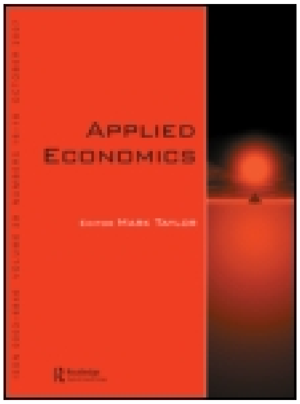

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Water quality and cottage prices in Ontario

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Water quality and cottage prices in Ontario

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We use hedonic analysis to show that water clarity has a significant effect on lakefront property values in the Near North Ontario, Canada. In this study, water clarity is measured by Secchi disc reading. Based on two different dependent variables; sales price and sales price per square foot, and the estimation of linear, log–linear and log–log models, we find that water clarity does matter to lakefront property buyers in the Near North, Ontario. In particular, our results indicate that buyers are willing to pay about 2% more for each 1-foot increase in water clarity or Secchi depth. This finding is consistent across all of our specifications.

Keywords: Near North Ontario; Canada; environment; water quality; hedonic regression

JEL Classification: Q51; Q53; R11

I. Introduction

Canada takes pride in its natural beauty and scenic appeal. More specifically, Canadians value the recreational and economic opportunities that their lakes offer both to tourists and natives of Canada. Freshwater lakes account for almost 9% of Canada's total area and are a defining feature of this country's landscape. The essential role that beautiful lakes play in Canada's legacy prompts the question; what is the monetary value of a cleaner lake?

Hedonic regression methods can provide an answer to this question. The hedonic approach, originally traced back to Rosen, shows that the price of any unit of a quality-differentiated good is a function of the levels of the characteristics embodied in the good (Rosen, 1974). This function is increasing in characteristics that are valued by individuals because buyers will bid up the price of units with more of a desirable attribute. Hedonic pricing techniques have been used in a number of applications to estimate prices of nonmarket amenities that may be capitalized in the price of a housing unit (Michael *et al.*, 2000), and hedonic property value models have been used to value everything from earthquake risk (Brookshire *et al.*, 1988) to countryside attributes (Garrod and Willis, 1992).

The hedonic approach is of great importance in examining the impact of environmental attributes on property values. For example, Leggett and Bockstael (2000) use hedonic techniques to demonstrate that water quality has a statistically significant effect on property values along Chesapeake Bay. They measure water quality as inversely related to the amount of faecal coliform bacteria in the water. Leggett and Bockstael (2000) find, using 1183 observations along the Anne Arundel coastline in Chesapeake Bay over a span of 4 years (1993–1997), that waterfront homeowners have a positive willingness to pay for reductions in faecal coliform bacteria concentrations.

Bin and Czajkowski (2013) use both traditional objective measures of water quality along with less technical

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and more easily understood measure of water quality, ‘location grade,’ available to homebuyers in an urban coastal housing market of South Florida. The northeastern portion of the Martin County, located on the Southeastern Atlantic coast of Florida, and its accompanying waterfront housing market located on the St. Lucie River, St. Lucie Estuary and Indian River Lagoon, were analysed for this study. The time period for this study was from January 2000 to August 2004 and what was tracked on a weekly basis by Florida Oceanographic Society for nine separate locations. The results indicate that water quality does matter to the waterfront homebuyers in South Florida, and this holds for both technical and nontechnical measures of water quality. More specifically Bin and Czajkowski (2013) find that homebuyers use the nontechnical measure as a warning sign when the location grade is within a failing range. This measure of water quality is more easily understood and accounted for by homebuyer’s willingness to pay. Homebuyers also seem very responsive to varying technical water quality measures. Higher values of all of the technical measures of water quality, excluding dissolved oxygen, increase property values significantly.

Michael *et al.* (2000) examine environmental quality and property prices using hedonic property value models of lakefront properties in Maine. Twenty-two Maine lakes were selected for this study which encompassed 39 organized towns and unorganized territories that consisted of residential or recreational single-family homes with shore frontage on a lake. Sales data were collected for the period, January 1990 to June 1994. The results reveal that the measurement of an environmental-quality variable, such as water clarity, affects the implicit prices derived from hedonic equations. A similar study conducted by Gibbs *et al.* (2002) examined the impact that water clarity had on residential property prices in New Hampshire. While the methods in this study were similar to those of Michael *et al.* (2000), the results were expected to differ. Due to New Hampshire lakes’ closeness to major metropolitan areas and highways systems, Gibbs *et al.* (2002) anticipate less ambiguous results. Sixty-nine public access lakes in 59 towns were selected for this study in order to examine water clarity as a measure of the degree of eutrophication (the ecosystem response to the addition of artificial or natural substances, such as nitrates and phosphates, through fertilizers or sewage, to an aquatic system) and its effect on sales data over a period of 6 years. Their findings confirmed that water clarity is a concern to consumers who own lakefront property on New Hampshire lakes.

There are several other studies of the effect of water quality on land or housing prices. For example, David (1968) used subjective government ratings of poor, moderate and good from the Department of Conservation and from the Committee on pollution in her Wisconsin study, while Epp and Al-Ani (1979) used a subjective measure of perceived water quality problems distinct from pH value obtained from telephone surveys. Krysel *et al.* (2003) find that water quality helps explain differences in lakeshore property values in Minnesota. Kashian *et al.* (2006) use hedonic methods to investigate the impact of cleaner water in Delavan Lake, the subject of a large rehabilitation programme. Poor *et al.* (2007) look at ambient water quality as measured by suspended solids and dissolved inorganic nitrogen. Their results indicate that 1 mg per litre change in total suspended solids and dissolved nitrogen caused a decrease in property value of –\$1086 and –\$17 672, respectively. Horsch and Lewis (2009) find a 13% fall in property values around lakes invaded by milfoil in Wisconsin. Using data from Florida and water quality measured as Secchi distance (a measure based on how far one can see down into the water body), Walsh *et al.* (2011) find that the value of increased water quality depends upon a property’s location and proximity to the water front. Boopathi and Rameshkumar (2011) find a negative association between industrial water pollution and farm land values.

The studies above all point to the positive effect of water quality on property values. However, the existence and magnitude of this effect has not been investigated for cottage properties just north of Toronto, Canada, is what is called ‘Cottage Country.’ Like most previous studies, we use Secchi disc readings to measure water clarity. This measure is obtained by attaching a Secchi disc to a pole and slowly lowering it into the water. The depth at which the design on the disc is no longer visible is recorded as the measure of the clearness of the water. Using data for about 250 cottages we estimate linear, log–linear and log–log models and find that a 1-foot increase in Secchi disc reading is associated with about a 2% increase in value, whether measured by sales price or sales price per square foot. Our results indicate that that water quality is an extremely important characteristic of cottage ownership in Ontario.

II. Models and Data

The data used in this hedonic price model were graciously provided by John Fincham of REMAX Parry Sound-Muskoka Realty Ltd. Brokerage, located in Magnetawan, Ontario. The cottages in the data set are located in the Huntsville North area, the Almaguin Highlands and the Parry Sound districts. We selected cottages in these areas for analysis primarily because the sample is relatively homogeneous and avoids comparisons with the extremely large lake houses/cottages in areas to the south of the study area.

Table 1. Sample statistics based on 253 observations

Variable	Mean	SD	Min	Max
Price	648 415.80	754 642.70	65 000	5 000 000
SF	1266.565	820.34	344	9000
Ppsf	443.566	341.49	59.47	2454.92
Bedrooms	3.150	1.073	1.00	10.00
Bathrooms	1.296	0.940	0.00	6.00
WF	236.778	266.98	50.00	2070.00
West	0.111	0.31	0.00	1.00
WQ	3.851	1.37	1.20	9.40
Small	0.170	0.38	0.00	1.00

The data set originally contained 276 observations on cottage sales in 2010 on 77 lakes in the Near North Ontario. However, due to missing data, only 253 observations from 74 lakes were used in the analysis. Data on lake size and Secchi depth are obtained from the *Lake Partner Program*, a province-wide volunteer based water quality monitoring programme. The summary statistics for the sample are given in Table 1. The average cottage in our study has a value of $443 per square foot, has 3.1 bedrooms, 1.3 bathrooms, 237 feet of water frontage and sits on a lake with a Secchi reading of 3.85 metres. 11% of the cottages in our sample face west and about 17% are on 'small' lakes.

Sales price and the logarithm of sales price are used as the dependent variables in our first set of regressions. In order to assess the impact of functional form, we estimate a linear model, a log–linear model and a log–log model. As explanatory variables we include, depending on the specification, either square footage of the cottage (*SF*) or the logarithm of square footage, either the number of bedrooms (*Bedrooms*) or the logarithm of the number of bedrooms, water frontage (*WF*) in feet or the logarithm of water frontage, a dummy variable indicating western exposure (*West*), water quality (*WQ*) measured as Secchi depth in metres or the logarithm of the Secchi depth and a dummy variable if the lake size is less than three quarters of a hectare (*Small*).

We expect positive slope coefficients for all explanatory variables except *Small*, for which we expect a negative coefficient. That is, more square feet, more bedrooms, more bathrooms, more water frontage, a western exposure and higher water quality should increase cottage value. However, small lakes do not allow many of the boating recreational activities that one can enjoy on a larger lake, hence the supposed negative relationship.

III. Empirical Results

Table 2 contains our first set of estimation results, with dependent variable based on sales price, *price*. Results from estimating our linear model are given in column 2 of Table 2. The model R^2 is 0.52 and the F-value is 18.60. All of the coefficients of the independent variables included are statistically significant at the α = 0.10 level or better except for the number of bedrooms (*Bedrooms*) and the exposure variable, *West*. The explanatory variable of interest, *WQ*, has a coefficient of 43 520 and is statistically significant at the α = 0.05 level. The estimated coefficient indicates an increase of $13 390 per foot of Secchi depth. At the sample average sale price, this amounts to about a 2.0% increase in the cottage sale price for each 1-foot increase in water clarity.

Table 2. Sales price regressions

Variable	Linear	Log–linear	Log–log
SF	587.766***	0.0005***	–
	(9.24)[a]	(4.32)	
Log(SF)	–	–	0.953***
			(10.62)
Bedrooms	−8614.659	0.082	–
	(0.16)	(1.33)	
Log(Bedrooms)	–	–	0.111
			(0.79)
WF	467.269*	0.0006***	–
	(1.95)	(2.92)	
Log(WF)	–	–	0.256***
			(4.16)
West	96 509.020	0.120	0.062
	(0.73)	(1.00)	(0.53)
WQ	43 520.430**	0.065***	–
	(2.49)	(3.24)	
Log(WQ)	–	–	0.269***
			(4.15)
Small	−159 538.700***	−0.200***	−0.189***
	(3.40)	(3.07)	(2.71)
Intercept	−371 178.300**	11.704***	4.481***
	(2.28)	(73.64)	(7.89)
R^2	0.52	0.51	0.57
F	8.60	17.62	46.93

Notes: [a]Figures in parentheses are absolute values of t-ratios based on robust SEs.
*** significant at the α = 0.01 level, two-tailed test. ** significant at the α = 0.05 level, two-tailed test. * significant at the α = 0.10 level, two-tailed test.

In order to investigate the impact of alternative specifications on our findings, we also estimate a log–linear model, with the logarithm of sales price as the dependent variable. These estimation results are given in column 3 of Table 2. The model R^2 is 0.51 and the F-statistic is 17.62. Once more, all the coefficients are statistically significant at the α = 0.01 level and all have the expected relationship with the logarithm of sales price except for the coefficients of *Bedrooms* and *West* which are, again, not statistically significant. The coefficient of *WQ* indicates that a one-unit (1 metre) increase in Secchi depth increases sales price about 6.5%. This translates into about a 2.0% increase for each 1-foot increase in Secchi depth.

Column 4 of Table 2 gives the results from estimating our log–log model with the logarithm of sales price as the dependent variable and with the logarithms of the continuous independent variables included as regressors. The model R^2 is 0.57 and the F-value increases to 46.93. As with the earlier specifications, only the coefficients of *Bedrooms* and *West* fail to achieve statistical significance. The important coefficient of log(WQ), now an elasticity, is 0.269, indicating that a 1% increase in Secchi depth increases the sales price about 0.27 of a per cent.

In order to evaluate the robustness of our results we re-estimated the three models using price per square foot or the logarithm of price per square foot as our dependent variable. The use of price per square foot as the dependent variable required omission of *SF* as an independent variable in this set of regressions. We expect the same relationships and signs for the coefficients as with the *price*-based results given in Table 2. The results from these estimations are given in Table 3.

The results from estimating the linear model are given in column 2 of the table. The R^2 is 0.14 and the F-value is 5.27. The coefficients of all variables except *Bedrooms* and *West* are statistically significant at the $\alpha = 0.05$ level or better. The important coefficient of water quality is about \$31 indicating that a 1-metre increase in water clarity will increase price per square foot by \$31, which translates into about \$9.50 per increased foot of clarity. When evaluated at the sample mean value of price per square foot, this amounts to about a 2.1% increase in value – an estimate very similar to our results in Table 2.

Table 3. Price per square foot regressions

Variable	Linear	Log–linear	Log–log
Bedrooms	17.715	0.299	–
	(0.75)[a]	(0.77)	
Log(Bedrooms)	–	–	0.073
			(0.61)
WF	0.376**	0.001***	–
	(2.52)	(2.72)	
Log(WF)	–	–	0.249***
			(4.19)
West	51.826	0.095	0.060
	(0.74)	(0.80)	(0.51)
WQ	30.988***	0.064***	–
	(3.02)	(3.32)	
Log(WQ)	–	–	0.268***
			(4.06)
Small	−106.068***	−0.191***	−0.187***
	(3.26)	(2.71)	(2.66)
Intercept	191.597**	5.470***	4.229***
	(2.50)	(41.71)	(14.35)
R^2	0.14	0.14	0.17
F	5.27	5.95	8.84

Notes: [a]Figures in parentheses are absolute values of t-ratios based on robust SEs.
*** significant at the $\alpha = 0.01$ level, two-tailed test. ** significant at the $\alpha = 0.05$ level, two-tailed test.

Column 3 of Table 3 gives the results from estimating our log–linear model. The R^2 is 0.14 and the F-value is 5.95. Except for the coefficients of *Bedrooms* and *West*, all coefficients are statistically significant at the $\alpha = 0.01$ level and have the expected relationship to price per square foot. In particular, we see the coefficient of water quality, *WF*, is 0.064 indicating that a one-unit (1-metre) increase in water clarity increases the price per square foot by 6.4%, or 1.97% per foot – an estimate also very similar to our Table 2 results.

Column 4 of the table gives the results from estimating our log–log model. The R^2 is 0.14 and the F-value is 5.95. Again, except for the coefficients of *Bedrooms* and *West*, all are statistically significant at the $\alpha = 0.01$ level and have the expected relationship to price per square foot. The coefficient of log(WQ) is 0.268 which indicates that a 1% increase in water clarity leads to 0.27% increase in price per square foot. This estimate is also remarkably similar to the elasticity estimate given in Table 2.

Our findings appear to be consistent with other empirical findings measuring the impact on value of an increase in Secchi depth. There are several empirical papers using Secchi depth as a measure of water quality and to facilitate comparisons with the present study, we converted earlier findings to percentage increases in value due to a 1-foot increase in Secchi depth.

One of the first studies to use Secchi depth as a measure of water quality is that of Stiennes (1992). Although Stiennes found an increase in property values associated with increased water clarity, the study does not provide the base price so a conversion to a percentage is not possible. However, Stiennes does say that '…the results suggest that economic value may be attached to a perceived, rather than actual, measure of water quality,' which is an apparent endorsement of the use of Secchi depth type measures of water quality.

More recently, Boyle and Taylor (2001) find that a 1-foot increase in Secchi depth increases property value by from 1% to 4%, depending on the market grouping examined. Using lake data from Wisconsin, Kashian *et al.* (2006) find that a 1-foot increase in Secchi depth increased property value by nearly 3% using an hedonic approach. In a similar study, Walsh, Milon and Scrogin find a 1.24% increase in lakefront property value associated with a 1-foot increase in Secchi depth. Collectively, these findings seem to bracket our results, all of which are very close to our 2%.

IV. Conclusion

This study utilizes a unique data set from Ontario, Canada, in order to estimate the effect that water quality, as measured by Secchi depth, has on the prices of lakefront cottages. Our results indicate that water clarity does in fact matter to lakeside homeowners – they are willing to pay more for a clearer lake. In this study we estimate linear, log–linear and log–log hedonic regressions based on two dependent variables; sales price and sales price per square foot. Our main result is consistent across these specifications – a 1-foot increase in water clarity as measured by Secchi depth is associated with about a 2% increase in cottage value. This finding emphasizes the importance of water quality to cottage owners.

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We are grateful to John Fincham of REMAX Parry Sound-Muskoka Realty Ltd. Brokerage, located in Magnetawan, Ontario, for assistance with the data.

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