimates of these parameters are applied, and the trip balancing factors (the O and D in the above equations) are then calculated through a standard iterative process. In model application these trip balancing factors are recalculated, while the parameters are simply input.

B.4 Logsum Calculations

For the pre-distribution structure it is required to 'pass' costs up the distribution model to the mode choice models. The input generalised cost matrices are required to be averaged across attraction zones for input into the production zone level mode choice model.

This averaging process is referred to as the centred logsum. As the name suggests, the approach is to take the log of the sum of the utility or impedance matrices. This summation is shown below.

$$CentredLogsum_i^k = \ln \frac{\sum_j A_j D_j e^{F(\cos t_{ij}^k)}}{\sum_j A_j D_j}$$

with k defined as the segment (both mode and car availability segment where appropriate) and the function F defined as previously.

B.5 Home Based Work - Simultaneous Model

This model structure undertakes both the mode choice and distribution at the same level in the model hierarchy. This entails slight modifications to the mathematical structure of the distribution model as shown below.

$$Trips_{ij}^{k,mode} = P_i^k O_i^k A_j D_j e^{F_{ij}^{k,mode}}$$

$$with$$

$$\mathrm{F}_{ij}^{k,mode} = Constant_{\sec tor}^{k,mode} + l_{\sec tor}^{k,mode} Cost_{ij}^{k,mode}$$

We have now additionally segmented the cost parameter by mode as well as car availability segment - ie the cost parameter is the same for both the distribution and mode choice models. Additional modal constants have been added into the cost functions - the constants vary by mode.

The trip balancing factors remain identical to that presented previously, ie one set of attraction factors and one set of production factors for each segment (not mode).

As we have only one level in the hierarchy, it is not required to calculate the cost logsums to transfer up the model hierarchy.

Appendix C Treatment of Walk and Cycle Trips and Costs

C.1 Introduction

A number of options were tested for the treatment of walk and cycle trips. Following approaches used in other models, our plan was that they would be included at the bottom of the hierarchy tree, after both trip distribution and mode choice.

This involved evaluating two modal combination options for the higher level mode choice and distribution models: either slow mode trips would have to be combined with public transport or with car. The choices made for each trip purpose and segment are discussed in later sections of this appendix.

The treatment of the cost of travel by slow modes was also an important consideration, in regard to determining the 'sub-mode' choice between slow and mechanised modes (car, public transport) and how the cost should be reflected (via logsums) at the higher levels in the model hierarchy (mode choice and distribution).

Previous research, including the models calibrated for the London Transportation Studies, suggest that sub-mode models could be calibrated using trip distance as the 'cost' for slow trips. While this approach appeared to be effective for the sub-model choice model, we found that the transfer of the 'logsum' costs to the next level of the hierarchy undermined the calibrations of the other models in the hierarchy. In particular, the calibrations resulted in distribution models with poor fits to the observed data and mode choice models that did not converge.

Following this preliminary analysis work, it was decided to use fixed slow: mechanised sub-mode shares as a function of distance (for each trip purpose and car availability segment – this distance function represents the decrease in walk and cycle trips as trip distance increases). This occurs at the lowest level of the model. Instead of using 'logsum' costs, the costs attributed to the new combined mode at the higher level were simply those of the relevant mechanised mode with which the slow mode trips were combined. The consequence of this was more stable and better-fitting mode choice and distribution model calibrations.

The choice of mechanised mode with which to combine the slow trips is discussed below for each purpose and segment. The general approach was to base the choice on the behaviour evident in the data – slow modes have the highest share at short distances, and we linked these modes to whichever of car and public transport showed the sharpest reduction in mode share for these shorter distances).

These plots include all data points present in the data and do not attempt to aggregate where the sample size is small. Hence some of these points are based on very small amounts of data and are not statistically significant. In application, these small sample distance bands have been aggregated to create a smooth curve.

Another point to note is the inclusion of car passenger with car driver, hence the presence of car trips for the captive segments.

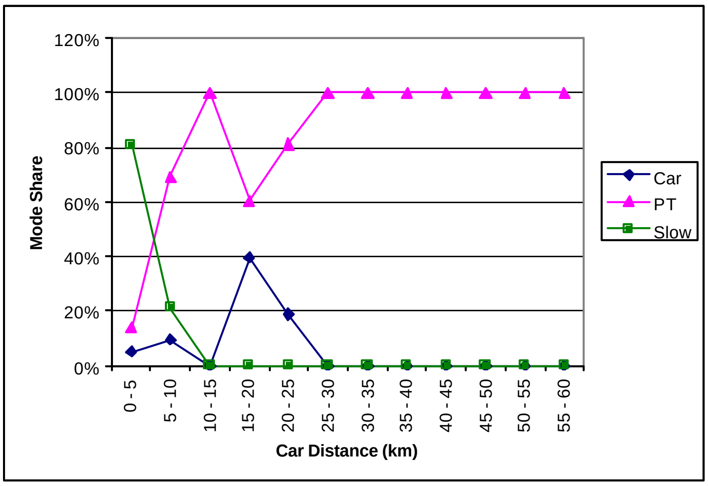
C.2 Home Based Work

Due to the small sample size, for the captive segment we have combined all three modes for trip distribution, using public transport costs for the combined segment. Both car and slow trips are factored from the synthetic captive trip matrix after distribution.

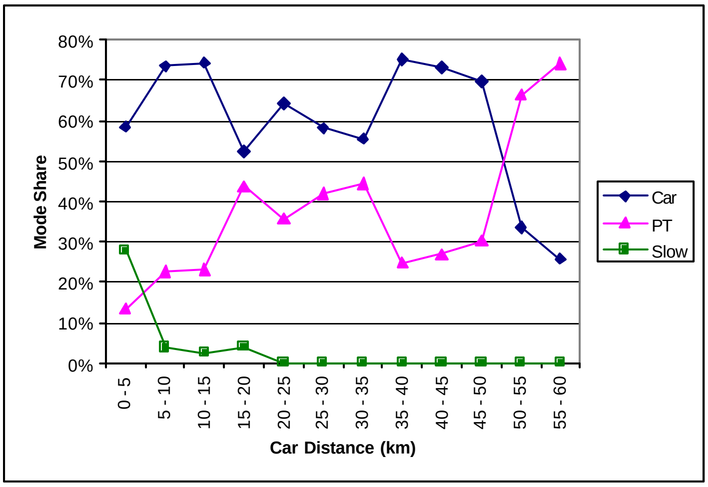
For the competition segment (Figure C-2) it was apparent that the largest competitor for short distance trips was the car mode. The plot for car drops sharply for trips less than 10 km in length from around 75% for 5-10km trips to 58% for 0-5 km trips, a drop of 17%, while public transport only drops by approximately 10% for the same interval.

On the other hand, the figure illustrating the mode choice relationships for the choice segment is a little ambiguous in terms of the most appropriate mode to combine with slow. However calibration tests clearly indicated that slow was best combined with public transport, the final decision adopted for this segment.

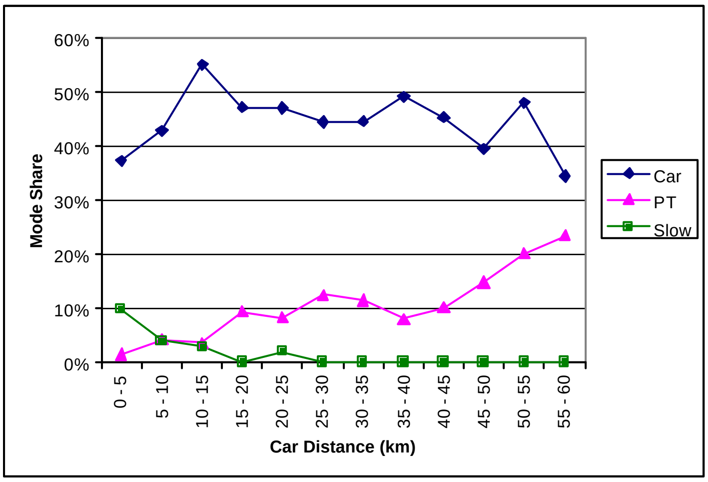
■ **Figure C-1 HBW Captive Mode Share by Car Distance**



■ **Figure C-2 HBW Competition Mode Share by Car Distance**



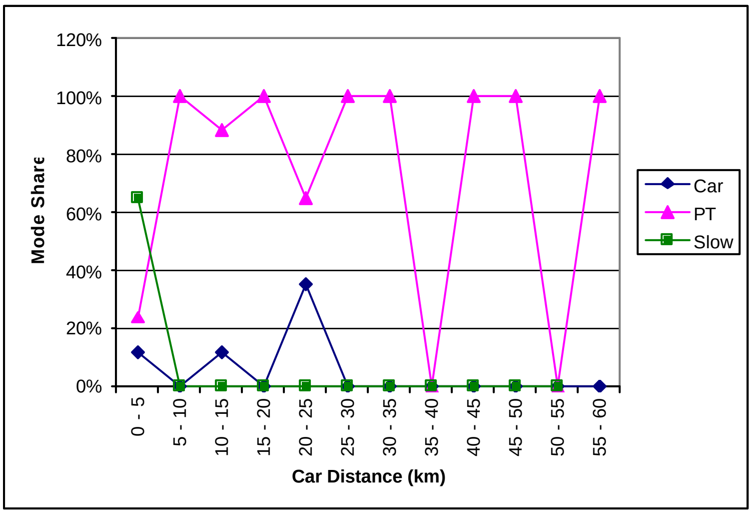
■ **Figure C-3 HBW Choice Mode Share by Car Distance**



C.3 Home Based Education

The two following figures illustrate the slow mode choice relationships for the captive and choice segments for home based education.

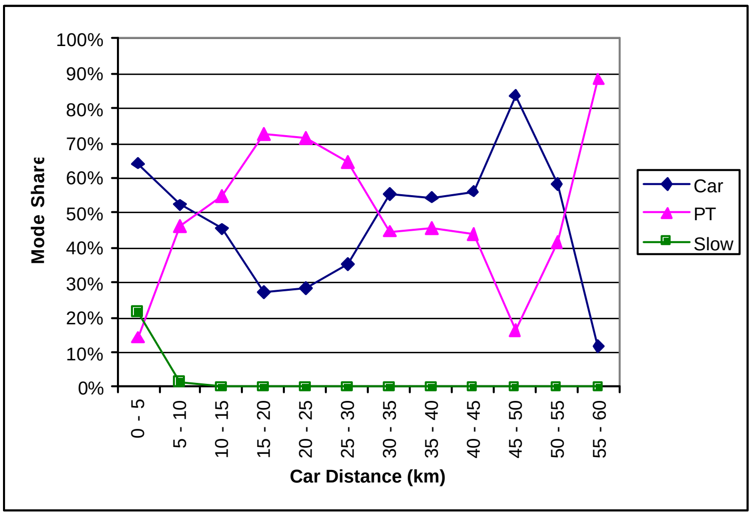
■ **Figure C-4 HBEd Captive Mode Share by Car Distance**



Similar to home based work, the three modes have been combined for the captive segment, and the public transport costs have been used for the distribution model for this segment. The slow modes have then been factored out of the final matrix, based on the car trip length. This is discussed further in the chapter on the home based education final models.

For the combined choice segment, the plot below indicates clearly that the best fit for slow would be with public transport. This indeed was the case in our model tests, and was the option chosen.

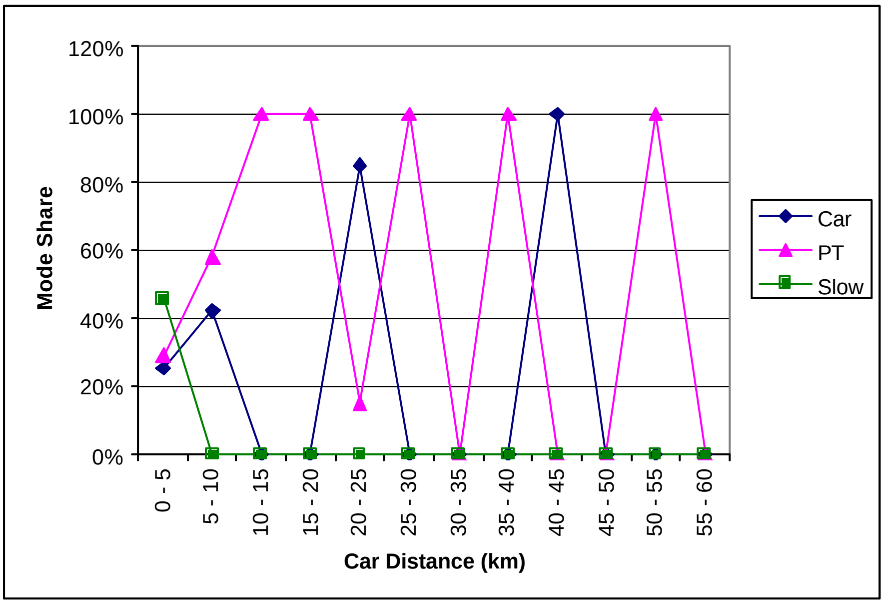
■ **Figure C-5 HBEd Combined Choice Mode Share by Car Distance**



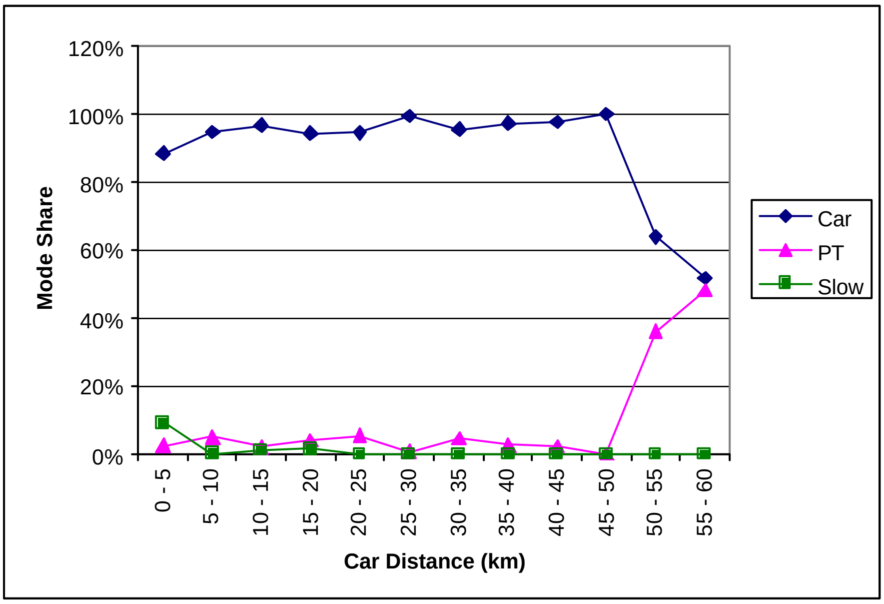
C.4 Home Based Shopping

For this purpose, the captive and choice segments were combined. However the two plots below show these segments separately. The combined choice segment dominates the overall number of trips. This plot (Figure C-7) indicates that the best fit of slow for this purpose would be with car, as the car mode share drops as the trip distance decreases, indicating it's competition with the slow mode trips.

■ **Figure C-6 HBSh Captive Mode Share by Car Distance**



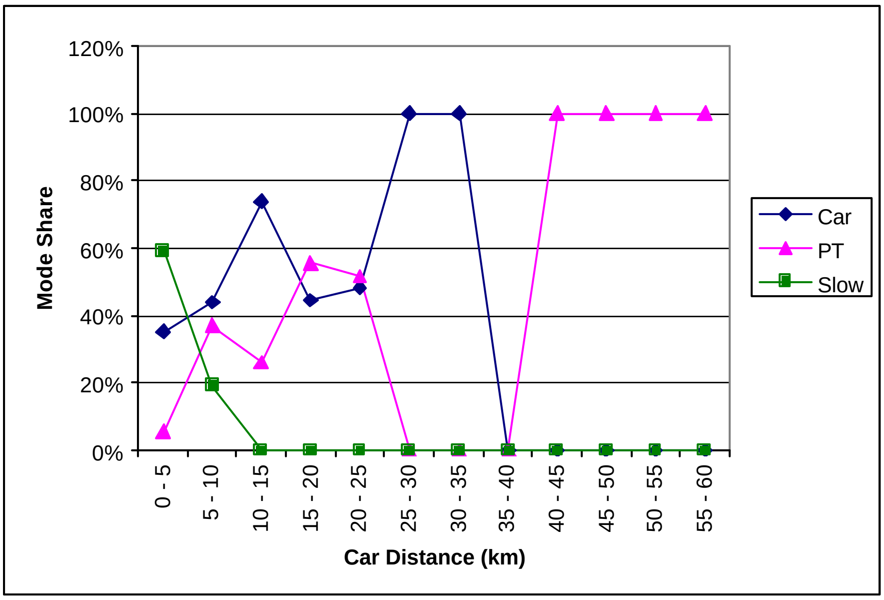
■ **Figure C-7 HBSh Combined Choice Mode Share by Car Distance**



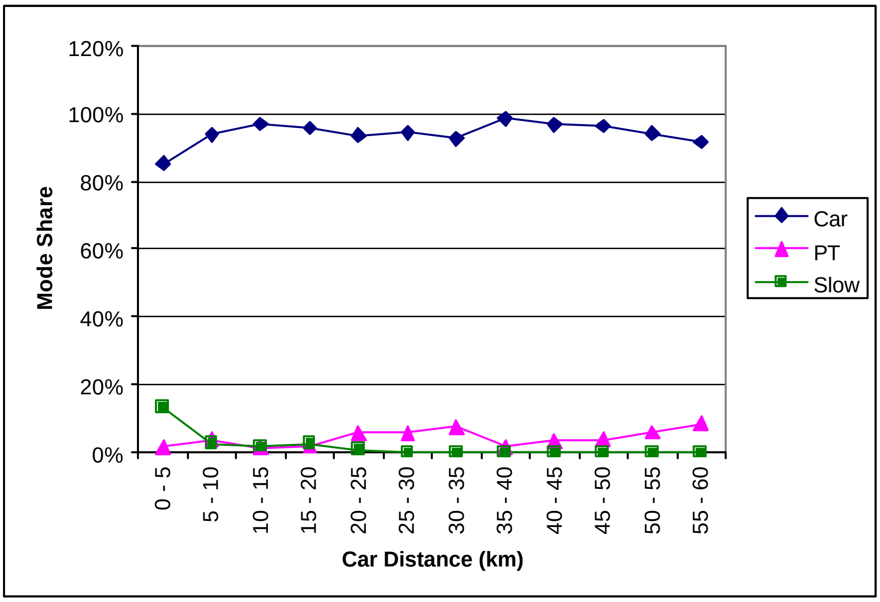
C.5 Home Based Other

The two plots for home based other are very similar to those for home based shopping. The same decision has been reached for this purpose, combining slow modes with car for the combined captive and competition/choice segment.

■ **Figure C-8 HBO Captive Mode Share by Car Distance**



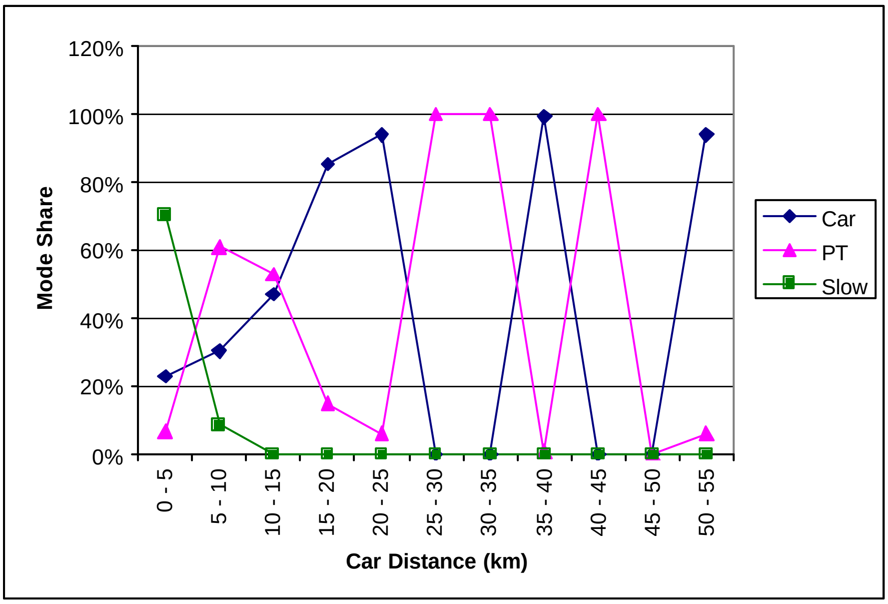
■ **Figure C-9 HBO Combined Choice Mode Share by Car Distance**



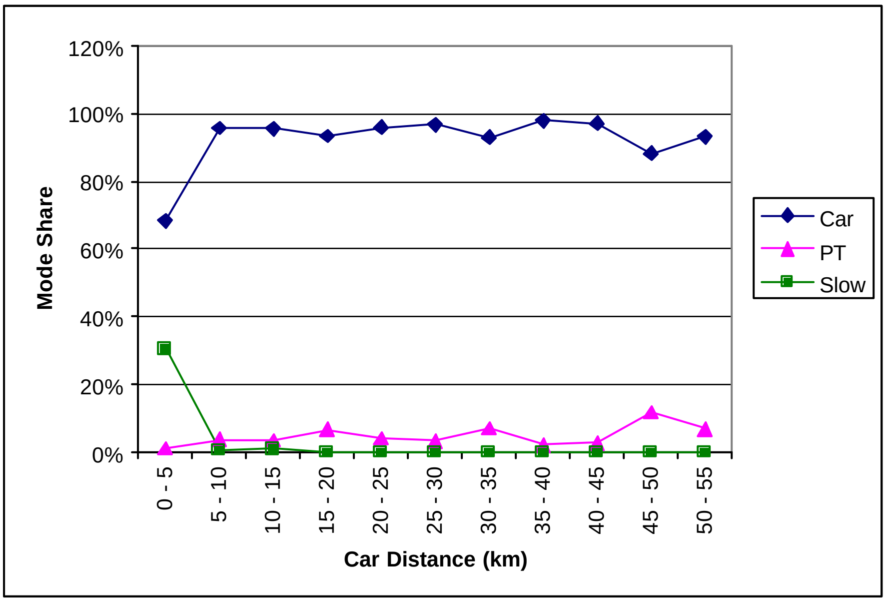
C.6 Non Home Based Other

For non home based the combined captive and competition/choice segment exhibits the same characteristics as both home based other and shopping. The drop in car mode share for short distance trips is even more marked for this purpose. Slow has therefore also been combined with the car trips for this purpose.

■ **Figure C-10 NHBO Captive Mode Share by Car Distance**



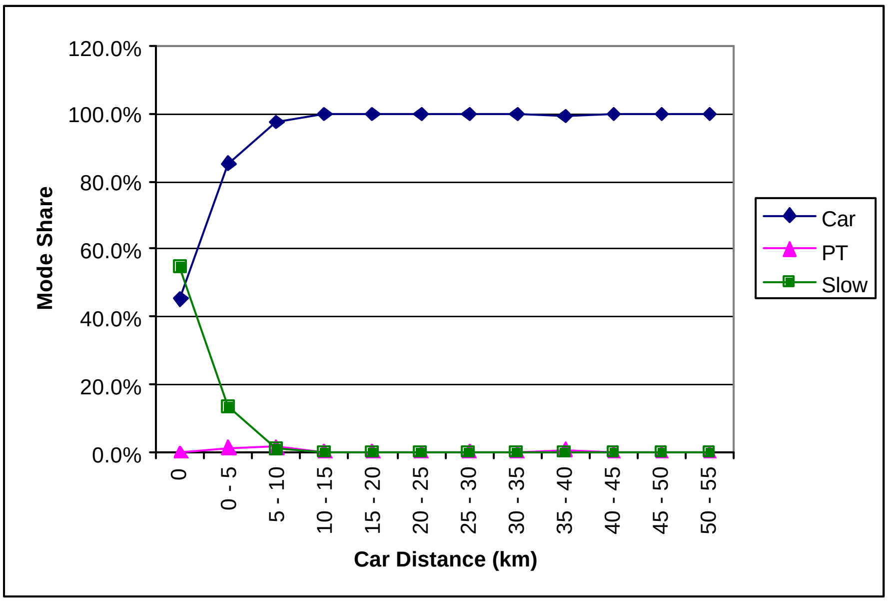
■ **Figure C-11 NHBO Combined Choice Mode Share by Car Distance**



C.7 Employers Business

For the single segment in employers business, the plot below indicates that slow should again be combined with the car mode. The drop in the car mode share for the short trips is quite substantial, dropping from approximately 98% for 5-10km trips to just over 83% for 0-5km trips and approximately 43% for intrazonals.

■ **Figure C-12 EB Mode Share by Car Distance**



Note: the '0' point refers to intrazonal trips

Appendix D Supplementary Model Fit Tables

Presented below are a series of model fit tables for each purpose, demonstrating the fit at the TLA matrix level for modelled trips and mean trip costs.

D.1 Home Based Work

- **Figure D-1 HBW Observed Trips**

HBW Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	101520	2500	722	1075	6311	0	227	241	112596
Porirua (Porirua)	13771	8253	479	410	2738	0	0	78	25728
Kapiti Coast (KC)	4133	989	11989	120	980	0	0	995	19208
Upper Hutt (UH)	5891	475	56	12094	4756	0	49	59	23379
Lower Hutt (LH)	16626	101	95	3109	32210	0	9	145	52294
Cart/Sth Wai (Car/SW)	866	27	0	44	173	3999	1318	32	6458
Masterton (Mast)	279	4	0	46	121	1449	12791	319	15010
External	462	89	934	40	145	40	497	0	2206
Total	143547	12438	14276	16937	47433	5487	14891	1868	256877

- **Figure D-2 HBW Modelled Trips**

HBW Synthetic	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	101870	2126	217	807	7533	16	4	23	112596
Porirua (Porirua)	13194	8135	506	895	2919	20	4	54	25728
Kapiti Coast (KC)	3847	772	12041	305	849	7	2	1230	19053
Upper Hutt (UH)	6024	513	119	12287	4268	125	28	15	23379
Lower Hutt (LH)	17605	773	151	2246	31448	44	10	17	52295
Cart/Sth Wai (Car/SW)	523	34	8	305	268	4213	1051	56	6458
Masterton (Mast)	216	6	1	51	48	969	13401	319	15010
External	251	80	1231	39	94	99	412	0	2206
Total	143530	12437	14274	16936	47428	5492	14912	1714	256723

- **Figure D-3 HBW Observed v Modelled Trips % Difference**

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	0%	-15%	-70%	-25%	19%	NA	-98%	-91%	0%
Porirua (Porirua)	-4%	-1%	6%	118%	7%	NA	NA	-30%	0%
Kapiti Coast (KC)	-7%	-22%	0%	155%	-13%	NA	NA	24%	-1%
Upper Hutt (UH)	2%	8%	112%	2%	-10%	NA	-44%	-74%	0%
Lower Hutt (LH)	6%	662%	59%	-28%	-2%	NA	9%	-88%	0%
Cart/Sth Wai (Car/SW)	-40%	26%	NA	597%	55%	5%	-20%	76%	0%
Masterton (Mast)	-23%	51%	NA	12%	-61%	-33%	5%	0%	0%
External	-46%	-10%	32%	-2%	-35%	150%	-17%	NA	0%
Total	0%	0%	0%	0%	0%	0%	0%	-8%	0%

■ Figure D-4 HBW Observed Mean Trip Cost

HBW Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	34	89	275	150	122	0	0	0	43
Porirua (Porirua)	105	50	110	0	169	0	0	0	72
Kapiti Coast (KC)	160	0	66	0	0	0	0	0	109
Upper Hutt (UH)	117	0	0	43	99	0	0	0	81
Lower Hutt (LH)	90	167	0	104	46	0	0	0	64
Cart/Sth Wai (Car/SW)	221	0	0	0	200	47	0	0	68
Masterton (Mast)	0	0	0	0	0	133	16	0	17
External	0	0	0	0	0	0	0	0	0
Total	43	54	191	62	72	51	16	0	48

■ Figure D-5 HBW Modelled Mean Trip Cost

HBW Modelled	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	40	82	171	150	95	0	0	0	42
Porirua (Porirua)	104	43	144	190	148	0	0	0	81
Kapiti Coast (KC)	156	120	45	230	191	0	0	0	81
Upper Hutt (UH)	125	173	234	42	93	246	0	0	72
Lower Hutt (LH)	91	142	203	86	47	0	0	0	63
Cart/Sth Wai (Car/SW)	237	282	0	186	220	20	123	220	37
Masterton (Mast)	272	0	0	227	260	120	19	198	22
External	0	0	0	0	0	0	0	0	0
Total	48	52	57	59	65	27	20	202	48

■ Figure D-6 HBW Observed v Modelled % Difference in Mean Trip Cost

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	16%	-7%	-38%	0%	-22%	0%	0%	0%	0%
Porirua (Porirua)	-1%	-13%	31%	0%	-12%	0%	0%	0%	13%
Kapiti Coast (KC)	-3%	0%	-31%	0%	0%	0%	0%	0%	-26%
Upper Hutt (UH)	7%	0%	0%	-3%	-6%	0%	0%	0%	-11%
Lower Hutt (LH)	2%	-15%	0%	-17%	2%	0%	0%	0%	-2%
Cart/Sth Wai (Car/SW)	7%	0%	0%	0%	10%	-57%	0%	0%	-46%
Masterton (Mast)	0%	0%	0%	0%	0%	-9%	18%	0%	30%
External	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	9%	-3%	-70%	-5%	-9%	-46%	28%	0%	-1%

D.2 Home Based Education

■ Figure D-7 HBEd Observed Trips

HBEd Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	34301	511	1	0	326	0	0	25	35164
Porirua (Porirua)	2662	7012	302	222	504	0	0	1	10703
Kapiti Coast (KC)	406	262	9457	0	0	0	0	178	10303
Upper Hutt (UH)	990	0	0	4689	943	0	0	2	6623
Lower Hutt (LH)	2213	0	0	549	17818	0	0	17	20597
Cart/Sth Wai (Car/SW)	143	0	0	0	8	1138	554	11	1854
Masterton (Mast)	41	0	0	0	12	0	5383	137	5573
External	21	4	114	0	1	2	105	0	248
Total	40777	7789	9875	5460	19612	1140	6042	371	91065

■ Figure D-8 HBEd Modelled Trips

HBEd Modelled	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	34098	258	42	65	698	0	1	3	35164
Porirua (Porirua)	2724	7237	168	91	472	0	1	10	10703
Kapiti Coast (KC)	385	117	9482	21	99	0	0	142	10246
Upper Hutt (UH)	758	51	20	4836	949	1	4	3	6622
Lower Hutt (LH)	2725	114	39	398	17313	1	2	4	20596
Cart/Sth Wai (Car/SW)	61	6	2	42	64	1127	495	51	1849
Masterton (Mast)	8	1	0	5	8	10	5438	101	5570
External	11	4	120	2	5	2	105	0	248
Total	40769	7787	9872	5459	19609	1140	6047	314	90997

■ Figure D-9 HBEd Observed v Modelled Trips % Difference

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	-1%	-49%	2864%	NA	114%	NA	NA	-89%	0%
Porirua (Porirua)	2%	3%	-44%	-59%	-6%	NA	NA	677%	0%
Kapiti Coast (KC)	-5%	-55%	0%	NA	NA	NA	NA	-20%	-1%
Upper Hutt (UH)	-23%	NA	NA	3%	1%	NA	NA	100%	0%
Lower Hutt (LH)	23%	NA	NA	-27%	-3%	NA	NA	-77%	0%
Cart/Sth Wai (Car/SW)	-57%	NA	NA	NA	672%	-1%	-11%	354%	0%
Masterton (Mast)	-82%	NA	NA	NA	-31%	NA	1%	-26%	0%
External	-47%	-14%	5%	NA	285%	-30%	0%	NA	0%
Total	0%	0%	0%	0%	0%	0%	0%	-15%	0%

Figure D-10 HBEd Observed Mean Trip Cost

HBEd Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	68	141	0	0	157	0	0	0	69
Porirua (Porirua)	138	31	0	273	202	0	0	0	52
Kapiti Coast (KC)	208	127	40	0	0	0	0	409	101
Upper Hutt (UH)	151	0	0	54	124	0	0	0	64
Lower Hutt (LH)	126	0	0	128	51	0	0	0	56
Cart/Sth Wai (Car/SW)	0	0	0	0	0	0	149	0	149
Masterton (Mast)	371	0	0	0	350	0	73	0	123
External	0	0	0	0	0	0	0	0	0
Total	72	50	40	59	59	0	107	409	68

Figure D-11 HBEd Modelled Mean Trip Cost

HBEd Modelled	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	66	130	256	209	150	0	0	0	68
Porirua (Porirua)	136	46	201	247	195	0	0	0	71
Kapiti Coast (KC)	185	140	55	291	238	0	0	0	64
Upper Hutt (UH)	165	225	299	51	108	0	359	0	68
Lower Hutt (LH)	130	196	269	111	62	0	393	0	76
Cart/Sth Wai (Car/SW)	346	0	0	272	291	17	146	265	43
Masterton (Mast)	0	0	0	0	0	0	12	0	12
External	0	0	0	0	0	0	0	0	0
Total	74	53	58	55	70	17	7725	265	70

Figure D-12 HBEd Observed v Modelled % Difference in Mean Trip Cost

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	-2%	-8%	0%	0%	-4%	0%	0%	0%	-2%
Porirua (Porirua)	-2%	47%	0%	-10%	-4%	0%	0%	0%	37%
Kapiti Coast (KC)	-11%	10%	37%	0%	0%	0%	0%	-100%	-37%
Upper Hutt (UH)	9%	0%	0%	-6%	-13%	0%	0%	0%	7%
Lower Hutt (LH)	2%	0%	0%	-13%	20%	0%	0%	0%	36%
Cart/Sth Wai (Car/SW)	0%	0%	0%	0%	0%	0%	-2%	0%	-71%
Masterton (Mast)	-100%	0%	0%	0%	-100%	0%	-83%	0%	-90%
External	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	3%	6%	44%	-6%	18%	0%	7130%	-35%	2%

D.3 Home Based Shopping

■ Figure D-13 HBSh Observed Trips

HBSh Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	109940	4627	91	46	2970	0	0	124	117797
Porirua (Porirua)	2697	24491	86	0	489	0	0	44	27805
Kapiti Coast (KC)	523	548	35584	0	54	0	0	738	37446
Upper Hutt (UH)	789	278	0	23690	1999	0	10	15	26781
Lower Hutt (LH)	2083	80	426	1176	57535	0	0	55	61355
Cart/Sth Wai (Car/SW)	0	0	0	93	144	6077	2162	10	8487
Masterton (Mast)	0	0	0	171	24	649	19527	282	20652
External	173	73	545	8	35	9	459	0	1302
Total	116205	30095	36732	25184	63249	6735	22158	1268	301625

■ Figure D-14 HBSh Modelled Trips

HBSh Modelled	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	110662	3112	163	365	3411	3	1	7	117724
Porirua (Porirua)	1356	25196	247	298	693	2	1	11	27805
Kapiti Coast (KC)	273	645	35353	104	200	1	0	771	37346
Upper Hutt (UH)	907	537	87	22780	2393	49	23	4	26780
Lower Hutt (LH)	2949	566	72	1315	56437	8	4	3	61355
Cart/Sth Wai (Car/SW)	39	24	4	315	104	6322	1663	16	8486
Masterton (Mast)	0	0	0	2	1	322	20044	67	20437
External	5	12	805	2	4	33	442	0	1302
Total	116191	30092	36730	25182	63242	6739	22177	880	301235

■ Figure D-15 HBSh Observed v Modelled Trips % Difference

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	1%	-33%	80%	701%	15%	NA	NA	-94%	0%
Porirua (Porirua)	-50%	3%	188%	NA	42%	NA	NA	-75%	0%
Kapiti Coast (KC)	-48%	18%	-1%	NA	270%	NA	NA	4%	0%
Upper Hutt (UH)	15%	93%	NA	-4%	20%	NA	137%	-71%	0%
Lower Hutt (LH)	42%	611%	-83%	12%	-2%	NA	NA	-94%	0%
Cart/Sth Wai (Car/SW)	NA	NA	NA	239%	-28%	4%	-23%	57%	0%
Masterton (Mast)	NA	NA	NA	-99%	-97%	-50%	3%	-76%	-1%
External	-97%	-84%	48%	-74%	-89%	261%	-4%	NA	0%
Total	0%	0%	0%	0%	0%	0%	0%	-31%	0%

■ **Figure D-16 HBSh Observed Mean Trip Cost**

HBSh Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	8	16	121	62	36	0	0	143	9
Porirua (Porirua)	41	7	60	0	46	0	0	111	12
Kapiti Coast (KC)	88	50	9	0	70	0	0	38	11
Upper Hutt (UH)	60	53	0	7	33	0	0	136	11
Lower Hutt (LH)	45	40	122	33	8	0	0	144	11
Cart/Sth Wai (Car/SW)	0	0	0	68	117	14	40	92	23
Masterton (Mast)	0	0	0	121	0	32	7	34	9
External	148	107	34	136	145	60	32	0	57
Total	10	10	11	9	11	16	11	59	11

■ **Figure D-17 HBSh Modelled Mean Trip Cost**

HBSh Modelled	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	8	21	76	61	33	142	178	128	10
Porirua (Porirua)	43	8	53	46	44	127	163	105	11
Kapiti Coast (KC)	82	46	8	77	78	157	193	41	11
Upper Hutt (UH)	63	51	85	8	33	83	120	137	13
Lower Hutt (LH)	45	51	87	31	8	114	150	139	11
Cart/Sth Wai (Car/SW)	131	119	152	70	102	13	42	74	23
Masterton (Mast)	188	173	0	126	157	34	7	29	7
External	143	106	31	139	139	59	32	0	34
Total	10	12	10	11	11	14	248	43	12

■ **Figure D-18 HBSh Observed v Modelled % Difference in Mean Trip Cost**

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	3%	31%	-37%	-2%	-9%	0%	0%	-11%	4%
Porirua (Porirua)	5%	4%	-11%	0%	-4%	0%	0%	-6%	-5%
Kapiti Coast (KC)	-7%	-8%	-9%	0%	11%	0%	0%	9%	-3%
Upper Hutt (UH)	4%	-5%	0%	9%	1%	0%	0%	1%	22%
Lower Hutt (LH)	0%	28%	-28%	-4%	0%	0%	0%	-3%	0%
Cart/Sth Wai (Car/SW)	0%	0%	0%	3%	-13%	-9%	6%	-20%	-1%
Masterton (Mast)	0%	0%	0%	4%	0%	5%	-6%	-14%	-20%
External	-4%	-1%	-9%	2%	-4%	-2%	-1%	0%	-40%
Total	-1%	13%	-13%	21%	2%	-7%	2227%	-27%	8%

D.4 Home Based Other

■ Figure D-19 HBO Observed Trips

HBO Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	136066	2571	558	467	4333	388	6	504	144892
Porirua (Porirua)	5322	28608	298	148	896	0	0	202	35475
Kapiti Coast (KC)	1341	540	40177	54	401	3	0	1501	44017
Upper Hutt (UH)	1081	552	127	24852	2716	0	108	105	29541
Lower Hutt (LH)	6193	6	561	3533	66216	156	0	720	77384
Cart/Sth Wai (Car/SW)	229	0	0	365	182	9346	1504	45	11673
Masterton (Mast)	0	0	0	171	66	679	22041	231	23189
External	651	143	958	75	113	49	236	2	2226
Total	150883	32420	42678	29665	74923	10621	23895	3311	368396

■ Figure D-20 HBO Modelled Trips

HBO Modelled	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	136909	1988	490	1127	4077	74	33	92	144790
Porirua (Porirua)	4170	27970	704	908	1541	57	23	102	35474
Kapiti Coast (KC)	1002	699	39398	325	497	21	9	1264	43214
Upper Hutt (UH)	1730	570	217	24450	2158	255	96	39	29514
Lower Hutt (LH)	6657	1002	352	2316	66281	143	60	62	76872
Cart/Sth Wai (Car/SW)	227	71	28	458	266	9337	1184	80	11651
Masterton (Mast)	11	4	1	24	13	673	22257	206	23189
External	158	115	1491	56	82	68	256	0	2226
Total	150864	32417	42681	29663	74915	10627	23917	1844	366928

■ Figure D-21 HBO Observed v Modelled Trips % Difference

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	1%	-23%	-12%	142%	-6%	-81%	432%	-82%	0%
Porirua (Porirua)	-22%	-2%	136%	513%	72%	NA	NA	-50%	0%
Kapiti Coast (KC)	-25%	29%	-2%	499%	24%	610%	NA	-16%	-2%
Upper Hutt (UH)	60%	3%	71%	-2%	-21%	NA	-11%	-63%	0%
Lower Hutt (LH)	8%	17788%	-37%	-34%	0%	-8%	NA	-91%	-1%
Cart/Sth Wai (Car/SW)	-1%	NA	NA	25%	46%	0%	-21%	76%	0%
Masterton (Mast)	NA	NA	NA	-86%	-80%	-1%	1%	-11%	0%
External	-76%	-20%	56%	-26%	-27%	40%	8%	-100%	0%
Total	0%	0%	0%	0%	0%	0%	0%	-44%	0%

Figure D-22 HBO Observed Mean Trip Cost

HBO Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	9	22	92	65	34	146	0	128	11
Porirua (Porirua)	35	7	63	37	43	0	0	105	13
Kapiti Coast (KC)	98	48	8	84	85	0	0	40	13
Upper Hutt (UH)	60	36	113	7	30	0	122	134	12
Lower Hutt (LH)	40	0	94	32	8	102	0	132	13
Cart/Sth Wai (Car/SW)	143	0	0	65	109	17	58	88	27
Masterton (Mast)	0	0	0	112	137	52	7	32	9
External	141	97	37	131	141	96	32	999	81
Total	13	9	12	13	11	25	10	80	13

Figure D-23 HBO Modelled Mean Trip Cost

HBO Modelled	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	9	31	79	59	36	140	173	101	11
Porirua (Porirua)	40	7	52	45	44	127	159	98	15
Kapiti Coast (KC)	86	51	7	81	83	163	195	39	12
Upper Hutt (UH)	63	48	83	8	33	84	116	127	16
Lower Hutt (LH)	43	47	84	32	8	115	147	118	13
Cart/Sth Wai (Car/SW)	138	123	158	81	109	12	55	87	25
Masterton (Mast)	180	165	200	122	151	36	7	30	8
External	135	100	40	131	133	65	31	0	55
Total	12	12	11	15	12	19	136	51	13

Figure D-24 HBO Observed v Modelled % Difference in Mean Trip Cost

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	3%	46%	-13%	-9%	8%	-4%	0%	-21%	-1%
Porirua (Porirua)	13%	6%	-18%	24%	4%	0%	0%	-7%	16%
Kapiti Coast (KC)	-12%	5%	-18%	-3%	-2%	0%	0%	-2%	-7%
Upper Hutt (UH)	4%	31%	-27%	21%	11%	0%	-5%	-5%	25%
Lower Hutt (LH)	8%	0%	-11%	-1%	2%	12%	0%	-10%	0%
Cart/Sth Wai (Car/SW)	-4%	0%	0%	24%	0%	-26%	-5%	0%	-8%
Masterton (Mast)	0%	0%	0%	10%	10%	-31%	5%	-7%	-11%
External	-4%	4%	7%	0%	-6%	-32%	-2%	-100%	-32%
Total	-1%	27%	-11%	21%	4%	-26%	1191%	-37%	7%

D.5 Non Home Based Other

■ Figure D-25 NHBO Observed Trips

NHBO Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	219454	6800	1532	1115	7045	243	6	313	236507
Porirua (Porirua)	4742	28706	448	430	628	33	0	57	35043
Kapiti Coast (KC)	859	392	40682	32	689	0	0	656	43310
Upper Hutt (UH)	924	287	74	26159	2929	233	59	19	30684
Lower Hutt (LH)	7056	810	365	2099	75894	167	0	76	86466
Cart/Sth Wai (Car/SW)	160	0	0	0	109	7035	2029	14	9347
Masterton (Mast)	149	0	0	0	163	1721	36091	215	38338
External	381	30	235	71	44	12	201	111	1085
Total	233726	37023	43335	29905	87500	9442	38386	1461	480779

■ Figure D-26 NHBO Modelled Trips

NHBO Modelled	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	220608	4808	856	1657	8459	76	16	27	236507
Porirua (Porirua)	3372	29030	754	586	1243	29	6	24	35043
Kapiti Coast (KC)	708	715	40407	180	310	9	2	581	42911
Upper Hutt (UH)	1680	869	292	24678	2829	268	57	11	30684
Lower Hutt (LH)	7232	1546	430	2556	74546	116	25	15	86466
Cart/Sth Wai (Car/SW)	44	22	7	138	68	7627	1403	37	9347
Masterton (Mast)	21	6	2	39	19	1298	36699	212	38295
External	16	21	505	7	10	33	203	0	793
Total	233681	37017	43252	29840	87484	9455	38410	907	480044

■ Figure D-27 NHBO Observed v Modelled Trips % Difference

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	1%	-29%	-44%	49%	20%	-69%	153%	-91%	0%
Porirua (Porirua)	-29%	1%	68%	36%	98%	-12%	NA	-57%	0%
Kapiti Coast (KC)	-18%	82%	-1%	467%	-55%	NA	NA	-11%	-1%
Upper Hutt (UH)	82%	203%	294%	-6%	-3%	15%	-4%	-41%	0%
Lower Hutt (LH)	2%	91%	18%	22%	-2%	-30%	NA	-81%	0%
Cart/Sth Wai (Car/SW)	-72%	NA	NA	NA	-37%	8%	-31%	159%	0%
Masterton (Mast)	-86%	NA	NA	NA	-88%	-25%	2%	-1%	0%
External	-96%	-31%	114%	-91%	-78%	185%	1%	-100%	-27%
Total	0%	0%	0%	0%	0%	0%	0%	-38%	0%

■ Figure D-28 NHBO Observed Mean Trip Cost

NHBO Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	7	28	86	59	33	138	0	150	9
Porirua (Porirua)	29	7	58	42	43	137	0	107	11
Kapiti Coast (KC)	91	52	9	76	86	0	0	36	12
Upper Hutt (UH)	62	43	89	5	31	55	118	141	10
Lower Hutt (LH)	37	46	89	32	7	140	0	143	11
Cart/Sth Wai (Car/SW)	129	0	0	0	108	14	33	98	22
Masterton (Mast)	181	0	0	0	173	35	6	33	9
External	154	112	37	141	150	83	32	0	103
Total	9	12	13	9	11	25	8	91	10

■ Figure D-29 NHBO Modelled Mean Trip Cost

NHBO Modelled	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	8	32	82	59	35	133	176	135	10
Porirua (Porirua)	36	6	53	49	46	123	166	105	12
Kapiti Coast (KC)	88	55	7	85	87	159	203	37	10
Upper Hutt (UH)	63	49	84	6	34	78	122	137	14
Lower Hutt (LH)	39	46	85	33	7	107	151	138	11
Cart/Sth Wai (Car/SW)	138	123	158	78	109	11	31	61	17
Masterton (Mast)	180	166	201	121	152	35	6	32	7
External	139	106	37	138	139	64	32	0	43
Total	9	13	10	13	11	19	302	44	11

■ Figure D-30 NHBO Observed v Modelled % Difference in Mean Trip Cost

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	8%	16%	-5%	1%	5%	-4%	0%	-10%	2%
Porirua (Porirua)	26%	-8%	-9%	16%	6%	-10%	0%	-2%	5%
Kapiti Coast (KC)	-3%	6%	-23%	13%	2%	0%	0%	3%	-18%
Upper Hutt (UH)	3%	14%	-6%	18%	10%	41%	3%	-2%	41%
Lower Hutt (LH)	6%	1%	-5%	3%	-5%	-23%	0%	-3%	2%
Cart/Sth Wai (Car/SW)	7%	0%	0%	0%	1%	-22%	-5%	-38%	-21%
Masterton (Mast)	-1%	0%	0%	0%	-12%	-1%	-3%	-4%	-18%
External	-10%	-5%	1%	-2%	-7%	-22%	-2%	0%	-58%
Total	3%	7%	-17%	36%	-2%	-22%	3864%	-52%	8%

D.6 Employers Business

■ Figure D-31 EB Observed Trips

EB Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	73820	1987	515	1024	5495	0	85	313	83239
Porirua (Porirua)	1964	3995	115	124	494	0	0	53	6744
Kapiti Coast (KC)	501	103	7165	46	131	0	0	438	8383
Upper Hutt (UH)	1267	228	0	5577	1642	106	85	48	8953
Lower Hutt (LH)	5426	404	302	1292	24427	106	92	165	32213
Cart/Sth Wai (Car/SW)	111	0	0	0	0	3172	830	29	4142
Masterton (Mast)	63	0	0	85	92	786	7503	294	8823
External	341	64	442	37	107	25	295	5	1316
Total	83493	6782	8540	8184	32387	4194	8889	1345	153813

■ Figure D-32 EB Modelled Trips

EB Modelled	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	74665	1725	368	1140	5266	77	23	90	83354
Porirua (Porirua)	1691	3709	216	300	697	20	6	52	6691
Kapiti Coast (KC)	438	268	6701	138	249	9	3	871	8676
Upper Hutt (UH)	1076	317	112	5272	1496	166	50	32	8521
Lower Hutt (LH)	5341	744	214	1588	24319	107	32	54	32398
Cart/Sth Wai (Car/SW)	55	16	6	121	75	3162	655	65	4154
Masterton (Mast)	14	4	1	30	19	592	7854	314	8827
External	81	49	626	28	47	51	269	0	1150
Total	83359	6832	8244	8616	32166	4185	8892	1476	153771

■ Figure D-33 EB Observed v Modelled Trips % Difference

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	1%	-13%	-29%	11%	-4%	NA	-72%	-71%	0%
Porirua (Porirua)	-14%	-7%	88%	####	41%	NA	NA	-2%	-1%
Kapiti Coast (KC)	-13%	161%	-6%	####	90%	NA	NA	99%	3%
Upper Hutt (UH)	-15%	39%	NA	-5%	-9%	56%	-41%	-34%	-5%
Lower Hutt (LH)	-2%	84%	-29%	23%	0%	1%	-65%	-67%	1%
Cart/Sth Wai (Car/SW)	-51%	NA	NA	NA	NA	0%	-21%	124%	0%
Masterton (Mast)	-79%	NA	NA	-65%	-80%	-25%	5%	7%	0%
External	-76%	-24%	42%	-25%	-56%	107%	-9%	-100%	-13%
Total	0%	1%	-3%	5%	-1%	0%	0%	10%	0%

Figure D-34 EB Observed Mean Trip Cost

EB Observed	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	6	19	55	41	21	0	107	95	9
Porirua (Porirua)	22	5	40	37	30	0	0	71	14
Kapiti Coast (KC)	66	36	7	48	58	0	0	26	13
Upper Hutt (UH)	42	41	0	5	23	50	73	95	16
Lower Hutt (LH)	22	29	63	21	6	67	95	101	11
Cart/Sth Wai (Car/SW)	80	0	0	0	0	19	23	53	22
Masterton (Mast)	115	0	0	72	94	36	6	23	11
External	97	74	26	94	98	50	24	999	58
Total	9	13	13	14	10	24	10	59	11

Figure D-35 EB Modelled Mean Trip Cost

EB Modelled	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	6	23	59	42	23	85	113	92	9
Porirua (Porirua)	27	5	39	37	31	81	108	72	17
Kapiti Coast (KC)	62	39	6	64	64	107	135	28	13
Upper Hutt (UH)	42	39	64	7	25	46	74	95	18
Lower Hutt (LH)	25	32	64	23	6	67	95	98	11
Cart/Sth Wai (Car/SW)	84	81	106	45	67	17	25	46	23
Masterton (Mast)	113	110	134	74	96	25	6	22	9
External	96	72	30	96	98	47	23	0	39
Total	9	16	14	16	11	24	9	36	11

Figure D-36 EB Observed v Modelled % Difference in Mean Trip Cost

% Difference	WC	Porirua	KC	UH	LH	Car/SW	Mast	External	Total
Wellington (WC)	1%	21%	8%	1%	11%	0%	6%	-2%	-1%
Porirua (Porirua)	18%	5%	-2%	-1%	4%	0%	0%	0%	21%
Kapiti Coast (KC)	-6%	10%	-13%	33%	10%	0%	0%	8%	2%
Upper Hutt (UH)	1%	-5%	0%	43%	6%	-8%	2%	0%	16%
Lower Hutt (LH)	10%	10%	2%	7%	1%	0%	0%	-3%	1%
Cart/Sth Wai (Car/SW)	5%	0%	0%	0%	0%	-10%	9%	-13%	6%
Masterton (Mast)	-2%	0%	0%	3%	2%	-31%	2%	-7%	-24%
External	-1%	-3%	18%	1%	-1%	-5%	-3%	-100%	-34%
Total	-2%	21%	5%	17%	5%	-2%	-13%	-38%	0%