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MEASURING THE PREFERENCE FOR DWELLING CHARACTERISTICS OF MELBOURNE: RAILWAY STATIONS AND HOUSE PRICES

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ABSTRACT

The relationship between public transportation and home values has proven to be complex, with studies providing divergent findings. Using Victorian Valuer General Data for 2009, this paper applies a hedonic pricing approach to the Melbourne metropolitan housing market in order to estimate the impacts of proximity to a train station on residential property prices. The findings reveal that, proximity to train stations has an overall positive effect on property values. In general, all other things being equal, being located 1 km further out from a train station is associated with a 2% discount in sale price. The magnitude of this relationship is most clearly stable up to 5 kms from a train station. No dis-amenity effect on sale price for properties in close proximity to a train station was found.

Keywords: Hedonic, Sale Price, Railway Stations

INTRODUCTION

Over the last decade the Victorian Government (DPCD 2002) has emphasised the importance of creating vibrant communities centred around public transport. While train stations are a key piece of community infrastructure, increasing accessibility to the CBD, policy makers have acknowledged negative aspects of these facilities, including crime and congestion in surrounding areas. With guidance from economic theory, and an assumption that the dwelling market is efficient and fully capitalised, all other things being equal dwellings subject to dis-amenities in net terms should be priced lower than other dwellings.

There is a significant international literature demonstrating the usefulness of hedonic models in estimating the effect of property characteristics, neighbourhood characteristics and locational amenities on house prices. While regression-based measures of house prices (hedonic and repeat-sales measures) have been used recently in the Australian context to control for compositional and quality change in order to provide accurate estimates of pure house price changes (Hanson, 2009; Rambaldi and Rao, 2011), as well as the relationship between housing prices and the quality of public schools in the ACT (Davidoff and Leigh, 2008), the application of hedonic approaches to the Australian housing market has been limited.

Using Victorian Valuer General Data for 2009, this paper applies a hedonic pricing approach to the Melbourne metropolitan housing market in order to estimate the impacts of proximity to a train station on residential property prices. The results are likely to be generalizable to other metropolitan areas throughout Australia. Further, although our data is limited to dwellings sold, our findings still have relevance to households that are renters, as preferences for spatial and dwelling characteristics are likely to be similar for both cohorts.

BACKGROUND

Recognizing that housing is not a homogenous good, hedonic price models attempt to explain the value of a dwelling based on the value of its various characteristics. Housing is a heterogeneous durable product, and the choice of housing involves consideration of both structural (e.g., lot size and number of bedrooms) and spatial dimensions (accessibility to public transport, shopping centres). The magnitude of the prices of characteristics will be influenced by the presence or absence of other characteristics in the hedonic regression. Hill (2012) and Malpezzi (2008) suggest that the problem of omitted variables, in particular locational characteristics, in hedonic models of housing prices is quite common,

This paper focuses on the impact on price of one particular locational characteristic: proximity to railway station. The impact of this locational characteristic has been widely studied in the international context (Bartholomew and Ewing

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2011; Debrezion, Pels, and Rietveld 2007, Hess and Almeida, 2007; Debrezion and Pels, 2010) but not in the Australian context (one exception is Ge et al, 2012). The relationship between public transportation and home values has proven to be complex, with studies providing divergent findings. While proximity to a railway station may affect property values positively through increased accessibility to the CBD, it may be offset by negative effects such as noise, congestion and crime for those dwellings that are particularly close. Furthermore, the value of proximity to public transport may differ amongst households of different sizes (Duncan 2008) and different income levels (Bowes and Ihlandfeldt 2001, Immergluck 2009). While those in higher paid occupations concentrated in the CBD may find public transportation particularly valuable, it is also possible that public transportation may increase employment opportunities for those located in lower income suburbs.

METHOD

Following Rosen (1974), McLeod (1982) and Abelson (1997) this research will apply this hedonic pricing approach to the housing market, using standard multiple regression techniques. The model we fit has a general form of:

$$ln(p_h) = \alpha + \sum_{i=1}^{k} \beta_{h.i} X_{h,i} + \sum_{j=1}^{m} \delta_{h.i} Z_{h,j} + e_h, \quad e_h \sim N(0, \sigma^2),$$

where $\ln(p_h)$ denotes the natural logarithm of the dwelling purchase price and $X_{h,i}$ & $Z_{h,j}$ denote known dwelling and spatial characteristics respectively. The degree and direction of influence these attributes exert are determined by the data and are denoted as $\beta_{h.i}$ and $\delta_{h.i}$ for the dwelling characteristics and spatial attributes respectively. These coefficients represent marginal prices.

DATA

We utilise the Victorian Valuer-General dataset containing all sales of dwellings recorded in 2009. This data set is rich in property and spatial variables. Selected attributes of these dwellings, including number of bedrooms, floor area and land area, are provided. Spatial variables include distance from major activity centres and distance from railway stations.

An overview of the data used is presented in Appendix 1. In total we utilise over 45 thousand sales corresponding to the Metropolitan Melbourne market[2]. Unfortunately, sale data relating to the Local Government Areas of Darebin and Cardinia were excluded from the analysis due to large amounts of missing data.

Below we identify the dwelling information that is in the Valuer General database that we intend to incorporate into our model. In addition we also indicate the direction of the impact we expect these variables to portray (see Table 1).

The physical characteristics of a property are common attributes included in a hedonic price regression (Sirmans, Macpherson and Zeitz, 2005). Physical characteristics commonly included are floor area and land area, while structural characteristics such as number of bedrooms are often used as a (albeit imperfect, when floor area is controlled for) proxy for quality. The age of the dwelling is also a commonly used attribute in hedonic studies, with the coefficient on age in a semi-logarithmic function equalling the depreciation rate. There may be an offsetting vintage effect, however, which the positive hedonic effect of construction at a particular point in history. We also include distance from the CBD to capture the expected negative rent gradient reported in the literature (Boymal, de Silva & Pomeroy 2013).

[2] The top 5% of dwellings corresponding to price, land area and floor area variables were eliminated from the sample as these were judged a-typical thus leaving approximately 45 thousand observations.

Table 1: Explanatory Variables

Explanatory Variable	Direction
Floor Area (m^2)	Positive
Land Area (m^2)	Positive
Age	Unclear
Municipality (Local Government Area)	Mixed – depending on demography
Dwelling type – Units/Apartments[3]	Negative in relation to houses
Number of Bedrooms	Positive
Distance from Nearest Primary School (km)	Negative
Distance from Nearest Secondary School (km)	Negative
Distance from nearest train station (km)	Negative
Distance from Nearest Activity Centre (Major Shopping Centre) (km)	Negative
Distance from CBD (km)	Negative

Distance from nearest primary school, secondary school, activity centre and municipality are also included to control for neighbourhood traits to correct a potential omitted variable problem. In the absence of controls for such locational characteristics, the coefficients on characteristics such as distance from nearest train station are biased upwards to the extent that they are positively correlated with these characteristics, and vice versa.

MODEL

To measure the significance of the proximity to a train station we fit the following model:

$$ln(p_h) = \alpha + \sum_{i=1}^{38} \beta_{h.i} X_{h,i} + \sum_{j=1}^{5} (\delta_{h.i} Z_{h,j} + \gamma_{h.i} Z_{h,j}^2) + \sum_{m=1}^{13} \theta_{h.i} D_{h,m} + e_h, \quad e_h \sim N(0, \sigma^2),$$

where the variables denoted as *X* represent the age of the property sold as well as the natural logarithm of floor area and land area. In addition the *X* variables include the categorical variables of bedroom, municipality and whether the dwelling sold was a unit/apartment.

The distance variables are represented by the variable *Z*, we specify this variable as a polynomial of degree two as we believe the influence of proximity will be better summarised as being non-linear rather than strictly linear.

The final set of variables denoted as $D_{h,m}$ represent indicator variables relating to various distance ranges from the nearest railway station. The ranges we have included for our analysis are:

- $D_{1,m}$ =1 if dwelling is located within 125 metres of the train station
- $D_{2,m}$ =1 if dwelling is located between 125 and 250 metres of the train station
- $D_{3,m}$ =1 if dwelling is located between 250 and 500 metres of the train station
- $D_{4,m}$ =1 if dwelling is located between 500 metres and one kilometre of the train station
- $D_{5,m}$ =1 if dwelling is located between one and two kilometres of the train station
- $D_{6,m}$ =1 if dwelling is located between two and three kilometres of the train station
- ……
- $D_{13,m}$ =1 if dwelling is located between nine and ten kilometres of the train station

[3] Only two types of dwellings are identified “houses” and “units/apartments”

The reason for choosing narrower ranges for dwellings in closer proximity to railway stations is to measure if there is a dis-amenity effect, and at what point it might be occurring. That is, is there a preference to live close, but not too close to railway stations? For the purposes of this paper we decide that the upper limit is ten kilometres which corresponds to approximately 90% of the sample of sales for the 2009 period. We believe this to be a sensible distance to consider as a threshold as the buyers purchasing dwellings more the ten kilometres from a railway station are unlikely to be factoring distance from railway stations as an important determinant in their decision making process.

RESULTS

Our proposed model is very large specifying 61 explanatory variables. Importantly, the sample size is extremely large capturing over 45 thousand sale transactions in the calendar year of 2009. Therefore despite the large number of parameters required to be estimated we have a more than adequate number of degrees of freedom to estimate our specified model.

Table 2: Selected Regression Results

Variable	Coefficient	P-value
Age	0.00103	<0.001
Floor Area	0.50461	<0.001
Land Area	0.04834	<0.001
Unit	-0.18794	<0.001
Bedroom 1	0.00228	0.883
Bedroom 2	0.04586	<0.001
Bedroom 3	0.00010	0.986
Bedroom 4	-0.00061	0.919
Bedroom 5	-0.00734	0.562
Bedroom 6+	-0.02050	0.514
Distance (Train Station)	-0.02422	<0.001
Distance (Train Station)^2	0.00038	<0.001
Distance (Activity Centre)	-0.00312	<0.001
Distance (Activity Centre)^2	0.00016	<0.001
Distance (CBD)	-0.03248	<0.001
Distance (CBD)^2	0.00026	<0.001
Distance (PS)	0.04529	<0.001
Distance (PS)^2	-0.00380	<0.001
Distance (SS)	0.00409	<0.001
Distance (SS)^2	-0.00004	<0.001
d125m	-0.28887	<0.001

d250m	-0.29875	<0.001
d500m	-0.25368	<0.001
d1km	-0.25495	<0.001
d2km	-0.27101	<0.001
d3km	-0.24824	<0.001
d4km	-0.21930	<0.001
d5km	-0.20135	<0.001
d6km	-0.15994	<0.001
d7km	-0.12599	<0.001
d8km	-0.08053	<0.001
d9km	0.03411	0.343
d10km	-0.15663	<0.001

Source: Authors Calculations

A selection of the parameter results are presented in Table 2. Appendix 2 contains a full overview of parameters and model fit. Interestingly, with the exception of a few of the bedroom variables and one distance variable all the variables are significantly different from zero. The model fit is also good capturing just over 66% of the variation in sale price.

Before we consider the distance from railway stations we interpret the control variables included in the model. We note that *Age* has a positive effect indicating that the older the dwelling the higher the sale price. This may reflect a vintage effect, which is the positive hedonic effect of construction at a particular point in history

Consistent with the stated priors the size variables *land* and *floor area* both have a positive effects. That is the larger the dwelling/property the higher the price. Notably, the size of the actual dwelling (*floor area*) has a much larger effect on the final sale price.

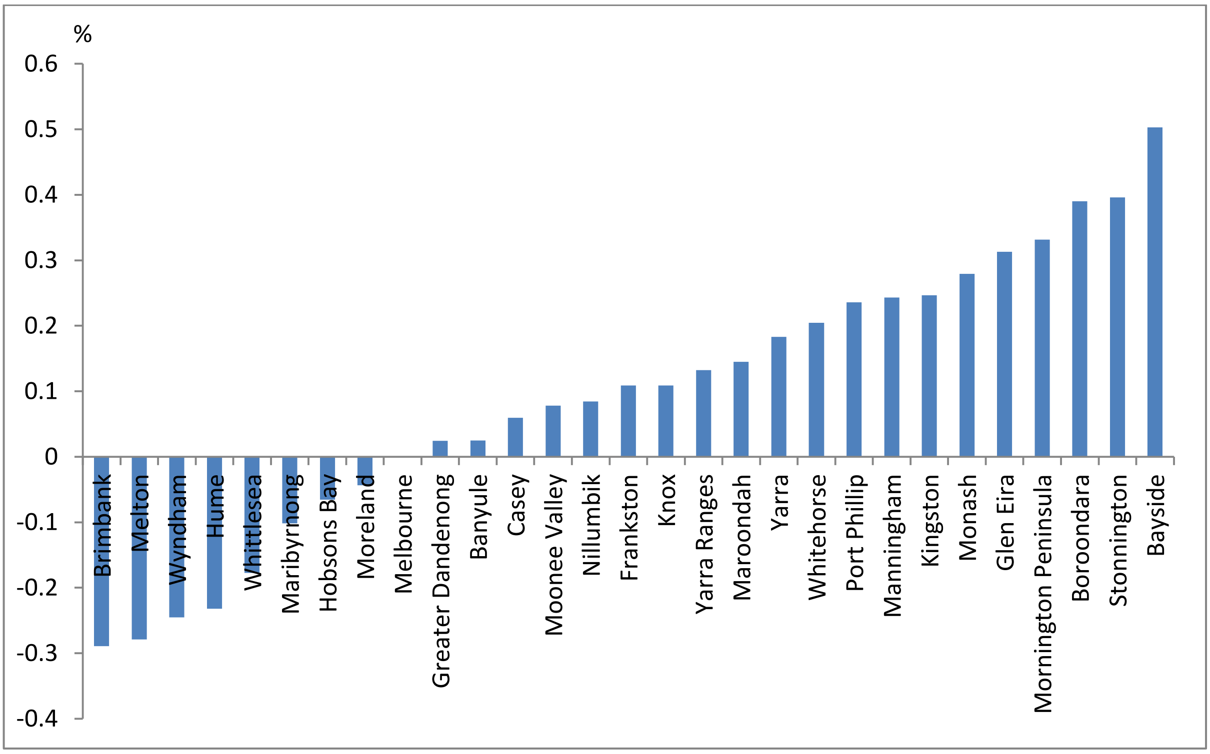
The next variables of interest are the indicator variables relating to whether the dwelling is a unit and the number of bedrooms. Before we interpret these variables we need to define the base or reference case. The reference case in our model is a house without any *recorded* bedrooms located in the local government area of Melbourne[4]. Therefore, the coefficient estimates of the categorical variables indicate the relative difference of each of these attributes holding everything else constant. Therefore, a unit relative to a house of the exact same features within the Melbourne Metropolitan area sold for approximately 19% less in 2009.

Interestingly, the movement from zero to one and two bedrooms seem to be positive and significant whereas the movement from zero to three or more bedrooms appear insignificant. We suspect that this may be attributable to the numerical size variable, floor area, capturing the size effect of three or more bedrooms. Interestingly, a significant percentage of studies that include the number of bedrooms as a hedonic characteristic report a negative coefficient (Sirmans, MacPherson and Zeitz, 2005) as, holding floor area constant, an increase in the number of bedrooms implies a reduction in the amount of space per room.

The final set of dwelling (categorical) control variables we considered are presented in the extended output in Appendix 2 and relate to local government areas (or municipalities). Figure 1 presents the approximate percentage difference, ceritus paribus, relating to the municipality, City of Melbourne.

[4] The reference LGA is Melbourne – refer to appendix 2 for further details.

Figure 1: Relative Municipality Premium



*Based on Melbourne Metropolitan Sale data for 2009. Sale data regarding Darebin and Cardinia was excluded from the analysis due to systemic data recording issues; City of Melbourne is reference case. Source: Authors Calculations

The second set of variables we consider is distance. We consider the five distance measures in three stages. The first is the effects of distance relative to Activity Centres, Primary Schools and Secondary Schools. Distance from the CBD and train stations will then be assessed separately.

Before we interpret the effects of distance from community spaces on dwelling price we draw attention to the range of typical distances from such spaces in Table 3. Figure 1 then presents the change in price for a three bedroom house of median characteristics given changes is the distance from a particular community space.

Table 3: Typical Distances from Community Spaces

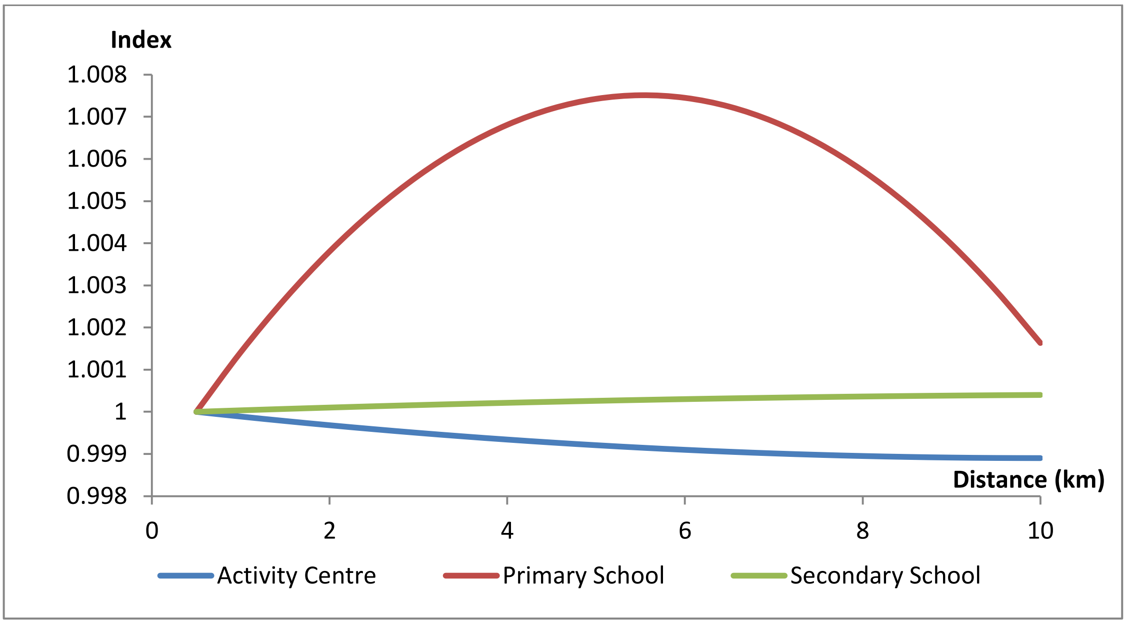
Percentile	Activity Centre (km)	Primary School (km)	Secondary School (km)
25	3.34	0.45	1.08
75	9.79	0.96	3.41
90	15.34	1.33	8.15

Source: Authors Calculations using Valuer General data

According to Table 4, 90% of properties sold in 2009 were located within 1.33 kilometres of a primary school. Therefore, the distance range considered in Figure 2 is very high. Importantly, the turning point at approximately the six kilometre mark is not relevant for the majority of properties sold in our sample.

Constraining our interpretation to the middle band (the range indicated by the 25th and 75th percentile) we note that the sale price increased as distance from secondary and primary school increased. This is different from the relationship depicted in relation to activity centre which indicates a negative, almost linear relationship, with sale price.

Figure 2: Sale Price by Activity Centre and School Distance



Source: Authors Calculations based on a three bedroom house with median characteristics

The Melbourne metropolitan area spans significant distances, with the 10% of dwellings sold in 2009 located greater than 43 kilometres from the CBD. Over this distance many local government areas will be crossed, and as such unique local government area effects will in part determine sale price, the distance from the CBD variable is therefore difficult to interpret meaningfully. Thus, we do not produce a graphic as we did for the first three distance variables considered. We note, however, that the relationship between sale price and location from CBD is negative, which is consistent with Boymal et al (2012).

The distance (train station) coefficient is negative and significant, suggesting that proximity to a railway station has an overall positive effect on property values. This is consistent with increased accessibility to the CBD in a monocentric city. Importantly, there appears to be no negative relationship between proximity to a train station and dwelling price for dwellings located in close proximity to train stations. This suggests either an absence of dis-amenity costs, or that those costs are not capitalised into the price of dwellings located in close proximity to a train station.

In general, all other things being equal, being located 1 km further out from a train station is associated with a 2% discount in sale price. The magnitude of this relationship is most clearly stable up to 5 kms from a train station.

CONCLUSION

This paper has focused on the impact on dwelling price of proximity to railway station in the Melbourne Metropolitan housing market. Interestingly, the proximity to a railway station does not seem to have an effect on property values. These results are likely to be broadly indicative of how households in other metropolitan areas throughout Australia price this attribute. Furthermore, although our data is limited to dwellings sold, our findings still have relevance to households that are renters, as preferences for spatial and dwelling characteristics are likely to be similar for both cohorts.

We acknowledge there are some limitations to our study. For example this study is based on 2009 data only, and therefore fails to account for changing consumer preferences over hedonic characteristics over time. It is unlikely, however, that consumer preferences have changed significantly over the last three years, and therefore the study provides a useful starting point for analysing the dis-amenity effect of proximity to a train station.

In addition, while we have considered location to a station, it would also be useful to determine the effects of living close to a train line. It is possible that there may be more significant dis-amenity effects associated with dwelling located in close proximity to train tracks as opposed to stations. Finally, many train stations throughout the metropolitan Melbourne are surrounded by community spaces, including retail areas and park land, and therefore the estimated effect of proximity to a train station may also be a partly influenced by these factors.

APPENDIX 1

Numerical Variables:

Variable	Mean	Std. Dev.	Min	Max
Price ($)	460757.9	198807.1	7000	1200000
land_area (m^2)	675.1126	332.4618	1	2969
floor_area (m^2)	140.1859	44.29355	16	277
Distance (Train Station) (km)	4.238277	7.187844	0.03	49.25
Distance (CBD) (km)	24.72444	14.27723	0.12	79.95
Distance (PS) (km)	0.793388	0.665281	0.002826	20.36
Distance (Activity Centre) (km)	8.050083	7.261072	0.03	57.41
Distance (SS)[2] (km)	7.202379	19.75187	0.01	122.03

Categorical Variables

Dwelling type:

	Freq.
House	40,729
Unit/Apartments	4,577

Bedrooms:

beds	Freq.
0	5,658
1	479
2	6,668
3	23,976
4	7,936
5	516
6	73

Municipality/Local Government Area:

	Frequency
Banyule	1,427
Bayside	740
Boroondara	1,067
Brimbank	2,116
Casey	3,819
Frankston	2,478
Glen Eira	1,365
Greater Dandenong	1,499
Hobsons Bay	1,312
Hume	2,436
Kingston	1,650
Knox	1,991
Manningham	891
Maribyrnong	1,147
Maroondah	1,563
Melbourne	310
Melton	1,179
Monash	1,945
Moonee Valley	1,030
Moreland	2,020
Mornington Peninsula	3,286
Nillumbik	509
Port Phillip	740
Stonnington	118
Whitehorse	2,100
Whittlesea	1,692
Wyndham	2,268
Yarra	659
Yarra Ranges	1,949

APPENDIX 2

Regression Output (Part 1 of 2)

Variable	Coef.	Std. Err.*	t	P>t
Age	0.00103	0.00008	13.55	<0.001
Floor Area	0.50461	0.00589	85.63	<0.001
Land Area	0.04834	0.00403	11.98	<0.001
Unit	-0.18794	0.00635	-29.62	<0.001
Bedroom 1	0.00228	0.01551	0.15	0.883
Bedroom 2	0.04586	0.00653	7.03	<0.001
Bedroom 3	0.0001	0.00541	0.02	0.986
Bedroom 4	-0.00061	0.00604	-0.1	0.919
Bedroom 5	-0.00734	0.01267	-0.58	0.562
Bedroom 6+	-0.0205	0.03144	-0.65	0.514
Dist(Train Station)	-0.02422	0.00349	-6.94	<0.001
Dist(Train Station)	0.00038	0.00008	4.76	<0.001
Distance (Activity Centre)	-0.00312	0.00088	-3.55	<0.001
Distance (Activity Centre 2	0.00016	0.00004	4.02	<0.001
Distance (CBD)	-0.03248	0.00101	-32.25	<0.001
Distance (CBD)	0.00026	0.00002	14.09	<0.001
Distance PS	0.04529	0.00287	15.78	<0.001
Distance (PS)	-0.0038	0.00036	-10.66	<0.001
Distance (SS)	0.00409	0.00045	9.16	<0.001
Distance (SS)	-0.00004	0	-10.58	<0.001
d125m	-0.28887	0.04272	-6.76	<0.001
d250m	-0.29875	0.03798	-7.87	<0.001
d500m	-0.25368	0.03588	-7.07	<0.001
d1km	-0.25495	0.0343	-7.43	<0.001
d2km	-0.27101	0.03191	-8.49	<0.001
d3km	-0.24824	0.02896	-8.57	<0.001
d4km	-0.2193	0.02621	-8.37	<0.001
d5km	-0.20135	0.02379	-8.46	<0.001

d6km	-0.15994	0.02195	-7.29	<0.001
d7km	-0.12599	0.01969	-6.4	<0.001
d8km	-0.08053	0.01919	-4.2	<0.001
d9km	0.03411	0.03595	0.95	0.343
d10km	-0.15663	0.02084	-7.52	<0.001
Constant	10.93481	0.0529	206.7	<0.001

Regression Output (Part 2 of 2)

Variable	Coef.	Std. Err.*	t	P>t
Banyule	0.02484	0.02018	1.23	0.218
Bayside	0.50272	0.0203	24.77	<0.001
Boroondara	0.38997	0.02013	19.37	<0.001
Brimbank	-0.2892	0.01945	-14.87	<0.001
Casey	0.05969	0.02248	2.66	0.008
Frankston	0.10875	0.02377	4.58	<0.001
Glen Eira	0.3132	0.0196	15.98	<0.001
Greater Dandenong	0.02441	0.02146	1.14	0.255
Hobsons Bay	-0.06549	0.01943	-3.37	0.001
Hume	-0.23206	0.02075	-11.18	<0.001
Kingston	0.24643	0.02103	11.72	<0.001
Knox	0.10908	0.02131	5.12	<0.001
Manningham	0.2429	0.02031	11.96	<0.001
Maribyrnong	-0.10149	0.01846	-5.5	<0.001
Maroondah	0.14512	0.02151	6.75	<0.001
Melton	-0.27899	0.02117	-13.18	<0.001
Monash	0.27916	0.01981	14.09	<0.001
Moonee	0.07799	0.01902	4.1	<0.001
Moreland	-0.04335	0.01814	-2.39	0.017
Mornington Peninsula	0.33138	0.02514	13.18	<0.001
Nillumbik	0.08444	0.02202	3.84	<0.001
Port Phillip	0.2359	0.02123	11.11	<0.001
Stonnington	0.39584	0.02417	16.38	<0.001
Whitehorse	0.20451	0.02082	9.82	<0.001
Whittlesea	-0.17753	0.01988	-8.93	<0.001
Wyndham	-0.24534	0.0209	-11.74	<0.001
Yarra	0.18326	0.01978	9.27	<0.001
Yarra Ranges	0.13242	0.02228	5.94	<0.001

*Standard tests suggested that the residuals were non-normal and heteroscedastic, hence the standard errors were calculated using a robust calculation method available in STATA. Notably, the residuals did indicate a few outliers - less than 0.1%. Importantly, we performed our own checks for robustness and found the results presented are robust (details available upon request). Further, we also suggest that the hypothesis test results are likely to be detecting trivial departures from normality and homoscedascity due to the extremely large sample size (for further discussions on this issue see http://magazine.amstat.org/blog/2010/09/01/statrevolution/).

Diagnostics:

Number of obs	=	45306
F(61, 45827)	=	1530.74
Prob > F	=	0
R-squared	=	0.6606
Root MSE	=	0.23765

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