

Zenith Model Recalibration and
Validation Version 3.0.1

Paper 4b - Non Home Based Trip Productions

May 2014

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Zenith Model Recalibration and Validation Version 3.0.1

Paper 4b - Non Home Based Trip Production Model Draft Report

Project No. ZML-VIC-Year4

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Executive Summary

The Zenith Model of Victoria is one of a family of models developed by Veitch Lister Consulting (VLC) for transport planning in Australian cities and regions. This document is one in a series of working papers that collectively describe the calibration and validation of the Zenith Model of Victoria. In particular, this document describes the Non Home Based Trip Production Model.

The aim of the Non Home Based Trip Production Model is to estimate (for each travel zone) the number of trips that will be produced for a range of non-home based trip purposes.

These purposes are:

1. Work Based Work (WBW)
2. Work Based Shopping (WBS)
3. Work Based Other (WBO)
4. Shopping Based Shopping (SBS)
5. Shopping Based Other (SBO)
6. Other Non-Home Based (OHNB)

Separate predictive models have been estimated and validated for each of the above trip purposes.

Each predictive model was developed using estimates of the number of trips produced (for each trip purpose) by each travel zone within the Zenith Model boundary. These estimates were derived from an expanded version of the *Victorian Integrated Survey of Travel and Activity* (VISTA).

The zonal variables that were available to predict the amount of non-home based trips produced by a region included:

- Total Employment
- Employment by occupation category (white / blue collar)
- Employment by industry
- Employment by industry x occupation category (white / blue collar)
- Number of households
- Number of educational enrolments (primary, secondary, tertiary)
- Visitor Accommodation and Recreation

2011 estimates for each of the above variables (at the zonal level) were sourced primarily from the 2011 ABS Census.

The resulting models were validated at two levels of spatial aggregation (travel zones and SA4s) using “leave-one-out cross validation”. This procedure provides an objective assessment of the predictive accuracy of each model.

The resulting models validate well with some small exceptions. An example is shown in Figure 0-1 below, which shows a comparison of total daily Work Based Work trip productions for each SA4, according to VISTA (in blue) and Zenith (in orange). It can be seen that in general the VISTA and Zenith estimates are in close alignment.

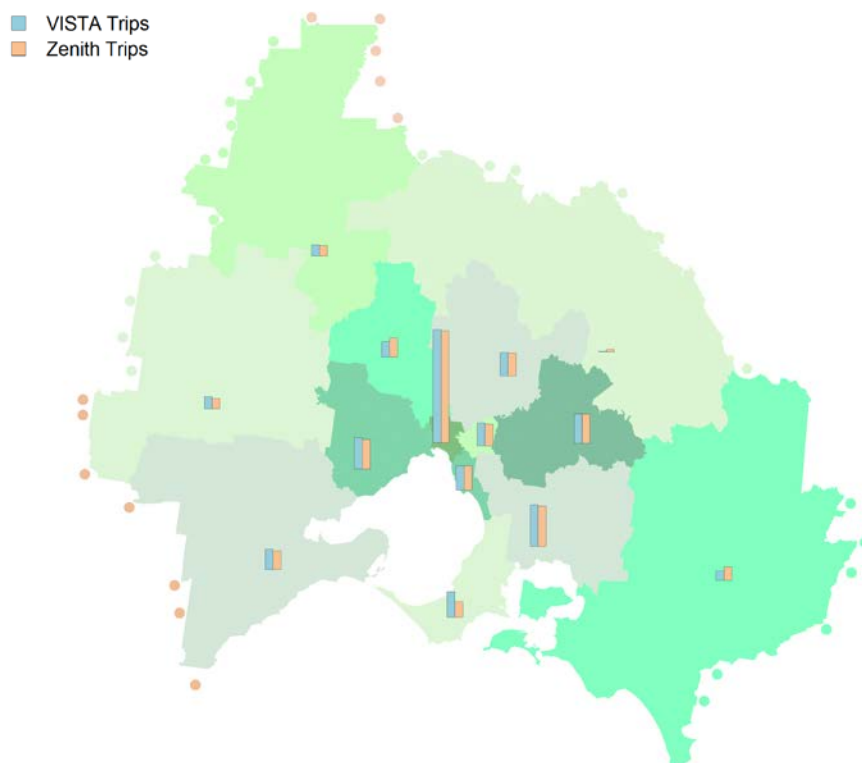


Figure 0-1 – Total Daily Work Based Work Trips Mapped by SA4

The model parameters described in this document have been implemented into the Zenith Model of Victoria.



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1 Introduction

1.1 Background

The Zenith Model of Victoria is one of a family of models developed by Veitch Lister Consulting (VLC) for transport planning in Australian cities and regions. This document is one in a series of working papers that collectively describe the calibration and validation of the Zenith Model of Victoria.

The primary focus of this document is the Non-Home Based Trip Production Model. Non-home based trips are trips that occur away the home (e.g. a trip from work to the shops or from one shop to another).

The aim of the Non Home Based Trip Production Model is to estimate (for each travel zone) the number of trips that will be produced for a range of non-home based trip purposes. These purposes are:

1. Work Based Work (WBW)
2. Work Based Shopping (WBS)
3. Work Based Other (WBO)
4. Shopping Based Shopping (SBS)
5. Shopping Based Other (SBO)
6. Other Non-Home Based (OHNB)

The scope of this paper is limited to the estimation and validation of the Non-Home Based Trip Production Models developed for the Zenith Model of Victoria. Details regarding methodology (including how the model is implemented within Zenith) are contained in the associated methodology document from the Framework series ("*Zenith Framework: Trip Productions*").

1.2 Report Structure

The balance of this report is structured as follows:

Chapter 2: Describes the data sources used to estimate and validate the Non-Home Based Trip Production Models;

Chapter 3: Describes the methodology by which each Non-Home Based Trip Production Model has been estimated and validated; and

Chapter 4: Presents the parameter estimates and validation results for each trip purpose.

1.3 Related Documents

The Zenith Model of Victoria is described in two complementary sets of technical notes:

- Zenith Framework Papers – these describe the methodology of the Zenith Model
- Zenith Victoria Papers – these describe the calibration and validation of the Zenith Model in the Victorian market.

This document is part of the second series and is intended to be read alongside the corresponding note from the first series "*Zenith Framework: Trip Productions*".



2 Data Sources

Two sources of information have supported the development of Non-Home Based Trip Production Models for the Zenith Model of Victoria:

- The *Victorian Integrated Survey of Travel and Activity (VISTA)*; and
- Zonal land use data for 2011, derived primarily from the ABS Census 2011.

Data from the following two editions of VISTA were pooled to maximise the available sample size:

- VISTA07 (a sample of 17,115 Victorian households surveyed between June 2007 and June 2008); and
- VISTA09 (a sample of 16,269 Victorian households surveyed between July 2009 and July 2010).

A more recent VISTA survey began in July 2012 but is not currently available for transport modelling purposes. Therefore VISTA07 and VISTA09 represent the latest available Victorian household travel surveys.



3 Methodology

3.1.1 Data Set Construction

The VISTA data was used to derive estimates of the daily number of non-home based trips (for each trip purpose) produced by each travel zone within the Zenith Model boundary.

These estimates were based on an expanded version of the VISTA data, whereby a household expansion factor was attached to each household such that the expanded VISTA sample would conform to 2011 population control totals by age, gender and SA3 which were extracted from the ABS Census 2011. This procedure enabled realistic estimates of the number of non-home based trips produced by each region to be calculated.

The zonal variables that were available to predict the amount of non-home based trips produced by a region included:

- Total Employment
- Employment by occupation category (white / blue collar)
- Employment by industry
- Employment by industry X occupation category (white / blue collar)
- Number of households
- Number of educational enrolments (primary, secondary, tertiary)

2011 estimates for each of the above variables (at the zonal level) were sourced primarily from the 2011 ABS Census.

3.1.2 Model Estimation Procedures

Parameter estimation was performed using constrained least squares linear regression. Each parameter was constrained to be positive.

Variable selection was performed using “*leave-one-out cross validation*”. This ensured that the selected model was that which exhibited greatest predictive ability.

3.1.3 Model Validation Procedures

Model validation was performed using “*leave-one-out cross validation*” to produce a “*prediction*” for each travel zone in the modelled area. The predictions for all travel zones were then grouped by SA4 and compared with the number of trips estimated by the VISTA survey. This enabled an objective analysis of the predictive ability of each model spatially.

3.1.4 Variable Naming

In the models which follow, the following abbreviated variable names are used. Note that the suffixes *_bc* and *_wc* are also used to denote the split of an employment variable into blue and white collar workers, i.e. *emp_cserv_wc* would refer to the number of white collar community services jobs in a travel zone.



<u>Variable Name</u>	<u>Description</u>
<i>households</i>	Households
<i>emp_total</i>	Employment - Total
<i>emp_blue</i>	Employment - Total Blue Collar
<i>emp_white</i>	Employment - Total White Collar
<i>emp_agric</i>	Employment - Agriculture
<i>emp_cserv</i>	Employment - Community Services
<i>emp_cons</i>	Employment - Construction
<i>emp_egw</i>	Employment - Electricity Gas & Water
<i>emp_finbus</i>	Employment - Finance & Business
<i>emp_manuf</i>	Employment - Manufacturing
<i>emp_pubad</i>	Employment - Public Administration
<i>emp_recps</i>	Employment - Recreation & Personal Services
<i>emp_ret</i>	Employment - Retailing
<i>emp_trst</i>	Employment - Transport & Storage
<i>emp_wh</i>	Employment - Wholesaling
<i>emp_ming</i>	Employment - Mining
<i>emp_commc</i>	Employment - Communications
<i>enrol_sec</i>	Enrolments - Secondary
<i>enrol_ter</i>	Enrolments - Tertiary
<i>enrol_ppr</i>	Enrolments - Primary



4 Model Estimation and Validation

This Chapter details the estimation and validation of the Trip Production Model developed for each trip purpose.

4.1 Work Based Work

4.1.1 Model Estimation

The model parameters estimated for the Work Based Work Trip Production Model are presented in Table 1 and Table 2 below. The Work Based Work model is separated into CBD and Non CBD Regions due to the inherently different generation characteristics of the CBD for work based travel purposes.

The value of the model parameter is referred to as the “Parameter Estimate”, while the P-Value can be used to judge the statistical significance of the parameter. A P-Value of less than 0.05 would indicate that the parameter is non-zero with 95% confidence. In some cases, a parameter with a P-Value in excess of 0.05 is included. This is because variable selection has been performed using “*leave-one-out cross validation*”, and parameters with P-Values larger than 0.05 can sometimes (but not often) improve the predictive accuracy of the model (as measured by cross validation).

Parameters	PARAMETER ESTIMATE	STANDARD ERROR	T-STATISTIC	P-VALUE
emp_blue	0.049	0.057	0.625	0.533
emp_white	0.095	0.014	5.060	0.000

Table 1 – Parameter Estimates for Work Based Work (CBD Region)

Parameters	PARAMETER ESTIMATE	STANDARD ERROR	T-STATISTIC	P-VALUE
households	0.020	0.003	7.051	0.000
enrol_sec	0.008	0.005	1.454	0.146
enrol_ter	0.002	0.002	1.172	0.241
emp_cons	0.075	0.030	2.514	0.012
emp_recps_wc	0.148	0.045	3.302	0.001
emp_blue	0.046	0.010	4.766	0.000
emp_white	0.036	0.005	6.977	0.000

Table 2 – Parameter Estimates for Work Based Work (Non - CBD Region)

The parameter estimates have also been compared visually in Figure 4-2 and Figure 4-1 below; the height of the bars indicates the scale of the relevant parameter.

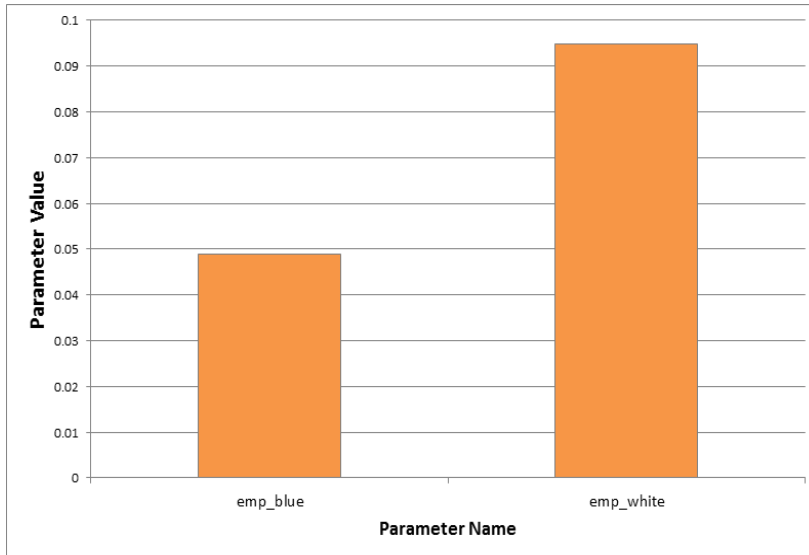


Figure 4-1 – A visual representation of the parameter values for WBW (CBD Regions)

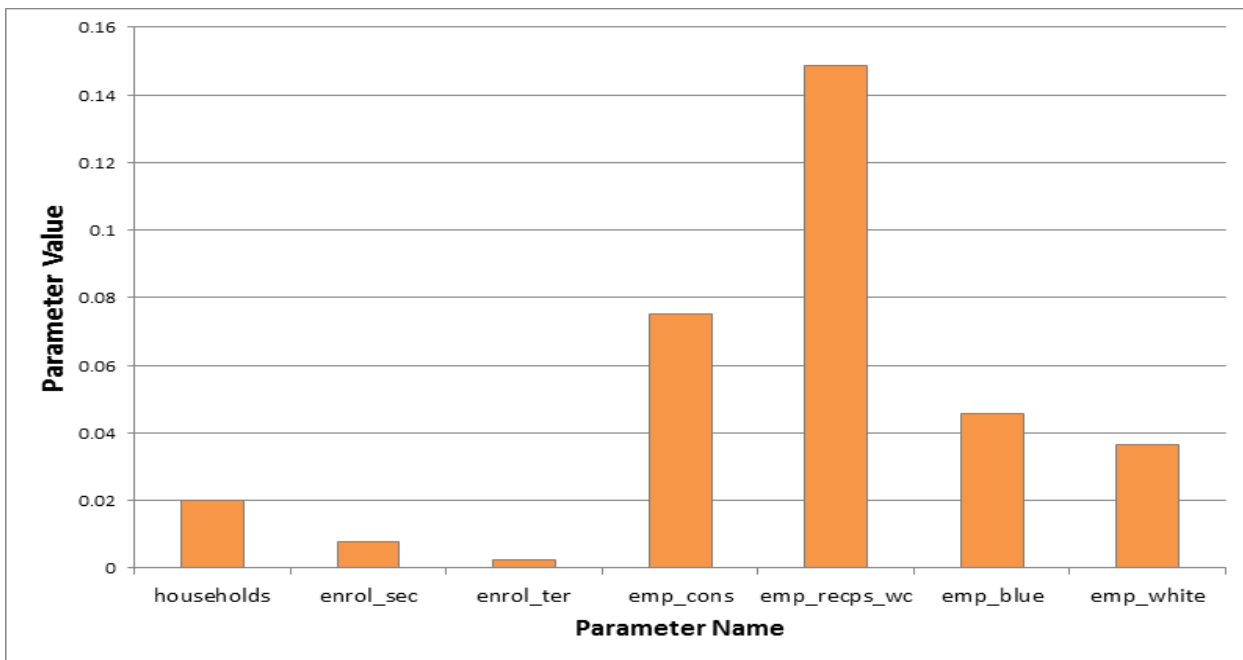


Figure 4-2 – A visual representation of the parameter values for WBW (Non CBD Regions)

4.1.2 Model Validation

Figure 4-3 and Figure 4-4 below present a comparison of the estimated number of WBW trips produced by each SA4 according to VISTA (in blue) and the Zenith Model (in orange). The Zenith estimates are true predictions in the sense that they are produced using “leave-one-out cross validation” at the level of individual travel zones. Figure 4-4 includes a 95% confidence interval on the VISTA estimates, reflecting the sample size of the VISTA survey.

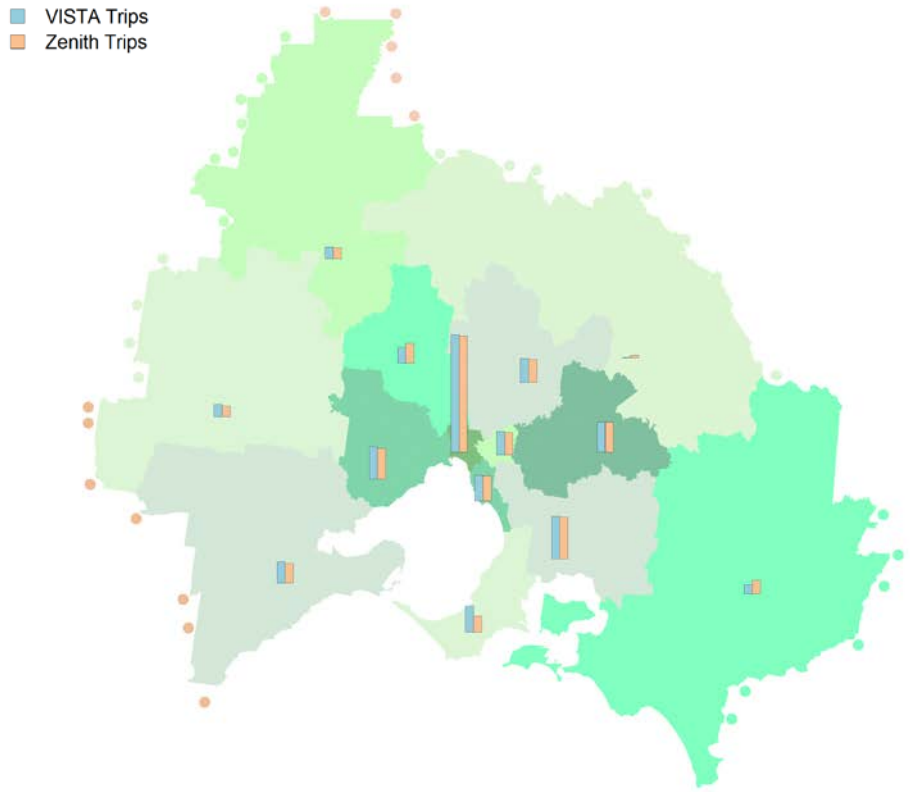


Figure 4-3 – Total Daily Work Based Work Trips Mapped by SA4

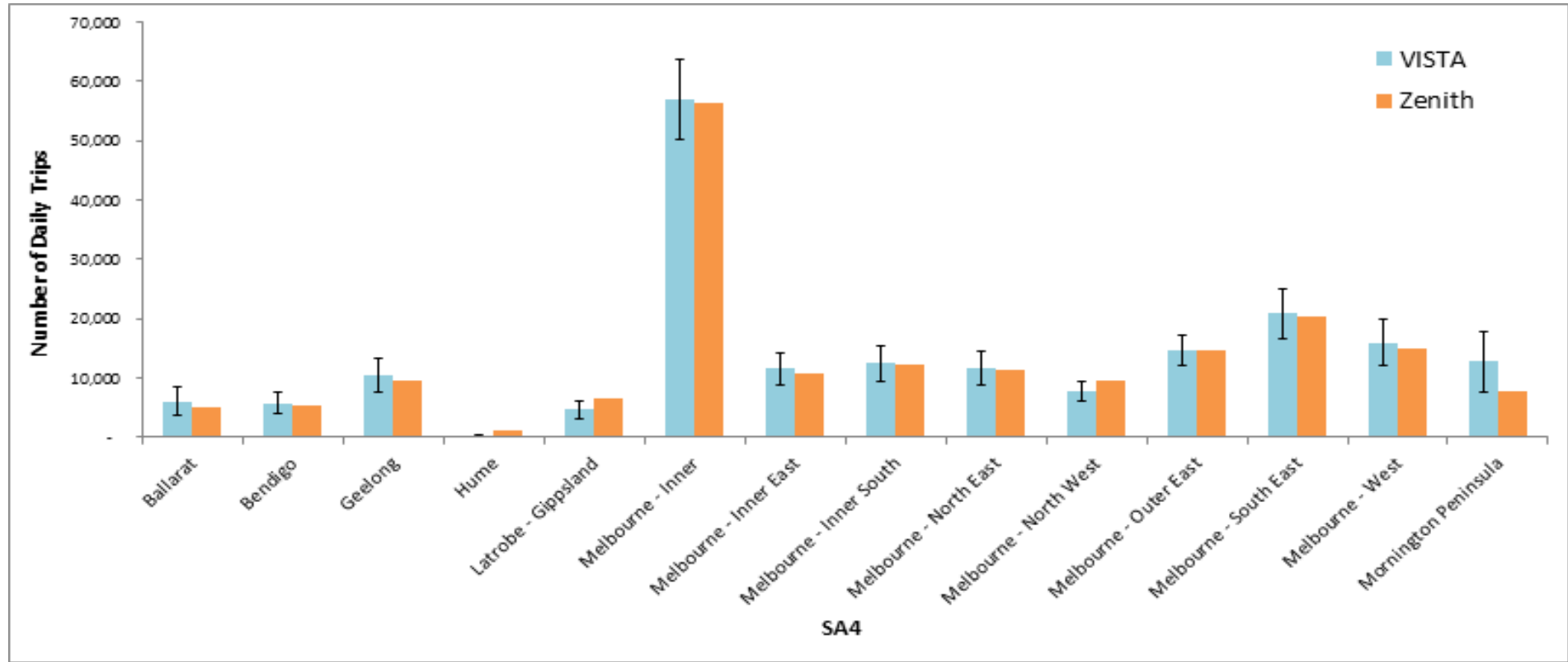


Figure 4-4 – Total Daily Work Based Work Trips by SA4



4.2 Work Based Shopping

4.2.1 Model Estimation

The model parameters estimated for the Work Based Shopping Trip Production Model are presented in Table 1 and Table 2 below. The Work Based Shopping model is separated into CBD and Non CBD Regions due to the inherently different generation characteristics of the CBD for work based travel purposes.

The value of the model parameter is referred to as the “Parameter Estimate”, while the P-Value can be used to judge the statistical significance of the parameter. A P-Value of less than 0.05 would indicate that the parameter is non-zero with 95% confidence. In some cases, a parameter with a P-Value in excess of 0.05 is included. This is because variable selection has been performed using “*leave-one-out cross validation*”, and parameters with P-Values larger than 0.05 can sometimes (but not often) improve the predictive accuracy of the model (as measured by cross validation).

Parameters	PARAMETER ESTIMATE	STANDARD ERROR	T-STATISTIC	P-VALUE
emp_blue	0.257	0.198	1.006	0.315
emp_white	0.265	0.041	5.040	0.000

Table 3 – Parameter Estimates and Properties for Work Based Shopping (CBD Regions)

Parameters	PARAMETER ESTIMATE	STANDARD ERROR	T-STATISTIC	P-VALUE
enrol_sec	0.025	0.010	2.557	0.011
emp_blue	0.027	0.013	2.026	0.043
emp_white	0.166	0.008	20.859	0.000

Table 4 – Parameter Estimates and Properties for Work Based Shopping (Non CBD Regions)

The parameter estimates have also been compared visually in Figure 4-5 and Figure 4-6 below; the height of the bars indicates the scale of the relevant parameter.

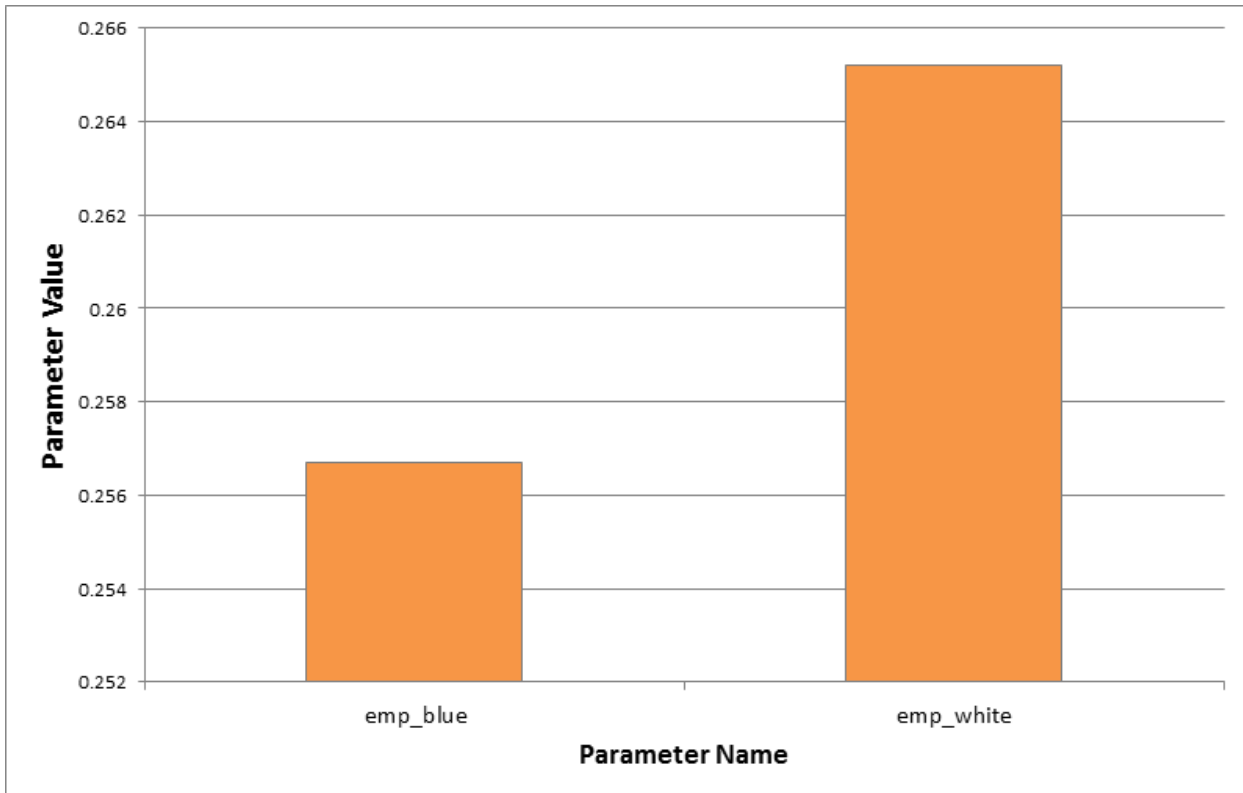


Figure 4-5 – A visual representation of the parameter values for WBS.(CBD Region)

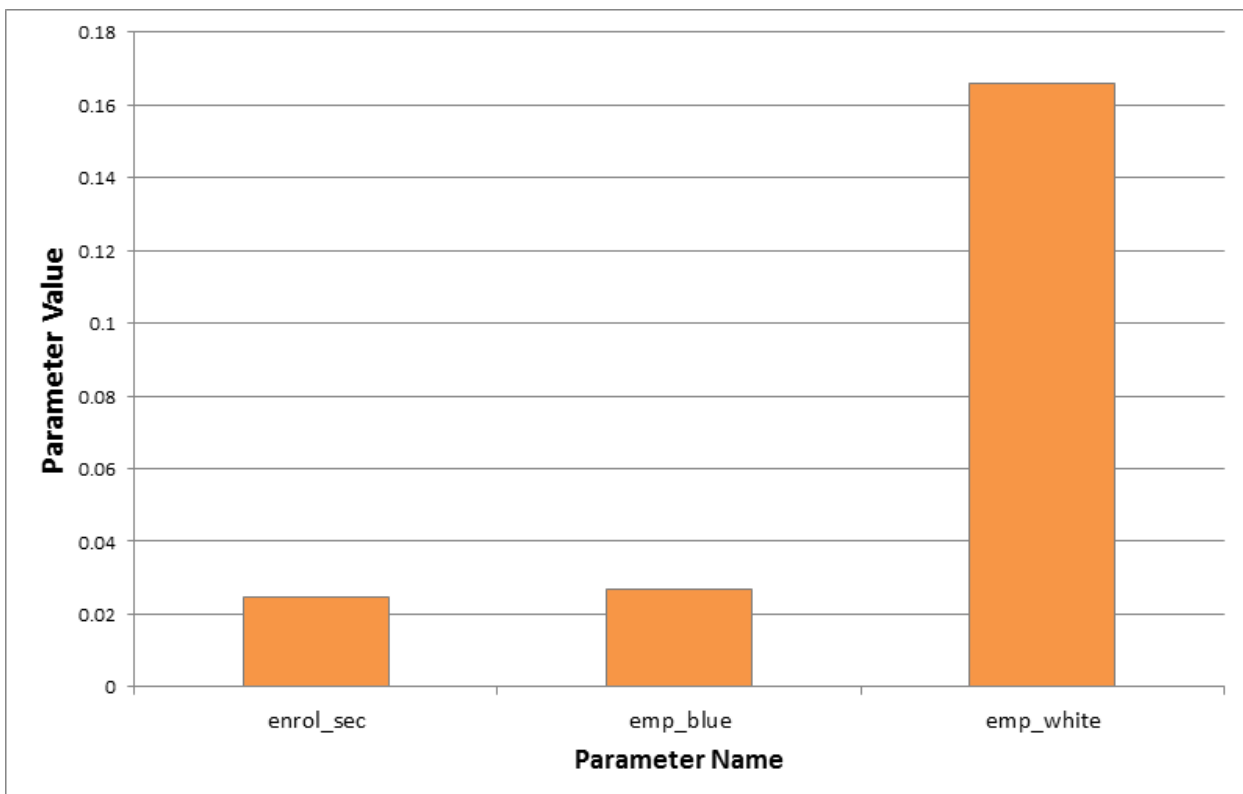


Figure 4-6 – A visual representation of the parameter values for WBS.(Non-CBD Region)

4.2.2 Model Validation



Figure 4-7 and Figure 4-8 present a comparison of the estimated number of Work Based Shopping trips produced by each SA4 according to VISTA (in blue) and the Zenith Model (in orange).

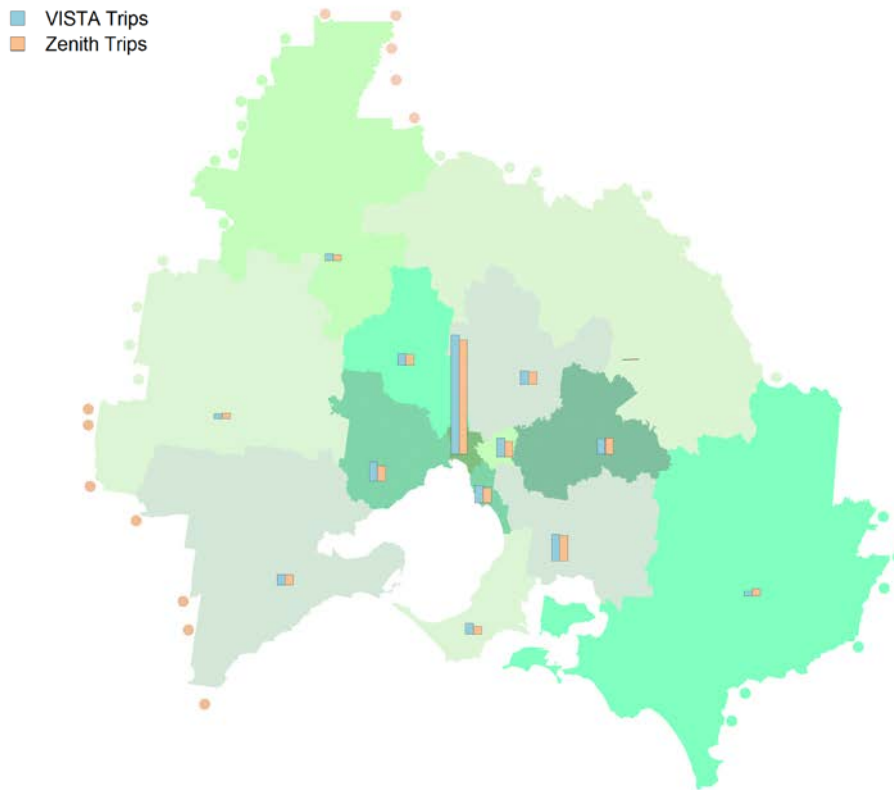


Figure 4-7 – Total Daily Work Based Shopping Trips Mapped by SA4

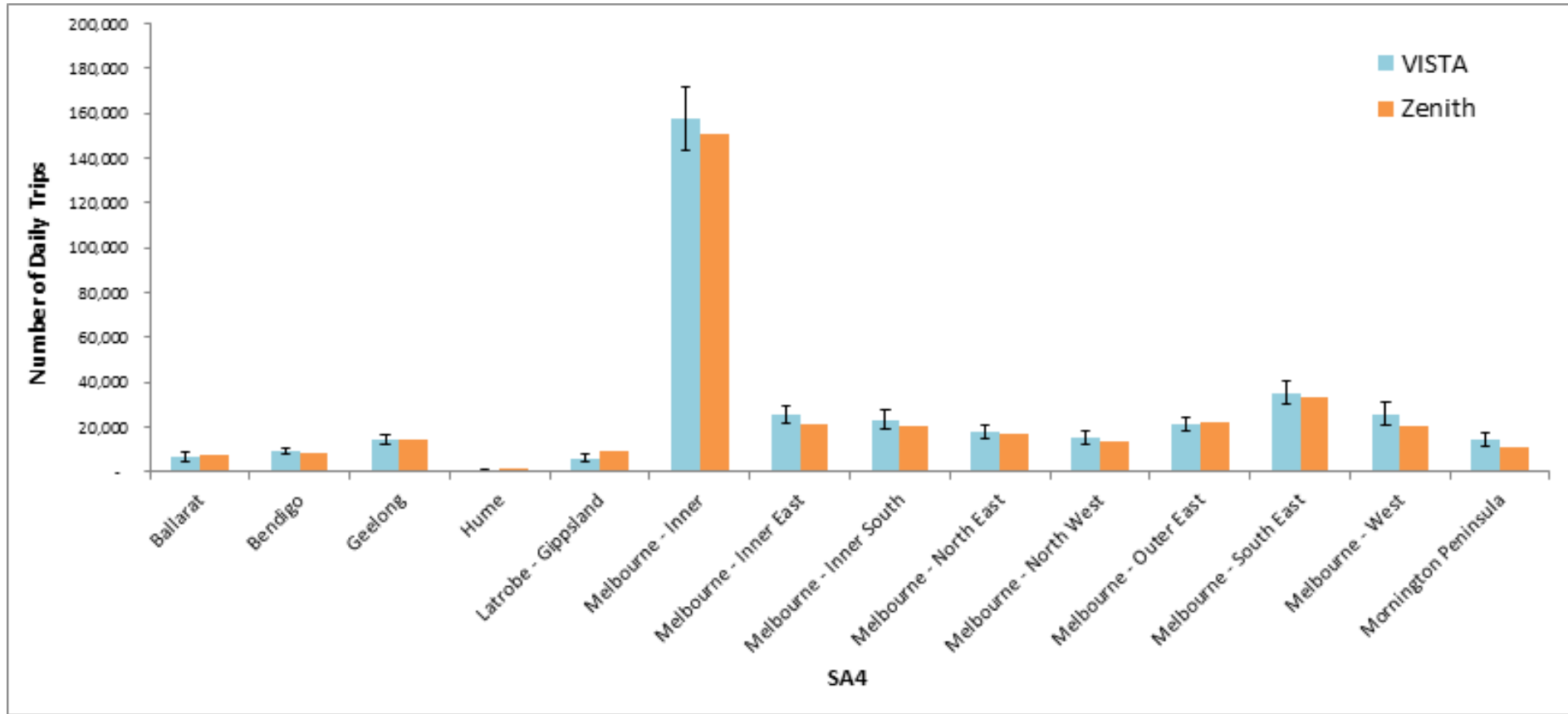


Figure 4-8 – Total Daily Work Based Shopping Trips by SA4



4.3 Work Based Other

4.3.1 Model Estimation

The model parameters estimated for the Work Based Other Trip Production Model are presented in Table 1 and Table 2 below. The Work Based Other model is separated into CBD and Non CBD Regions due to the inherently different generation characteristics of the CBD for work based travel purposes.

The value of the model parameter is referred to as the “Parameter Estimate”, while the P-Value can be used to judge the statistical significance of the parameter. A P-Value of less than 0.05 would indicate that the parameter is non-zero with 95% confidence. In some cases, a parameter with a P-Value in excess of 0.05 is included. This is because variable selection has been performed using “*leave-one-out cross validation*”, and parameters with P-Values larger than 0.05 can sometimes (but not often) improve the predictive accuracy of the model (as measured by cross validation).

Parameters				
	PARAMETER ESTIMATE	STANDARD ERROR	T-STATISTIC	P-VALUE
enrol_sec	0.166	0.089	1.555	0.121
enrol_ter	0.055	0.012	3.915	0.000
emp_total	0.057	0.007	7.112	0.000

Table 5 – Parameter Estimates and Properties for Work Based Other (CBD Region)

Parameters				
	PARAMETER ESTIMATE	STANDARD ERROR	T-STATISTIC	P-VALUE
enrol_sec	0.016	0.006	2.415	0.016
enrol_ter	0.007	0.003	2.577	0.010
emp_total	0.064	0.002	27.505	0.000

Table 6 – Parameter Estimates and Properties for Work Based Other (Non-CBD Region)

The parameter estimates have also been compared visually in Figure 4-9 and Figure 4-10 below; the height of the bars indicates the scale of the relevant parameter.

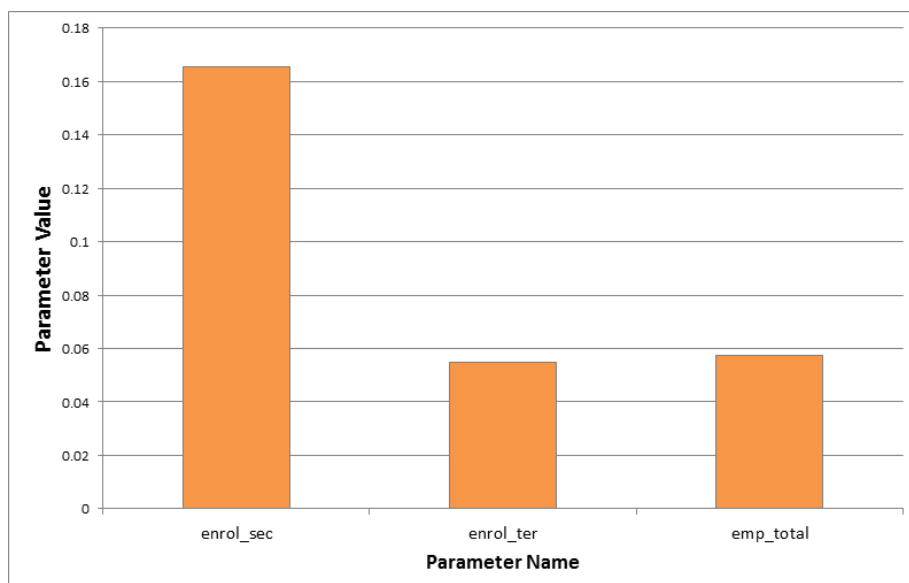


Figure 4-9 – A visual representation of the parameter values for WBO (CBD Region)

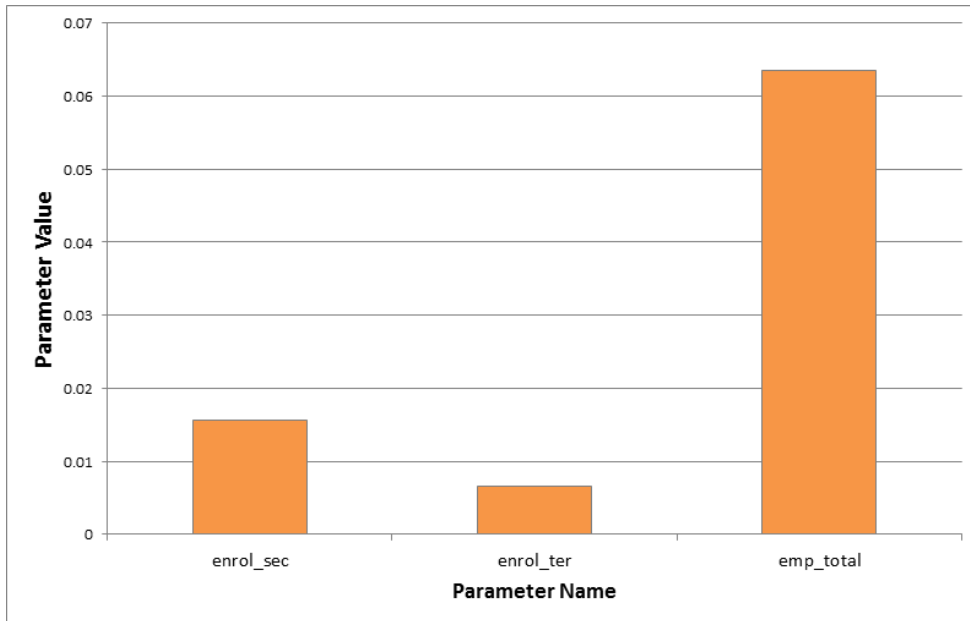


Figure 4-10 – A visual representation of the parameter values for WBO (CBD Region)

4.3.2 Model Validation

Figure 4-11 and Figure 4-12 present a comparison of the estimated number of Work Based Other trips produced by each SA4 according to VISTA (in blue) and the Zenith Model (in orange).

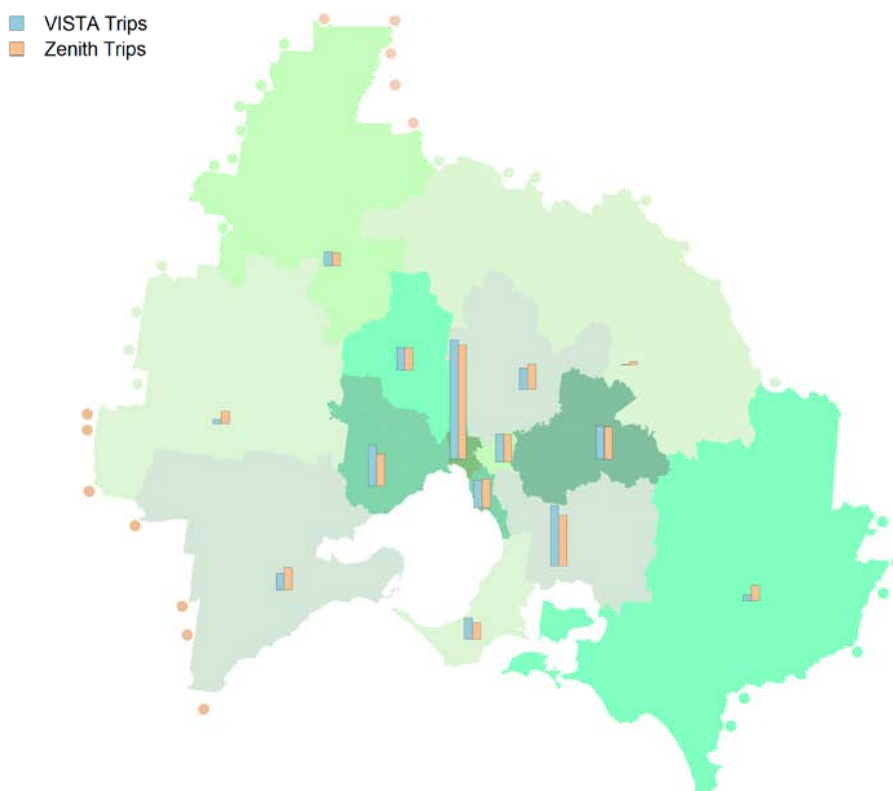


Figure 4-11 – Total Daily Work Based Other Trips Mapped by SA4

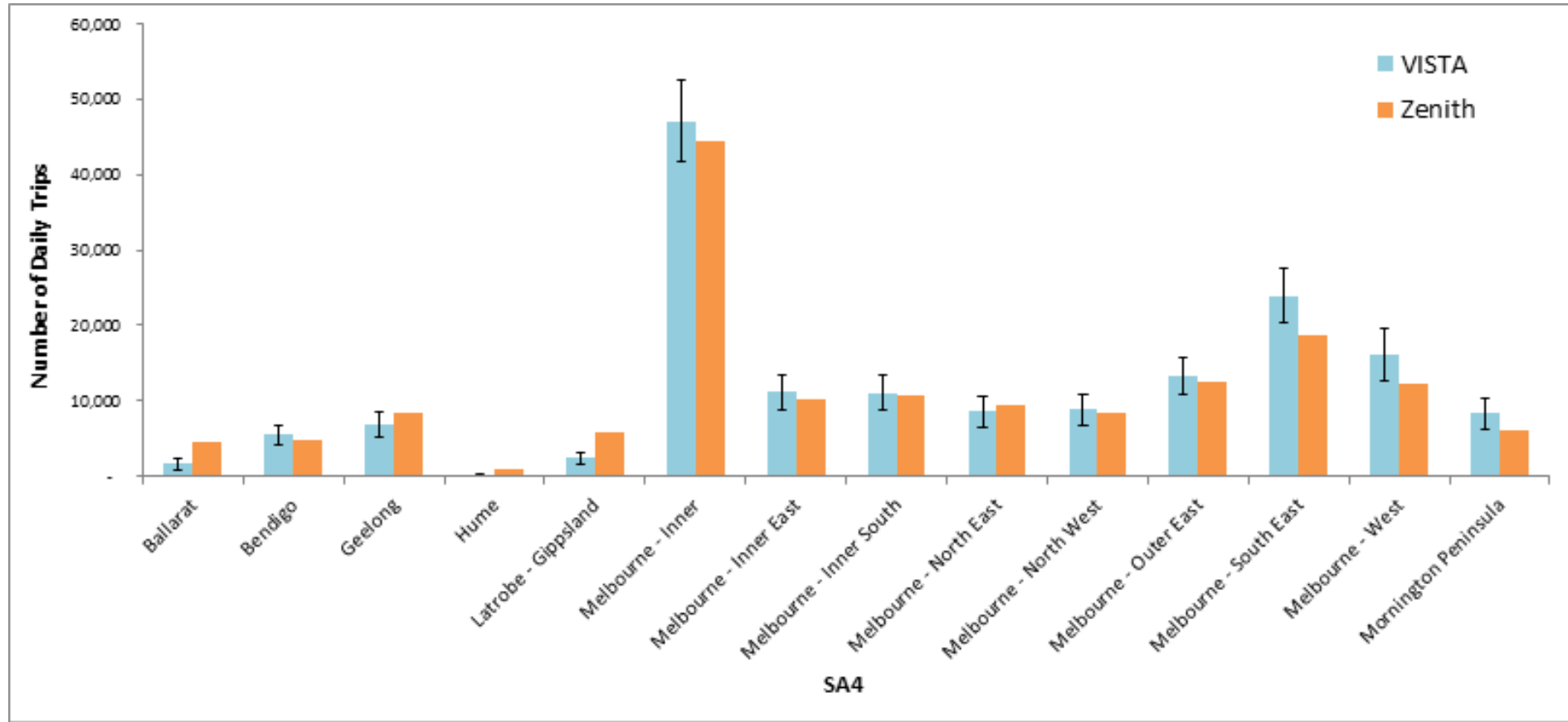


Figure 4-12 – Total Daily Work Based Other Trips by SA4



4.4 Shopping Based Shopping

4.4.1 Model Estimation

The model parameters estimated for the Shopping Based Shopping Trip Production Model are presented in Table 7 below. The parameters are presented visually in Figure 4-13.

Parameters				
	PARAMETER ESTIMATE	STANDARD ERROR	T-STATISTIC	P-VALUE
households	0.090	0.008	12.016	0.000
emp_cserv_bc	0.257	0.146	1.762	0.078
emp_cserv_wc	0.054	0.022	2.439	0.015
emp_pubad	0.323	0.051	6.358	0.000
emp_recps	0.268	0.038	7.128	0.000
emp_ret	0.392	0.029	13.505	0.000

Table 7 – Parameter Estimates and Properties for Shopping Based Shopping

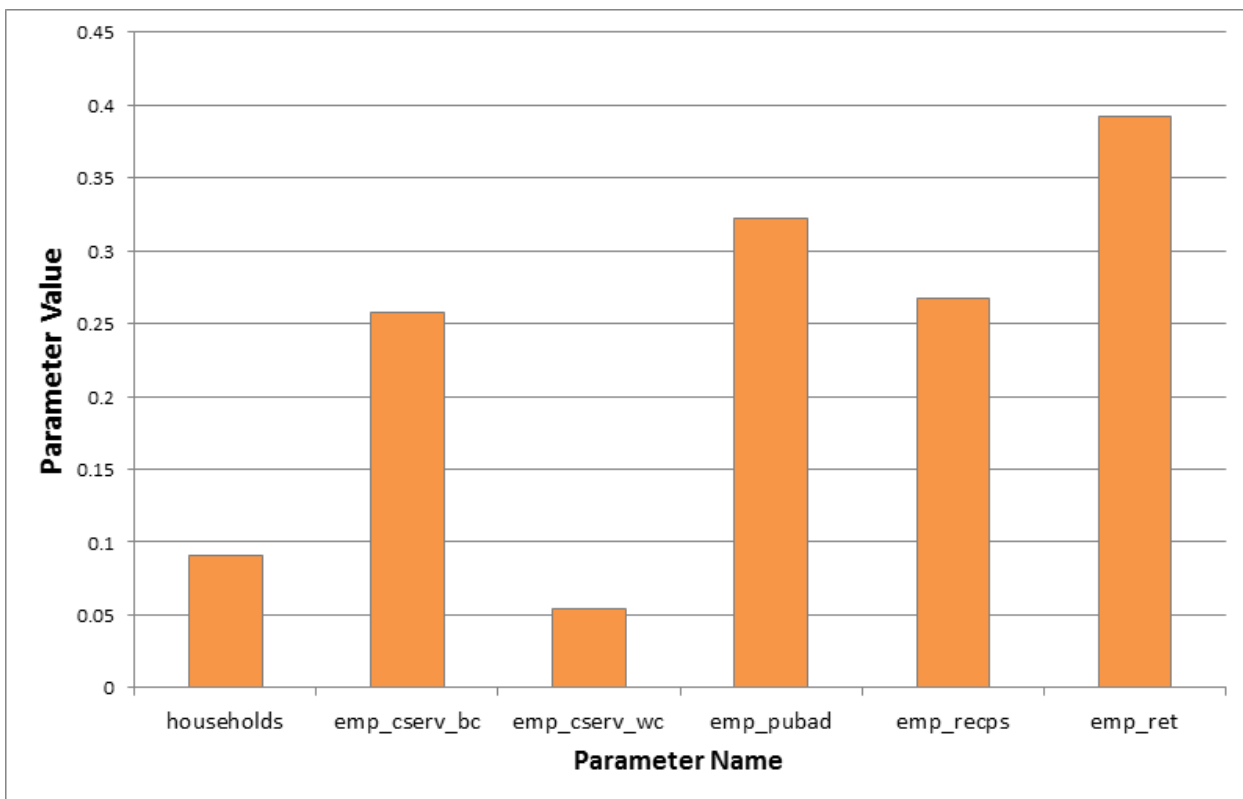


Figure 4-13 – A visual representation of the parameter values for SBS

4.4.2 Model Validation

Figure 4-14 and Figure 4-15 present a comparison of the estimated number of Shopping Based Shopping trips produced by each SA4 according to VISTA (in blue) and the Zenith Model (in orange).

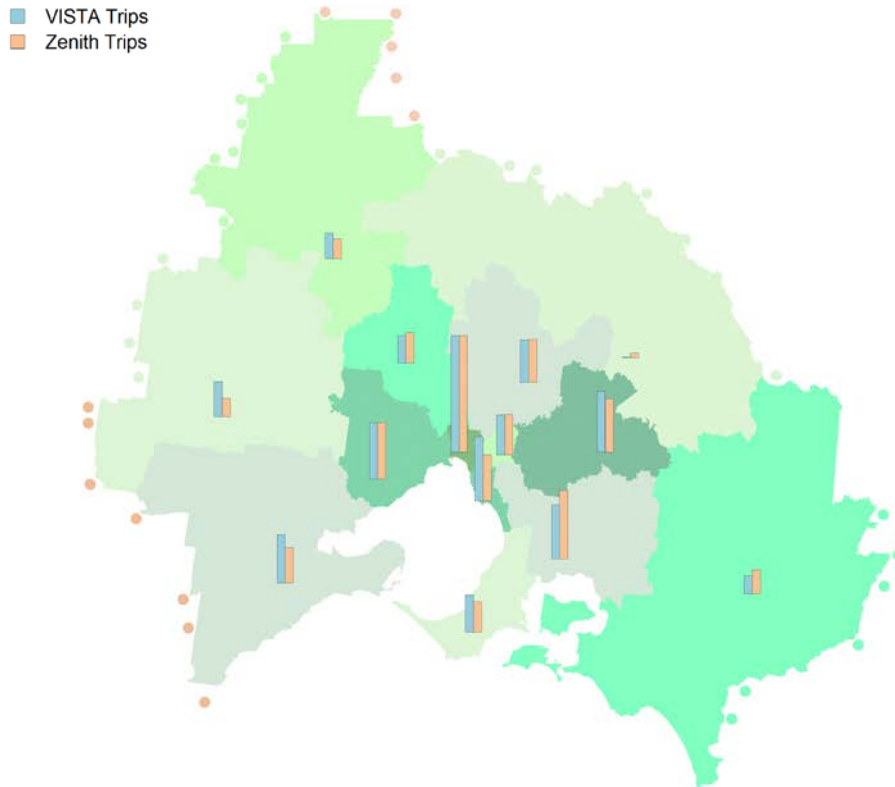


Figure 4-14 – Total Daily Shopping Based Shopping Trips Mapped by SA4

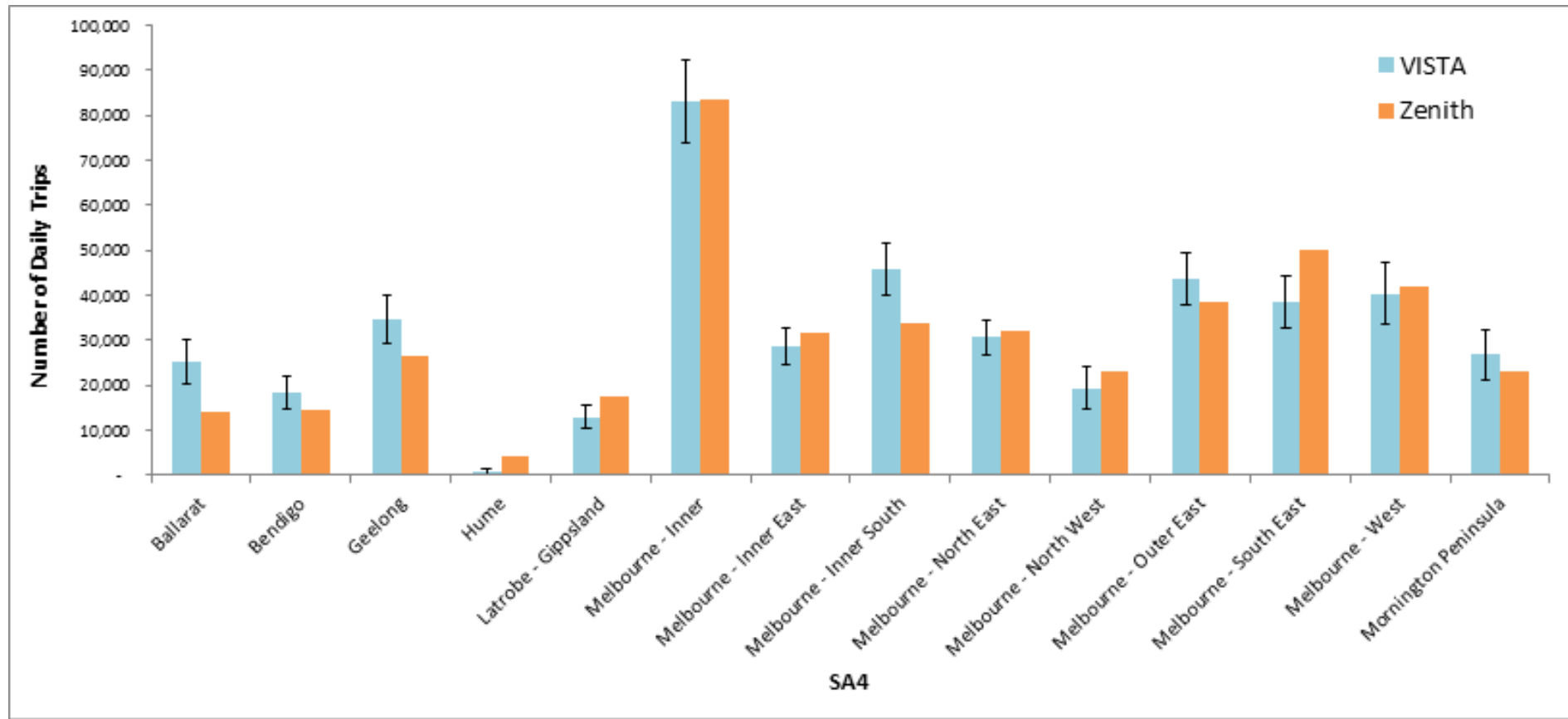


Figure 4-15 – Total Daily Shopping Based Shopping Trips by SA4



4.5 Shopping Based Other

4.5.1 Model Estimation

The model parameters estimated for the Shopping Based Other Trip Production Model are presented in Table 8 below. The parameters are presented visually in Figure 4-16.

Parameters				
	PARAMETER ESTIMATE	STANDARD ERROR	T-STATISTIC	P-VALUE
households	0.066	0.006	10.591	0.000
enrol_ppr	0.060	0.017	3.546	0.000
enrol_sec	0.044	0.012	3.754	0.000
enrol_ter	0.006	0.004	1.406	0.160
emp_cserv	0.049	0.011	4.631	0.000
emp_recps	0.187	0.025	7.529	0.000
emp_ret	0.279	0.020	14.104	0.000

Table 8 – Parameter Estimates and Properties for Shopping Based Other

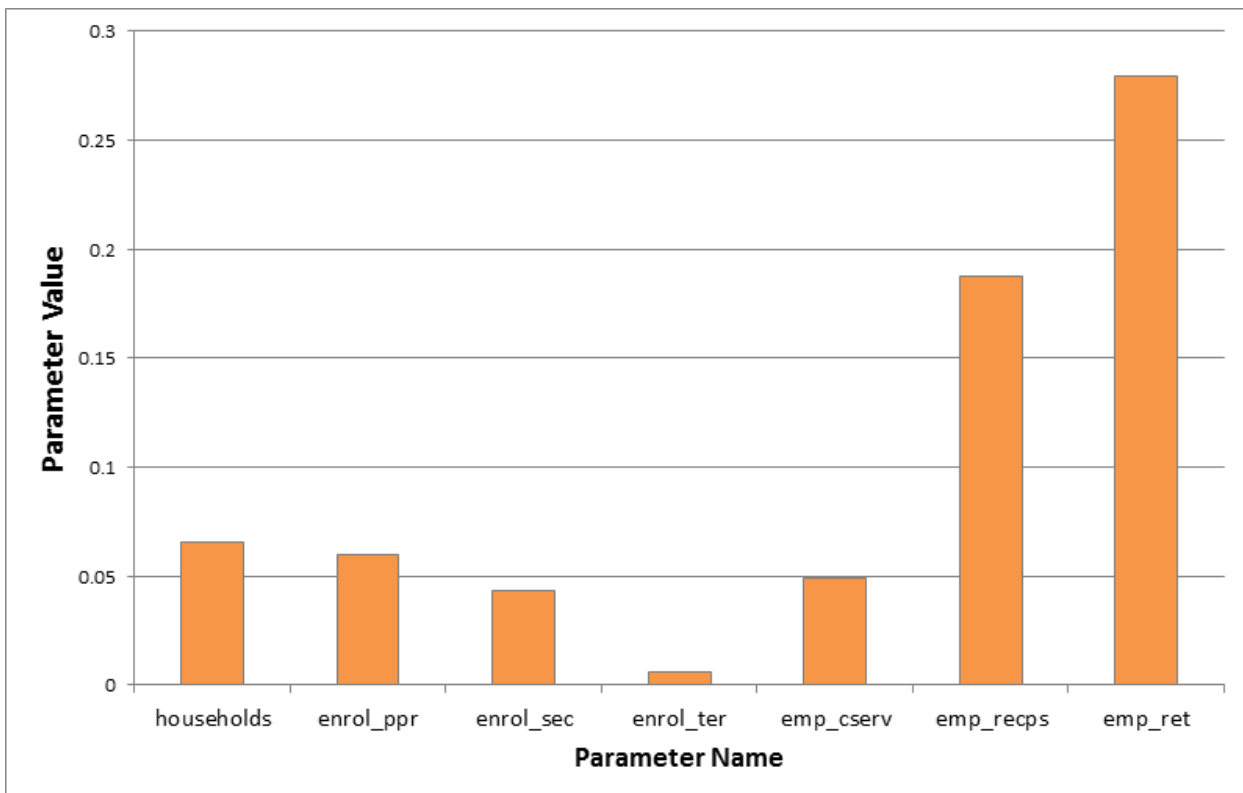


Figure 4-16 – A visual representation of the parameter values for SBO

4.5.2 Model Validation

Figure 4-17 and Figure 4-18 present a comparison of the estimated number of Work Based Shopping trips produced by each SA4 according to VISTA (in blue) and the Zenith Model (in orange).

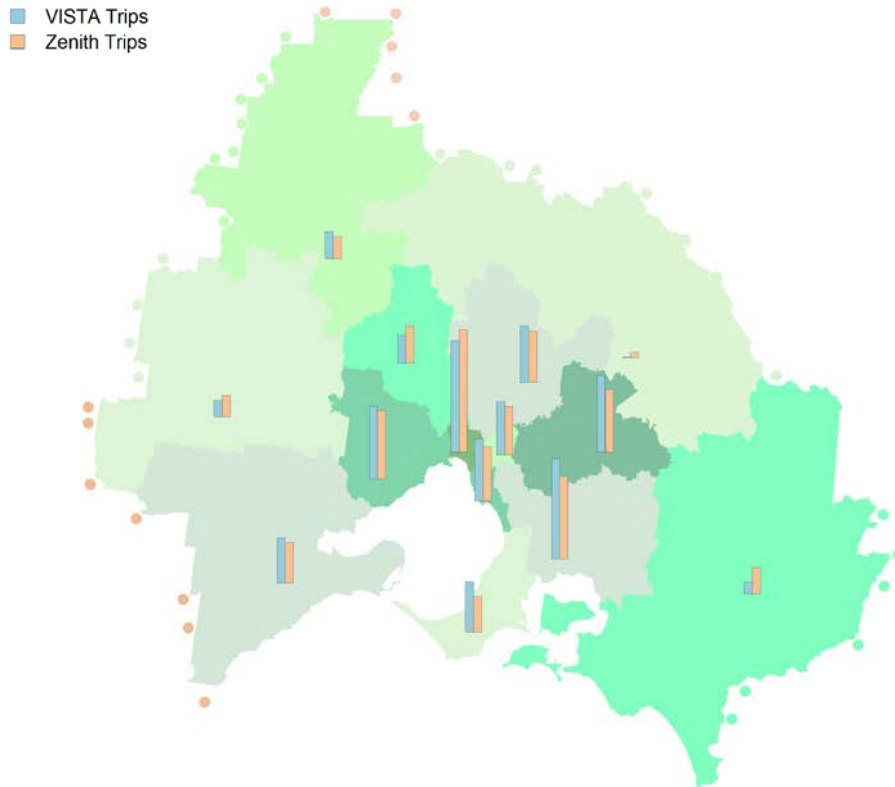


Figure 4-17 – Total Daily Shopping Based Other Trips Mapped by SA4

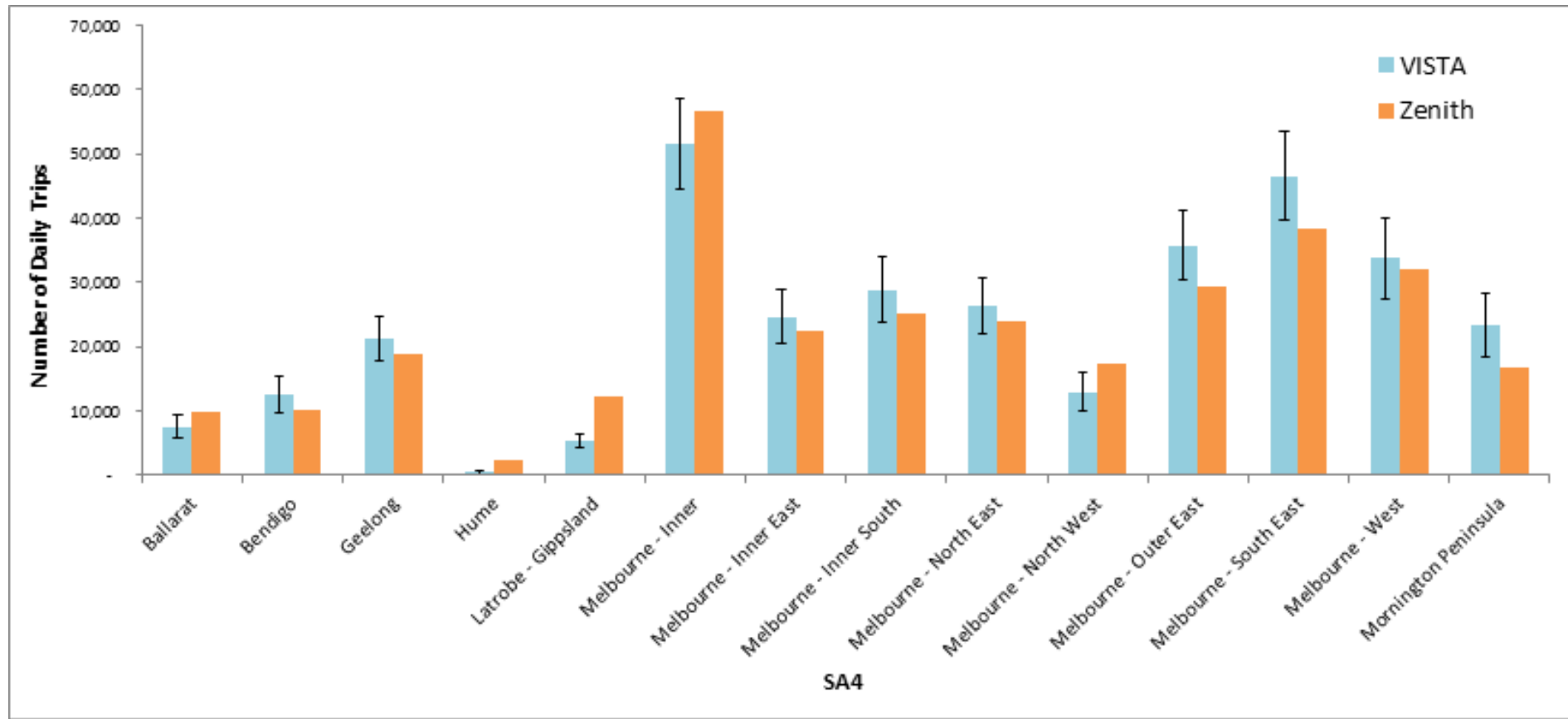


Figure 4-18 – Total Daily Shopping Based Other Trips by SA4



4.6 Other Non-Home Based

4.6.1 Model Estimation

The model parameters estimated for the Other Non-Home Based Trip Production Model are presented in Table 9 below. The parameters are presented visually in Figure 4-19.

Parameters				
	PARAMETER ESTIMATE	STANDARD ERROR	T-STATISTIC	P-VALUE
households	0.064	0.004	15.389	0.000
enrol_ppr	0.140	0.011	12.283	0.000
enrol_sec	0.094	0.008	12.054	0.000
enrol_ter	0.010	0.003	3.734	0.000
emp_cserv	0.034	0.008	4.159	0.000
emp_ret	0.069	0.014	4.948	0.000
emp_total	0.009	0.003	2.771	0.006

Table 9 – Parameter Estimates and Properties for Other Non-Home Based

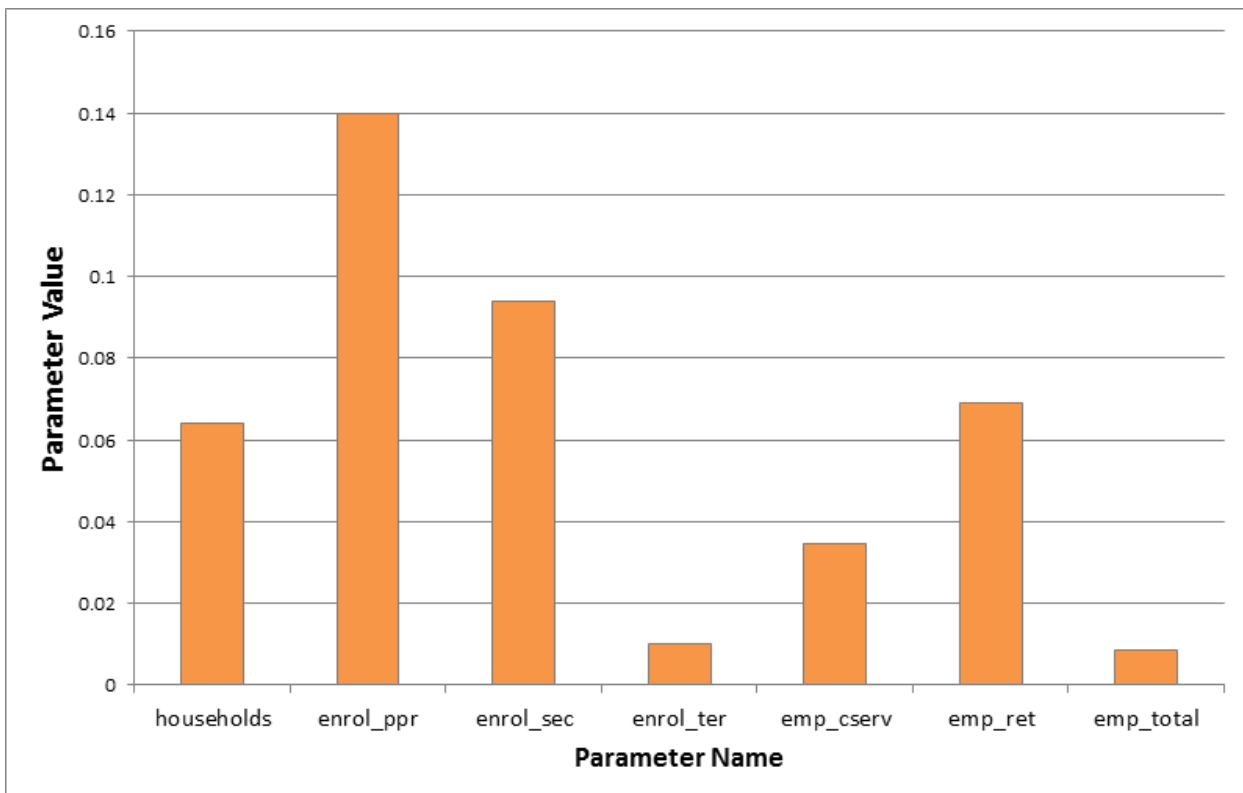


Figure 4-19 – A visual representation of the parameter values for ONHB

4.6.2 Model Validation

Figure 4-20 and Figure 4-21 present a comparison of the estimated number of Other Non-Home Based trips produced by each SA4 according to VISTA (in blue) and the Zenith Model (in orange).

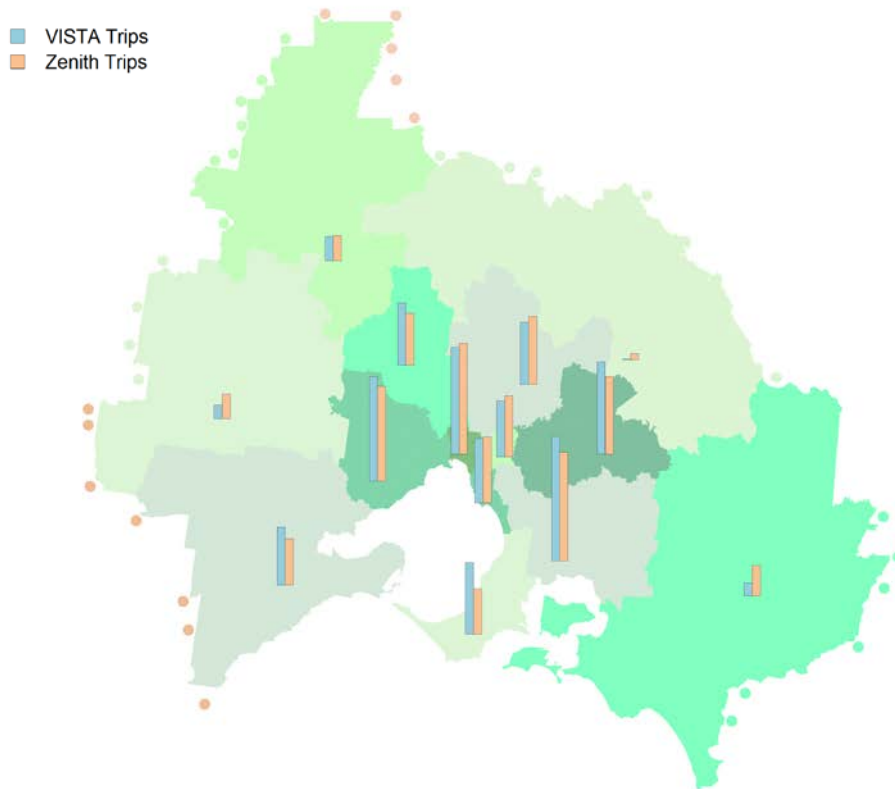


Figure 4-20 – Total Daily Other Non-Home Based Trips Mapped by SA4

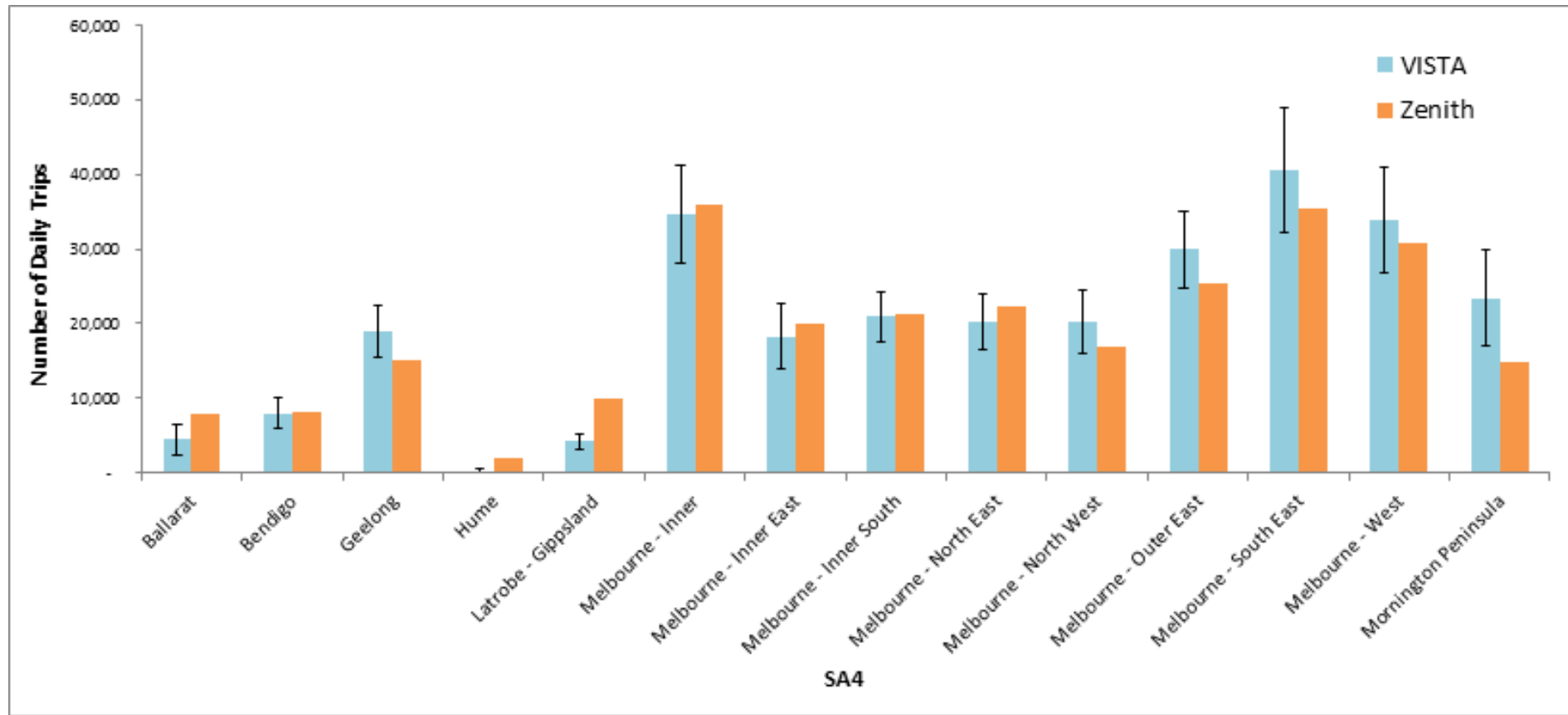


Figure 4-21 – Total Daily Other Non-Home Based Trips by SA4