

CHAPTER 5

ECONOMETRIC DEVELOPMENT OF MODEL, TESTING AND RESULTS

CHAPTER 5

TABLE OF CONTENTS	PAGE NO.
5.1 INTRODUCTION	296
5.2 ECONOMETRIC DEVELOPMENT OF MODEL	297
5.2.1 Data For Analysis	299
5.2.1.1 Expected Capitalisation Rate At Time t	299
5.2.1.2 The Risk Free Rate	299
5.2.1.3 Measure For The Determinant Of Building	300
5.2.1.4 Measure For The Determinant Of Location	301
5.2.1.5 Measure For The Determinant Of Tenant	301
5.2.1.6 Summary - Data For Analysis	303
5.2.2 Development Process	303
5.2.2.1 Expected Results From Regression Analysis	303
5.2.2.2 Expected Signs For Regression Coefficients	305
5.2.2.3 Cross Sectional Multiple Regression Analysis	306
5.2.2.3.1 Multiple Regression Analysis	307
5.2.2.3.2 Econometric Model	310
5.2.2.3.3 Summary - Cross Sectional Multiple Regression Analysis	312
5.2.2.4 Summary - Development Process	312
5.2.3 Summary - Econometric Development Of Model	313
5.3 TEST OF THESIS HYPOTHESIS	314
5.3.1 Standard Deviation Of Sample Of n Properties	315
5.3.2 t-Test For Sample Of n Properties	320
5.3.3 Coefficient Of Variation For Sample Of n Properties	320
5.3.4 Summary - Test Of Thesis Hypothesis	321
5.4 INVESTIGATION OF THESIS PROPOSITION	322
5.4.1 Sample Of N Properties	323
5.4.1.1 Standard Deviation Of Sample Of N Properties	323
5.4.1.2 t-Test For Sample Of N Properties	326
5.4.1.3 Coefficient Of Variation For Sample Of N Properties	326
5.4.1.4 Summary - Sample Of N Properties	327

5.4.2	Property x	327
5.4.2.1	Testing - Property x	328
5.4.2.2	Comparison To Practitioner Survey	329
5.4.2.3	Property x - Issues Arising	330
5.4.2.4	Summary - Property x	333
5.4.3	Summary - Investigation Of Thesis Proposition	334
5.5	SUMMARY, AREAS FOR FURTHER RESEARCH AND CONCLUSIONS	334
5.5.1	Summary	335
5.5.2	Areas For Further Research	337
5.5.3	Conclusions	338

TABLES

5.1	Initial Cross Sectional Multiple Regression Analysis - Summary Of Results	307
5.2	Correlation Matrix - Cross Sectional Multiple Regression Analysis "A"	309
5.3	Final Cross Sectional Multiple Regression Analysis - Summary Of Results	310
5.4	Sub-Sample Of n Properties - Summary Of Econometric Model And Practitioner Survey Results	316
5.5	Sub-Sample Of n Properties - Comparative Standard Deviations	317
5.6	Sub-Sample Of n Properties - Summary Of Practitioner Survey Results	318
5.7	Sub-Sample Of n Properties - Summary Of Grouped Practitioner Survey Results	318
5.8	Sub-Sample Of n Properties - Comparative Coefficients Of Variation	320
5.9	Sample Of N Properties - Comparative Standard Deviations	324
5.10	Sample Of N Properties - Summary Of Comparative Capitalisation Rates	325
5.11	Sample Of N Properties - Comparative Coefficients Of Variation	326

APPENDICES

- 5.1 Complete Data Set
- 5.2 Data Set For The Initial Cross Sectional Multiple Regression Analysis
- 5.3 Results Of The Initial Cross Sectional Multiple Regression Analysis
- 5.4 Results Of The Final Cross Sectional Multiple Regression Analysis
- 5.5 Data Set For The Samples N And n And Property x
- 5.6 Standard Deviation Tables
- 5.7 n Properties - t-Test Results
- 5.8 N Properties - t-Test Results

5.1 INTRODUCTION

The previous Chapter formed the second part of the modelling step or process and comprised the analysis of the data collected, seeking to quantify each of the components of the single, potentially explanatory equation, optimise the data set, verify the validity of each of the assumed theoretical principles underlying the equation and investigate the validity of the findings of the review of literature within Chapter 1 concerning aspects of current practise in the capitalisation rate selection and adjustment process.

Each of the assumed theoretical principles underlying the equation were verified and validated, confirming the equation to be theoretically defensible, with the findings concerning current practise in the capitalisation rate selection and adjustment process confirming the findings of the literature review and substantiating the Thesis Problem. Furthermore, the sample was found to be statistically valid which renders the proposed testing rigorous and the findings of the pilot studies were supported such that no revision to the theoretical basis of the model was required.

A range of alternative expressions were quantified for each of the components of the single, potentially explanatory equation and an optimised data set derived that will be used to develop an econometric model through cross sectional multiple regression analysis in this Chapter, which will comprise the third and final part of the modelling step or process, in order to assess the practical relevance or otherwise of the factors to the determination of the capitalisation rate.

The tripartite modelling process comprised the second step in the proposed sequential approach to addressing the Thesis Problem, which may be restated as follows:

that the current method of capitalisation rate determination is subjectively based, informal, heuristic and lacks a framework which accords with property, finance, commerce and economic theory, so contributing to an unacceptably high level of variability in capitalisation rate adjustment between properties at a point in time.

Having contended that the solution to the Thesis Problem was to investigate and identify a deterministic approach to capitalisation rate determination which reduces the variability in adjustment between two properties at a point in time, it was proposed that the use of an econometric model would achieve this and ensure objectivity, consistency and formality in such determination, if it accorded with property finance, commerce and economic theory, being based on rational and logical criteria which more

closely simulate the approach adopted by an investor to an appraisal of worth and so contribute to a reduction in or elimination of the reliance upon the interpretation of comparables.

Accordingly, having quantified the components of the single, potentially explanatory equation and derived, in this Chapter, an econometric model of the determination of the capitalisation rate (between properties at a point in time, which accords with property, finance, commerce and economic theory), this Chapter will also then detail the application of the model to investigate the Thesis Proposition:

that the use of an econometric model will reduce the variability in
capitalisation rate adjustment

through testing of the Thesis Hypothesis:

that the standard deviation of a sample of capitalisation rates calculated by an
econometric model will be below that of a sample selected by property
valuers using the current method of capitalisation rate determination

in order to assess the practical relevance of otherwise of the factors to the determination of the capitalisation rate and to ascertain if the model solves the Thesis Problem, being structured as follows:

- 5.2 Econometric Development Of Model
- 5.3 Test Of Thesis Hypothesis
- 5.4 Investigation Of Thesis Proposition

The third and final step in the proposed sequential approach to addressing the Thesis Problem will then comprise a summary of the approach adopted in, the identification of areas for further research beyond the scope of, the conclusions that may be drawn from and the policy recommendations arising out of this Thesis.

5.2 ECONOMETRIC DEVELOPMENT OF MODEL

The single, potentially explanatory equation for development may be restated as follows:

$$E(y_t) - r_f = f(k_{1t}, k_{12t}, k_{13t}) | \emptyset_t \quad \text{Equation 4.1}$$

where: $E(y_t)$ = expected capitalisation rate at time t
 r_f = risk free rate
 k_{11} = $k_{2(R < A - G > A)}$
 k_{12} = $k_{5(R < A - G > A)}$
 k_{13} = $k_{10(R < A - G > A)}$
 k_2 = building
 k_5 = location
 k_{10} = tenant
 R = Risk
 G = Growth
 \emptyset_t = information subset available at time t

Appendix 5.1 comprises the complete data set constructed from the findings of the Practitioner Survey and that analysis undertaken in Chapter 4, including:

- three alternative expressions for the expected capitalisation rate;
- three alternative measures for the determinant of Building;
- a measure for the determinant of location; and
- three alternative measures for the determinant of tenant,

for each of the 31 properties, comprising the sample of twenty six, the four n sample properties and the control property (number 99).

Consistent with an objective and measured approach to capitalisation rate determination, it is proposed that the econometrically developed model should minimise the role of practitioner opinion, intuition and experience. The above variables for use in the cross sectional multiple regression analysis include a combination of both factual data (concerning age, location, vacancy rate and nett lettable area), raw data sourced from the Practitioner Survey (concerning capitalisation rates) and refined data or derived expressions (such as the measures for the determinants of building and tenant). Ideally, it would be preferable to include, within the model, as much factual data as possible in preference to the Practitioner sourced data (both raw and refined) and it will be interesting to observe if the cross sectional multiple regression analysis results in such a preference being achieved.

Accordingly, to develop the single, potentially explanatory equation into an econometric model, it is proposed to combine data for the expected capitalisation rate at time t with the risk free rate as the dependent variable regressed against the independent variables, being the measures of the determinants of building, location and tenant previously optimised through cross sectional multiple regression analysis.

The following sub-sections consider each of the variables to be combined in the econometric development process, with the cross sectional multiple regression analysis addressed in the Section thereafter.

5.2.1 Data For Analysis

The variables for combination in the econometric development process will be considered as follows:

- 5.2.1.1 Expected Capitalisation Rate At Time t ;
- 5.2.1.2 The Risk Free Rate;
- 5.2.1.3 Measure For The Determinant Of Building;
- 5.2.1.4 Measure For The Determinant Of Location; and
- 5.2.1.5 Measure For The Determinant Of Tenant.

5.2.1.1 Expected Capitalisation Rate At Time t

The Practitioner Survey sought respondents views as to the expected capitalisation rate for each property in the sample, on the basis of a series of specified assumptions. The data collected was analysed to derive an average capitalisation rate, modal capitalisation rate and adjusted modal capitalisation rate (being the alternative modal capitalisation rate where the respondents provided two modal capitalisation rates), with the resulting data collected being summarised in Appendix 5.1.

Following analysis of this data, above, it was found that the capitalisation adjusted modal rate (CAM) data provided the optimal relationships. Accordingly, it is proposed to use the CAM data in the cross sectional multiple regression analysis to be undertaken in the next Section.

5.2.1.2 The Risk Free Rate

Section 3.4.5 considered the factual or hard data collected, including the nett lettable area, direct vacancy and age of each property (as obtained from BOMA) and an expression for the risk free rate.

Having selected the Federal Governments 10 Year Bond Rate as an appropriate proxy for the Australian risk free rate, the last close of business rate prior to the Practitioner Survey being conducted was found to be 10.17%. Accordingly, this rate was adopted for the purposes of analysis.

5.2.1.3 Measure For The Determinant Of Building

In an attempt to minimise the role of practitioner opinion, intuition and experience, two of the three measures for the determinant of Building contained in Appendix 5.1 comprise factual or hard data with only one being a composite of opinion on ten contributory influences sourced from data collected in the Practitioner Survey.

The three proxies may be summarised as:

Nett Lettable Area

Being that area statistic sourced from BOMA for each property in the optimised data set. It is contended that some relationship between the size of the property, the size of the investment and the capitalisation rate may be anticipated;

Age - Years

Being the date of construction or major refurbishment sourced from BOMA and expressed relative to 1994 for each property in the optimised data set. It is contended that some relationship between the age of the building and the capitalisation rate might be anticipated;

Building Score

Being the building quality measure based on ten contributory influences sourced from the Practitioner Survey and derived in Section 4.2.1.3.2, above for each property in the optimised data set. Given that the measure is based on that source data which also provided the capitalisation rate, some relationship might be anticipated,

with each measure specified for each property within the optimised data set given in Appendix 5.1.

It will be interesting to observe whether all three, just two or only one of the above measures for the determinant of building prove to be significant contributors to the econometric model derived from the cross sectional multiple regression analysis below.

5.2.1.4 Measure For The Determinant Of Location

The derivation of a measure for the determinant of location comprising the straight line distance from the prime CBD office property location in Sydney, based on the findings of the Practitioner Survey, was considered in Section 4.2.1.1.2 above.

As the measure for the determinant of location is factual and capable of physical measurement, it is contended to achieve the stated aim of minimising the role of practitioner opinion, intuition and experience within the derivation of the variables comprising the model. Given the impact of removing outlying location data found in Section 4.2.3, above, some relationship with the capitalisation rate might be anticipated.

Accordingly, the measure for the determinant of location for each of the properties in the optimised data set is included within Appendix 5.2 for adoption in the cross sectional multiple regression analysis, below.

As also noted in Section 4.2.1.1.2, six alternative Location Variables were also specified for use in modelling and comparison of the results to those of the principal location variable referred to above.

5.2.1.5 Measure For The Determinant Of Tenant

Consistent with the attempt to minimise the role of practitioner opinion, intuition and experience, one of the three measures for the determinant of tenant contained in Appendix 5.1 comprises factual or hard data with one being a composite of data sourced from the Practitioner Survey and the other being a combination of the first two.

The three measures may be summarised as follows:

Vacancy Rate

Being that statistic sourced from BOMA for each property in the optimised data set. As vacancy rate is the opposite expression to occupancy rate, it might be expected to be a guide to that extent of the building which is income producing and so some relationship with the capitalisation rate might be anticipated;

Covenant Score

Being the tenant quality measure based on the results of the Practitioner Survey and derived in Section 4.2.1.2, above, for each property in the

optimised data set. Given that the measure is predicated on that source data which provided the capitalisation rate, some relationship might be anticipated;

Covenant/Occupancy Score

The occupancy rate is the opposite expression to the vacancy rate and provides a guide to the extent of the building which is income producing but does not provide any indication of the quality of the income stream.

Conversely, the Covenant Score measure provides a guide to the quality of the income stream but effectively assumes that the building is fully let to an assumed tenant profile (see Section 4.2.1.2, above) and so does not adequately reflect the effect of vacancy within the property.

In order to derive a measure which reflects both the extent of the building which is income producing and the quality of the income stream so produced, the Covenant/Occupancy Score measure was derived which is simply the product of the Covenant Score and the Occupancy Rate.

For example, Property 40 in Appendix 5.1 has the following:

Vacancy Rate	27.53%
Covenant Score	35
Occupancy Rate = $100\% - 27.53\% =$	72.47%
Covenant/Occupancy Score = $35 \times 72.47\% =$	25

Given that each of the contributory variables is anticipated to have some relationship with the capitalisation rate, a similar result may also be anticipated for the product.

The three measures for the determinant of tenant for each of the properties in the optimised data set are contained in Appendix 5.2. It will be interesting to observe whether all three, just two or only one of the above measures for the determinant of tenant prove to be significant contributors to the econometric model derived from the cross sectional multiple regression analysis below.

5.2.1.6 Summary - Data For Analysis

The range of data collected for use as independent variables in the econometric development of a model based on the single, potentially explanatory equation, by cross sectional multiple regression analysis, below, is detailed in Appendix 5.2 and may be summarised as follows:

- Nett Lettable Area
- Age - Years
- Building Score
- Location Score
- Vacancy Rate
- Covenant Score
- Covenant/Occupancy Score

Having collated the requisite independent variable data concerning measures for the determinants of building, location and tenant, it is proposed to combine these with the dependent variable data for the expected capitalisation rate at time t less the risk free rate through cross sectional multiple regression analysis to econometrically develop a model based on the single, potentially explanatory equation.

5.2.2 Development Process

To econometrically develop a model based on the single, potentially explanatory equation, the dependent variable of the CAM less the risk free rate will be regressed through cross sectional multiple regression analysis against the independent variables, considered in the previous Section, to derive the model.

It is proposed to briefly consider some contextual issues, prior to the development process, as follows:

- 5.2.2.1 Expected Results From Regression Analysis
- 5.2.2.2 Expected Signs For Regression Coefficients
- 5.2.2.3 Cross Sectional Multiple Regression Analysis
- 5.2.2.4 Summary - Development Process

5.2.2.1 Expected Results From Regression Analysis

Given that the single, potentially explanatory equation for capitalisation rate determination is specified on the basis of and so accords with finance, commerce, economic and property theory, the dependent variables should have a significant relationship with the independent variable.

If correctly specified, the CAM less the risk free rate at a point in time should be explained by a function of the determinants of building, location and tenant, resulting in a significant R^2 and Adjusted R^2 from a cross sectional multiple regression analysis of such variables.

Conversely, however, the significance of such a relationship may be adversely affected by the problems typically inherent in the analysis of property sector data. It is acknowledged that the data set is limited in size and includes several opinion based variables as well as being subject to other limitations concerning property data. Accordingly, these issues may be expected to adversely affect the significance of the relationships derived from the following cross sectional multiple regression analysis.

To attain the Thesis Principle of maintaining a practical application and industry relevance for the study's findings through the development of a model which is capable of use by and is user friendly for practitioners, the final model should preferably be simply constructed using easily assessable input variables. Optimally, therefore, it would be preferable to achieve one expression for each of the three independent variables in the final quantified model and for each such expression to also be easily assessable.

Further, consistent with the intention to minimise the role of practitioner opinion, intuition and experience, it would be preferable if the independent variables were to be factually based rather than composite variables.

Whilst, given the range of independent variables, it may be possible that the model may ultimately rely on only one expression for each of the three independent variables, the prospect of such an independent variable being easily assessed and factually based (with the exception of location) is considered less likely.

The alternative expressions for both tenant and building include an equal number of easily assessable, factual variables and composite variables derived from the analysis of a range of source data. Accordingly, whether or not the model comprises easily assessable, factual variables will depend upon whether the majority of the tenant and building variables adopted in the final quantified model are factual or composite variables.

Having regard to the greater apparent relevance of the composite variables than the factual variables to the capitalisation rate for the determinants of tenant and building, it is anticipated that the model may ultimately comprise a greater proportion of composite than factual variables.

In summary, therefore, the optimal expected result would be a significant relationship between the CAM less the risk free rate at a point in time and one, factually based expression of each of the determinants of building, location and tenant. However, whilst such a relationship is expected to be found, it is not expected to be significant and the majority of determinants in the final quantified model are not expected to be factually based variables.

5.2.2.2 Expected Signs For Regression Coefficients

The proposed cross sectional multiple regression analysis will combine the dependent variable of CAM less the risk free rate with the following independent variables:

- Nett Lettable Area
- Age - Years
- Building Score
- Location Score
- Vacancy Rate
- Covenant Score
- Covenant/Occupancy Score

The CAM, by definition, is an inverted expression. As values increase, the CAM decreases and as values decrease, the CAM increases.

The dependent variable, by construction, is a negative expression. Accordingly, a sum of the independent variables which reflects a superior combination of determinants will result in an increase in the negative expression of the dependent variable (or decrease in the CAM). Conversely, a sum of independent variables that reflects an inferior combination of determinants will result in a decrease in the negative expression of the dependent variable (or increase in the CAM).

Having regard to the above and given the expected nature of the relationship between the dependent variable and the independent variables for prime, CBD office investment property, the following signs for each of the regression coefficients are expected:

Independent Variable	Expected Sign	Comment On Sign Expectation
Building Score	Negative	As Building Score rises, quality of property is improving such that dependent variable would increase/CAM decrease.
NLA	Positive	Probable relationship unclear. However, as size of property increases, its liquidity potentially decreases

		such that the dependent variable would decrease/CAM increase.
Location	Positive	As location distance increases, quality of location deteriorates such that dependent variables would decrease/CAM increase.
Age - Years	Positive	As age rises, quality of property deteriorates such that dependent variable would decrease/CAM increase.
Covenant Score	Negative	As Covenant Score rises, quality of property as an investment rises such that dependent variable would increase/CAM decrease.
Vacancy Rate	Positive	As vacancy rate rises, quality of property as an investment falls such that dependent variable would decrease/CAM increase.
Cov/Occ Score	Negative	As the Covenant/Occupancy Score rises, quality of property as an investment rises such that dependent variable would increase/CAM decrease

The inverted character of both the CAM and the dependent variable render logical interpretation of the expected signs for regression coefficients particularly challenging. Whilst the above is considered to be a correct and logical interpretation, it will be interesting to observe if the findings of the cross sectional multiple regression analysis highlight any mis-interpretations of the anticipated behaviour of the independent variables.

Having collated the data for analysis and considered both the expected results and the expected signs for the regression coefficients, the following Section will consider the cross sectional multiple regression analysis undertaken to econometrically develop the single, potentially explanatory equation.

5.2.2.3 Cross Sectional Multiple Regression Analysis

To econometrically develop the single, potentially explanatory equation using the dependent and independent variable data considered above, a cross sectional multiple regression analysis was undertaken using Minitabs software at the Royal Melbourne Institute Of Technology.

This analysis will be considered in the following sections:

- 5.2.2.3.1 Multiple Regression Analysis
- 5.2.2.3.2 Econometric Model
- 5.2.2.3.3 Summary - Cross Sectional Multiple Regression Analysis

5.2.2.3.1 Multiple Regression Analysis

The initial analysis comprised the regression of the dependent variable, being the sum of the CAM for a given property less the risk free rate, with the following independent variables:

- Nett Lettable Area
- Age - Years
- Building Score
- Location Score
- Vacancy Rate
- Covenant Score
- Covenant/Occupancy Score

with the data set used for the initial analysis being contained in Appendix 5.2.

Each of the variables was included in the cross sectional multiple regression analysis and the results, which are included as Appendix 5.3, are summarised in Table 5.1.

R-sq = 65.8%		R-sq (adj) = 55.4%		F = 6.32	
Predictor	Coeff	St Dev	t-Score	p	VIF
Constant	-1.1148	0.5163	-2.16	0.042	
Building Score	-0.017155	0.005442	-3.15	0.004	1.3
NLA	0.00000053	0.0000072	0.07	0.942	1.9
Location	0.0009146	0.0002698	3.39	0.003	1.3
Age - Years	-0.00348	0.04229	-0.08	0.935	1.6
Cov Score	-0.02001	0.04185	-0.48	0.637	72.0
Vac Rate	1.356	1.911	0.71	0.485	15.0
Cov-Occ Score	0.00638	0.04417	0.14	0.886	115.3

Initial Cross Sectional Multiple Regression Analysis Summary Of Results

Table 5.1

Given the anticipated problems that may arise from property data generally, the quality of the specific data and the potential limitations of the sample size, the R^2 and Adjusted R^2 achieved in Table 5.1 were significantly stronger than expected. It is also notable, in Table 5.1, that only two independent variables (and the constant) achieved t-scores greater than 2, being those for Building Score and Location. Furthermore, the high VIF scores suggest that multi-collinearity may exist amongst Covenant Score, Vacancy Rate and Covenant/Occupancy Score, which may be anticipated given that Covenant/Occupancy Score is a composite measure of other two variables.

The expectations for signs were supported for each variable except the following:

Variable	Sign Expected	Sign Found
Age -Years	Positive	Negative
Cov/Occ	Negative	Positive

The negative sign for Age-Years defies simple explanation. Possibly, the newer properties in the sample had poorer locations, poorer quality tenants or greater vacancy such that other variables combine to attribute a different emphasis or direction to the age variable. Similarly, the positive sign for Covenant/Occupancy Score is also difficult to easily explain, though it is notable that the contribution of this variable may be impacted by multi-collinearity. It is not proposed to consider the unexpected signs further, at this point, as the analysis will be continued below and the above variables may cease to be of relevance.

The Summary Of Results in Table 5.1 adopts the principal location variable of distance from that prime location specified in Section 4.2.1.1.2, with an R^2 of 65.8% and Adjusted R^2 of 55.4% resulting.

If the analysis is recalculated using the six alternative Location Variables, also considered in Section 4.2.1.1.2, the following results are observed:

Location	R^2	Adjusted R^2
A	64.6%	53.4%
B	64.5%	53.2%
C	57.9%	44.5%
D	61.3%	49.0%
E	63.7%	52.2%
F	63.9%	52.4%

Accordingly, none of the alternative Location Variables considered produce a stronger result than the use of the principal location variable of distance from the specified prime location. It was, therefore,

proposed to continue the development of the econometric model using the principal location variable only.

To further investigate the relationships between the dependent and independent variables, a correlation matrix was computed, which is contained in Table 5.2, for use in identifying any particularly strong relationships for further consideration.

	CAM	Building	NLA	Loc'n	Years	Cov Score	Vac Rate
Building	-0.438						
NLA	-0.228	0.360					
Location	0.384	0.060	0.061				
Age -Years	0.111	0.116	-0.245	0.400			
Cov Score	-0.511	0.145	0.406	0.104	-0.135		
Vac Rate	0.409	0.069	0.123	-0.065	-0.226	-0.559	
Cov/Occ	-0.532	0.104	0.241	0.111	0.001	0.950	-0.776

Correlation Matrix - Cross Sectional Multiple Regression Analysis "A"

Table 5.2

Surprisingly, given the relative strength of the R^2 and the Adjusted R^2 , only five correlations were found which were stronger than 0.50. Of these, the most significant correlations were the following:

Covenant Score	Cov/Occ Score	0.950
Vacancy Rate	Cov/Occ Score	- 0.776
Covenant Score	Vacancy Rate	- 0.559

which involved inter-dependent variables such that a significant correlation might be anticipated.

The remaining two correlations above 0.50 were found to be between CAM and Covenant Score and between CAM and Covenant/Occupancy Score, respectively. Such an emphasis on the tenant measure is interesting as is the absence of other significant correlations both between CAM and other independent variables and between unrelated, independent variables.

Given the absence of significant correlations, it is noted that the variables appear to be relatively independent such that each of those variables which appear in the final econometric model, derived from further cross sectional multiple regression analysis below, may be likely to be making a significant contribution in its own right.

Having investigated the initial relationship between the dependent variable and each of the independent variables, the following Section will summarise the results of progressive cross sectional multiple regression analyses undertaken to eliminate those variables making sub-optimal contributions prior to the derivation of the econometric model.

5.2.2.3.2 Econometric Model

A series of cross sectional multiple regression analyses were undertaken to progressively remove those independent variables which were providing a sub-optimal contribution to the quality of the econometric model.

These analyses culminated in the final, cross sectional multiple regression analysis, the results of which are contained in Appendix 5.4 and summarised in Table 5.3 with the final econometric model generated being described below.

R-sq = 64.8%		R-sq (adj) = 60.9%		F = 16.59	
Predictor	Coeff	St Dev	t-Score	p	VIF
Constant	-0.9376	0.3784	-2.48	0.020	
Building Score	-0.015992	0.004480	-3.57	0.001	1.0
Location	0.0009175	0.0002249	4.08	0.000	1.0
Cov-Occ Score	-0.018265	0.003892	-4.69	0.000	1.0

Final Cross Sectional Multiple Regression Analysis Summary Of Results

Table 5.3

It is contended to be significant that the final econometric model contained one measure for each of building, location and tenant, which is consistent with the findings of the literature review and the subsequent analysis in Chapters 3 and 4.

Furthermore, it is interesting to note that, of the three measures, only that for location is factually based, with the other two being composite variables. Similarly, it is notable that the measure for tenant which comprised a combination of both covenant quality (derived) and level of vacancy (factual) was found to be more significant than those variables which represented either covenant quality or vacancy alone.

As, effectively, half of the independent variables are factual and half comprise derived expressions, the final quantified model half fulfils the proposal of minimising the role of practitioner opinion, intuition and experience. However, given the limited number of independent variables, the final econometric model fully achieves the Thesis Principle of maintaining a practical application and industry relevance for the study's findings, through the development of a model which is capable of use by and is user friendly for practitioners, being simply constructed using easily assessable input variables.

Overall, from initial to final analysis, whilst the R^2 of the econometric model fell slightly (65.8% to 64.8%), this was offset by the significant increase in the strength of the Adjusted R^2 (55.4% to 60.9%). Further, the F statistic rose from 6.32 to 16.59 which exceeded the target range of 7-9 and was a particularly high score, as is preferable¹. The VIF scores each fell to one which supports the independence of the variables and the results of the correlation matrix in Table 5.2 (above) with each of the t-Scores being above two.

Whilst such a strong result was very pleasing, it was also surprising given the problems inherent in the analysis of property data and the potential limitations of sample size, as considered above. It should be noted that testing for heteroscedasticity was not undertaken but, given the profile of the data, this is not anticipated to be a significant problem.

The coefficient signs may be compared with expectations as follows:

Variable	Sign Expected	Sign Found
Building	Negative	Negative
Location	Positive	Positive
Cov/Occ	Negative	Negative

Accordingly, each of the coefficient signs are as expected which further supports the findings of the literature review and the analysis in Chapters 3 and 4.

The final cross sectional multiple regression analysis provided the following model based on the single, potentially explanatory equation:

$$\text{CAM - RFR} = -0.938 - 0.0160 \text{ Building Score} + 0.000918 \text{ Location Score} - 0.0183 \text{ Covenant-Occupancy Score} \quad \text{Equation 5.1}$$

¹ Consistent with Locational Theory, the Inverse Square Rule of $1/d^2$ was alternatively adopted for the Location Score, a series of cross-sectional multiple regression analyses undertaken and the results considered. The adoption of $1/d^2$ resulted in an R-sq of 68.5% and an R-sq (adj) of 63.6% with an F statistic of 9.90. Whilst the R-sq and R-sq (adj) were marginally stronger than were found in the final, cross sectional multiple regression analysis (summarised in Table 5.3), the significantly weaker F statistic was considered to render the use of the Location Score preferable to that of its inverse square for modelling purposes.

which comprises an econometric model for the determination of the capitalisation rate for prime, CBD office investment property that is based upon and accords with finance, commerce, economic and property theory.

5.2.2.3.3 Summary - Cross Sectional Multiple Regression Analysis

The cross sectional multiple regression analysis started with seven independent variables, being three for the determinant of building, one for the determinant of Location and three for the determinant of tenant, which were regressed against the dependent variable of CAM less the risk free rate.

Following the completion of the cross sectional multiple regression analysis, three independent variables were found to offer the optimal econometric model, comprising one measure for each of the building, Location and tenant determinants. The final econometric model is contended to be statistically robust with a strong Adjusted R^2 and other relevant statistical measures.

The final econometric model is consistent with the findings of the literature review and so is based on and accords with property, finance, commerce and economic theory.

Accordingly, the cross sectional multiple regression analysis is contended to have successfully converted that data sourced from the Practitioner Survey for the respective determinants into a soundly based econometric model that may be used, below, for Hypothesis testing.

5.2.2.4 Summary - Development Process

The theoretical specification of the single, potentially explanatory equation was based on and so accorded with finance, commerce, economic and property theory such that the independent variables were expected to have a significant relationship with the dependent variable. Such a relationship was found to exist and the problems associated with property data and sample size did not transpire as particularly significant.

As the cross sectional multiple regression analysis indicated that the CAM less the risk free rate was substantially explained by the determinants of building, location and tenant, the single, potentially explanatory equation is contended to be correctly specified.

To attain the Thesis Principle of maintaining a practical application and industry relevance for the study's findings through the development of a model which is capable of use by and is user friendly for practitioners, it was proposed that the final model should preferably be simply constructed using easily assessable input variables. Whilst the final model was simply constructed, comprising only three

independent variables, the measure for location and half of the measure for tenant were the only easily assessable determinants with the balance each requiring composition from other data. Though such composition is not challenging, its mere requirement results in the principle of easily assessable input variables being only half fulfilled.

Furthermore, such composition involves a series of subjective adjustments which, accordingly, also only partially achieves the proposal of developing an objective and measured approach by minimising the role of practitioner opinion, intuition and experience.

It is, however, contended that the final econometric model exceeds the expectations outlined in Section 5.2.2.1, above, as the identified relationship between dependent and independent variables was found to be significant and the expectation that the majority of the determinants would not be factually based variables did not transpire.

Interestingly, given the challenging logic involved in negative and double negative relationships, each of the coefficient signs in the final multiple regression equation were found to be as expected, so further supporting the theoretical validity of the econometric model.

Accordingly, therefore, the development process successfully converted the single, potentially explanatory equation into an econometric model for use in Thesis Hypothesis testing and also, significantly, generally achieved the Thesis Principle.

5.2.3 Summary - Econometric Development Of Model

Having derived a single, potentially explanatory equation, for the determination of the capitalisation rate, as follows:

$$E(y_t) - r_f = f(k_{11}, k_{12}, k_{13}) \mid \emptyset_t \quad \text{Equation 4.1}$$

where: $E(y_t)$ = expected capitalisation rate at time t

r_f = risk free rate

k_{11} = $k_{2(R < A - G > A)}$

k_{12} = $k_{5(R < A - G > A)}$

k_{13} = $k_{10(R < A - G > A)}$

k_2 = building

k_5 = location

k_{10} = tenant

- R = Risk
 G = Growth
 \emptyset_t = information subset available at time t

the above econometric development process adopted cross sectional multiple regression analysis to derive the following model:

$$\text{CAM - RFR} = -0.938 - 0.0160 \text{ Building Score} + 0.000918 \text{ Location Score} - 0.0183 \text{ Covenant-Occupancy Score} \quad \text{Equation 5.1}$$

Given the composition of Equation 5.1, it is contended that the final econometric model has theoretical validity being consistent with the findings of the literature review and subsequent analysis which culminated in the single, potentially explanatory equation given in Equation 4.1.

Whilst a greater achievement of the Thesis Principle of developing a model which is simply constructed with easily assessable input data that minimises the role of practitioner opinion, intuition and experience would have been optimal, it is contended that Equation 5.1 exceeded expectations and may, therefore, be considered a very satisfactory result.

Accordingly, having specified the single, potentially explanatory equation, developed the model through the analysis of collated data and found the econometric model to be theoretically valid, the practical validity of the econometric model will now be investigated through the test of the Thesis Hypothesis and subsequent investigation of the validity of the Thesis Proposition which will be considered, respectively, below.

5.3 TEST OF THESIS HYPOTHESIS

The Thesis Hypothesis may be restated as follows:

That the standard deviation of a sample of capitalisation rates calculated by an econometric model will be below that of a sample selected by property valuers using current methods of capitalisation rate determination.

Accordingly, therefore, it is proposed to compare the standard deviation of the capitalisation rates assessed by the econometric model for the sub-sample of n properties to that of the capitalisation rates provided by respondent valuers in the Practitioner Survey for the same properties.

In addition to calculation of the respective standard deviations, a t-Test will also be undertaken and the Coefficient Of Variation calculated for both sets of capitalisation rate data for the sub-sample of n properties.

Further investigation to determine the validity of the Thesis Proposition, which is complementary to the Thesis Hypothesis testing, will then be undertaken in the following Section.

5.3.1 Standard Deviation Of Sample Of n Properties

For the Thesis Hypothesis to be proven, the standard deviation of the capitalisation rate sample, derived from the application of the econometric model to the sub-sample of n properties, should be below that of the capitalisation rate sample derived from the responses to the Practitioner Survey for the same properties.

The sub-sample of n properties, identified in Section 4.2.2.2, above, comprised the following:

Prop No	Address	CBD Area
4	6-10 O'Connell Street	Core
21	7-15 Macquarie Place	Core
28	580 George Street	Mid-Town
33	45 Clarence Street	Western

As noted in Section 4.2.2.2, above, the sub-sample of n properties was intended to be sufficiently large to permit meaningful testing and to include properties which were spread across the core, mid-town and western corridor areas of the Sydney CBD. It is contended that the above sub-sample achieves these objectives.

The sub-sample of n properties was excluded from the data set from which the model was derived, such that the test of the Thesis Hypothesis is contended to be rigorously founded.

Appendix 5.5 contains the following data for the sub-sample of n properties:

- the Building, Location and Covenant/Occupancy Score for each property, derived from Appendix 4.2;
- the CAM, average capitalisation rate and modal capitalisation rate for each property, derived from the results of the Practitioner Survey as summarised in Appendix 4.2;
- the predicted capitalisation rates resulting from the application of the model,

with the results summarised in Table 5.4 which includes both the nominal result arising from the application of the econometric model and the nearest 0.25% increment. It should be noted that the CAM data and modal capitalisation rate data in Appendix 5.5 is the same for each of the sub-sample of n properties.

Pr No	Model Cap Rate	Avg Cap	Diff	Model Rounded	CAM /Mode	Diff
4	7.693877	7.62	-0.07	7.75	8.00	0.25
21	7.648437	7.04	-0.61	7.75	7.00	-0.75
28	7.939450	7.68	-0.26	8.00	7.00	-1.00
33	7.482467	7.93	0.45	7.50	7.50	0.00

Sub-Sample Of n Properties
Summary Of Econometric Model And Practitioner Survey Results

Table 5.4

Using the data contained in Table 5.4 and the statistical function within Excel 5, the standard deviation of the respective samples was calculated and is given in Appendix 5.6, with a summary in Table 5.5.

As Table 5.5 shows, the standard deviation of the capitalisation rate sample derived from the application of the econometric model to the sub-sample of n properties is below that of the capitalisation rate sample derived from the responses to the Practitioner Survey for the same properties. The Thesis Hypothesis is, therefore, found to be proven.

Data Set From	Standard Deviation
Model	0.1888856
CAM/ Modal Cap'n Rates	0.4787136
Average Cap'n Rates	0.3764195

Sub-Sample Of n Properties - Comparative Standard Deviations

Table 5.5

Proof of the Thesis Hypothesis provides support for the validity of the Thesis Proposition and the proposed solution to the Thesis Problem. The results suggest that the adoption by the valuer of a deterministic approach, based on rational and logical criteria, may contribute towards a closer simulation of that approach adopted by the investor to an appraisal of worth and towards a reduction in the reliance upon the interpretation of comparables.

The results, as summarised in Tables 5.4 and 5.5, also offer a range of interesting insights into capitalisation rate determination. A comparison of the results of the model with the average of the Practitioner Survey responses, in Table 5.4, shows Property Number 4 to be very close but the other three properties to be between approximately one quarter and three quarters of one percent different. When rounded to the nearest quarter percent and compared to the comparable CAM/Modal results of the Practitioner Survey, Property Number 33 is found to match exactly and the other three are found to be 0.25% to 1.00% different.

Accordingly, with reference to the alternative bases of comparison, the econometric model can be argued to produce broadly similar results to those of the Practitioner Survey for each of the properties except Property Number 21. As the sub-sample of n properties were not included within the data set from which the econometric model was derived, it is proposed to briefly review, below, the capitalisation rate data sourced from the Practitioner Survey for each property and to endeavour to identify potential contributors to the differences in the results of the Practitioner Survey and the model.

The capitalisation rates attributed by the Practitioner Survey to each of the sub-sample of n properties are detailed in Appendix 4.2 and are summarised in Table 5.6.

Prop No	Avg Cap Rate	Modal Cap Rate	Range - Extent	Range - %	% Of Respondents At Mode Not At Mode	
4	7.62%	8.00%	6.75% - 8.50%	1.75%	23%	77%
21	7.04%	7.00%	6.25% - 8.00%	1.75%	34%	66%
28	7.68%	7.00%	6.75% - 9.50%	2.75%	27%	73%
33	7.93%	7.50%	7.00%-10.00%	3.00%	23%	77%

Sub-Sample Of n Properties - Summary Of Practitioner Survey Results

Table 5.6

As Table 5.6 clearly shows, the average of capitalisation rate responses extends from within 0.04% to 0.68% of the modal responses, with the range of responses being very wide. At best, the range of responses falls within a band of 1.75% and at worst, 3.00%. For each property, the majority of respondents did not select the modal capitalisation rate and in three of the four cases only approximately one quarter of the respondents selected the modal capitalisation rate.

The data from the Practitioner Survey concerning capitalisation rates for each of the sub-sample of n properties is, therefore, extremely widely spread and the prospect of an econometric model accurately matching a consensus of such data is, accordingly, diminished.

On the assumption that the econometric model provides the valid capitalisation rate for each of the sub-sample of n properties and if such a rate is then rounded to the nearest 0.25%, the number of responses in the Practitioner Survey that match the model or fall above or below are summarised in Table 5.7.

Prop No	Nearest 0.25%		
	% Resp Below	% Resp At Rate	% Resp Above
4	54%	4%	42%
21	92%	4%	4%
28	69%	4%	27%
33	27%	23%	50%

Sub-Sample Of n Properties - Summary Of Grouped Practitioner Survey Results

Table 5.7

As Table 5.7 shows, in each case more respondents invalidly determined the capitalisation rate than validly determined it. It would appear that respondents significantly over-priced Property Number 21 and also over-priced, though to a lesser extent, Property Number 28. Conversely, Property Number 33 would appear to have been under-priced and Property Number 4 approximately evenly under and over-priced by the respondent sample.

Such a conclusion is, however, dependent on the assumption that the econometric model provides the valid capitalisation rate. It is possible that the independent variables for each of the properties are sub-optimally specified, which contributes to the difference between the results of the Practitioner Survey and the application of the model. Conversely, the respondents may be mis-pricing the respective properties generally or mis-pricing due to the adoption of 0.25% increments in capitalisation rates. Alternatively, the differences may be a combination of both respondent and model related issues.

For example, the comparatively higher pricing of Property Number 33 may be due to the econometric model attributing the property with a location close to prime as the straight line map distance does not reflect the topographical separation of the western corridor from the CBD core. Similarly, for Properties 21 and 28, respondents may be over-estimating the quality of the building and tenant or, alternatively, the econometric model may have under-estimated the quality of each. Without further analysis, however, it is not possible to determine the exact sources of the differences in the results from the application of the econometric model to those of the Practitioner Survey².

Having considered the relative standard deviations and found the test to prove the Thesis Hypothesis, it is proposed to also use the data from the sub-sample of n properties to undertake a t-Test and comparatively analyse the results therefrom prior to calculating the Coefficients Of Variation for consideration.

² If the econometric model is recalculated using the alternative Location Variables A and B considered in Section 4.2.1.1.2 (being those alternatives achieving the highest R^2 and Adjusted R^2 in Section 5.2.2.3.1), the following capitalisation rates and standard deviations result:

Prop No	Model Rounded	CAM / Mode	Avg Cap	Loc Vble A Rdnd	Loc Vble B Rdnd
4	7.75%	8.00%	7.62%	7.50%	7.50%
21	7.75%	7.00%	7.04%	7.50%	7.50%
28	8.00%	7.00%	7.68%	7.75%	7.75%
33	7.50%	7.50%	7.93%	7.50%	7.50%
Std Devn	0.1888	0.4787	0.3764	0.1272	0.1108

Whilst these results further support the proof of the Thesis Hypothesis, they also indicate that the alternative Location Variables further reduce the standard deviation from that achieved using the principal location variable. The results suggest that the specification of the principal location variable may be capable of refinement though given the range of variation considered, it may be likely that further Practitioner Survey data regarding perceptions of location would be required to achieve such refinement. However the relativity of standard deviations does not indicate that respecification of the location variable alone would be a panacea for the resolution of differences between the results of the model and those of the Practitioner Survey, though it may be a significant contributor.

5.3.2 t-Test For Sample Of n Properties

Using the data contained in Appendix 5.5 and the statistical function within Excel 5, a t-Test was undertaken and the results are given in Appendix 5.7.

A value of zero was adopted for the hypothesised mean difference, indicating that the sample means are hypothesised to be equal. Accordingly, if the null hypothesis is supported, the mean of the data set derived from the use of the model is equal to that derived from the Practitioner Survey responses. Given the findings of Section 5.3.1, above, the two means are not expected to be equal.

As the results in Appendix 5.7 indicate, the t-statistic was calculated to be 1.088095 at a 95% confidence level which rejects the null hypothesis and confirms, as expected, that the two means are not equal. The result of the t-Test is, therefore, contended to be consistent with the result of Section 5.3.1 above and further supports the proof of the Thesis Hypothesis.

5.3.3 Coefficient Of Variation For Sample Of n Properties

Having regard to the findings of the t-Test, as the two means differ the Coefficient Of Variation was calculated for each to provide a relative dispersion measure for comparison to the absolute dispersion measure, with the results summarised in Table 5.8.

Data Set From	Standard Deviation	Coeff Of Variation
Model	0.1888856	2.44% ³
CAM/ Modal Cap'n Rates	0.4787136	6.49%
Average Cap'n Rates	0.3764195	4.97%

Sub-Sample Of n Properties - Comparative Coefficients Of Variation

Table 5.8

³ The Coefficient Of Variation in the capitalisation rate sample derived from the application of the econometric model, but without rounding of the results, is 2.46%.

As Table 5.8 indicates, the Coefficient Of Variation is significantly greater in each capitalisation rate sample derived from the responses to the Practitioner Survey than in the sample derived from the application of the econometric model for the same properties. Accordingly, the findings concerning relative dispersion are consistent with and support those for absolute dispersion and further support the proof of the Thesis Hypothesis.

5.3.4 Summary - Test Of Thesis Hypothesis

The Thesis Hypothesis, that the standard deviation of a sample of capitalisation rates calculated by an econometric model will be below that of a sample selected by property valuers using current methods of capitalisation rate determination, was found to be proven.

Given that the data for the sub-sample of n properties was not included within that data used for the development of the econometric model, the capitalisation rates for the sub-sample of n properties attributed by the econometric model are wholly independent of the model development process and the test of the Thesis Hypothesis is, accordingly, contended to be rigorous.

Though the econometric model can be argued to produce broadly similar results to those of the Practitioner Survey for the majority of properties (depending on the basis of comparison), some significant differences were observed. Though the results of the Practitioner Survey show an extremely divergent view of the appropriate capitalisation rate by respondents, which would prove challenging for any econometric model, the differences in results were contended to possibly also be attributable to the adoption of 0.25% increments by respondents, inaccuracy in pricing by respondents, sub-optimal variables within the model or a combination of each. The extent and relativity of such differences was statistically confirmed by the results of the t-Test and Coefficients Of Variation which also further supported the proof of the Thesis Hypothesis.

Significantly, the econometric model mimics the average capitalisation rate assessed from the Practitioner Survey to within less than 10% of resulting capital value. For example, assuming an annual net income stream of \$10 million, the econometric model values Property Number 21 at 8.52% below the average of the Practitioner Survey and Property Number 33 at 6.01% above. Accordingly, relative to the average, the results are within the 10% bounds of acceptable inconsistency proposed in Section 1.2.5.

However, the findings of the test of the Thesis Hypothesis raise a range of significant aspects of the main issue, which is the pricing of prime, CBD office investment property by valuers, for consideration. For example, assuming an annual net income stream of \$10 million, Property Number 21 may be over-

priced by respondents by upto \$29 million or 18% and Property Number 33 may be under-priced by upto \$34 million or 34% giving an unacceptably wide range of valuation outcomes which go beyond the bounds of acceptable inconsistency towards the realm of negligence, as considered in Section 1.2.4.1.

Based on common information and assumptions, for so many highly qualified and experienced respondent valuers to provide such a diverse range of capitalisation rates with such significant pricing impacts substantiates the principal issue identified from the general problem area in Chapter 1. It is also a major cause for concern on several bases including the establishment of what is the correct value for an asset, the pricing of property relative to other asset classes, the ability to earn excess returns through the identification of underpriced assets, the professional indemnity of valuers and the efficiency and smooth operation of the property market. Such causes for concern provide a range of significant issues worthy of further research.

Having undertaken the test of the Thesis Hypothesis and found it to be proven, further investigation into the validity of the Thesis Proposition was then undertaken through a series of tests which are complementary to the tests of the Thesis Hypothesis and which are detailed in the following Section.

5.4 INVESTIGATION OF THESIS PROPOSITION

The Thesis Proposition may be restated as follows:

that the use of an econometric model will reduce the variability in capitalisation rate adjustment.

The test of the Thesis Hypothesis undertaken in Section 5.3, above, provided one approach to determining the validity of the Thesis Proposition. It is proposed, in this Section, to undertake two additional tests, complementary to the test of the Thesis Hypothesis, to further investigate the validity of the Thesis Proposition:

- a test of comparative standard deviations, t-Test and Coefficients Of Variation, as undertaken in 5.3.1 and 5.3.2 above, but for the sample of N properties which formed the data set from which the model was derived; and

- a comparison of that capitalisation rate produced by the econometric model to that adopted by an independent valuer in a fee based valuation of a property (Property x) which was not included within the data set from which the model was derived,

which will be outlined, respectively, together with the results achieved, below. It is contended that if both tests also support the Thesis Proposition, then the Thesis Proposition may be considered valid.

5.4.1 Sample Of N Properties

The sample of N properties comprised thirty-one buildings, with the following data for the sample contained in Appendix 5.5:

- the Building, Location and Tenant Score for each property, derived from Appendix 4.2;
- the CAM, average capitalisation rate and modal capitalisation rate for each property, derived from the results of the Practitioner Survey as summarised in Appendix 4.2;
- the predicted capitalisation rates resulting from the application of the model.

Given that the model was derived from the data for the sample of N properties, it is acknowledged that tests involving the sample of N properties will be less rigorous than those involving the sub-sample of n properties or Property x which were excluded from the sample used for model derivation.

5.4.1.1 Standard Deviation Of Sample Of N Properties

For the Thesis Proposition to be valid, the standard deviation of the capitalisation rate sample, derived from the application of the econometric model to the sample of N properties, should be below that of the capitalisation rate sample derived from the responses to the Practitioner Survey for the same properties.

Using the data contained in Appendix 5.5 and the statistical function within Excel 5, the standard deviation of the respective samples was calculated and is given in Appendix 5.6, with a summary in Table 5.9.

Data Set From	Standard Deviation
Model	0.4024641
CAM	0.4998656
Modal Cap'n Rates	0.4808147
Average Cap'n Rates	0.3920519

Sample Of N Properties - Comparative Standard Deviations

Table 5.9

Given that the econometric model is derived from the data for the sample of N properties, an almost identical level of standard deviation may be expected to be found and was found for the statistical average of the Practitioner response sample and for the model (2.65% difference), as shown in Table 5.9.

It is, however, contended that the CAM and modal capitalisation rates are more relevant comparisons than the average of the Practitioner Survey responses given the propensity of respondents to adopt 0.25% increments. The standard deviation for the modal and adjusted modal capitalisation rates attributed by respondents exceeds the standard deviation of the capitalisation rates calculated by the econometric model for the sample of N properties, which supports both the validity of the Thesis Proposition and the previous finding that the Thesis Hypothesis is proven.

Table 5.10 provides a summary of the results of a comparison of the capitalisation rate provided by the econometric model to those of the Practitioner Survey responses for each of the N properties in the sample, as given in full in Appendix 5.5.

As Table 5.10 shows, only one capitalisation rate observation exactly matched the rate determined by the econometric model for the entire sample of N properties and the three bases of capitalisation rate specification.

As expected, the average capitalisation rates from the Practitioner Survey responses were matched by approximately half of the capitalisation rates determined by the econometric model, when levels of rounding were adopted, with the average capitalisation rate showing the highest level of results within 0.05 of the econometric model results.

	CAM	Cap Avg	Cap Mode
Standard Deviation	0.4998	0.3920	0.4808
Model Result Exactly Matching Survey	0	1	0
Model Result Within 0.05 Of Survey	16%	25%	19%
Model:Survey Differences			
< 0.125	39%	42%	45%
> 0.125	35%	16%	26%
< 0.250	74%	52%	71%
> 0.250	26%	42%	29%
Model Within +/- 0.13% Of Survey	52%	42%	58%
Correlation With Model Results	0.8045	0.7517	0.7617

Sample Of N Properties - Summary Of Comparative Capitalisation Rates

Table 5.10

Surprisingly, however, the results for the CAM and Cap Mode were stronger than expected. Whilst, as may be expected, fewer Practitioner Survey responses were within 0.05 of the results derived by the econometric model than was found for the average capitalisation rate, a significantly greater proportion of Practitioner Survey responses were within 0.13% of the capitalisation rate derived by the econometric model. This result is supported by the correlation between the results using the econometric model and the Practitioner Survey responses, where the correlation coefficient for CAM and the modal capitalisation rate exceeds that for the average capitalisation rate.

Given that the econometric model was derived from an analysis of the data set comprising N properties, a significant similarity between the capitalisation rates produced by the model and those of the statistical average of the Practitioner Survey responses for each of N properties might be expected and was found to exist.

However, when the more relevant results of the CAM and modal capitalisation rates (in increments of 0.25%) from the Practitioner Survey responses are compared to the results of the econometric model for each of the N properties in the sample, the Thesis Proposition is found to be supported and the Thesis Hypothesis further supported as the standard deviations of the former are greater than that of the latter.

Having found that the standard deviation test of the sample of N properties supports the findings of the same test for the sub-sample of n properties, it is now proposed to undertake a t-Test of the sample of N

properties and compare the result to that for the sub-sample of n properties prior to calculating and analysing the Coefficients Of Variation.

5.4.1.2 t-Test For Sample Of N Properties

Using the data contained in Appendix 5.5 and the statistical function within Excel 5, a t-Test was undertaken and the results are given in Appendix 5.8.

A value of zero was adopted for the hypothesised mean difference, indicating that the sample means are hypothesised to be equal. Accordingly, if the null hypothesis is supported, the mean of the data set derived from the use of the econometric model is equal to that derived from the Practitioner Survey responses.

Given that the CAM data was used for the test and that such data exhibited a correlation coefficient of 0.8045 to the capitalisation rate data derived from the application of the econometric model, it is possible that the two means may be similar and the null hypothesis supported.

As the results in Appendix 5.8 indicate, the t-statistic was calculated to be -0.09075 at a 95% confidence level which effectively supports the null hypothesis and confirms, as expected, that the two means, whilst not identical, are very similar.

5.4.1.3 Coefficients Of Variation For Sample Of N Properties

Having regard to the findings of the t-Test, as the sample means are very similar it may be anticipated that the level of relative dispersion may be similar to the level of absolute dispersion found. Accordingly, the Coefficient Of Variation was calculated with the results summarised in Table 5.11.

Data Set From	Standard Deviation	Coeff Of Variation
Model	0.4024641	5.32%
CAM	0.4998656	6.61%
Modal Cap'n Rates	0.4808147	6.01%
Average Cap'n Rates	0.3920519	5.00%

Sample Of N Properties - Comparative Coefficients Of Variation
Table 5.11

Consistent with the findings for absolute dispersion, Table 5.11 shows that the Coefficient Of Variation was found to be very similar for each sample though greater for the CAM and modal capitalisation rate samples. Accordingly, the Coefficients Of Variation found support both the validity of the Thesis Proposition and the previous findings that the Thesis Hypothesis is proven.

5.4.1.4 Summary - Sample Of N Properties

Whilst it was acknowledged that the derivation of the econometric model from the sample of N properties would reduce the rigour of tests of the model against the sample of N properties, it was proposed to undertake such tests to further investigate the validity of the Thesis Proposition and to compliment the test of the Thesis Hypothesis.

The results of the standard deviation test, the t-Test and the calculation of the Coefficients Of Variation confirmed that the commonality of base data to both sets of derived capitalisation rates was an issue that reduced the rigour of the test.

However, the results of such tests generally supported those of the test of the Thesis Hypothesis which is contended to further support the validity of the Thesis Proposition.

Having considered the application of the model to the sample of N properties, it is now proposed to consider the application of the econometric model in a single property, static comparative test to complete the investigation into the validity of the Thesis Proposition.

5.4.2 Property x

In Section 4.2.2.1, above, Property Number 34 was selected as Property x for use in a static, comparative test of the capitalisation rate attributed by the econometric model to that adopted by an independent valuer in a fee based valuation, to complete the investigation into the validity of the Thesis Proposition.

It should be noted that neither the property nor the valuer were within the sample that produced the data from which the econometric model was derived. Accordingly, the results of this investigation of the Thesis Proposition are totally independent of the model derivation process and this is contended to increase the rigour of the test.

The test will permit comparison of the capitalisation rate produced by the econometric model to that adopted by the independent valuer. If the Thesis Proposition is valid, the capitalisation rate determined by the independent valuer should be different to that determined by the econometric model. If the capitalisation rates are found to differ, the extent of such difference will be interesting to compare with that found in the test of the Thesis Hypothesis and noted in Section 5.3.3, above. On the assumption that the econometric model provides the valid capitalisation rate for Property x, the extent of the difference between the two may provide an indication of the extent of the inaccuracy and inconsistency in the independent valuers determination.

However, by definition, Section 5.3 considered the comparison of the capitalisation rates determined by the econometric model to those of almost forty respondents in the Practitioner Survey for each of the sub-sample of n properties. In this test, the capitalisation rate determined by the econometric model is compared to that selected by a single, independent valuer and it is not, therefore, possible to estimate whether the extent of the difference will be lesser or greater than that found in Section 5.3.3.

For completeness, a comparison to those capitalisation rates attributed to Property x by the respondents in the Practitioner Survey will also be undertaken.

In the following sections, respectively, the capitalisation rate for Property x will be derived from the application of the econometric model, compared to that determined by the independent valuer and then compared to the results of the Practitioner Survey prior to a consideration of the issues arising.

5.4.2.1 Testing - Property x

Section 4.2.2.1, above, described the basis upon which Property Number 34 at 1 Margaret Street, Sydney was selected as Property x. The subject property may be factually summarised as follows:

Description:	A modern office building comprising 22 levels and occupying a prominent position on the corner of Margaret and Clarence Streets in the western corridor of the Sydney CBD.
Tenant:	Whole building leased to Citibank Limited for a term of 10 years expiring in July, 2001.
Nett Lettable	
Area:	Approximately 21,000 sqm.
Vacancy Rate:	0%.
Age:	Approximately 10 years old.

The analysis undertaken in Chapter 4 attributed the following measures of each determinant for the property, as stated in Appendix 4.1:

Building Score:	74
Location Score:	300
Tenant Score:	64

If the econometric model stated in Equation 5.1 is applied to the above data, a capitalisation rate of 7.155282% is produced which may be rounded to 7.16%.

The independent valuer of Property x noted that the property was over-rented by approximately 25% and attributed a value to the property, prior to rounding, of \$93,722,705 which may be devalued to an equivalent yield of 7.91% after allowance for all adjustments.

As the capitalisation rate determined by the independent valuer differs from that determined by the model, the Thesis Proposition is supported.

Interestingly, the independent valuers determination of the capitalisation rate differs from that of the econometric model by 0.75% which, on the assumption that the model is valid, would indicate that current methods of capitalisation rate determination are not only contributing to inconsistency and inaccuracy in such determination but also that such inconsistency and inaccuracy is potentially significant.

Prima facie, the independent valuer would appear to have understated the value of the property by approximately \$9.88 million or 9.53% which, whilst significantly less than the 34% understatement for Property Number 33 suggested in Section 5.3.3, above, is still a significant difference.

Accordingly, the static, comparative test would appear to further support the validity of the Thesis Proposition and both the findings of the test of the sample of N properties and of the Thesis Hypothesis.

5.4.2.2 Comparison To Practitioner Survey

To provide contextual relativity for the apparent difference in value of 9.53% between the econometric model and the independent valuer, it is contended to be relevant to compare each to those capitalisation rates provided by the respondents to the Practitioner Survey. As stated in Appendices 4.1 and 4.6, the Practitioner Survey attributed the following to Property x:

CAM:	7.50%
Modal Capitalisation Rate:	7.75%
Average Capitalisation Rate:	7.88%

Range:	6.75% - 9.50%			
Frequency:	6.75%	1	8.25%	3
	7.00%	1	8.50%	2
	7.25%	3	8.75%	0
	7.50%	5	9.00%	2
	7.75%	5	9.25%	0
	8.00%	3	9.50%	1

Accordingly, the modal and adjusted modal (CAM) capitalisation rates are each of an equal number of observations, but in total are exceeded by the number of other observations. Interestingly, neither the CAM, average nor modal capitalisation rates from the Practitioner Survey are within 0.25% of that capitalisation rate produced by the econometric model (7.16%) but that rate adopted by the independent valuer (7.91%) sits marginally above the average capitalisation rate on the upper side of the middle of the frequency range.

However, only 30% of respondents to the Practitioner Survey attributed a capitalisation rate of 7.75% or 8.00% to Property x such that, although the independent valuer has some support from the respondent sample, the majority of the respondent sample arrived at a different conclusion.

Thus, whilst the independent valuer would appear, *prima facie*, to have understated the value of the property and so supported the validity of the Thesis Proposition, it is notable that the capitalisation rate derived from the application of the model appears to potentially overstate the value of the property when compared to the frequency of capitalisation rates produced by the Practitioner Survey. Such an alternative view should, however, be considered in the context of the very wide range of capitalisation rates attributed by respondents to Property x in the Practitioner Survey.

5.4.2.3 Property x - Issues Arising

Though, *prima facie*, the Thesis Proposition appears to be supported, the very wide range of capitalisation rates attributed by the respondent sample to the property and the greater apparent consistency between the independent valuer and the respondent sample than between the econometric model and the independent valuer warrant further attention, in an endeavour to identify the possible contributing influences to such differences.

For simplicity, it is initially proposed to consider the capitalisation rate produced by the econometric model through a review of the independent variables:

Covenant/Occupancy Score

As the property is entirely leased to a major world bank, there is little likelihood of ambiguity concerning the quality of the tenant covenant or the level of occupancy. Accordingly, it is unlikely that this variable could be sub-optimally specified in the model;

Building Score

The property was attributed with a score of 74. Having been built in 1984, the property was given a low score for the three influences measured on the basis of age and which comprise 32% of the Building Score. A difference may, potentially, arise between the respondents perception of the quality of the building and the Building Score. If the respondents are perceiving the property to be a good quality building, they would be effectively attributing it with a Building Score which assumes that it is either under five years old or approximately five years old. However, such attribution would result in the model producing a capitalisation rate of 6.74% - 6.94% which is a movement in the contrary direction;

Location Score

The property was attributed with a Location Score of 300 as, on a flat, one dimensional map, it appears to be relatively close to the specified prime location within the Sydney CBD. However, topographically, the western corridor is separated from the core by a slight incline which potentially creates a significant difference in the respondents perception of the quality of the property's location. If the capitalisation rate generated by the model is made to equal that adopted by the independent valuer (7.91%) through an adjustment to the Location Score, a Location Score of 1,125m results.

Given the contrary direction of the Building Score, it would appear that the respondents are considering the quality of the location of the property to be significantly inferior to that attributed by the current basis of quantifying the Location Score.

Accordingly, within the construction of the econometric model variables, there are several potential contributors to the differences between the capitalisation rate produced by the model, that adopted by the independent valuer and those provided by the respondents in the Practitioner Survey.

The basis upon which the independent variables within the econometric model are quantified may be sub-optimal as, though consistent and rigorous, it may not adequately reflect all of the perceptual nuances considered by the respondent practitioners for each variable and manifest in their determination of the capitalisation rate.

The result of the econometric model may also be influenced by the slight difference in the timing of the independent valuation and the Practitioner Survey. Whilst the independent valuer does not state the date of inspection, the date of instruction is given as 13th September, 1994 and the date of valuation as 30th September, 1994. Accordingly, it is reasonable to assume that the valuer determined the capitalisation rate in mid to late September, 1994 compared to the Practitioner Survey respondents and model which determined the capitalisation rate on 24th October, 1994.

Alternatively, there may be significant differences in perception between the respective practitioners. Given the very wide range of capitalisation rates attributed by the respondents to the property in the Practitioner Survey, there are clearly considerable differences of opinion amongst practitioners. It may be that the independent valuer was merely also adding a further expression of opinion that was of comparable validity to those of the respondents.

As a further alternative, the capitalisation rate determined by the independent valuer may also be invalid. Given that 19% of the capital value determined by the independent valuer is attributable to the over-renting of the property, the validity of the resulting equivalent yield is placed under considerable pressure. Whether the independent valuer had too little, too much or the correct regard to the over-renting aspect in the determination of the equivalent yield adopted is highly debatable. Whilst, theoretically, the adoption of an equivalent yield should allow comparability with that rate determined by the respondent sample, this may not, potentially, have transpired as unequivocally in practice as it should have. Though the respondent sample provided greater support to the independent valuers opinion than to the result of the model, the range of respondents views effectively precludes an assessment of whether the valuers or the model are more valid.

It is contended to be significant that so many respondents can attribute such a wide range of capitalisation rates to a property based on identical information. Further, that an independent valuer with full information on the property can attribute a capitalisation rate that broadly accords with the statistical average of the respondent sample but differs from both the modal and adjusted modal capitalisation rates of the respondent sample and from that rate determined by 69% of the respondents, after allowing for rounding to the nearest 0.25% either way, is also contended to be of considerable concern.

Such a divergence of opinions is contended to be a manifestation of the Thesis Problem identified for attention. The subjectively based, inconsistent, informal and heuristic approach adopted by valuers to

the determination of the capitalisation rate may simply be resulting in the wide range of capitalisation rates found in the Practitioner Survey. It may be that each of the respondents and the independent valuer has a slightly different view on the quality of the location, tenant and building and that these are manifest in the range of capitalisation rates attributed by each. Such differences would, given the approach adopted to the development of the econometric model, result in a potentially sub-optimal specification of the model.

Accordingly, the differences in the capitalisation rates calculated by the econometric model, adopted by the independent valuer and provided by the respondents in the Practitioner Survey may be attributable to one or more of a range of possible issues including timing, sub-optimal quantification of variables in the model, inconsistent information processing by the respondents and/or the independent valuer and the subjectively based, inconsistent, informal and heuristic approaches to capitalisation rate determination adopted by valuers. Further research to identify the significance of each contributing element is, however, beyond the scope of this Thesis.

5.4.2.4 Summary - Property x

The static comparison of the capitalisation rate produced by the econometric model to that adopted by an independent valuer in a fee based valuation of a property was undertaken to further investigate the validity of the Thesis Proposition.

Given the independence of the valuer from the respondent sample and of the subject property from the data set from which the econometric model was derived, it was contended that the test was rigorous. Prima facie, as the capitalisation rate determined by the independent valuer differed from that determined by the econometric model, the test supported the validity of the Thesis Proposition.

Conversely, however, the range of capitalisation rates determined by the respondent sample apparently provided greater support to that rate determined by the independent valuer than the rate derived from the application of the econometric model. Which of the capitalisation rates determined by the model, the independent valuer and the respondent sample was of greater validity was not, however, capable of assessment here.

Whilst potential contributory influences to such differences between the three sources were considered, it is not possible to definitively determine here which, if any, are of greater significance than the remainder. The difference is, however, worthy of note as it not only indicates the scope and potential effects of the Thesis Problem but also raises a series of highly relevant issues concerning the determination of the capitalisation rate for further research beyond the scope of this Thesis.

5.4.3 Summary - Investigation Of Thesis Proposition

Whilst the test of the Thesis Hypothesis undertaken in Section 5.3, above, provided one approach to establishing the validity of the Thesis Proposition, two further complementary tests were undertaken to investigate and determine the validity of the Thesis Proposition.

Both the rigorous test involving Property x and the less rigorous test using the sample of N properties provided, *prima facie*, support for the validity of the Thesis Proposition and complimented the findings of the test of the Thesis Hypothesis.

Accordingly, with the Thesis Hypothesis having been proved and two further tests also supporting the result, it is contended that the Thesis Proposition is valid.

Furthermore, such investigation into the validity of the Thesis Proposition not only focussed attention upon and further substantiated the nature of the Thesis Problem, but also suggested a range of areas for further research beyond the scope of this Thesis.

Having tested the Thesis Hypothesis and investigated and established the validity of the Thesis Proposition, the following Section will summarise the results and conclusions of this Chapter concerning the development and testing of the econometric model and identify areas for further research arising therefrom.

5.5 SUMMARY, AREAS FOR FURTHER RESEARCH AND CONCLUSIONS

The previous Chapter comprised the analysis of data collected in Chapter 3 and validated each of the assumed theoretical principles underlying the equation, confirmed current practise in the capitalisation rate selection and adjustment process, confirmed the sample to be statistically valid and supported the findings of the pilot studies. Further, Chapter 4 provided a range of alternative, quantified expressions for each component of the single, potentially explanatory equation and an optimised data set for use in this Chapter so forming the second part of the modelling process.

The third and final part of the modelling process was then undertaken in this Chapter and comprised the development of an econometric model for the determination of the capitalisation rate, between properties at a point in time.

5.5.1 Summary

The tripartite modelling process comprised the second step in the proposed sequential approach to addressing the Thesis Problem, which may be restated as follows:

that the current method of capitalisation rate determination is subjectively based, informal, heuristic and lacks a framework which accords with property, finance, commerce and economic theory, so contributing to an unacceptably high level of variability in capitalisation rate adjustment between properties at a point in time.

Having contended that the solution to the Thesis Problem was to investigate and identify an approach to capitalisation rate determination which reduces the variability in adjustment between two properties at a point in time, it was proposed that the use of an econometric model would achieve this and ensure objectivity, consistency and formality in such determination, if it accorded with property, finance, commerce and economic theory.

Based on the single, potentially explanatory equation for the determination of the capitalisation rate and the alternative expressions for each determinant specified in Chapter 4, the following econometric model was developed through cross sectional multiple regression analysis:

$$\begin{aligned} \text{CAM} - \text{RFR} = & -0.938 - 0.0160 \text{ Building Score} + 0.000918 \text{ Location} \\ & \text{Score} - 0.0183 \text{ Covenant-Occupancy Score} \end{aligned} \quad \text{Equation 5.1}$$

which was both statistically significant and robust.

As the single, potentially explanatory equation was based on property, finance, commerce and economic theory, it was contended to be validly specified and the econometric model to accord with theory, so being theoretically defensible and confirming that the CAM less the risk free rate is substantially explained by the determinants of building, location and tenant.

Furthermore, the coefficient signs resulting from the development process were found to be as expected and the anticipated problems attributable to the data set being limited in size and suffering those problems inherent in the analysis of property data did not appear to significantly affect the resulting relationships identified.

The econometric model substantially attained the Thesis Principle of maintaining a practical application and industry relevance for the study's findings through the development of a model which is capable of use by and is user friendly for practitioners, being simply constructed and using easily assessable input variables.

Furthermore, the composition of the econometric model partially achieved the proposal of developing an objective and measured approach by minimising the role of practitioner opinion, intuition and experience.

Having developed a theoretically defensible econometric model for the determination of the capitalisation rate, it was applied to the sub-sample of n properties to test the Thesis Hypothesis:

that the standard deviation of a sample of capitalisation rates calculated by an econometric model will be below that of a sample selected by property valuers using the current method of capitalisation rate determination

which was found to be proven.

Given that the data for the sub-sample of n properties was not included within that data used for the development of the econometric model, the test was contended to be wholly independent of the model development process and so to be rigorous. Further, those properties within the sub-sample of n properties were spread across all CBD sectors and bias accordingly avoided.

By proving the Thesis Hypothesis, it was contended that the Thesis Proposition:

that the use of an econometric model will reduce the variability in capitalisation rate adjustment

was valid and this was confirmed by two further, complementary tests involving the sample of N properties and Property x .

Furthermore, the results suggest that the adoption by the valuer of a deterministic approach, based on rational and logical criteria, may contribute towards a closer simulation of that approach adopted by the

investor to an appraisal of worth and towards a reduction in the reliance on the interpretation of comparables.

Whilst it was acknowledged that the commonality of the base data set to both the econometric model and the sample of N properties reduced the rigour of the test, it was contended that Property x was both external to the base data set and independently valued by a valuer not amongst the respondent sample and was, therefore, a rigorous test which, *prima facie*, validated the Thesis Proposition.

Significant differences were, however, found between the capitalisation rate for Property x determined by the model, that selected by the independent valuer and the wide range attributed by the respondents in the Practitioner Survey. Having briefly considered some of the potential contributing influences to such differences, it was contended that an assessment of the significance of each was beyond the scope of this Thesis. Such differences would, however, appear to be a further manifestation of the Thesis Problem, as identified in Chapter 1.

Significantly, each of the tests contributed a range of issues worthy of further research but which are beyond the scope of this Thesis.

5.5.2 Areas For Further Research

A range of areas for further research, beyond the scope of this Thesis, arise from the development of the econometric model and its subsequent testing.

The refinement of the variables comprising the model to increase the role of factual or absolute data would be worthwhile to contribute to a further reduction in the role of practitioner opinion, intuition and experience so making the model more objective and measured and further increasing its simplicity and user friendliness.

The use of the econometric model in testing suggested that the composite variables may be sub-optimally specified. Accordingly, further research into the incorporation of all relevant perceptual nuances within the variables may improve the quality of the econometric model.

Furthermore, a range of issues concerning the related topics of information processing, the impounding of information into price and market efficiency in a property context are contended to be worthy of considerable further research. The wide range of capitalisation rates attributed by the respondents illustrates the extent to which differing conclusions can be drawn by valuers from the same basic information. Research into how such a range might be narrowed through greater consistency in

information processing may significantly enhance the validity of the resulting capitalisation rate determination.

Such research would also contribute to establishing the value of property in an economic sense such that mis-pricings could be identified to facilitate the consistent achievement of abnormal returns. Similarly, further investigation into the extent and implications of the apparent and potentially widespread mis-pricing of prime, CBD office investment property by valuers could be very worthwhile. Coupled with research into issues concerning information processing, this could have implications for a wide range of diverse issues such as the pricing of property relative to other asset classes, the validity of the adoption of the 0.25% increment, the professional indemnity of valuers and the smooth operation of the property market.

The investigation of the Thesis Proposition through the test involving Property x provided a fascinating microcosm of the Thesis Problem and an interesting sample of the potentially wide, varied, complex and inter-relating nature of the many areas that are worthy of further research but beyond the scope of this Thesis.

5.5.3 Conclusions

The development of the econometric model established that the determinants of the capitalisation rate could not only be effectively quantified but were also capable of being modelled. Through rigorous testing it was established that the use of an econometric model which is based on and so accords with property, finance, commerce and economic theory contributes to a reduction in the variability in capitalisation rate adjustment.

Further the standard deviation of a sample of capitalisation rates calculated by an econometric model was found to be below that of a sample selected by property valuers using current methods of capitalisation rate determination.

Those factors identified as relevant to the determination of the capitalisation rate in theory were also found to be clearly relevant in practice. The econometric model, as developed, therefore exhibits both theoretical and practical validity.

Accordingly, it may be concluded that the Thesis Hypothesis is found to be proven, the Thesis Proposition to be valid and the Thesis Problem to be solved.

It may also be concluded from the wide range of capitalisation rates attributed to each property in the sub-sample of n properties, despite the commonality of information available to respondents in the Practitioner Survey and their profile and experience, that the Thesis Problem is clearly substantiated and found to be of significance.

The results of the test of the Thesis Hypothesis and the investigation of the Thesis Proposition through the analysis of Property x also confirm that considerable scope exists for the potential mis-pricing of prime, CBD office investment property by valuers through the adoption of the current method of capitalisation rate determination.

Having now completed the tripartite modelling process which comprised the second step in the proposed sequential approach to address the Thesis Problem, the third and final step, comprising a summary of the approach adopted in, the identification of areas for further research beyond the scope of, the conclusions that may be drawn from and the policy recommendations arising out of this Thesis, will be undertaken below.

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