Combined Residential and Commercial Models for a Sparsely Populated Area

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The Municipal Property Assessment Corporation (MPAC) is the assessment authority for the Province of Ontario, Canada. With nearly 4.6 million parcels, it is the largest assessment jurisdiction in North America.

During the past province-wide revaluations, MPAC has successfully valued over 3.5 million residential, condominium, and recreational waterfront properties, as well as small commercial properties and industrial condominiums in larger urban areas using the sales comparison approach to value through application of multiple regression analysis (MRA). Application of valuation models for small commercial properties in smaller urban and rural areas has met with limited success, however, because of the lack of adequate sales necessary to build a sales-based computer-assisted mass appraisal (CAMA) model.

This article explores the development of a combined residential and commercial model for a broad, sparsely populated region. Both residential and commercial sales were used to calibrate a single valuation model, which included variables for individual property types and economic neighbourhoods (municipalities).

Current Modelling Methodology

MPAC stratifies its market analysis for MRA by property type—residential, condominium, recreational waterfront, small commercial, and small industrial

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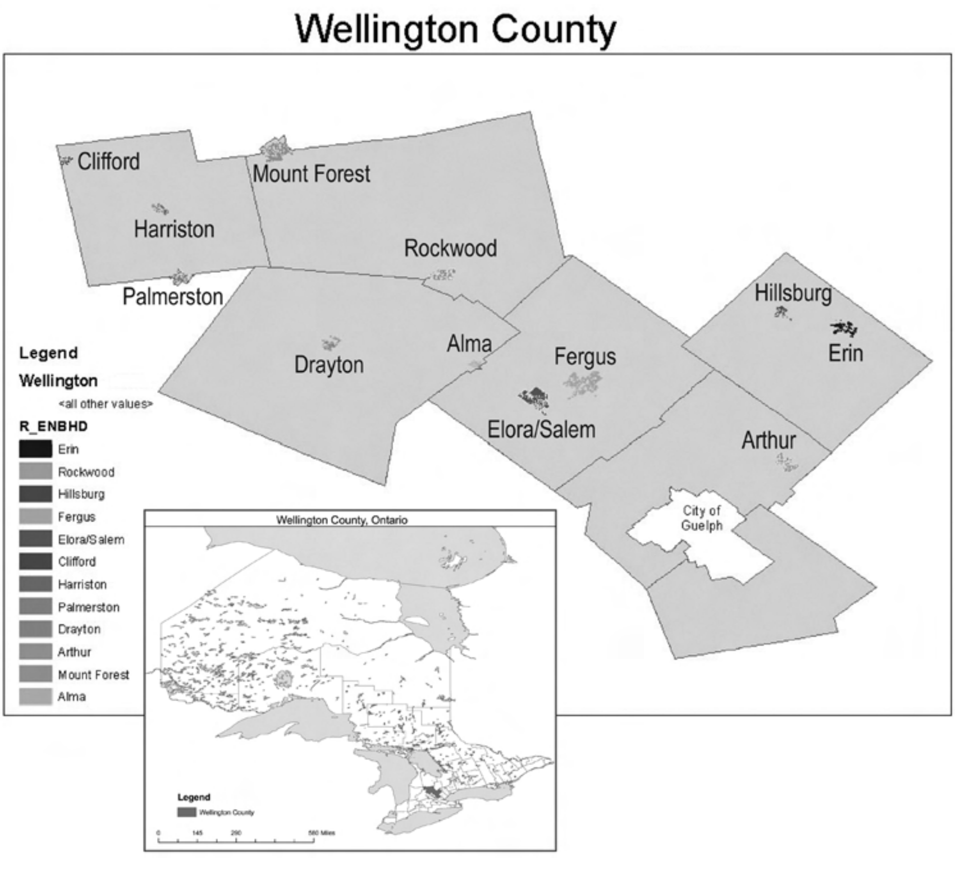
properties. To ensure an adequate sales sample for small commercial properties outside the major cities of Toronto and Ottawa, market areas are usually defined across large geographic regions that include both small urban and rural areas. This practice has resulted in mediocre modelling results due to inconsistent data and the combination of sales subject to different economic influences. This technique also did not address the issue of limited sales information by economic neighbourhood on the location adjustment. While small urban and rural residential areas were already combined across broad geographic areas, there generally were adequate sales to derive sound location adjustments.

Our premise was that combining residential and small commercial properties together in a single valuation model would improve the consistency and stability of location adjustments for the commercial properties. Even though traffic and other site-specific features can impact residential and commercial properties differently, we postulated that economic neighbourhood influences were common to both property types and thus that the larger sample sizes resulting from combining them would afford more stable, reliable results for small commercial properties without meaningfully compromising the results for the large base of residential properties.

Market Background and Database Summary

All 12 towns in Wellington County were selected as the market area for this analysis (see figure 1). Wellington County is located in southwestern Ontario, approximately 100 kilometres northwest of Toronto. The geographic area of the

Figure 1. Towns selected for modeling in Wellington County, Ontario



county is approximately 1,000 square miles with a total population of 75,000. Population in the selected towns ranges from 792 to 11,052, with strong growth in the south end of the county (10% over five years) according to the 2001 general census of Canada (Statistics Canada 2002).

Although the towns are scattered throughout the county and are separated by rural areas, they are similar in that they all have a defined central business district (downtown) and evidence similar "small town" market influences. In addition, residential models based on this market area have been developed and applied for a number of years, making it much easier to make relevant comparisons.

For the purpose of this analysis, these towns were considered "sparsely populated" because the commercial activity is mostly limited to small retail operations (typically less than 10,000 square feet) and is not influenced locally by larger retail competitors (e.g., power centers, malls, and the like). These small commercial properties can comprise garages, retail stores, or office buildings and are typically bought and sold based on a comparable-sales or value-per-square-foot analysis, as opposed to income capitalization, making them a good test for the sales comparison approach.

This analysis considered sales from a five-year period from December 2000 to November 2005. The sales database included 3,742 residential property sales (3,570 improved, 172 vacant land) and 93 commercial parcels (85 improved and 8 vacant land). The commercial sales consisted of older downtown retail stores with residential units above (54%), which are typical of small Ontario towns, as well as retail stores of less than 10,000 square feet, office buildings with less than 7,500 square feet, houses converted to commercial use, garages, and a few other small retail operations. Commercial vacant land greater than three acres was removed because these sales more closely resemble those of development land than a "small retail" purchase. In addition, properties with multiple primary structures were removed in an effort to simplify the analysis. Table 1 summarizes some of the main characteristics of the database.

Modelling Approach and Issues

Two models were developed: an additive model and a hybrid model. Each model

Table 1. Sales database summary

	Number of Sales	Median	Mean	Minimum	Maximum
Frontage	3,835	65.0	67.0	14.5	474.3
Depth	3,538	130.0	141.0	40.8	999.0
Total Floor Area	3,655	1,318	1478.6	392	12,792
Building Quality (Residential Structures)	3,576	6.0	6.0	4.0	8.5
Year of Construction	3,655	1974	1959	1830	2005
Sale Amount * (Improved Residential)	3,570	$170,000	$182,788	$35,000	$680,000
Sale Amount * (Residential Vacant Land)	172	$42,000	$46,274	$9,000	$200,000
Sale Amount* (Improved Commercial)	85	$170,000	$184,099	$35,000	$825,000
Sale Amount* (Commercial Vacant Land)	8	$72,000	$80,712	$28,800	$225,000

* *All sale price information is expressed in Canadian dollars.*

contained both vacant and built-on residential and commercial sales.

The additive model was developed first in order to compare results with a similarly structured additive model developed for residential properties only during the prior general revaluation. The primary issues were: (1) how would performance results hold up for residential properties with the addition of commercial sales, and (2) what caliber of results could be obtained for the commercial sales.

Next, the model was recalibrated using a non-linear regression (NLR) model structure in order to test the hypothesis that a hybrid model structure would be able to produce improved results for the small commercial properties and possibly the residential properties as well. Hybrid models are known to be more flexible, because they can accommodate percentage as well as lump-sum and per-unit adjustments. They also are better able to calibrate curvilinear influences than additive models. These features were anticipated to be particularly important for commercial properties. In addition, the NLR model structure allows building components to be valued separately for the two property types.

Modeling residential and small commercial properties in a combined model poses some subtle valuation issues that need to be tested during the specification and calibration process. The main issues concern whether separate time, land size, and site influence variables are required. For example, heavy traffic is generally considered a negative influence for residential properties but a plus for commercial properties.

In addition, there is a significant technical challenge involved in combining both residential properties and commercial properties into one analysis. Commercial information is extracted from a different data source than residential data, with differing data format and display characteristics, making database creation for the combined model both complex and time consuming. Once this issue is addressed, model specification and calibration can begin.

Additive Model Specification and Calibration

Wellington County is very economically diverse. The southeastern portion of the county is influenced by its proximity to major urban centers. As the distance to these urban centers increases, values decrease proportionately. For this reason, the towns were grouped into four main areas:

- Land Area 1: Towns of Erin, Rockwood, and Hillsburg (premium area)
- Land Area 2: Towns of Fergus, and Elora/Salem (good area)
- Land Area 3: Towns of Alma, Drayton, Arthur, and Mount Forest (average area)
- Area 4: Towns of Clifford, Harriston, and Palmerston (below average area)

These groupings enabled the model to test and adjust for the value dispersion between areas (time, land value, and structure area).

The influence of time was measured in various ways to ensure proper representation among land areas and property types. Time trends for improved properties were tested for each area, a single trend was tested for vacant land, and commercial properties were combined into two groups for testing (Land Areas 1 and 2 and Land Areas 3 and 4). The results indicated that improved residential properties in Land Areas 1, 2, and 3 appreciated in value at a rate of approximately 31% over the five-year period. Improved residential properties in Land Area 4 experienced slightly slower growth at a rate of 26%. Vacant residential properties saw a stronger increase in value at around 46% with no measurable differences between land areas. Commercial properties in the southern area of the county (Land Area 1 and 2) saw a marginal 16% appreciation of value over five years while commercial properties in Land Area 3 and 4 remained constant (no adjustment for time).

To accommodate differences between residential and commercial properties, the following variables were tested separately based on property type:

- **Corner.** It is typically advantageous for a commercial property to be situated on a corner for visibility and accessibility reasons. This variable was tested and entered the additive model at a premium of $18,000. The influence of a corner location on residential properties was insignificant in the model.
- **Traffic.** For residential properties, the traffic variable was linearized and entered the model at –$4,900 (–$12,250 for extremely heavy traffic, –$9,800 for heavy traffic, –$4,900 for medium traffic, and –$2,450 for light traffic). In contrast, heavy traffic patterns are typically considered desirable for commercial properties. Therefore, separate variables for these influences were created and tested. While not significant, they were forced into the additive model using adjustments ranging from $2,400 to $3,000. It was expected that these variables would make increased appraisal sense as percentage adjustments in the hybrid model.
- **Depreciation.** Commercial structures are renovated to meet local building code and to accommodate an occupant's specific requirements much more often than residential structures. This renovation typically is conducted at various intervals throughout the lifetime of the occupying business and almost always takes place when the building is sold. As a result, depreciation does not increase at the same rate as the structure's age. In fact, the sales indicated that depreciation increased quite dramatically until age 40, after which it remained constant. Therefore, the age variable for commercial structures was capped at 40 years. To express depreciation as a rate per square foot, the square root of the building age was calculated and then multiplied by square feet. A similar approach was taken for residential structures with age capped at 80 years based on the initial analysis. It is important to note, however, that while commercial properties do not require increased depreciation adjustments past the 40-year mark, the rate of depreciation is much larger greater for residential properties. Table 2 details the depreciation adjustment applied by the model per 1,000 square feet:
- **Area.** Size adjustments for commercial structures and residential structures had to be measured separately. First, there are obvious differences in value between the two property types based on desirability and the construction materials used. Second, while quality of construction plays an important

Table 2. Comparison of depreciation adjustments per 1,000 square feet

Age in Years	Depreciation Adjustment (Commercial)	Depreciation Adjustment (Residential)
100	−$35,253	−$21,287
50	−$35,253	−$16,839
25	−$27,870	−$11,900
10	−$17,626	−$7,526
5	−$12,463	−$5,321

role in the valuation of residential structures, structure type is more important for commercial properties. As a result, residential area rates were linearized by construction quality while commercial rates were based on structure type. (For instance, a garage had a lower rate than a typical retail store).

The final additive model produced a coefficient of dispersion (COD) of 9.42 and an R-squared of 90.5, which indicates a strong relationship between the sales prices and the values produced by the model. Figure 2 shows the results of the model calibration.

Table 3 provides two sample calculations of the additive model results using a residential and commercial property.

Comparison to Prior Values (Additive Model)

The results of the additive model indicated that the addition of commercial sales had virtually no effect on the results of the residential predictions. Figure 3 illustrates the results of the original residential model and compares it to the combined commercial and residential model.

In addition, as figure 4 indicates, the commercial sales experienced a significantly improved COD. While the mean and median ratios appear worse, this result has more to do with the change of model format from non-linear to additive than the combination of property types. Further discussion of this effect will take place in the non-linear section of this article.

Table 3. Sample property table

	Residential Property	Commercial Property
Site Dimensions	30 x 100 feet	30 x 100 feet
Neighbourhood	212	212
Sub-neighbourhood	R15	R15
Heavy Traffic	Yes	Yes
Abuts Commercial Property	Yes	No
1st Floor Area	900 square feet	900 square feet
2nd Floor Area	900 square feet	900 square feet
Construction Quality	6.0	N/A
Year of Construction	1920	1920
Basement Area	900 square feet	900 square feet
Number of Baths	2 Full	2 Full
Heating Type	Forced Air	Forced Air
Porch Points	10	10

	Residential Property	Commercial Property
Constant	$28,730.39	$28,730.39
Location	0	0
Heavy Traffic	(−9,843.45)	2,403.30
Abuts Commercial Property	(−4,502.80)	0
Frontage	33,009.02	33,009.02
Depth	28,521.72	28,521.72
1st Floor Area	63,149.40	67,373.1
2nd Floor Area	55,688.40	53,898.48
Depreciation	(−38,317.26)	(−63,455.53)
Basement Area	13,280.40	13,280.40
Porch Points	2,330.24	0
Number of Baths	4,782.58	0
Heating	0	0
Total Predicted Value	$176,828.64	$163,760.88

Figure 2. Additive model output

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	28730.391	2851.924		10.074	.000
NB201	14539.290	5330.417	.015	2.728	.006
NB202	−28370.383	8543.511	−.026	−3.321	.001
NB203	−9706.133	4125.335	−.014	−2.353	.019
NB205	16600.763	6051.497	.015	2.743	.006
NB206	5713.357	3022.787	.012	1.890	.059
NB207	16339.847	3554.310	.028	4.597	.000
NB208	−13386.772	3328.420	−.028	−4.022	.000
NB214	5618.955	2848.231	.012	1.973	.049
NB216	10843.714	2701.173	.022	4.014	.000
NB217	8038.160	2311.400	.019	3.478	.001
NB218	14890.555	2515.975	.032	5.918	.000
NB219	25270.037	4929.063	.038	5.127	.000
NB225	−17544.475	3384.832	−.032	−5.183	.000
NB229	14947.243	2369.403	.048	6.308	.000
NB237	19671.518	4370.490	.027	4.501	.000
NB241	−18176.313	2844.282	−.037	−6.390	.000
NB243	−4686.145	2985.744	−.009	−1.570	.117
NB244	−13528.853	2126.408	−.039	−6.362	.000
E202_R53	42096.385	11730.782	.026	3.589	.000
E208_R60	−22978.747	6969.199	−.018	−3.297	.001
E211_R19	−11866.353	2490.453	−.026	−4.765	.000
E214_R13	13046.789	4927.054	.016	2.648	.008
E216_R27	−16114.714	9297.597	−.009	−1.733	.083
E219_R28	−27266.840	6898.749	−.027	−3.952	.000
E229_R43	9078.190	4851.433	.010	1.871	.061
E237_R70	26450.990	8989.245	.017	2.943	.003
E239_R79	6573.626	3965.769	.009	1.658	.097
E243_R88	−12839.995	7323.004	−.010	−1.753	.080
Commercial vacant land linearized by Land Area 1, 2, 3, and 4	−44695.102	9679.777	−.025	−4.617	.000
Improved commercial property—Land Area 2	−11847.176	6358.127	−.012	−1.863	.062
Improved commercial property—Land Area 3	−15125.109	6860.694	−.015	−2.205	.028
Residential vacant land—Land Area 1 and 2	−40674.160	4249.576	−.055	−9.571	.000
Residential vacant land—Land Area 3	−44365.640	4080.370	−.070	−10.873	.000
Residential vacant land—Land Area 4	−21447.423	4087.108	−.033	−5.248	.000
Square root of effective frontage based on typical—Land Area 1	851.437	81.523	.277	10.444	.000
Square root of effective depth based on typical—Land Area 1	415.114	38.565	.268	10.764	.000
Square root of effective frontage based on typical—Land Area 2	747.507	54.472	.293	13.723	.000
Square root of effective depth based on typical—Land Area 2	250.152	26.660	.203	9.383	.000

A Dependent Variable: Adjusted Time Adjusted Sale Amount

(figure continued on next page)

Figure 2. Additive model output (*continued*)

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Square root of effective frontage based on typical—Land Area 3	414.729	61.847	.146	6.706	.000
Square root of effective depth based on typical—Land Area 3	233.791	27.664	.174	8.451	.000
Square root of effective lot size based on typical—Land Area 4	2.575	.351	.105	7.331	.000
Linearized Traffic—Commercial	2403.296	4605.262	.004	.522	.602
Linearized Traffic—Residential	−4921.726	1054.618	−.026	−4.667	.000
Abuts Premium 1	57389.244	5659.038	.052	10.141	.000
Commercial property located on a corner	18639.507	6306.391	.017	2.956	.003
Linearized Abuts and Proximity to Commercial, Industrial, Multi-Res (Res)	−4502.800	1596.302	−.015	−2.821	.005
Quality adjusted first-floor area—Land Area 1 and 2	70.166	2.167	.549	32.377	.000
Quality adjusted area, second floor and up—Land Area 1 and 2	61.876	1.507	.328	41.052	.000
Quality adjusted first-floor area—Land Area 3 and 4	56.545	2.625	.374	21.541	.000
Quality adjusted area, second floor and up—Land Area 3 and 4	41.296	2.240	.154	18.438	.000
Commercial str rate per sq. ft. linearized by floor level and str code	74.859	3.483	.438	21.492	.000
Square root of age capped at 80 years by sq. ft.—Residential	−2.380	.148	−.156	−16.072	.000
Square root of age capped at 40 years by sq. ft.—Commercial	−5.574	.444	−.245	−12.546	.000
Linearized condition types x sq.ft.	15.889	1.145	.073	13.879	.000
Linearized structure codes-square footage-Res	−13.869	1.336	−.063	−10.382	.000
Linearized renovation type—by sq. ft., Res. str codes	15.204	1.737	.045	8.751	.000
Net basement area adjusted by height	14.756	1.824	.083	8.088	.000
Finished basement area linearized by type—mezzanine and interior office also	13.126	1.824	.044	7.197	.000
Total porch points	233.024	35.409	.040	6.581	.000
Total number of fireplaces	3111.871	957.917	.020	3.249	.001
Total number of baths	2391.292	974.263	.021	2.454	.014
Heating system linearized by type x sq. ft.	−3.890	.900	−.023	−4.322	.000
Back or front split	4923.074	2164.876	.012	2.274	.023
Improved residential property with 1 or 0 bedrooms	−8764.374	4309.083	−.010	−2.034	.042
Side split	3500.373	2011.030	.009	1.741	.082
Quality adjusted garage area linearized by type	22.649	1.898	.076	11.932	.000
Quality adjusted pool area linearized by type	18.520	4.572	.021	4.051	.000

A Dependent Variable: Adjusted Time Adjusted Sale Amount

Figure 3. Residential results comparison (original model and combined additive model)

	Original Model	Combined Additive Model
Mean	1.013	1.013
Median	1.003	1.003
Minimum	.423	.501
Maximum	1.790	1.878
Std. Deviation	.128	.127
Price Related Differential	1.013	1.013
Coefficient of Dispersion	9.10	9.00
Coefficient of Variation	12.9	12.7

Note: A slightly improved COD and COV in the combined model are more likely the result of the two additional years of residential sales than the addition of the commercial sales.

Figure 4. Commercial results comparison (original model and combined additive model)

	Original Model	Combined Additive Model
Mean	1.052	1.105
Median	.991	1.053
Minimum	.327	.489
Maximum	2.954	3.001
Std. Deviation	.453	.372
Price Related Differential	1.109	1.106
Coefficient of Dispersion	30.90	25.40
Coefficient of Variation	46.1	35.7

Non-linear (NLR) Model Specification and Calibration

The non-linear model specification and calibration expanded upon the work done during the additive model stage and created a model equation that would maintain some of the additive features while adding multiplicative adjustments for certain variables that more closely resemble the market dynamics. The equation was specified as follows:

(Landsize * site amenities * location) +
[(Residential Structure area * depreciation) +
(Commercial Structure area * depreciation) +
Structure amenities] * location adjustment

Note: "Location adjustment" refers to a percentage adjustment to the structure value in lower value economic areas (i.e., Land Areas 3 and 4). Without this adjustment, the land value has a tendency to drop too low.

The final non-linear model produced similar overall results as the additive model with a (COD) of 9.80 and an R-squared of 90.4. Figure 5 shows the results of the NLR model calibration.

Figure 5. Non-linear model output

Dependent Variable TAS_NLR

Source	DF	Sum of Squares	Mean Square
Regression	72	1.711579E+14	2377192484168
Residual	3763	2480024587673	659055165.472
Uncorrected Total	3835	1.736379E+14	
(Corrected Total)	3834	2.585078E+13	

R squared = 1 − Residual SS / Corrected SS = .90406

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Figure 5. Non-linear model output (continued)

			Asymptotic 95% Confidence Interval	
Parameter	Estimate	Asymptotic Std. Error	Lower	Upper
Square root of effective frontage based on typical—Land Area 1	959.749	77.651	807.507	1111.991
Square root of effective depth based on typical—Land Area 1	542.907	38.362	467.694	618.120
Square root of effective frontage based on typical—Land Area 2	821.048	52.258	718.592	923.503
Square root of effective depth based on typical—Land Area 2	351.773	23.242	306.205	397.342
Square root of effective frontage based on typical—Land Area 3	567.266	73.776	422.621	711.911
Square root of effective depth based on typical—Land Area 3	269.035	31.853	206.583	331.486
Square root of effective lot size based on typical—Land Area 4	4.486	0.362	3.776	5.196
NBHD_201	1.103	0.041	1.023	1.184
NBHD_202	0.903	0.042	0.821	0.984
NBHD_203	0.940	0.031	0.880	1.001
NBHD_205	1.062	0.036	0.990	1.133
NBHD_206	1.031	0.024	0.984	1.078
NBHD_207	1.151	0.034	1.085	1.217
NBHD_208	0.863	0.020	0.823	0.902
NBHD_212	1.101	0.026	1.050	1.153
NBHD_213	1.065	0.023	1.021	1.109
NBHD_214	1.181	0.031	1.120	1.242
NBHD_215	1.020	0.033	0.955	1.084
NBHD_216	1.126	0.031	1.065	1.187
NBHD_217	1.145	0.031	1.085	1.206
NBHD_218	1.208	0.033	1.143	1.273
NBHD_219	1.349	0.058	1.234	1.463
NBHD_225	0.596	0.069	0.461	0.732
NBHD_229	1.382	0.082	1.222	1.542
NBHD_235	1.002	0.049	0.905	1.098
NBHD_237	1.261	0.062	1.138	1.383
NBHD_241	0.696	0.041	0.616	0.776
NBHD_242	0.938	0.067	0.807	1.069
NBHD_243	0.929	0.047	0.838	1.021
NBHD_244	0.782	0.033	0.717	0.847
E207_R65	0.957	0.038	0.883	1.031
E212_R17	0.898	0.039	0.822	0.975
E213_R08	0.948	0.055	0.841	1.056
E219_R28	0.728	0.045	0.640	0.815

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Figure 5. Non-linear model output (continued)

			Asymptotic 95% Confidence Interval	
Parameter	Estimate	Asymptotic Std. Error	Lower	Upper
E227_R38	0.274	0.245	−0.206	0.754
E229_R41	1.488	0.148	1.197	1.779
E235_R46	0.959	0.054	0.852	1.066
E237_R71	0.868	0.079	0.713	1.024
E239_R78	0.864	0.060	0.747	0.980
E243_R88	0.806	0.099	0.612	1.000
E244_R90	1.093	0.104	0.890	1.296
Heavy Traffic—Commercial	1.259	0.052	1.156	1.361
Heavy Traffic—Residential	0.879	0.022	0.836	0.922
Medium Traffic—Residential	0.952	0.018	0.917	0.987
Abuts Commercial, Industrial, Multi-Res—(Res)	0.961	0.016	0.928	0.993
Abuts Premium 1	1.404	0.050	1.306	1.502
Vacant land—Residential	0.663	0.027	0.611	0.715
Vacant land—Commercial	0.622	0.063	0.499	0.745
Corner—Commercial	1.167	0.068	1.033	1.301
Quality adjusted first floor area (Residential)	68.373	2.239	63.983	72.762
Quality adjusted second floor area (Residential)	54.377	1.583	51.273	57.482
Depreciation exponent (Residential)	0.712	0.046	0.622	0.801
Linearized structure rate by floor and code (Commercial)	92.761	6.149	80.704	104.817
Depreciation exponent (Commercial)	5.822	0.485	4.872	6.773
Linearized garage rate	23.497	2.091	19.397	27.597
Unfinished basement/mezzanine/interior office rate	16.325	2.021	12.363	20.287
Linearized condition rate	19.599	1.251	17.147	22.052
Finished basement rate	10.788	1.947	6.971	14.605
Renovation rate (Residential)	17.133	1.913	13.383	20.883
1 or 0 bedrooms (Residential)	−4935.245	4630.545	−14013.866	4143.377
Linearized structure code rate (Residential)	−9.647	1.349	−12.292	−7.001
Porch point rate	277.962	38.898	201.700	354.225
Pool rate	16.253	4.791	6.860	25.646
Fireplace rate	1919.296	1004.934	−50.971	3889.564
Linearized inferior heat rate	−4.180	0.985	−6.111	−2.250
Bathroom rate	3382.490	1024.670	1373.526	5391.453
Back split rate	5891.793	2306.988	1368.725	10414.862
Side split rate	2949.761	2122.142	−1210.900	7110.422
Residential Structure Rate Adjustment (Land Area 3)	0.900	0.024	0.852	0.948
Residential Structure Rate Adjustment (Land Area 4)	0.838	0.026	0.786	0.890
Commercial Structure Rate Adjustment (Land Area 3)	0.970	0.080	0.814	1.127
Commercial Structure Rate Adjustment (Land Area 4)	0.712	0.084	0.547	0.878

Table 4. Sample non-linear model application property table

	Residential Property	Commercial Property
Frontage	$36,256.59	$36,256.59
Depth	$40,107.95	$40,107.95
Neighbourhood Multiplier	1.10	1.10
Heavy Traffic Multiplier	0.88	1.26
Abuts Comm. Multiplier	0.96	N/A
Total Land Value	$70,964.04	$105,841.25
Ground Floor	$61,533.00	$83,448.00
Second Floor	$48,942.00	$66,789.00
Total Area Value	$110,475.00	$150,237.00
Depreciation Multiplier	0.70	0.27
Net Area Value	$77,332.50	$40,563.99
Baths	$6,764.98	0
Basement Area	$14,688.00	$14,688.00
Porch Points	$2,779.60	0
Total Structure Value	$101,565.08	$55,251.88
Total Value	$172,529.12	$161,093.24

Figure 5. Residential results comparison (original model and combined NLR model)

	Original Model	Combined NLR Model
Mean	1.013	1.009
Median	1.003	0.997
Minimum	.423	.238
Maximum	1.790	2.008
Std. Deviation	.128	.132
Price Related Differential	1.013	1.012
Coefficient of Dispersion	9.10	9.40
Coefficient of Variation	12.9	13.3

Figure 6. Commercial results comparison (original model and combined NLR model)

	Original Model	Combined NLR Model
Mean	1.052	1.091
Median	.991	1.003
Minimum	.327	.465
Maximum	2.954	2.504
Std. Deviation	.453	.354
Price Related Differential	1.109	1.083
Coefficient of Dispersion	30.90	26.10
Coefficient of Variation	46.1	36.4

Table 4 provides a sample calculation of the non-linear model using the data from table 3.

Comparison to Prior Values (Hybrid Model)

The results of the non-linear model indicated that the addition of commercial sales had virtually no effect on the results of the residential predictions. In addition, the change of model format (from additive to non-linear) had no significant impact on the residential values. Figure 6 illustrates the results of the original residential model and compares it to the combined commercial and residential NLR model.

The commercial results of the combined NLR model indicate that the quality of the prediction has improved both over the additive model attempt and the original commercial model (see figure 7). Note also the improved median ratio for the commercial properties (1.003 vs. 1.053). This is likely the result of elimination of the constant and addition of percentage adjustments in the NLR model.

Conclusions

The results of this research indicate that combining residential and commercial properties into a single valuation model improves the predictions on commercial properties without significantly compromising the results of the residential properties. Both the additive model and the non-linear model suggest that values for commercial properties are better understood and explained by comparing different properties in the same location, rather than analyzing only commercial sales across vast areas. Further research would be required to determine whether these results could be reproduced in rural areas where a defined business district (downtown) does not exist. In addition, it would be interesting to test the combination of residential and commercial properties in an urbanized setting, where more commercial sales were available but still not enough to model commercial properties separately as in major urban areas.

References

Statistics Canada. 2002. *Population and dwelling counts*, 2001. Ottawa, ON: Statistics Canada.