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What is the real premium in residential beachside suburbs?

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Abstract: In recent years there has been an impression in Australia that beachside suburbs have outperformed other suburbs in terms of capital returns. On other occasions there are pronouncements that inner city properties or rural living units have outperformed the aggregate market.

This paper reports some preliminary results of a research project that aims to develop simple regularly produced regression models in order to answer such questions about the residential property market in Adelaide, South Australia. The project aims to use aggregate data rather than individual transactions because of the difficulty of recording a wide range of attributes about each transaction. The available data has a small set of individual characteristics about the properties but lacks good location data. While this could be gathered via GIS, the data matching is time consuming and requires a continuously updated data set. It is thought that a generalized model using aggregate data may provide useful information while keeping the production time to a minimum.

The report shows the results of various models developed over a time period using data at suburb level. The method of restricted least squares is used to test if the models are significantly different over time. The models show some changes in the pricing structure over time and the various premiums paid for beachside suburbs.

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Introduction

Residential property prices in Australia have been on the march over the last few years. As prices have continued to rise, prices in some locations are believed to be outstripping even the huge growth experienced across all capital cities. One issue that is frequently reported in the popular media is that values in beachside suburbs seem to be growing above the metropolitan average. This suggests that the premium paid for beachside suburbs has been increasing over time. This study seeks to establish if this premium has changed over the last ten years in the beachside suburbs of Adelaide in South Australia as well as experimenting with aggregate models that will enable frequent monitoring of such changes.

Adelaide has a population of around one million, is the state capital of South Australia and lies in a coastal plain between the Adelaide Hills to the east and Gulf St. Vincent to the west. The city centre is located some nine kilometres from the coast, approximately mid-way between the coast and the hills. The City stretches north and south within the confines of the coast and hills. These features are shown on the map in Appendix C. Like most Australian's, people in Adelaide have always been drawn to the beach (this is shown in preferences studies by Stevens et al, 1992 and Rossini 1998a) and as a result property prices have tended to be higher in locations adjacent to the beach. Typically real estate in beachside areas are analysed separately from other locations in order to reduce the variations price and find more "comparable" data. However such studies that use transactions over small areas and at a fixed period of time cannot quantify the premium (since it is embedded in all sales) nor consider if it has changed over time. The purpose of this paper is to quantify this premium in percentage terms and to establish if this premium has been increasing over time. As well as considering this particular issue, the research aims to test the use of aggregate price models to determine these premiums. Aggregate models are quick and easy to produce and if suitable will be a cost effective way to continually monitor this and other real estate market premiums.

Methodology

This research is based on regression analysis using data from property transactions. The use of regression to estimate implicit prices follows the early work by Rosen (1974) and has been used in countless published and unpublished studies and includes studies using the same data set used for this research. Examples of such studies are Bjornlund et al (1998), Rossini (1998b), Rossini et al (2002) and Marano (2000). These studies use a predominantly linear or log form to estimate dollar values (as in Bond & Hopkins (2000) and Colwell (1990) in terms of transmission lines) however the exponential form is commonly used to test for percentage premiums in the other real estate markets. Examples are Rodriquez et al, (1994) for views and Burns et al (1989) and Levesque (1994) for aircraft noise. In this study, models are produced at three different time periods and the percentage premiums are calculated. This is similar to the method used by Radcliffe (1985) to examine models over three time periods. To test to see if these premiums vary between each period, an F test based on both a restricted and unrestricted model is used. Radcliffe (1985) uses a similar test to examine the stability of the hedonic price function over three periods. He creates three separate models (one for each time period) and then a fourth pooled model that includes dummy variables for two of the time periods. The F statistic is then used to test for a general difference between the restricted and unrestricted models. This is testing for a total change in the models (stability of the coefficients). However we are concerned here with a change to a single variable, the beachside premium. The fact that other premiums may change is unimportant; we are concerned with the statistical relevance of a change in the beachside premium. In order to test for the change in premium the model is restricted by requiring the premium in following years to be the same as in the previous period.

Data

Data for the study was extracted from the UPmarket sales database that contains data of registered transactions of property in South Australia. This data combines property sales data with legal and physical data about the property. In a previous study (Rossini, 1998b) it was established that while this data may be good for modelling property within small local areas, additional neighbourhood and locational data was needed to use the data over a wider space. A GIS system was used to add this type of information to the database in a study on aircraft noise in Adelaide (Burns et al, 2001) and subsequent regression modelling proved to be highly successful in establishing the discounts (negative premiums) associated with high aircraft noise. The problem with this type of study is the high cost of running and updating a GIS system and of associating this with individual property transactions. In a previous study of aircraft noise, Burns (1989) had used data at a suburban aggregate level and discovered similar results to those in the study that used individual transactions. While models based on individual transactions are preferable, aggregate models may produce consistent results at a lower cost. This study seeks to determine if such aggregate models would be useful for ongoing market research of locational premiums.

For this paper, data was collected for the calendar years 1993 and 1995 and for the first 9 months of 2003 and aggregated at suburban level. Only sales of detached residential properties were used. Sales of vacant land would have enable more straight forward modelling by reducing the variation (i.e. no improvement variables), however there are insufficient sales over most of the metropolitan area. Sales where heavily screened to remove potentially non-market transactions including probable redevelopment sites and then averages calculated for continuous variables including the price, land and building areas. Proportions of properties sold with different building styles and wall construction were calculated. These variables characterise the physical nature of the sale properties in each suburb. These characteristics of the actual sales were then combined with other data that described the suburb in terms of neighbourhood and location. These included the proportion of all properties that were commercial and industrial, the distance to the centre of the main city area (CBD) in kilometres and a series of dummy variables indicating locational traits. These included whether the suburb was adjacent to a beach, within 2 to 2.9, 3 to 3.9 or 4 to 4.9 kilometres of the beach or in the foothills or hills areas. Finally the data set was trimmed to exclude suburbs with very small volumes of sales.

Model Specification

In order to establish percentage premiums, models for each time period were specified as

$$P = \beta_0 \beta_1{}^{A} \beta_2{}^{B} \beta_3{}^{D} \beta_4{}^{C} \beta_5{}^{I} \beta_6{}^{X_1} \ldots\ldots \beta_n{}^{X_n} \theta_1{}^{L_1} \ldots\ldots \theta_n{}^{L_n} \varepsilon$$

Where

P	=	average of observed transaction prices within the suburb
β_0	=	a constant
$\beta_{1\ldots}\beta_n$	=	market determined parameters
ε	=	stochastic errors
A	=	a vector of average land areas of all observed transactions within each suburb
B	=	a vector of average building areas of all observed transaction within each suburb
D	=	a vector of distances from the suburb centroid to the CBD (in kilometers)
C	=	a vector of proportions of commercial land uses in each suburb
I	=	a vector of proportions of industrial land uses in each suburb
$X_{1\ldots}X_n$	=	vectors of proportions of all observed transactions within each suburb with specific building styles and wall cladding
$L_{1\ldots}L_n$	=	vectors of dummy variables recording if suburbs are in specific locations
$\theta_{1\ldots}\theta_n$	=	market determined estimates of 1 plus the premium for location Ln

This model is estimated by taking the natural log of the dependent variable (average price) and using ordinary least squares. This gives the following functional form

$$\hat{P} = e^{b_0 + b_1 A + b_2 B + b_3 D + b_4 C + b_5 I + b_6 X_1 \ldots. b_n X_n + \phi_1 L_1 \ \ldots. \phi_n L_n} \varepsilon$$

Location premiums θ_n are estimated by $1 - e^{\phi_n}$ and expressed in percentage terms.

Hypothesis testing

If a locational premium has remained unchanged from 1993 to 1998 and from 1998 to 2003

Then we can express the hypotheses as

$$H_0 : e^{\phi_{n,1993}} = e^{\phi_{n,1998}} \quad H_1 : e^{\phi_{n,1993}} \neq e^{\phi_{n,1998}}$$

and

$$H_0 : e^{\phi_{n,1998}} = e^{\phi_{n,2003}} \quad H_1 : e^{\phi_{n,1998}} \neq e^{\phi_{n,2003}}$$

respectively.

These hypotheses can be tested using analysis of variance (ANOVA) and the following F test. (as shown in Hill et al, 1997, p158 and used in Mendenhall et al, 1996, p737)

$$F = \frac{(SSE_R - SSE_U)/J}{SSE_U / [n-(K+1)]}$$

where

F	=	Calculated F value at j and n-k-1 degrees of freedom
SSE_R	=	error sum of squares from the restricted model
SSE_U	=	error sum of squares from the unrestricted model
n	=	number of observations
K	=	number of independent variables

This requires the 1998 and 2003 models to be estimated in a restricted and unrestricted form, the 1998 model re-estimated by restricting the premium of location Ln to that from the 1993 model and for the 2003 model by restricting the premium for location Ln to the 1998 premium. In each case the model is estimated with a single (1) restriction.

There is likely to be a problem of spatial autocorrelation in these models. The residuals (errors) from the original models are regressed against polynomial expansions of simple coordinate values as a spatial indicator. This follows the approach taken by geographers (a good early example is in Smith, 1977) and is a crude test off spatial autocorrelation. This is a problem suggested by Wiltshaw (1996), and has been the subject of a number of subsequent studies. Further work on this issue will be pursued in later research.

Results

The three regression models were estimated using ordinary least squares. The results for each of the three models are shown in Appendix A and summarised in Table 1. The resulting models are very similar for each time period. Key value determinants such as land and building area and distance to the city are very stable across all three models. The proportion variables change slightly over the time periods but given that these values are often close to 0 the values are remarkably stable. At face value the coefficients for the beachside location appear to have increased over the two time periods, with other locational variables remaining stable. Considering the model, for 2003 the premium for a beachside suburb location is approximately 35.5% (1-1.355) compared to other suburbs. Suburbs between 2 and 4 kilometres from the beach have lower premiums at around 10%. At greater than 4 kilometres from the beach there is no premium and the coefficients become insignificant even at a 90% level. The 1993 model suggest a premium of only 18.3% for beachside suburbs.

In each case the models have high R squared values and significant F tests. Coefficients for land area, building area and distance to the CBD are always significantly different from zero with other significance levels being somewhat variable. The variance inflation factors, VIF (these are shown on the models in Appendix A) suggest no real problems with multicollinearity. Analysis of residuals shows no significant problems with heteroscedasticty. Spatial autocorrelation is a minor problem in all models and suggests an omitted variable problem. The regression estimates for residuals from the 2003 model are shown in Appendix B. The regression model is weak with the R squared being around .1 however the ANOVA does show that there is a statistically significant relationship. The isoline plot of the trend from this model shows a trend towards positive residuals in the northern areas of Adelaide and negative residuals tot he south. This suggests a need to re-specify the model in subsequent research with either a non-linear expression of the distance to the CBD or the inclusion of locational coordinate variables.

Table 1 Regression Model Comparative Results

	1993	1998	2003
R Square	0.9330	0.9160	0.9270
Std. Error of the Estimate	0.1026	0.1332	0.1159
F (Ho: $b_1=b_2=b_n=0$)	222.834	177.546	199.477
Number of Observations	325	330	316

	1993		1998		2003	
Coefficients	EXP (b)	Sig	EXP (b)	Sig	EXP (b)	Sig
			48146.3		97929.2	
(Constant)	46304.76	**	2	**	0	**
Average Land Area	1.0001	**	1.0000	**	1.0001	**
Average Building Area	1.0082	**	1.0085	**	1.0072	**
Distance to the City (CBD)	0.9836	**	0.9826	**	0.9800	**
Proportion Commercial Land Use	1.2763	*	0.9052		1.0748	
Proportion Industrial Land Use	0.2856	**	0.3461	*	0.2299	*
Proportion Timber Frame Walls	0.8616	**	0.9221		0.9894	
Proportion Stone Walls	1.2956	**	1.5450	**	1.4993	**
Proportion Architectural Style	1.1422		2.2034	**	1.9232	**
Proportion Austerity Style	0.8386	**	0.7993	**	0.8261	**
Proportion Bungalow Style	1.0793	*	1.1252	**	1.1677	**
Proportion Contemporary Style	0.7132	**	0.7906	**	0.6590	**
Proportion SAHT Style	0.8411	**	0.7550	**	0.7993	**
Proportion Tudor Style	1.3785	*	1.2190		1.5129	*
Location Hills	0.9499		1.0265		0.9896	
Location Foothills	1.0052		0.9797		0.9555	**
Location Beachside	**1.1829**	******	**1.2105**	******	**1.3553**	******
Beach 2-2.9 Kms	1.0495	**	1.0141		1.1052	**
Beach 3-3.9 Kms	1.0851	**	1.0644		1.1074	**
Beach 4-4.9 Kms	0.9895		0.9971		1.0143	

Significant at 95% **
Significant at 90% *

The intertemporal changes to the prices for detached dwellings in Adelaide are indicated by the change in the constant terms. These are expressed in dollar terms and show a very small movement from 1993 to 1998 during a period that is generally consider showing little or no price movement. The change from 1998 to 2003 indicates the dramatic change to residential property market values over that period.

The 1998 and 2003 models are then restricted to test for the change in the beachside suburb premium. The coefficient for beachside location in the 1998 model is restricted to equal the 1993 value (1.1829) with the resulting ANOVA.

Restricted Least Squares ANOVA (1998 restricted to 1993 premium)

	Sum of Squares	df	Mean Square	F	Sig.
SSRu	59.8300	19			
SSEr	5.5278	1	0.0119	0.6720	0.4130
SSEu	5.5159	311	0.0177		
SST	65.3460	330			

The null hypothesis is accepted at a 60% level of confidence suggesting that the beachside premium remains unchanged over the period 1993 to 1998.

The coefficient for beachside location in the 2003 model is restricted to equal the 1998 value (1.21) with the resulting ANOVA

Restricted Least Squares ANOVA (2003 restricted to 1998 premium)

	Sum of Squares	df	Mean Square	F	Sig.
SSRu	50.9170	19			
SSEr	4.2615	1	0.2715	20.2101	0.0000
SSEu	3.9900	297	0.0134		
SST	54.9070	316			

In this case the null hypothesis is rejected at a 99% confidence level and provides clear evidence that the premium for beachside suburbs have increased over the five year period from 1998 to 2003.

Conclusions

This paper shows that it is possible to build a simple aggregate model to consider locational premiums. This simple model structure will enable a regular analysis of such premiums in a cost effective manner. There would appear to be some minor problems with the model specification and changes to these will be the focus of further research. In particular this will involve changes to the structural form especially for the distance variable. Further more a more sophisticated test suggested by Wiltshaw (1996) will be used to test for spatial autocorrelation.

The restricted least squares test appears to be a robust test for a premium change and shows that the price premium paid for beachside suburbs has increased over time. The results of the research show that this beachside premium has changed from about 20% in 1993 and 1998 to around 35% by 2003.

This type of aggregate model will be used on an ongoing basis to test for other locational premiums.

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Appendix A

Regression Estimates, unrestricted model using 1993 aggregate data

Model Summary **Using sales from 1993**

R	R Square	Ad R Square	Std. EE
0.966	0.933	0.928	0.102647

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	44.609	19	2.348	222.834	0
Residual	3.224	306	1.05E-02		
Total	47.834	325			

Coefficients

	B	Std. Error	Beta	t	Sig.	VIF	EXP(B)	Sig (B)
(Constant)	10.743	0.043		250.009	0.000		46304.76	**
LANDAREA	9.17E-05	0.000	0.095	4.783	0.000	1.791	1.00	**
BuildArea	8.12E-03	0.000	0.649	28.889	0.000	2.294	1.01	**
TFWALL	-1.49E-01	0.045	-0.056	-3.297	0.001	1.329	0.86	**
STWALL	2.59E-01	0.045	0.111	5.708	0.000	1.727	1.30	**
ARCHITECT	1.33E-01	0.220	0.01	0.605	0.545	1.28	1.14	
AUSTERITY	-0.176	0.068	-0.043	-2.6	0.010	1.271	0.84	**
BUNGALOW	7.63E-02	0.042	0.034	1.8	0.073	1.608	1.08	*
CONTEMPORARY	-3.38E-01	0.084	-0.07	-3.996	0.000	1.41	0.71	**
SAHT	-1.73E-01	0.033	-0.093	-5.288	0.000	1.392	0.84	**
TUDOR	0.321	0.174	0.032	1.845	0.066	1.327	1.38	*
DISCITY	-1.65E-02	0.001	-0.376	-18.841	0.000	1.807	0.98	**
LUC2	0.244	0.143	0.035	1.709	0.089	1.857	1.28	*
LUC3	-1.253	0.409	-0.059	-3.062	0.002	1.661	0.29	**
HILLS	-5.14E-02	0.043	-0.021	-1.185	0.237	1.394	0.95	
Foothills	5.20E-03	0.019	0.005	0.267	0.789	1.545	1.01	
Beachside	0.168	0.022	0.132	7.645	0.000	1.359	1.18	**
BEACH3	4.84E-02	0.024	0.032	2.007	0.046	1.13	1.05	**
BEACH4	8.16E-02	0.029	0.043	2.797	0.005	1.084	1.09	**
BEACH5	-1.06E-02	0.026	-0.006	-0.41	0.682	1.127	0.99	

Significant at 95% **
Significant at 90% *

Regression Estimates, unrestricted model using 1998 aggregate data

Model Summary **Using sales from 1998**

R	R Square	Ad R Square	Std. EE
0.957	0.916	0.91	0.133177

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	59.83	19	3.149	177.546	0
Residual	5.516	311	1.77E-02		
Total	65.346	330			

Coefficients

	B	Std. Error	Beta	t	Sig.	VIF	EXP(B)	Sig (B)
(Constant)	10.782	0.0530		204.6910	0.0000		48146.32	**
LANDAREA	1.72E-05	0.0000	0.0360	2.0960	0.0370	1.1110	1.00	**
BuildArea	8.42E-03	0.0000	0.6250	26.1890	0.0000	2.0970	1.01	**
TFWALL	-8.11E-02	0.0620	-0.0240	-1.3030	0.1930	1.2790	0.92	
STWALL	4.35E-01	0.0570	0.1690	7.5890	0.0000	1.8180	1.54	**
ARCHITECT	7.90E-01	0.3430	0.0440	2.3060	0.0220	1.3470	2.20	**
AUSTERITY	-0.224	0.1080	-0.0410	-2.0750	0.0390	1.4650	0.80	**
BUNGALOW	1.18E-01	0.0550	0.0440	2.1210	0.0350	1.5570	1.13	**
CONTEMPORARY	-2.35E-01	0.0950	-0.0470	-2.4610	0.0140	1.3450	0.79	**
SAHT	-2.81E-01	0.0430	-0.1260	-6.5590	0.0000	1.3690	0.76	**
TUDOR	0.198	0.2760	0.0140	0.7170	0.4740	1.4100	1.22	
DISCITY	-1.75E-02	0.0010	-0.3450	-15.9510	0.0000	1.7220	0.98	**
LUC2	-0.09965	0.1870	-0.0120	-0.5320	0.5950	1.9010	0.91	
LUC3	-1.061	0.5590	-0.0420	-1.8970	0.0590	1.8450	0.35	*
HILLS	2.62E-02	0.0450	0.0100	0.5850	0.5590	1.0940	1.03	
Foothills	-2.05E-02	0.0250	-0.0170	-0.8210	0.4120	1.5420	0.98	
Beachside	0.191	0.0280	0.1290	6.8090	0.0000	1.3180	1.21	**
BEACH3	1.40E-02	0.0310	0.0080	0.4500	0.6530	1.1120	1.01	
BEACH4	6.24E-02	0.0380	0.0280	1.6500	0.1000	1.0810	1.06	
BEACH5	-2.88E-03	0.0340	-0.0020	-0.0850	0.9320	1.1530	1.00	

Significant at 95% **
Significant at 90% *

Regression Estimates, unrestricted model using 2003 aggregate data

Model Summary **Using sales from 2003 (January to September)**

R	R Square	Ad R Square	Std. EE
0.963	0.927	0.923	0.115906

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	50.917	19	2.68	199.477	0
Residual	3.99	297	1.34E-02		
Total	54.907	316			

Coefficients

	B	Std. Error	Beta	t	Sig.	VIF	EXP(B)	Sig (B)
(Constant)	11.492	0.048		237.053	0.000		97929.20	**
LANDAREA	1.15E-04	0.000	0.096	4.730	0.000	1.687	1.00	**
BuildArea	7.17E-03	0.000	0.551	23.141	0.000	2.321	1.01	**
TFWALL	-1.06E-02	0.058	-0.003	-0.183	0.855	1.270	0.99	
STWALL	4.05E-01	0.054	0.165	7.517	0.000	1.957	1.50	**
ARCHITECT	6.54E-01	0.210	0.057	3.112	0.002	1.370	1.92	**
AUSTERITY	-0.191	0.082	-0.042	-2.333	0.020	1.306	0.83	**
BUNGALOW	1.55E-01	0.051	0.058	3.012	0.003	1.507	1.17	**
CONTEMPORARY	-4.17E-01	0.091	-0.081	-4.568	0.000	1.284	0.66	**
SAHT	-2.24E-01	0.040	-0.106	-5.654	0.000	1.429	0.80	**
TUDOR	0.414	0.234	0.030	1.769	0.078	1.205	1.51	*
DISCITY	-2.02E-02	0.001	-0.427	-20.517	0.000	1.769	0.98	**
LUC2	0.07214	0.194	0.008	0.372	0.710	2.045	1.07	
LUC3	-1.47	0.836	-0.037	-1.758	0.080	1.842	0.23	*
HILLS	-1.04E-02	0.050	-0.004	-0.208	0.835	1.284	0.99	
Foothills	-4.56E-02	0.022	-0.040	-2.081	0.038	1.479	0.96	**
Beachside	0.304	0.025	0.220	12.095	0.000	1.353	1.36	**
BEACH3	1.00E-01	0.028	0.061	3.650	0.000	1.153	1.11	**
BEACH4	1.02E-01	0.033	0.050	3.081	0.002	1.095	1.11	**
BEACH5	1.42E-02	0.029	0.008	0.491	0.624	1.121	1.01	

Significant at 95% **
Significant at 90% *

Appendix B

Spatial trend of errors from 2003 model using cubic polynomial expansion of X,Y coordinates

Plots shows the spatial area of metropolitan Adelaide with the CBD indicated near the centre

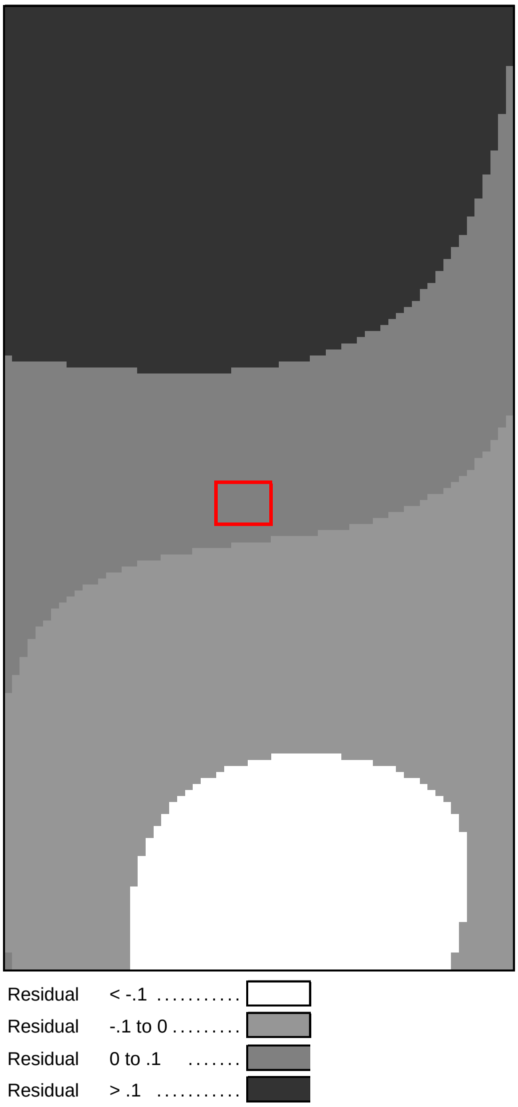
Regression Statistics	
R Square	0.130041
Adj R Square	0.104537
Std Error	0.106332
Observations	317

ANOVA

	df	*SS*	*MS*	*F*	*Conf*
Regression	9	0.51886	0.0577	5.0989	**
Residual	307	3.47111	0.0113		
Total	316	3.98997			

	Coefficients	*Std Error*	*t Stat*	*P-value*	*Conf*
Intercept	0.012362	0.04445	0.2781	0.7811	
XCoord	-0.00932	0.00618	-1.5084	0.1325	
YCoord	-0.00158	0.00216	-0.7313	0.4652	
XSqd	0.000165	0.00014	1.158	0.2478	
YSqd	3.71E-05	3.5E-05	1.0648	0.2878	
XY	9.48E-05	7.6E-05	1.255	0.2104	
Xcub	-6.4E-07	8.6E-07	-0.7464	0.456	
Ycub	-1.3E-07	1.9E-07	-0.6843	0.4943	
XsqdY	-1.2E-06	8.2E-07	-1.4036	0.1615	
YsqdX	-2.9E-07	5.1E-07	-0.5735	0.5667	

Significant at 95% **
Significant at 90% *



Appendix C – Adelaide Metropolitan Area