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Industrial Wind Turbine Ratio Study
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At the request of the Municipal Property Assessment Corporation (MPAC), the author conducted an analysis of residential sales within 5 kilometers of industrial wind turbines. The objective of the project was to determine the impact of location near a wind turbine on residential property values.

The analysis used 110,143 improved residential sales in 14 regions and 25 market areas that occurred from January 2012 through October 206 (58 months). All the sales were adjusted to the assessment date, 1 January 2016. The table below shows the distribution of the sales by property type:

PropertyType

		Frequency	Percent
Valid	Attached residential	7319	6.6
	Improved residential not on water	93019	84.5
	Improved residential on water	7712	7.0
	Multi family residential	2093	1.9
	Total	110143	100.0

The dependent variable in the analysis was assessment-to-sales ratios in which 2016 values were divided by time-adjusted sales prices. The models that produced 2016 values did not contain variables related to proximity near wind turbines. Thus, the relevant question is to what extent ratios on those properties are too high because of the absence of such adjustments. Independent variables included the following:

- A binary variable for abutting a property with a wind turbine
- Binary variables for being within 1, 2, and 5km of a wind turbine
- The number of wind turbines within 1, 2, and 5km
- The combined capacity in kilowatts of wind turbines within 1, 2, and 5km

The table below shows the number of sales and median and mean sales ratio of properties abutting a wind turbine (165 sales), within 1km (1,016 sales), within 2km (3,058 sales), within 5km (10,622 sales), and more than 5 km from a wind turbine (95,282 sales). Although the medians for the first four groups are all higher than for those more than 5km away, the differences are all

modest: between less than 1% in the case of those within 5km and just over 3% for those within one kilometer. According to the IAAO *Standard on Ratio Studies* (2013), median ratios for various property groups should not be provably more than 5% from the overall median ratio (.9743 in this case). As can be seen, the median ratios for all five groups are well within this threshold.

Figure 1 – Sale Counts and Summary Ratios

RATIO

PROXIMITY_IWT	N	Median	Mean	Minimum	Maximum
0 Abuts	165	1.0006	1.0193	.63	1.72
1 1 km	1016	1.0077	1.0215	.54	1.74
2 2 km	3058	.9940	1.0134	.54	1.79
5 5 km	10622	.9770	.9958	.54	1.78
6 >5 km	95282	.9733	.9895	.54	1.79
Total	110143	.9743	.9911	.54	1.79

Figure 2, which presents the median ratios in the form of a bar chart, illustrates the closeness of the assessment levels.

Figure 2 – Bar Chart of Median Ratios

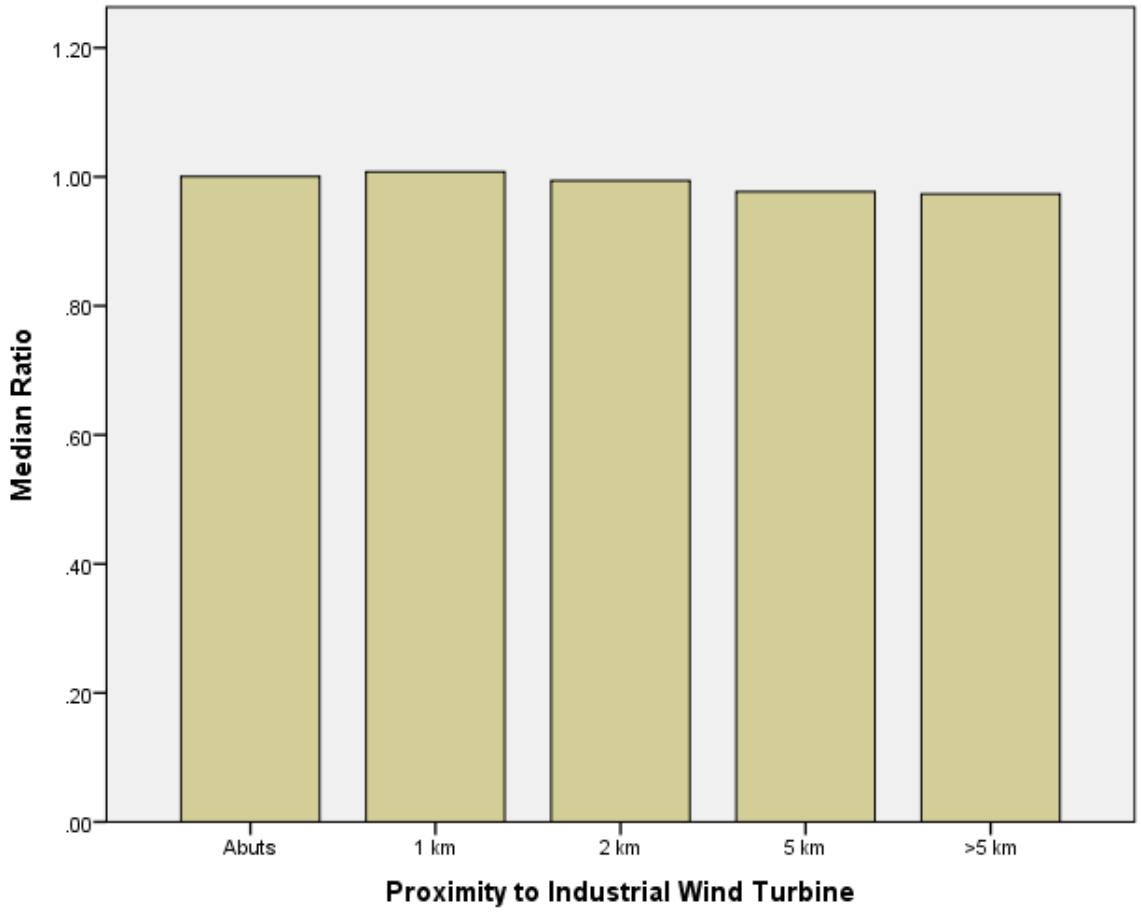
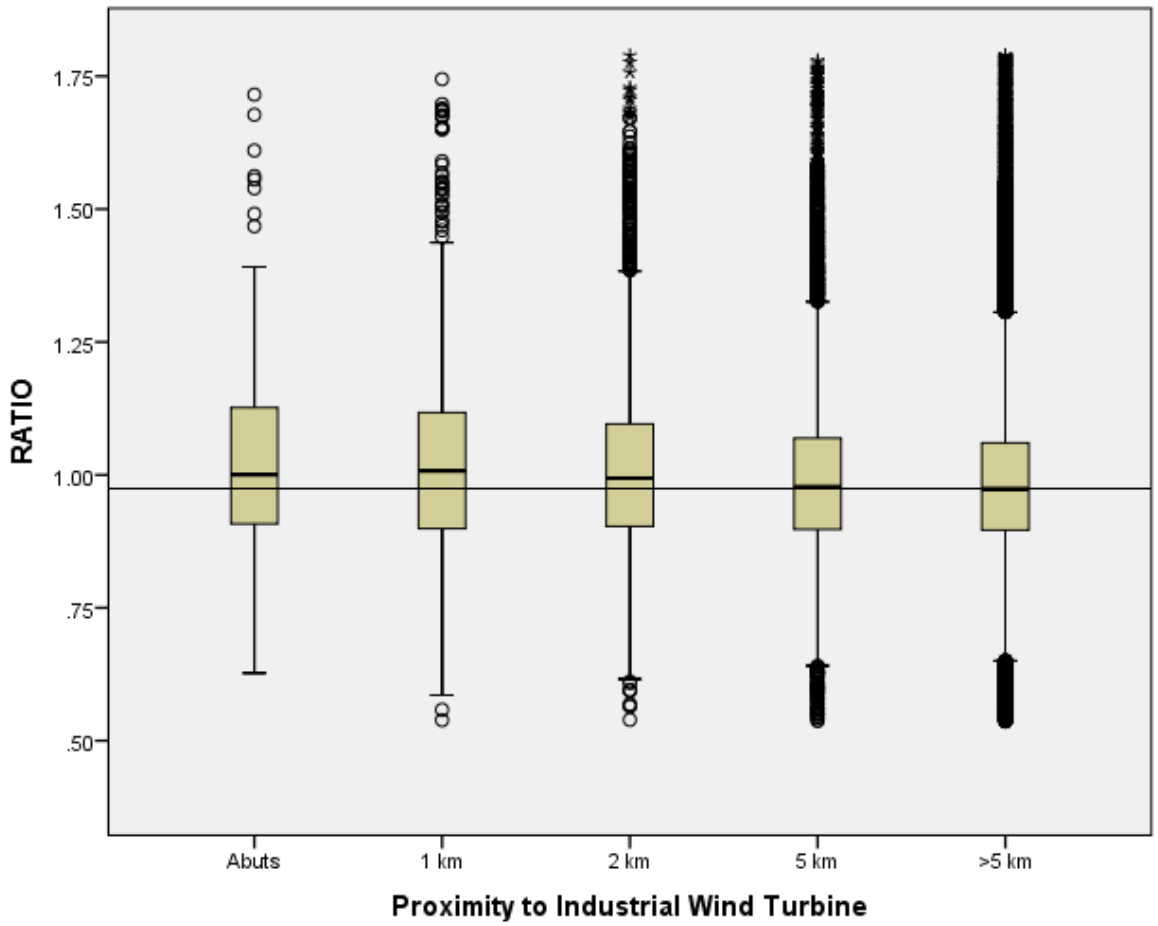


Figure 3 contains a box plot of the ratios. The boxes contain the middle 50% of observations and the black horizontal lines toward the middle of each box represent the median ratios. The boxes are closely aligned with only modest differences among the medians.

Figure 3 – Box Plot of Ratios



To further evaluate uniformity, a regression analysis was performed in which assessment ratios were regressed on binary variables (coded 0 or 1) for abutting a wind turbine and being within 1, 2, or 5 kilometers. Figure 4 presents the results. The Adjusted R-Square is .001, meaning that the four variables for proximity to a wind turbine together explain only 0.1% of the variation in assessment ratios. Consistent with the previous analyses, the variables for abutting or within 1 kilometer of a wind turbine indicate differences of about 3% with lesser differences for greater distances.

Figure 4 – Regression Analysis for Presence of Wind Turbines

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.034[a]	.001	.001	.15575

a. Predictors: (Constant), DIST_5km, PropAbutsIWT, DIST_1km, DIST_2km

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.990	.001		1961.172	.000
	PropAbutsIWT	.030	.012	.007	2.450	.014
	DIST_1km	.032	.005	.020	6.511	.000
	DIST_2km	.024	.003	.025	8.345	.000
	DIST_5km	.006	.002	.012	3.960	.000

a. Dependent Variable: RATIO

Similar analyses were conducted by property type and region. In no instance did the results fail the IAAO uniformity threshold.

To test the hypothesis that the presence of multiple wind turbines is associated with relatively high assessment ratios, a regression analysis was run with independent variables for the number of wind turbines within 1, 2, and 5 kilometers. Figure 5 contains the results. Again, the adjusted R-Square is .001. The variable for number of wind turbines within 5 kilometers or less indicates that ratios rise, on average, .0012 for each turbine. Thus, for example, ratios average .060 higher for the presence of 50 turbines within 5km (.012 x 50 = .060). Only 72 sales have 50 or more turbines within 5km. The other two variables for number of wind turbines within 1 and 2 kilometers are insignificant, indicating there is no additional difference if the turbines are concentrated closer to a subject property.

Figure 5 – Regression Analysis for Number of Wind Turbines Within 1, 2, and 5km

Model Summary

Model: 3

R	R Square	Adjusted R Square	Std. Error of the Estimate
.038[c]	.001	.001	.15572

c. Predictors: (Constant), IWT_Count_5km_sum

Coefficients[a]

Model: 3

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	.989	.000		2031.071	.000
IWT_Count_5km_sum	.0012	.000	.038	12.739	.000

a. Dependent Variable: RATIO

Excluded Variables

Model: 3

	Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
					Tolerance
IWT_Count_1km_sum	-.002	-.611	.541	-.002	.770
IWT_Count_2km_sum	-.006	-1.362	.173	-.004	.474

A similar analysis was performed for the total capacity in kilowatts of turbines within 1, 2, and 5 kilometers. Figure 5 contains the results. The adjusted R-Square is slightly higher at .002 and, consistent with the prior analysis, the only variable significant in the model is the total capacity of wind turbines within 5km. The variable has a coefficient of .0006. Thus, if total capacity were 100kv, ratios would be .060 higher than if total capacity were 0 (no wind turbines). There are only 39 sales for which the total capacity of wind turbines within 5km or less is 100kv or more.

Figure 6 – Regression Analysis for Total Capacity of Wind Turbines Within 1, 2, and 5km

Model Summary

Model: 3

R	R Square	Adjusted R Square	Std. Error of the Estimate
.040[c]	.002	.002	.15571

c. Predictors: (Constant), Capacity_Total_5km_sum

Coefficients[a]

Model: 3

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	.989	.000		2031.583	.000
Capacity_Total_5km_sum	.0006	.000	.040	13.248	.000

a. Dependent Variable: RATIO

Excluded Variables

Model: 3

	Beta In	t	Sig.	Partial Correlation	Collinearity Statistics: Tolerance
Capacity_Total_1km_sum	-.002	-.578	.563	-.002	.775
Capacity_Total_2km_sum	-.006	-1.268	.205	-.004	.468

In conclusion, properties located near industrial wind turbines are, on average, assessed slightly higher than other properties of the same type in the same geographic area but the differences are minimal (3% or less) and well within IAAO standards. The differences are slightly higher (over 5%) for properties near heavy concentrations of turbines. However, such properties constitute no more than 1% of those within 5km of a wind turbine.