Impact of Hauraki Gulf Amenity on the Land Price of Neighbourhood Properties

An Empirical Hedonic Pricing Method
Case Study North Shore, Auckland

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Impact of Hauraki Gulf Amenity on the Land Price of Neighbourhood Properties

An Empirical Hedonic Pricing Method
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Mehrnaz Rohani
Research, Investigations and Monitoring Unit
Social and Economic Research

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Abstract

The Hauraki Gulf is a coastal feature of the North Island of New Zealand. It has a total area of 4000 km^2 and lies between the Auckland region, the Hauraki Plains, the Coromandel Peninsula and Great Barrier Island.

This case study has evaluated the impacts of the Hauraki Gulf on property land values in the North Shore of Auckland. The study used Hedonic price modelling to quantify the effects of Gulf amenity.

Previous studies have focused on the impact of views on property values rather than the impact of beach amenity on property value. Consequently, this study considers both and provides an empirical analysis of the impact of access to the nearest designated beach as well as view amenity for more than 8500 properties, in 12 census area units on the North Shore.

Results show that views and amenity of the Hauraki Gulf has significant impact on land prices in the study area. On average, a wide water view could increase the mean land value by 50 percent while locations on the coastline could increase land value by 43 percent, if all the other factors are held constant. If the network distance of a property to access the beach doubled, the land price would decline by 17 percent.

This study is the first phase of the investigation into the impact of the Hauraki Gulf amenity on the land price within neighbourhood properties. It is proposed that two other submarkets be included in this study for comparative purposes.

Contents

1. Introduction

Environmental protection is one of the principal concerns in the 21st century. The environment is a public good, meaning it belongs to "everybody" while it belongs to "nobody" exclusively, (Gundimeda, 2006).

The costs of protecting the environment can be substantial and also measurable, but there is always a question, how to measure the benefits of protecting the environment.

If individuals want to buy a consumer good, for instance a property, the benefit derived from the property will be at least equal to what the individuals are willing to pay for that. So the market price can be used to calculate the individual's willingness to pay and is indicative of the economic value of the good to that individual.

In the case of environmental goods and services, there is no market value. To measure the environmental value some market or nonmarket valuation techniques are required, which can be based on the same principle of an individual's willingness to pay for environmental derived benefits. (Gundimeda, 2006)

A number of techniques are available to value the environmental goods and services. These can be categorised into revealed preference and stated preference techniques. In revealed preference methods, individuals indirectly reveal the willingness to pay for environmental goods through market and surrogate market prices. In stated preferences, the individuals are directly asked what their willingness to pay is. These techniques can be classified according to the method used for valuation ie, market based, surrogate market or non-market based.

The Hedonic[1] Price Method (HPM) is a revealed preference method of valuation. The hedonic price method of environmental valuation uses surrogate markets for placing a value on environmental quality. The real estate market is the most commonly used surrogate in hedonic pricing of environmental values because it shows the willingness of the households to pay for a property.

Hedonic property models are predicated on the theory that the prices of heterogeneous goods reflect the component values of those goods' characteristics (Rosen, 1974).

Households make their purchase decisions based on a number of *structural*, *environmental* and *neighbourhood* characteristics. Market price as the equilibrium price shows the value of property attributes. The HPM is a tool to separate out the environmental component of value from the observed market price and use that as a surrogate for the environmental value. It is assumed that proximity to the beach and water views are among the most influential factors in a household's decision to purchase a property in coastal neighbourhood areas.

This method has been used extensively in the economics literature to measure the impact of a given resource, such as a beach, river, or lake on the value of locating properties close to the resource. This proximity consists of two separate benefits households derive from living close to the resource, namely access and views.

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[1] The word "hedonic" comes from a Greek origin, which means, "pleasure".

The objective of this study is to identify and measure these two components that are derived from proximity to the Hauraki Gulf in 12 “census area units”[1] on the North Shore of Auckland.

While the positive impact of views on Auckland properties have been shown by previous studies (Bourassa et al (2004), Bourassa et al (2005), Samarasinghe and Sharp (2008) and Filippova (2008), this study augments previous research in New Zealand by examining the impact of access distance to the nearest beach, which has not been measured before.

Morgan and Hamilton (2011) suggest that using a network distance parameter in the hedonic model is more appropriate to measure the household access to the beach for leisure and recreational purposes, which is different from linear distance to the shoreline. Furthermore, network access varies independently of view, as homes farther from the coast with less view amenity can be closer to access points. Hence, collinearity effects are reduced, and two amenity parameters, access and view, can be separated in the model.

Since land value from the unique rate assessment (1 June 2011) is the estimated selling price of the land if vacant as at the effective date of valuation, the land value has been considered as the land market price for more than 8500 single properties.

[1] Statistics New Zealand, “Area units are aggregations of meshblocks. They are non-administrative areas that are in between meshblocks and territorial authorities in size. Area units within urban areas normally contain a population of 3,000–5,000, though this can vary due to such things as industrial areas, port areas, and rural areas within the urban area boundaries.”

2. Literature

The hedonic price model is derived mostly from Lancaster's (1966) consumer theory and Rosen's (1974) model. Both of these approaches aimed to impute prices of attributes based on the relationship between the observed prices of products and the number of attributes associated with these products.

The Lancaster model presumes that goods are members of a group and that some or all of the goods in that group are consumed in combinations, subject to the consumer's budget. In comparison, Rosen's model assumes there is a range of goods, but that consumers typically do not obtain preferred attributes by purchasing a specific combination of goods. Rather, each good is chosen from the spectrum of brands and is consumed separately. The hedonic price approach also does not require joint consumption of goods within a group. Therefore, In the literature the Rosen approach has been followed.

2.1 General Literature of water amenity

Numerous studies have examined the aesthetic value of views within the hedonic framework. Some early research captured property views by utilising a single dummy[1] variable. A common shortcoming of earlier studies is that a single dummy classified as view or no view did not distinguish neither different types of view (ocean, lake, mountain, etc.) nor the different scope of view (wide, moderate and slight).

The others (see for instance, Bourassa et al. 2004) used the view scale, which is a type of subjective view measure that required a number of dummy variables to represent the quality of a view.

Benson, et al. (1997) in Point Roberts, Washington noted that the view amenity may not be uniform; it varies by type (eg, water view, mountain view, and valley view) and by quality (eg, full view, partial view or poor partial view). They classified the views as oceanfront, ocean view, partial ocean view, and no view. Their study results show that, relative to no view, an ocean frontage adds 147 percent to the selling price of a property, an ocean view adds 32 percent, and a partial ocean view adds 10 percent.

In their later study of the city of Belinghamm, Washington, Benson et al. (1998) considered three types of views (ocean, lake and mountain) and further defined four scopes for ocean views and included interacted variables with distance to the coast. They found that the highest increase in value was for lakefront properties, followed by ocean views, with mountain views having no significant impact on house prices.

The majority of studies include a variable measuring the distance to the source of a view. The results consistently indicate a decline in premiums as distance increases. Some studies also examined the role of distance on the value of views (Bourassa et al. 2004). The typical finding across these studies is that views positively affect property values and the total value of a view decreases with increasing distance from a resource.

[1] In statistics and econometrics, particularly in regression analysis, a dummy variable (also known as an indicator variable) is one that takes the values 0 or 1 to indicate the absence or presence of some categorical effect that may be expected to shift the outcome. (Smith, 1998)

In their study, Morgan and Hamilton (2011), accounted for true access to waterfront, not by the linear distance to the shoreline, but rather by the network distance from each property to the nearest designated beach access point. They argued that since homes closer to the coast have typically on improved view, the linear distance and view are highly correlated, consequently, this will raise collinearity concern and will derive imprecise coefficient estimates.

Results from a spatial autoregressive model indicate that, as network distance can vary independently of view, its inclusion can mitigate collinearity concerns[1], and yield more reliable amenity value coefficient estimates.

This is the method that will be followed in this study and all the distance vectors will be measured by network distance rather than Euclidean (straight-line) distance.

2.2 Specific literature of water amenity evaluation in New Zealand

Several studies have evaluated water amenity in New Zealand. These studies have been described in this section

2.2.1 Bourassa et al. (2004)

They provided a detailed literature review as well as an empirical analysis of the impact of a view on residential property values using a very rich database of nearly 5,000 sales in Auckland. Several dimensions of a view were analysed (type of view, scope of view, distance to coast, and quality of surrounding improvements). They found that wide views of water add an average of 59 percent to the value of a waterfront property, but this effect decreases quite rapidly as the distance from the coast increases. Attractive landscaping and buildings in a property's neighbourhood on average add 5 percent and 37 percent to value, respectively. Particularly attractive improvements in the immediate surroundings of a property add another 27 percent to value on average.

Their results lead to the conclusion that aesthetic externalities are multi-dimensional and can have a substantial impact on residential property values.

The results demonstrate the importance of water views, but only when views have either a medium or a wide scope. At the coastline, a wide view commands a premium of 59 percent on average, compared with a premium of 33 percent for medium scope views. These premiums decrease quite rapidly as the distance to the coast increases. At 2,000 metres from the coast, for instance, these premiums are 14 percent and 12 percent, respectively.

2.2.2 Bourassa et al. (2005)

More recently, they analysed the three largest urban areas in New Zealand and found that market variations in price impacts for water views are inversely related to the supply of such views. So since 18.6 percent of Wellington properties, 12.5 percent of Auckland properties and 2.5 percent of Christchurch properties have water view the percentage price impact are 6.6, 9.7 and 10.9 respectively.

[1] Collinearity is a linear relationship between two explanatory variables. Two variables are perfectly collinear if there is an exact linear relationship between the two.

2.2.3 Filippova (2008)

Filippova evaluated the impact of submarkets on water view premiums of residential properties and investigated the correlation between submarket view premium and socioeconomic status for Auckland. This is a unique study that considers submarkets in a city.

The key variables in this study are three dummy variables for water views (wide, moderate and slight) and three interaction variables equal to the product of the dummy variable water wide/moderate/slight and the natural log of distance to the nearest coast.

The study shows a wide water view adds 18 percent to a home's value if the property is located 500m to the water, assuming all other variables are constant. However, when the region is broken into submarkets the price premium ranges from a modest 5 percent in West Harbour to 54 percent in Mission Bay.

2.2.4 Samarshinghe and Sharp (2008)

They estimated the value of the view amenity in Auckland while considering distance to the coast and type and scope of view. Their results lead to the conclusion that the value of a house located 100m from the coast would be 33 percent lower if it has moderate water views, 36 percent lower if it has slight water views and 43 percent lower if it has no water views compared to a similar house with wide water views at the same location. Also a house with wide water views has 11 percent less value if located 100m away from the coast, 25 percent less value if located 250m away from the coast, and 43 percent less if 500m away form the coast compared to a similar house on the coastline, on average. On average a house with moderate water views has 31 percent less value if located at the coastline, 33 percent less, 35 percent less and 38 percent less if located 100m, 250m , 500m away from the coast respectively compared to a similar house at the same location with wide water views. For a property with slight water views and no water views, average percentage impacts differ across distance in a similar manner.

The most related studies in New Zealand have been summarised in Table 1.

In this study on the impact of the Hauraki Gulf amenity on land properties prices, various view scopes similar to the other studies will be used. However, this study also considers the vector of the network access distance to the nearest designated beach rather than linear distance to the coastline.

Table 1: Previous studies of the impacts of views amenity in New Zealand

Author	Location, type of data and number of observations	Type of view	Method	Result	New point
Bourassa et al.(2004)	Auckland, 4,880 sales transactions,	water	Dummy variable	View increases value by 8 percent	Used type and scope of view and access to the beach for leisure
Bourassa et al.(2005)	Auckland 128,982 sales transactions, Wellington 28357 sales transaction and Christchurch 73,851 sales transaction,(1986-1996)	water	Dummy variable	Average view impact is 10.9 percent in Christchurch, 9.7 percent in Auckland and 6.6 percent in Wellington, in accordance with greatest and least supply of view Wellington and Christchurch.	Examined the supply of view in different cities
Samarasinghe and Sharp (2008)	Auckland City, 2,531 sales transactions (2004)	water and other	Dummy variable for view, Distance to nearest coast measured to the nearest 100 metres	View increases the mean sale price approximately by 44 percent at coastline	
Filippova (2008)	17 defined submarkets in Auckland region, 53,000 sales transactions (2004-2006)	water	Straight-line distance to the coast, three interaction variables equal to the product of the *dummy variable* water wide/ moderate/ slight and the *natural log of distance to nearest coast*	View impact varies across the submarkets, for example it increase value of coast line 5 percent in West Harbour and 54 percent in Mission Bay	Comparison of submarkets in a city

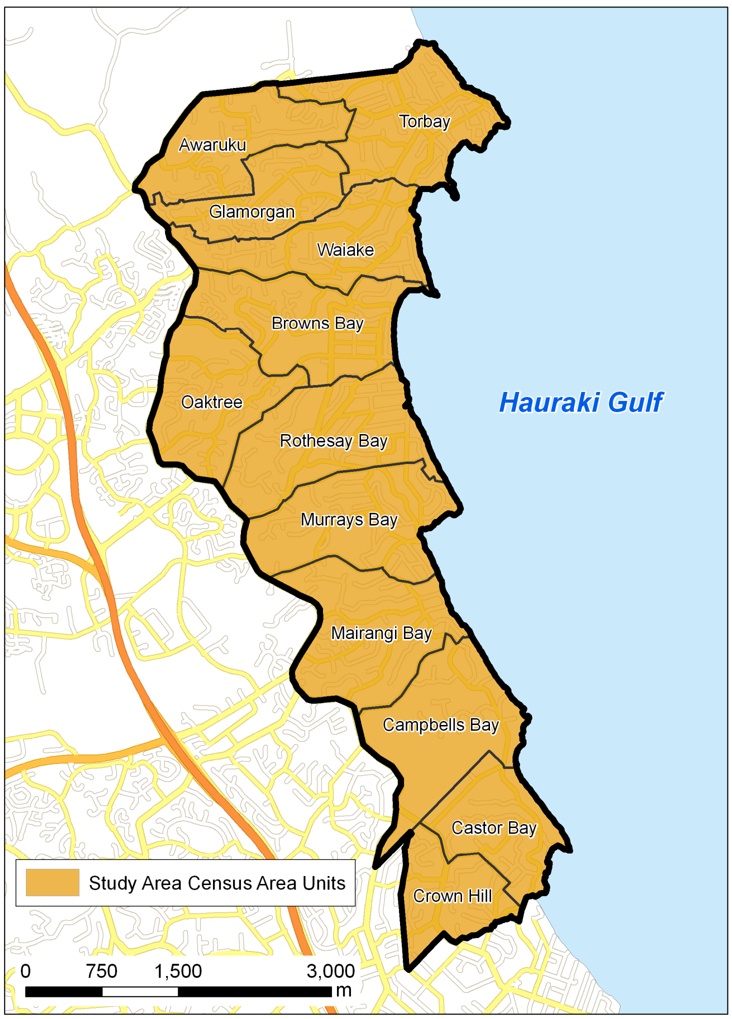
3. Study Area

The study area in this paper is a combination of 12 census area units (CAUs) (2006) on Auckland's North Shore (see Figure 1). Eight CAUs[1] border the Hauraki Gulf, stretching more than 12 kilometres on the Gulf side and four CAUs (Awaruku, Glamorgan, Oaktree and Crown Hill) are located in more inland areas.

These area units have been selected by considering the following factors:

- Proximity to Gulf (ie, the Hauraki Gulf would have more impact on property price compared with further area units);
- Not influenced by another water view (eg, the Takapuna area was not chosen because it includes Lake Pupuke); and
- The seaward catchment is same in these CAUs.

Figure 1: Study Area



[1] Torbay, Waiake, Browns Bay, Rothesay Bay, Murrays Bay, Mairangi Bay, Campbells Bay and Castor Bay.

4. Methodology and Model Specification

The semi-logarithmic hedonic specification is widely used in the property value literature. Its use is justified because it gives robust estimates and enables convenient coefficient interpretation, (Debrezion et al, 2010). The data have been organised in a cross-sectional pattern.

The general structure of Hedonic models is:

$$Ln(Pi) = B0 + B1'Xi1 + B2'Xi2 + ... + Bn'Xin + ei$$

Where, *Pi* is the price of house/land *i*; and *Xi*1 ... *Xin* are vectors of explanatory variables for the price of house *i*. The dependent variable is given in the natural logarithmic form; thus, the values of the coefficients represent percentage change.

The dependent variable is the land price per square metre derived from the land price valued by Auckland Council in 2011 rates assessments.

The transaction price is highly dependent on structural variables (number of bedrooms, floor area, number of parking spaces, etc), and land value is independent of these characteristics. Therefore, using land value per square metre as the dependent variable would streamline the HPM.

Furthermore, using the land price rather than market price ensures consistency as the land prices have been computed on the same date and the model does not have the bias of different selling dates.

As suggested by Bin et al. (2008) and Morgan and Hamilton (2011), the proximity parameter estimate for distance should reflect the ease of access to the shore for leisure and recreation purposes. Therefore, a true measure of access in these communities is not the linear distance to the coast, but rather the network distance from each property to the closest designated beach access point. One of the key explanatory variables as an environmental characteristic in this model is network distance from each property to the closest designated beach access.

According to Butler (1982), since all estimates of hedonic price models are to some extent miss specified[1], models that use a small number of key variables generally would suffice. Mok et al. (1995) concurred that biases due to missing variables are small, and have negligible prediction and explanatory powers on the equation.

A logarithmic transformation of the continuous variables have been used in the estimation. The empirical hedonic specification used here is:

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[1] Misspecification in Linear Regression means, in econometric theory it is usually assumed that economic theory provides a "true" specification of the stochastic equation to be estimated. It is therefore obvious that if economic theory is incomplete, the estimated parameters would (almost surely) be biased**.**

$$\ln(lv_i) = b_1 + b_2(\ln Dbeach_i) + b_3(Cline_i) + b_4(Wview_i) + b_5(Mview_i) + b_6(Sview_i) + b_7(Oview_i) + b_8(\ln Dschool_i) + b_9(\ln Dsmarket_i) + b_{10}(\ln Income) + e_i$$

Where they defined as follows:

Lv_i	Land price per square metre of the *i*th property
$Dbeach_i$	Network distance to the beach from the *i*th property
$Cline_i$	Dummy variable for the coast line properties (1) otherwise (0)
$Wview_i$	Dummy variable for the properties with water wide view category (1) otherwise (0)
$Mview_i$	Dummy variable for the properties with water moderate view category (1) otherwise (0)
$Sview_i$	Dummy variable for the properties with water slight view category (1) otherwise (0)
$Oview_i$	Dummy variable for the properties with Other view category (1) otherwise (0)
$PSzone_i$	Dummy variable for the properties in the defined popular school zone (1) otherwise (0)
$Dschool_i$	Network distance to nearest school from the *i*th property
$Dsmarket_i$	Network distance to the nearest supermarket from the *i*th property
Income	Median household income in each MB
e_i	The error term
b_1	Constant
$b_2, b_3, ..., b_{10}$	Coefficients, percentage of change[1]

Distance to the nearest public secondary school is one of the neighbourhood characteristics in this model. A key finding of Rehm and Filippova (2008) shows that the influence of school zoning on house prices is not uniform and proximity of a suburb to a popular school has a considerable impact on the location premium that suburb commands. The quality of public schools has been found to have a great impact on real house prices.

Since all the public secondary schools in the study area have similar quality in terms of decile rating and popularity, the impact of the school zone was not considered in this model.

Proximity to shopping complexes and the size of shopping centres have both been found to exert an influence on the value of the surrounding residential properties (Des Rosiers et al., 1996; Sirpal, 1994). Proximity to a shopping centre could mean easy access to facilities, and reduced travelling costs. Consequently, since supermarkets are generally located in larger centres along with a whole range of other amenities (goods and services) they represent high amenities. Therefore, distance to the nearest supermarket as a proxy for business centre has been added to the model as a neighbourhood attribute.

[1] Since the dependent variable is given in the natural logarithmic form, the value of the coefficients, represent percentage change.

5. Data

The data used in this analysis covers 8587 unique rate assessments (1 July 2011) of the properties located in the study area. This dataset was reduced from 16,754 residential rates assessments for the ease of data analysis. The properties included in the dataset are those:

- Related to parcels with only one property so that accurate land area and value information are straightforward to extract for such properties (9794),

- Related to parcels with land area between 350 square metres and 2000 square metres, since they are not outliers[1], and also properties that do not have shared driveways, since they do not cause two distances[2] to the nearest amenities (8920),

- Had median income information since they located in the meshblocks with a population more than 20 (8587).

The Auckland Council Geographic Information System (GIS) estimated all the accessibility vectors (distance to the nearest beach, distance to the supermarket and distance to the nearest school) through the network distance.

The income vector represents 2006 Census[3] median household income of the meshblock in which the property is located.

Table 2 presents the descriptive statistics for the dataset.

[1] In statistics, an outlier is an observation that is numerically distant from the rest of the data
[2] One distance from the middle of drive way and the other from property.
[3] Statistics New Zealand, "Total Household Income, for Households in Private Occupied Dwellings"

Table 2: Descriptive statistics of characteristics[1]

Variable Definition	Variable Symbol	Mean*	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
Land value per square metre ($)	LV	598.07	523.60	3596.88	158.37	280.41	2.53	13.95
Access distance to the nearest beach (km)	DBEACH	1.30	1.24	3.18	0.00	0.70	0.35	2.25
The coastline properties (Dummy)	CLINE	0.02	0.00	1.00	0.00	0.15	6.22	39.71
Hauraki Gulf wide view (Dummy)	WVIEW	0.08	0.00	1.00	0.00	0.27	3.08	10.48
Hauraki Gulf moderate view (Dummy)	MVIEW	0.21	0.00	1.00	0.00	0.41	1.44	3.07
Hauraki Gulf slight view (Dummy)	SVIEW	0.19	0.00	1.00	0.00	0.40	1.55	3.41
Other view (Dummy)	OVIEW	0.32	0.00	1.00	0.00	0.47	0.77	1.59
Access distance to the nearest school (km)	DSCHOOL	2.21	2.22	4.12	0.10	0.83	-0.09	2.33
Access distance to the nearest supermarket (km)	DSMARKET	2.02	1.88	4.70	0.10	0.91	0.56	2.73
Median household income in each meshblocks ($1000)	INCOME	80.14	80.50	100.00**	21.40	14.14	-0.38	2.71

* Mean for Dummy variables indicate the proportion of properties with a particular characteristic (ie, two percent of samples are located on the coastline)
** The maximum household income is $100,000 and households with more income does not identify because the 31st question in "individual Form" of "New Zealand census of population and dwelling" ask households about total amount of all sorts of their income. The answer options under this question are from "zero income" option to "$100,001 or more".[2]

[1] See statistics graphs of characteristics in Appendix 1.
[2] The sensibility analysis shows that the result has minor change if the median household incomes randomly change to more than $100,000. See the sensitivity analysis in Appendix 2.

6. Estimation Result and Discussion

The parameters of the semi logarithmic hedonic equation have been estimated by the Ordinary Least Square (OLS) regression[1]. Table 3 presents coefficients and the standard error of the model. The explanatory power is not high with an R^2 of 50 percent. A possible reason for this could be a lack of other explanatory variables such as distance to the business centres, distance to the highway and so on. The omission of these variables caused a lower R^2 so it could be improved by adding more characteristics in the next iteration.

All variables are statistically significant at the 99 percent confidence level and most of them are in the expected direction. Distance to school is an exception, which does not hold the expected negative effect. This could happen because of the school zoning system, which limits households' choice. Hence, while they are in the zone of a specific school they choose to enrol their children in, living near but not close to the school is preferable.

The result shows a significant impact of median income on the land value, the possible reason for that is that income is the only socioeconomic category in the model and its impact could diminish by considering other socioeconomic characteristics such as the household's ethnicity and the education level.

Table 3: OLS Estimation Results[2]

	Coefficient*	t- statistics	Std. Error
Constant	4.50	66.65285	0.067
ln(DBEACH)	-0.17	-36.49811	0.004
CLINE	0.36	16.15365	0.022
WVIEW	0.40	29.4444	0.013
MVIEW	0.26	28.28357	0.009
SVIEW	0.14	15.41796	0.009
OVIEW	0.05	6.429434	0.008
ln(DSCHOOL)	0.03	5.406811	0.006
ln(DSMARKET)	-0.13	-20.71104	0.006
ln(INCOME)	0.40	25.68798	0.015
R-squared	0.51		
Adjusted R-squared	0.51		
S.E. of regression	0.27		
Sum squared resid	622.64		
F-statistic	990.16		

***All significant at 0.01 level (99 percent)

1 In statistics, ordinary least squares (OLS) or linear least squares is a method for estimating the unknown parameters in a linear regression model. This method minimizes the sum of squared vertical distances between the observed responses in the dataset and the responses predicted by the linear approximation.

2 For more information about statistical tests, see appendix 3: Multicollinearity.

The coefficients of the continuous variables that transformed as natural logarithms represent elasticity, measuring the percentage change in land value associated with one percent change in the property characteristic. The elasticity of the beach amenity is -0.17, which means if the access distance between the property and the beach doubles, the land price declines by 17 percent (everything else being hold constant).For dummy variables, which were entered without transformation, the percentage impact on land value illustrated on Table 3 is computed as follows:

$100^* (e^{\beta} – 1)$

Where β is the coefficient value for the particular characteristic (Benson et al 1998).

Table 4: the percentage impact of each dummy characteristic

Dummy Characteristic	Coefficient	Percentage Impact
CLINE	0.36	43
WVIEW	0.40	50
MVIEW	0.26	30
SVIEW	0.14	15
OVIEW	0.05	6

Water views have a positive impact on land values and this effect increases with the scope of the view. Wide view scope has the most impact on the land price and other view (Oviews) does not have significant impact on land price(6 percent impact). A land value would increase 50, 30 and 15 percent with a wide, moderate and slight view scale respectively, compared with a no view property in the same area, assuming all other characteristics are constant.

Locating along the coastline would increase land value by 43 percent, ie, land value of a coastline property would cost 43 percent more than properties in the neighbourhood all other variables being constant.

Since the effects of water amenity vary by both views scope and distance to the coast, the effect of the Hauraki Gulf on land value is reported at the amenity of four different distance intervals[1], at the coastline, 100 metres, 500 metres, 1000 metres and 2000 metres from beach[2], for three scopes of view. These impacts are computed as follow:

$$100^* (e^{(\beta_i + \gamma^* \ln(\text{distance to beach}))} – 1)$$

Where β_i are the coefficients on each of the three i scopes of water view and γ is the coefficient for the distance to the coast variable. (See Benson et al., 1998)

[1] Distance here refers to access distance as has been defined earlier in this report.
[2] Since the maximum distance from the beach in this study is a bit more than 3 kilometres, calculation outside the range of data may not follow the same pattern.

Table 5: Mean percentage impact of Hauraki Gulf amenity on land price

	Wide view	Moderate view	Slight view
At the beach		-20	-34
100 metres from the beach	-32	-41	-47
500 metres from the beach	-48	-55	-60
1000 metres from the beach	-54	-60	-65
2000 metres from the beach	-59	-65	-69

The results contained in Table 5 imply that land with a wide water view valued at $1000 per square metres value on the coastline, would cost $680, $520, $460 and $410 if located 100 metre, 500 metres, 1000 metres and 2000 metres away from the beach respectively, keeping other characteristics constant.

The land price of a property with a moderate view would cost on average 20 percent less if located at the coastline, 41 percent less if located 100 metres from the coastline and 65 percent less if located two kilometres from the coastline compared to similar property with a wide view at the same location.

7. Summary and Conclusion

This study has focused on the Hauraki Gulf amenity impact on the value of residential properties land. The access distance to the nearest beach has been considered as the distance variable in the model to avoid the collinearity between direct distance and views.

Hedonic estimation results for the study area[1] align with the reported literature results in Auckland that show the significant impact of water amenity on land price. This impact increases with the scope of views (highest impact from “wide views” lowest impact from “slight views”) and decreases with the access distance to the beach.

Keeping all other variables constant, the land value of a property 100 metres from the coastline is 41 and 47 percent less if it has moderate and slight views scope respectively compared to a similar property at the same location with wide views. Furthermore, land of a property with wide water views would cost in average, 32, 48 and 59 percent less if located 100, 500 and 2000 metres from the coast respectively.

This methodology could be extended to other areas of Auckland. As results of an earlier study in Auckland varied for different submarkets (Filippova 2009), it is suggested that other Gulf neighbourhoods, for instance Howick and Te Atatu be included in the second phase of the study. In addition, more explanatory variables[2] could be added to the model to improve its explanatory power.

[1] 12 area units in North Shore, Auckland
[2] For instance: distance to highway, distance to rail station, ethnicity, etc

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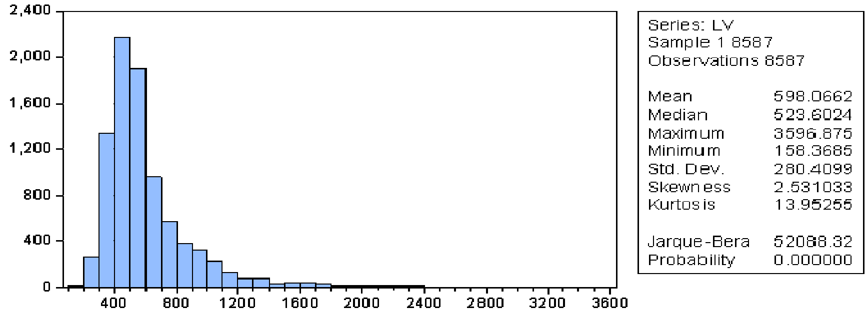
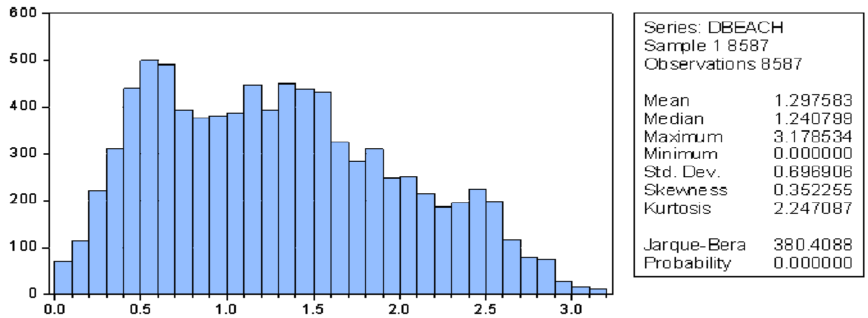
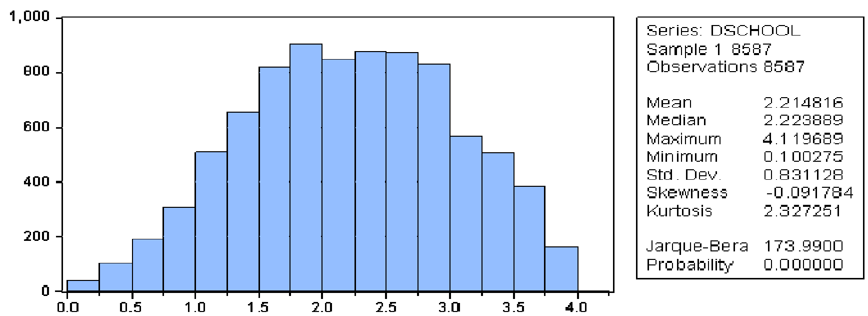
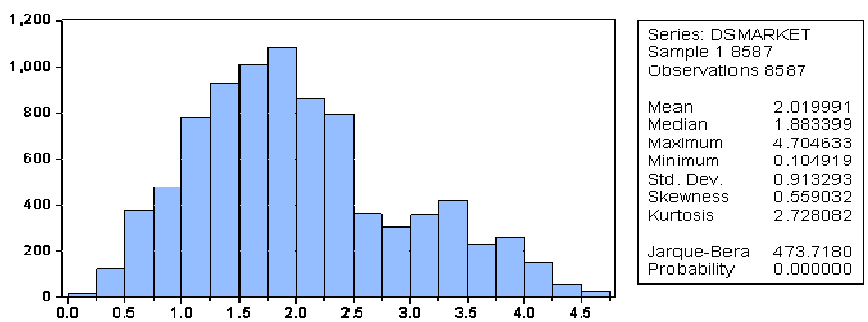
Appendices

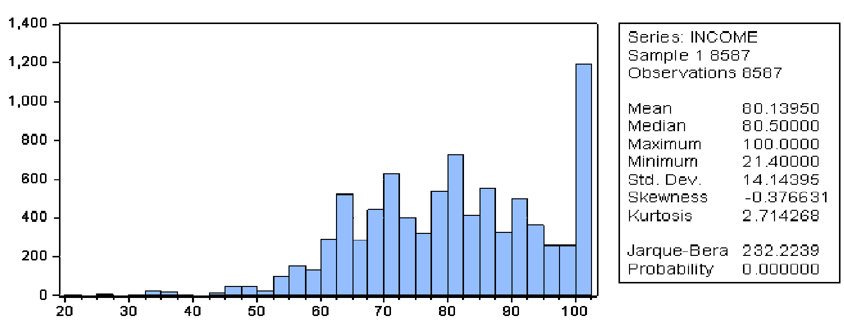
Appendix 1: Statistical graphs of characteristics



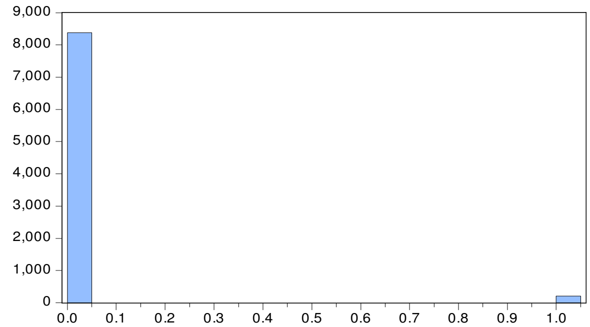




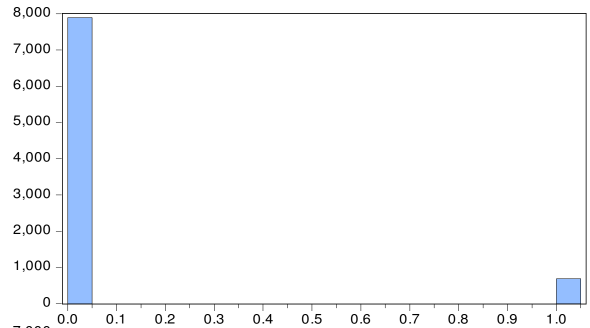




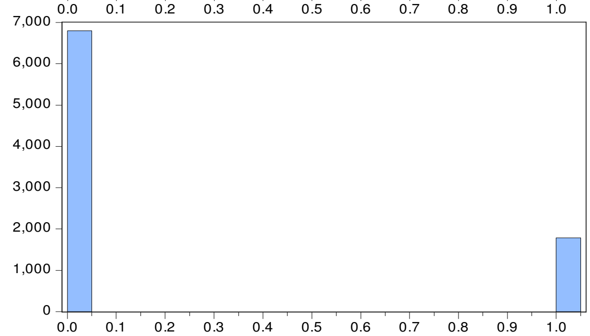
Appendix 1: Continued



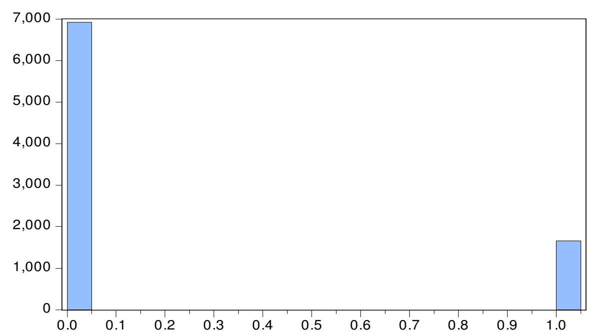
Series: CLINE	
Sample 1 8587	
Observations 8587	
Mean	0.023990
Median	0.000000
Maximum	1.000000
Minimum	0.000000
Std. Dev.	0.153026
Skewness	6.221659
Kurtosis	39.70905
Jarque-Bera	537542.7
Probability	0.000000



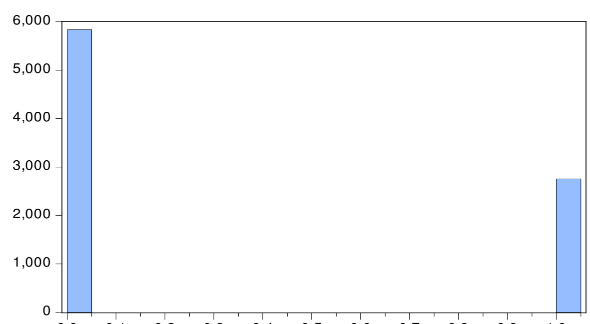
Series: WVIEW	
Sample 1 8587	
Observations 8587	
Mean	0.080703
Median	0.000000
Maximum	1.000000
Minimum	0.000000
Std. Dev.	0.272395
Skewness	3.078773
Kurtosis	10.47884
Jarque-Bera	33578.19
Probability	0.000000



Series: MVIEW	
Sample 1 8587	
Observations 8587	
Mean	0.207872
Median	0.000000
Maximum	1.000000
Minimum	0.000000
Std. Dev.	0.405809
Skewness	1.439815
Kurtosis	3.073067
Jarque-Bera	2968.815
Probability	0.000000



Series: SVIEW	
Sample 1 8587	
Observations 8587	
Mean	0.193548
Median	0.000000
Maximum	1.000000
Minimum	0.000000
Std. Dev.	0.395102
Skewness	1.551344
Kurtosis	3.406667
Jarque-Bera	3503.512
Probability	0.000000



Series: OVIEW	
Sample 1 8587	
Observations 8587	
Mean	0.320834
Median	0.000000
Maximum	1.000000
Minimum	0.000000
Std. Dev.	0.466824
Skewness	0.767641
Kurtosis	1.589272
Jarque-Bera	1555.407
Probability	0.000000

Appendix 2: Median household income sensitivity analysis

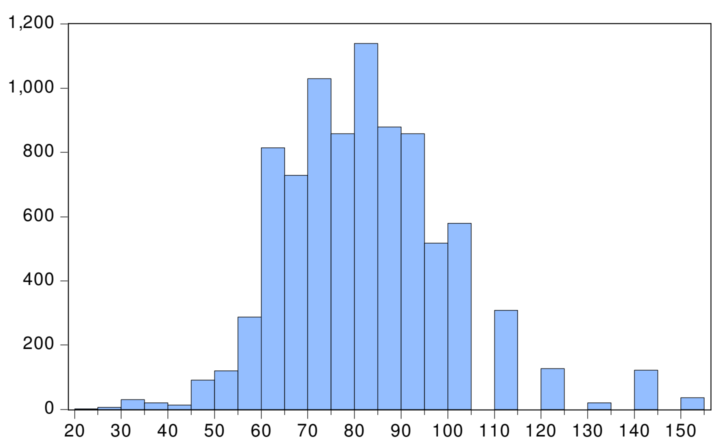
LN_LV_=C(1)+C(2)*DBEACH+C(3)*CLINE+C(4)*WVIEW+C(5)*MVIEW

+C(6)*SVIEW+C(7)*OVIEW+C(8)*DSCHOOL+C(9)*DSMARKET+C(10)

*INCOME

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	4.755867	0.060412	78.72436	0.0000
C(2)	-0.176952	0.004706	-37.59942	0.0000
C(3)	0.363620	0.022260	16.33545	0.0000
C(4)	0.406828	0.013800	29.47949	0.0000
C(5)	0.259874	0.009263	28.05393	0.0000
C(6)	0.143535	0.009364	15.32848	0.0000
C(7)	0.053631	0.008432	6.360240	0.0000
C(8)	0.033894	0.006197	5.469571	0.0000
C(9)	-0.133134	0.006308	-21.10607	0.0000
C(10)	0.338449	0.013814	24.50109	0.0000

R-squared	0.506380	Mean dependent var	6.312189
Adjusted R-squared	0.505862	S.D. dependent var	0.384533
S.E. of regression	0.270308	Akaike info criterion	0.222651
Sum squared resid	626.6884	Schwarz criterion	0.230870
Log likelihood	-945.9513	Hannan-Quinn criter.	0.225454
F-statistic	977.6339	Durbin-Watson stat	1.880569
Prob(F-statistic)	0.000000		



Series: INCOME	
Sample 1 8920	
Observations 8587	
Mean	81.64177
Median	80.50000
Maximum	150.0000
Minimum	21.40000
Std. Dev.	17.38649
Skewness	0.697819
Kurtosis	4.749361
Jarque-Bera	1791.845
Probability	0.000000

Appendix 3: Multicollinearity

Among the various statistical tests of Classical linear regression model (Heteroscedasticity, Autocorrelation, multicollinaerity, …) multicollinearity is the one that has been tested in this study since this is the most appropriate test cross-sectional data.

Multicollinearity is a statistical phenomenon in which two or more predictor variables in a multiple regression model are highly correlated. In this situation, the coefficient estimates may change erratically in response to small changes in the model or the data. Multicollinearity does not reduce the predictive power or reliability of the model as a whole, at least within the sample data themselves. It only affects calculations regarding individual predictors.

Results of the regression reject multicollinearity since:

Formal detection-tolerance or the variance inflation factor (VIF) for multicollinearity reject the possibility of multicollinearity. In statistics, the variance inflation factor (VIF) quantifies the severity of multicollinearity in an ordinary least squares regression analysis. It provides an index that measures how much the variance (the square of the estimate's standard deviation) of an estimated regression coefficient is increased because of collinearity.

$$\text{tolerance} = 1 - R_j^2, \quad \text{VIF} = \frac{1}{\text{tolerance}},$$

where R^2_j is the coefficient of determination of a regression of explanator j on all the other explanators. A tolerance of less than 0.20 or 0.10 and/or a VIF of 5 or 10 and above indicates a multicollinearity problem (see O'Brien 2007).

Dependent variable	dbeach	cline	wview	income	dsmarket	dschool	mview	sview	oview
Explanatory variable					Others				
R^2	0.25	0.27	0.40	0.04	0.17	0.03	0.40	0.38	0.45
tolerance	0.75	0.73	0.60	0.96	0.83	0.97	0.60	0.62	0.55
VIF	1.33	1.36	1.66	1.04	1.20	1.04	1.66	1.61	1.82
Collinearity	No	No	No	No	No	No	No	No	No