Assessing Land and Structure Values in a Mass-appraisal Framework

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This draft paper is circulated for comments only, not for citation.

Abstract

The assessed value of a real property is supposed to serve as an accurate indication of its corresponding market value. If property value is not properly assessed, the advantages of value-based policies, such as property tax and eminent domain, will be lost and land uses will consequently be distorted. Samples of 10,191 residential properties transacted between January 1999 and June 2004 in Taipei City are thoroughly examined. Assessment ratio study finds no significant assessment regressivity or progressivity. The assessment ratios between houses, apartments and high-rise apartments, however, are found to be significantly different. As a result, owners of different types of properties but at the same market price are treated differently. Spatial consideration is explicitly added into this study. A potential clustering of lis with similar assessment ratios is identified. This non-random pattern infers assessment inequity in a spatial sense. Another recognized clustering of inaccurately assessed properties suggests that the assessment errors shall be related to certain socio-economic factors that vary over space.

Property Assessment as Economic, Social and Spatial Issues

Property assessment issues have been examined in a variety of studies, primarily in the context of property tax. Two topics are frequently raised: horizontal and vertical tax inequity. Horizontal inequity refers to the systematic variations in assessment level among properties of a similar value. Vertical inequity refers to the systematic variations in assessment level among properties of different values. Assessment ratio, defined as assessed value divided by market value, is introduced to measure tax inequity. Horizontal inequity is identified when properties with similar market value are not treated uniformly or are appraised not at the same percentage of market value (Allen and Dare 2002). In contrast, vertical inequity is present when assessment ratio is significantly different over differing price ranges of the same type of property (Sirmans et al.1995). Horizontal and vertical tax inequity is largely due to assessment bias or the poor correspondence between assessed value and market value. Some recent studies, Clapp (1990), Sunderman et al. (1990), Birch et al. (1990), and Cornia and Slade (2005), are still inconclusive regarding tax regressivity or progressivity but have highlighted the importance of a sound property assessment system. In addition to efforts on revealing the regressive or progressive nature of property tax, several works have reported factors that account for tax inequity. Goolsby (1997) finds that high-valued and aged properties tend to be undervalued. DeCesare and Ruddock (1998) note that appraisal errors are significantly related to certain property characteristics such as floor areas and property age. Allen and Dare (2002) conclude that the effects of property age, floor area and site area on price are not well considered in property assessment. This line of research points to the adverse consequences of unsatisfactory property assessment.

The above researches view property assessment as an economic issue and focus their emphasis on redistribution of tax liability and valuation errors among properties. Thrall (1979a) introduces a geographic criterion to identify property-tax assessment inequity. Thrall uses 572 single-family dwellings in Hamilton, Ontario of 1976 as example to depict a contour map of assessment ratios. One should not be able to observe a significant contour surface if assessment were truly equitable. It is found that areas where properties are over-assessed contain residents of low income and high population density, and areas where properties are under-assessed are at the fringe of the central business district and at the urban fringe. This study brings the spatial perspective into the property assessment. Thrall (1979b) reports, again using Hamilton, Ontario as study area, that assessment ratios vary with respect to not only property price but also neighborhoods. Assessment ratios are demonstrated to be not uniform across space. Thrall (1993) explicitly employs geographic information system technology to redo his

1979 works. He argues that if assessors perform their duty perfectly, a frequency distribution of assessment ratios would be a spike. A criterion as a measure for the quality of property assessment is whether a frequency of the ratios among all assessed properties is more peaked or concentrated around the mean ratio. In addition, the criterion for evaluating the quality of property assessment should be spatial for real estate phenomenon is spatial. Property assessment is found unequal if observations that fall within the tales of a frequency distribution of assessment ratios are shown to cluster rather than being spatially disbursed. The measure of skewness indicates that more houses in Hamilton are over-assessed than are under-assessed. Visual inspection of maps with over and under assessed properties leads Thrall to conclude no apparent spatial regularities. Harris and Lehman (2001) undertake an intertemporal study of property assessment for Hamilton, Ontario. They confirm the previous research findings that cheap houses are often over-assessed and suburb residents are usually favored. It is concluded that inaccuracies in the assessment are not random, but instead produce systematic inequities in space.

The assessed value is expected to reflect accurately its corresponding market value. If property value is not assessed properly, the advantages of value-based policies, such as property tax and eminent domain, will be lost and land uses will consequently be distorted. Property assessment, undertaken by assessing officers, requires estimate of values on a pre-determined date. However, the infrequent property transactions and lack of relevant information pose problems to assessors.

Valuation of Land and Improvements in Taiwan

The philosophy of regarding land as a gift of nature leads the Taiwan government to designing taxation and valuation systems with differential treatments of land and improvements. Thus, the government adopts not only a two-rate property tax, levied annually with land taxed at a higher rate than improvements, but also a land increment tax, which is paid when land is transferred. Besides, land and improvements are separately compensated when a property is under eminent domain. The differing treatment of land and improvements naturally calls for the separate valuation of land and improvements. It is believed that values given by nature are different form those arising from investment of capital and labor.

As far as land valuation is concerned, the land administration department in each local government is responsible for collecting market data and based on this data estimate land value for individual parcels. In addition, each local government is required to establish a land value assessment committee. This committee is given authority to approve the assessed land values and make changes to them when members think appropriate.

The land value assessment committee is made up of elected representatives and persons of high social standing. Procedure of valuing land is based on regulation of investigating and estimating land value. Jurisdiction of a local government is divided into a number of sections. Land parcels within a section are similar in price and site characteristics, and influenced by the same market forces. Every year, data of land and property sales are collected. In the case of property sales, current improvements value, decoration and equipment costs and expected profits from improvements sales are deducted from the sales price to estimate land value. The current improvements value is estimated through cost approach: replacement costs new less accrued depreciation. Replacement cost and depreciation rate for a variety of types of properties are specified and announced by local governments. The medium land value per square meter is therefore the sectional land value that is indicative of the general price level for sites within the section. It is a common practice that the assessed values for all land parcels within the same section are the same. There are a total of 2878 land value sections in Taipei as of year 2004.

The revenue service department of a local government is the competent authority for assessing improvement value. Assessment results are submitted to the real estate assessment committee for approval. The real estate assessment committee is composed of officers-in-charge and experts in related professions. Materials used, durability periods and depreciation are all considered when determining standard value of improvements. Furthermore, supply of and demand for improvements and market price of similar improvements in local areas are additional factors to be taken into account. The standard values of improvements shall be reassessed every three years.

To put it simply, local governments assess values of land and improvements of all properties in Taiwan, and owners are notified of the results. Land value is assessed by the land administration department, and improvement value is assessed by the revenue service department, both at a constant interval. The land administration department is required to collect property sales data in the market. The residual of sales price less specified items of value and cost is attributed to land value. It is an application of the extraction method in appraisal principles. The revenue service department is not primarily concerned with the sales data. It calculates the current improvement value based on cost tables published by the local government. Although land and improvements are assessed separately, the majority of improvements and the site on which the improvements are located are owned by the same owner.

The empirical data examined in this study is the 10,191 residential properties transacted between January 1999 and June 2004 in Taipei City. Figure 1 shows the distribution of property samples over the location. Table 1 provides summary of main property characteristics. The sample properties overall distribute widely over price, structure age, building area and site size, and are therefore suitable for further analysis.

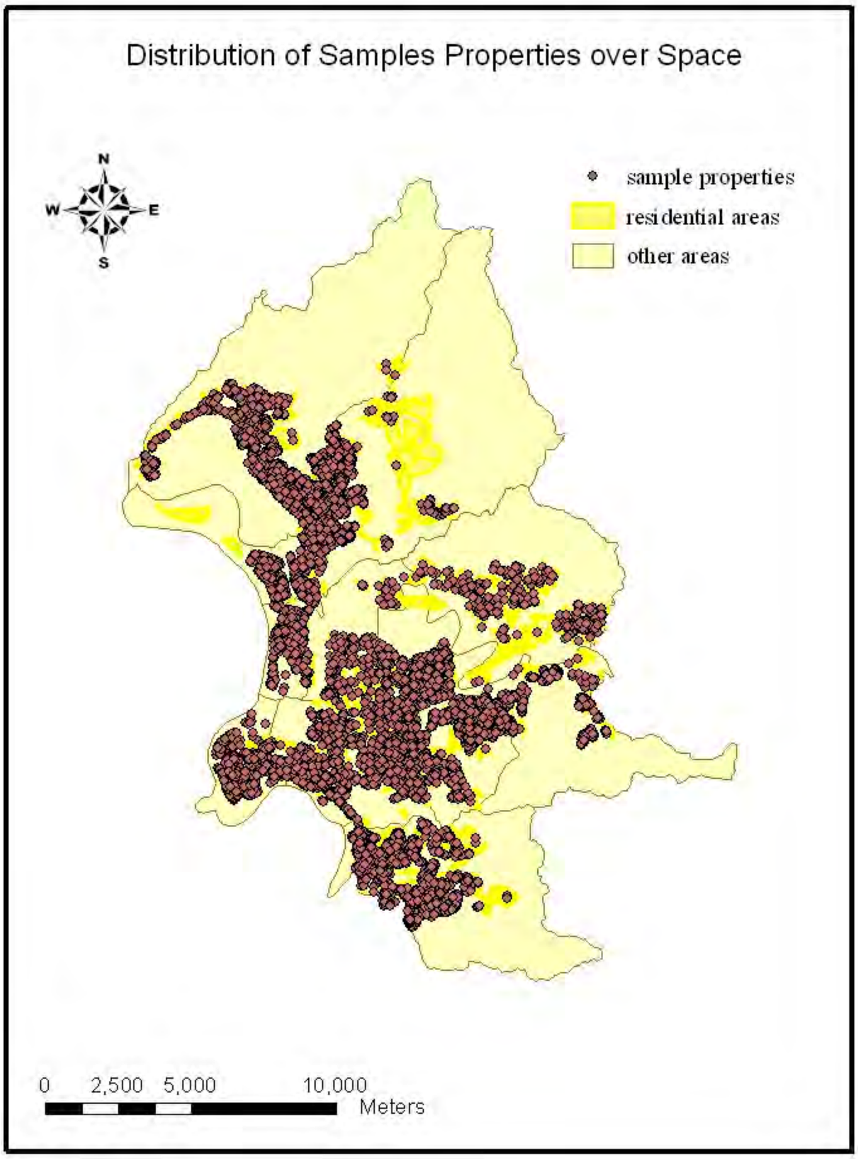

Figure 1. Distribution of Sample Properties over Space.

Table 1 Statistical Summary of Sample Properties

	Min.	*Max.*	*Mean*	*SD*
Total price (NT dollar)	880,000	192,000,000	7,076,231	4,969,744
Structure age(in years)	0	48	19.66	7.94
Building areas (m^2)	5.00	2,795.00	109.21	55.19
Site size (m^2)	0.85	486.81	32.88	22.08

The principal criterion adopted in this study to evaluate assessment performance is the assessment ratio. Assessment ratio is the ratio of the assessed value to an indicator of market value; and by extension, an estimated fractional relationship between the assessed values and market values of a group of properties (IAAO 1990: 633). Sales price is often used as the proxy for market value. This criterion has been employed in a number of studies on assessed property values in relation to tax equity, such as Paglin and Fogarty (1972), Birch et al. (1990, 1992) and Janssen and Soderberg (1999) among others. There shall be no significant variations over assessment ratios among individual properties, or among properties grouped by their price, type or location. If assessment ratio varies among different groups of property, they will be treated differently and inequity issues arise.

Equity of Property Assessment

Table 2 shows the statistics on assessment ratios for the entire sample of 10,191 properties. Figure 2 graphs the distribution of assessment ratios. The assessed value of properties is on average 57 percent of their sales price. The distribution is skewed towards the right with a positive skewness value. Using mean value as a benchmark, this right-skewed pattern indicates more property being over-assessed than under-assessed. In addition, the kurtosis value is greater than 3, thus indicating a leptokurtic distribution that is peaked at the mean ratio and with flat tails. Vertical equity of assessment ratios is detected by price-related differential. This is a statistic for measuring regressivity or progressivity of assessment ratios over property prices (IAAO 1990: 539). If the value of price-related differential is greater than 1, high-value properties are under-appraised. Regressivity of assessment ratios is thus suggested. In contrast, if the value of price-related differential is less than 1, high-value properties are over-appraised. Thus, progressivity of assessment ratios is suggested. As a general rule, price-related differential should range between 0.98 and 1.03 (IAAO 1990: 540). In our case, the value of 1.05 indicates a significant but mild assessment regressivity. High-value properties are slightly under-appraised.

Table 2 Statistical Summary of Assessment Ratios

	Min.	*Max.*	*Mean*	*SD*	*Skewness*	*Kurtosis*	*Price-Related Differential*
ratios	0.03	2.07	0.57	0.19	1.25	4.17	1.05

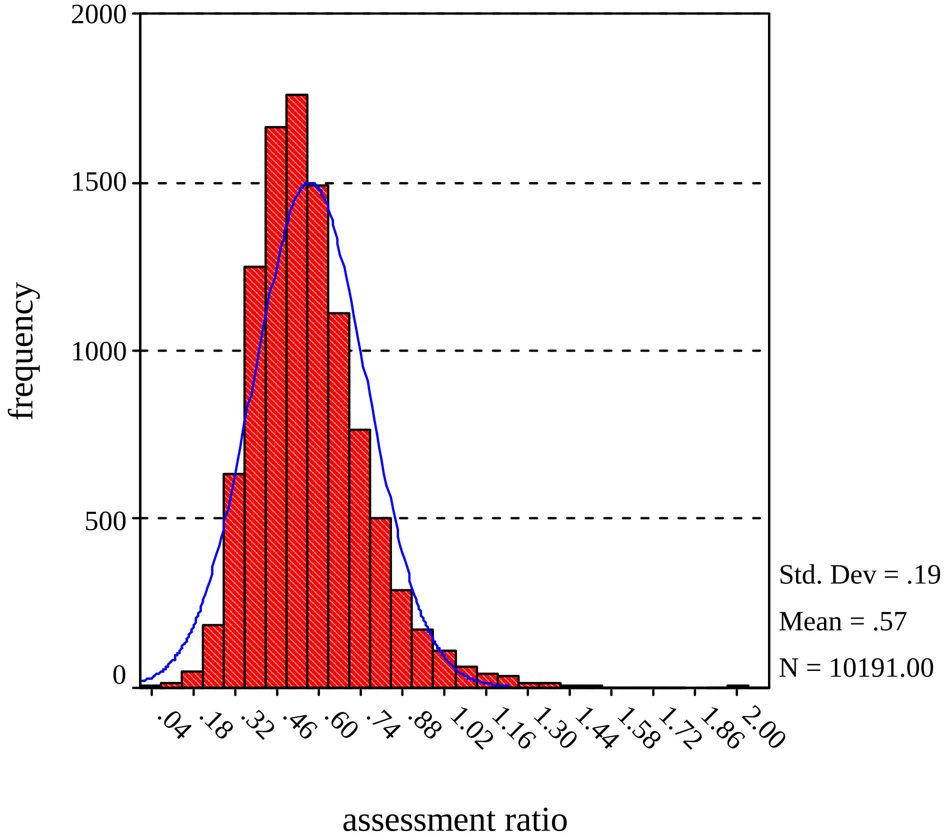

Figure 2. Frequency Distribution of Assessment Ratios for the entire Sample Properties.

The relationship between the level of sales price and its corresponding assessment ratio is one of our principal concerns. Table 3 provides the summary statistics of the sales price, and Figure 3 illustrates this relationship through the scattered plots. Figure 3 seems to suggest an inverse relationship between sales price and assessed ratio.

Table 3 Summary Statistics of Sales Price

	Min.	*Max.*	*Mean*	*SD*
Sales prices (unit: NT 1,000)	880	192,000	7,076	4,970

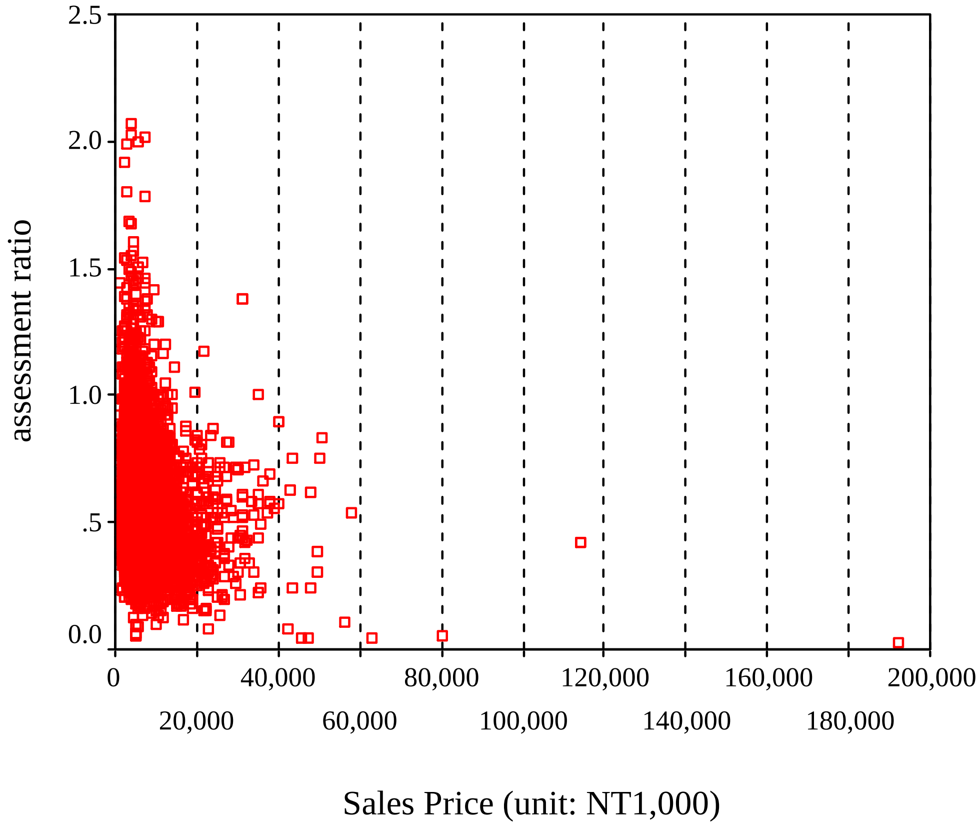

Figure 3. Relationship between Sales Price and Assessment Ratio.

We further divide the total sample data over years. Table 4 provides the information on distribution of sales prices and assessment ratios over the six-year sample period. The mean assessment ratio over the six years ranges between 0.53 and 0.6, not a significant difference. The ratio level seems to be stable over time. Except for 2004, assessment ratios exhibit a leptokurtic distribution that is peaked at the mean ratio and with flat tails. The coefficient of variation (COV), standard deviation expressed as a percentage of the mean, makes comparisons of assessment ratios between years possible (IAAO 1990: 539). The values of COV remain stable among years, suggesting a stable quality of assessment. Taking all the evidence into account, the majority of properties are assessed at a stable fraction of sales price over time. This suggests a reasonable assessment performance in terms of stability. However, the values of price-related differential suggest the common phenomenon of regressivity of assessment ratio. The high-value properties are relatively under-assessed. This raises the concern of assessment inequity. In addition, Figure 4 provides visual inspection of the relationship between sale price and assessment ratio for individual years.

Table 4 Sales Prices and assessment ratios over 1999 through 2004

Sales Prices (unit:NT 1,000)				
	Mean	Min.	Max.	SD
1999	7,770	1,439	50,550	4,813
2000	7,526	1,200	192,000	6,703
2001	6,569	880	58,000	3,709
2002	6,757	1,250	43,000	3,709
2003	6,662	900	80,000	4,645
2004	7,770	1,550	63,000	4,645

Assessment ratio									
	Numbers	Mean	Min.	Max.	SD	Skewness	kurtosis	COV	PRD
1999	1,777	0.55	0.15	2.00	0.18	1.21	4.07	32.73	1.04
2000	2,343	0.53	0.03	2.02	0.18	1.27	4.97	33.94	1.06
2001	2,129	0.60	0.05	2.02	0.20	1.15	3.16	33.13	1.05
2002	1,546	0.59	0.07	1.99	0.19	1.38	5.45	31.99	1.03
2003	1,699	0.58	0.04	2.07	0.20	1.35	4.19	33.98	1.04
2004	679	0.54	0.05	1.46	0.16	0.90	2.33	30.15	1.05

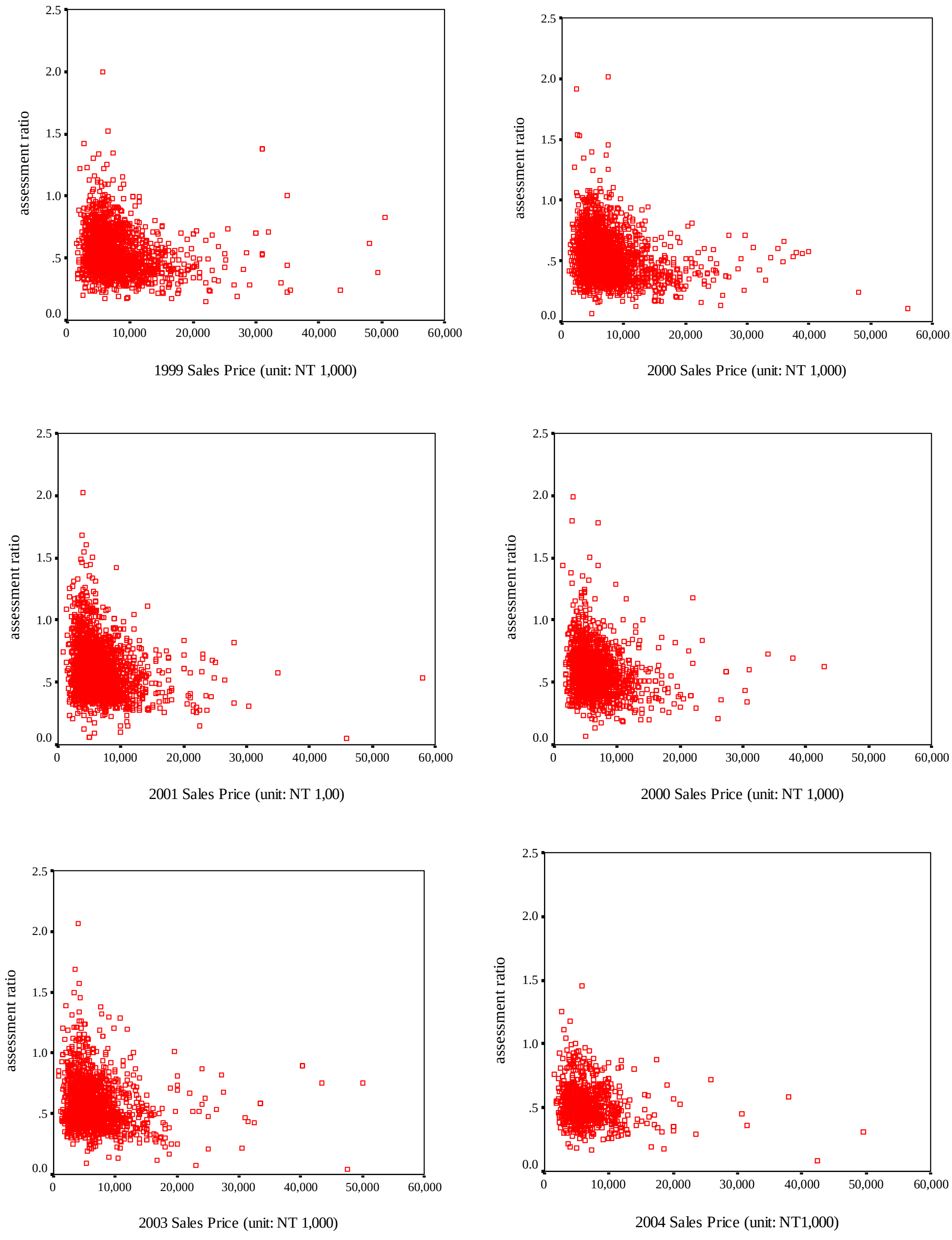

Figure 4. Relationship between assessment ratio and sales prices over years.

As well with price-related differential, the regressive or progressive nature of assessment is explored through comparison of assessment ratios among properties grouped by price levels. We group the entire sample into five price quintiles with equal number of properties within each. The result is shown as Table 5. SP_1, SP_2, SP_3, SP_4

and SP_5 represent the groups of properties with a descending order in sales price. It is clear that the mean assessment ratio decreases with increase in price from 0.62 to 0.49. This suggests a regressive nature of assessment. The higher coefficients of variation for most and least expensive properties indicate the potential difficulties with assessing those properties compared to properties of medium price. The assessment difficulty leads to a higher standard variation in assessment. This regressive nature of assessment persists over years and this is evidenced by Table 6. Tables 5 and 6 support that regressivity is an inherent and long-term nature of property assessment.

Table 5 Distribution of Assessment Ratios among Property Groups by Prices

	Number	*Mean*	*SD*	*COV*
SP_1	2,038	0.49	0.17	34.77
SP_2	2,038	0.55	0.17	30.64
SP_3	2,039	0.57	0.17	30.40
SP_4	2,038	0.60	0.19	30.95
SP_5	2,038	0.62	0.22	34.83

Table 6 Distribution of Assessment Ratios among Property Groups by Prices over Years

1999	***Number***	***Mean***	***SD***	***2000***	***Number***	***Mean***	***SD***	***2001***	***Number***	***Mean***	***SD***
SP_1	0.47	0.16	0.47	SP_1	469	0.46	0.16	SP_1	0.53	0.18	0.53
SP_2	0.53	0.16	0.53	SP_2	468	0.53	0.19	SP_2	0.57	0.16	0.57
SP_3	0.57	0.18	0.57	SP_3	469	0.53	0.15	SP_3	0.63	0.19	0.63
SP_4	0.59	0.18	0.59	SP_4	468	0.57	0.17	SP_4	0.64	0.21	0.64
SP_5	0.60	0.19	0.60	SP_5	469	0.57	0.20	SP_5	0.67	0.23	0.67
2002	***Number***	***Mean***	***SD***	***2003***	***Number***	***Mean***	***SD***	***2004***	***Number***	***Mean***	***SD***
SP_1	0.52	0.17	0.52	SP_1	340	0.51	0.19	SP_1	0.49	0.16	0.49
SP_2	0.57	0.17	0.57	SP_2	340	0.55	0.17	SP_2	0.53	0.13	0.53
SP_3	0.59	0.17	0.59	SP_3	339	0.58	0.17	SP_3	0.53	0.16	0.53
SP_4	0.62	0.19	0.62	SP_4	340	0.62	0.21	SP_4	0.56	0.17	0.56
SP_5	0.64	0.21	0.64	SP_5	340	0.63	0.22	SP_5	0.58	0.18	0.58

Assessment among Property Types

As argued earlier, as far as valuation is concerned, no significant assessment difference shall be detected among different types of property. The entire property sample is divided into three property types: houses, apartments and high-rise apartments. Houses are a self-standing or detached building with its own entrance. Apartments refer to a building of less than five-stories (including) occupied by several households. High-rise apartments are buildings of over five-stories, with elevators, and occupied by more households than apartments. The site of a house is normally owned by a single owner. The site of apartments or high-rise apartments is typically in multi-ownership held by all households in that building. These differences pose challenges to property valuation. Houses are generally heterogeneous in property characteristics and with the smallest number of units in the housing market. These features contribute to difficulties in finding comparables and making adjustments in values. By contrast, apartments and high-rise apartments are popular dwelling types in terms of their numbers, but they pose problems with valuation as well. It is relatively easy to find comparables, even possibly in the same building as the subject property. However, the attribution of a fraction of the value of a site in multi-ownership to one of the several units within a building is by no means an easy task. Not only the floor area, allocated site size and other often considered variables, but even the floor a unit occupies affects price significantly. Table 7 supplies the related evidence. The least number of houses in our study reflects the smallest share in housing stock. The initial observation is that the three kinds of properties are assessed differently, with houses assessed at the highest degree of 71%, and high-rise apartments at the lowest level of 48%. Tax burden for a residential property will vary with its property type: house, apartment or high-rise apartment. Assessment inequity seems to be in place. In addition, this is contrary to the principle of ad valorem property tax. Another statistics that some attention is needed is coefficient of variation. Both coefficients of variation for apartments and high-rise apartments are higher than that of houses. Assessment of properties in multi-ownership is comparatively difficult reflected by a higher coefficient of variation for assessment ratio. A visual inspection of Figure 5 shows that frequency distribution of assessment ratios for the three types of properties reveals the same information. Assessment level is not independent of property type, and this implies assessment inequity among property types.

Table 7 Assessment Ratios for Houses, Apartments and High-rise apartments

	Numbers	*Mean*	*SD*	*Skewness*	*Kurtosis*	*COV*	*PRD*
House	335	0.71	0.20	1.05	4.00	28.52	1.03
Apartment	6,574	0.60	0.19	1.13	3.66	31.31	1.04
High-rise Apart.	3,282	0.48	0.15	2.01	11.78	31.92	1.03

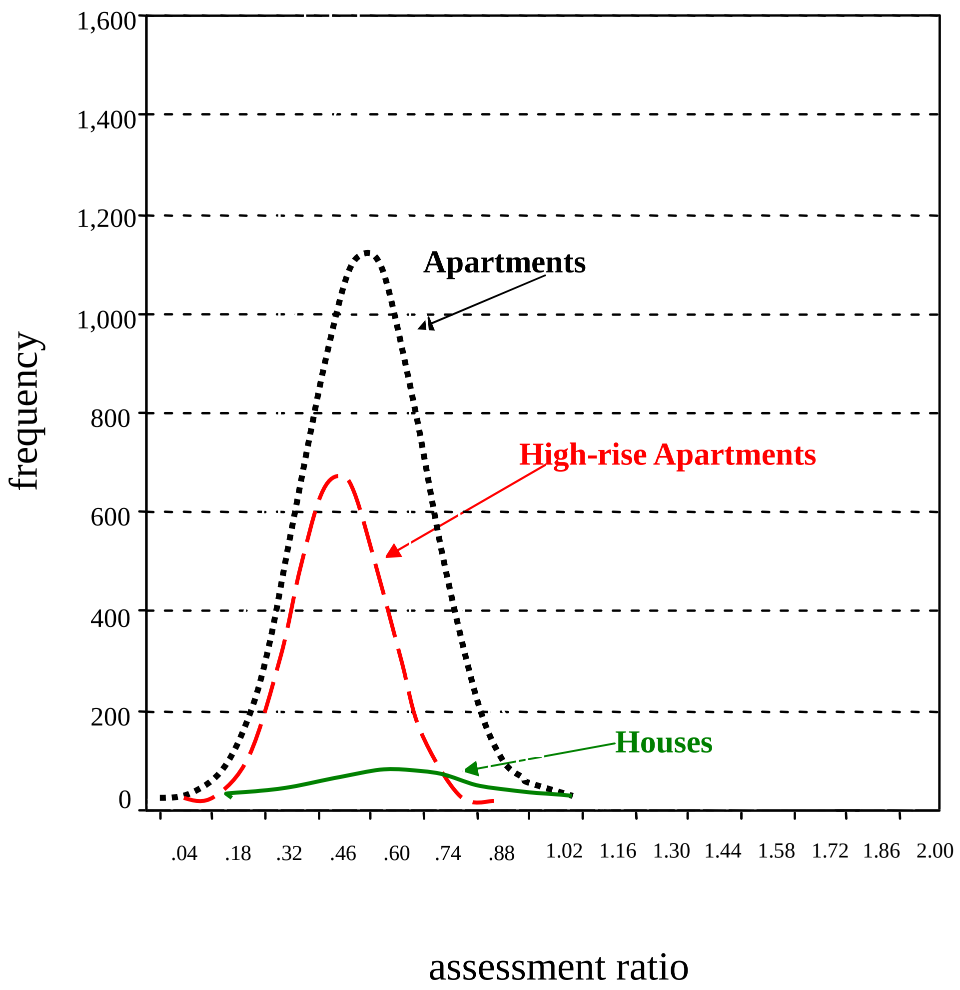

Figure 5. Frequency Distribution of Assessment Ratios for Houses, Apartments and High-rise Apartments.

Examination of mean assessment ratio and coefficient of variation both point out differences among houses, apartments and high-rise apartments. The Kruskal-Wallis test is also employed to see whether the assessment ratios among the three property types are equal. The nonparametric K-W test does not require the assumptions of normality and equal variances (Anderson et al. 1999: 827). With 2 degrees of freedom and 5 percentage of significance level, the null hypothesis that three property types are equal in their assessment ratios are refuted as the statistics in Table 8 shows. In addition, Figure 5 initially suggests that the frequency distribution of assessment ratios for different property types differs. Two-sample Kolmogorov-Smirnov Test is used to compare statistically whether any two of the three property groups have the same frequency distribution of assessment ratios. Table 9 indicates that neither any two of the three property types have the same assessment ratio distribution. It is therefore clear that houses, apartments and high-rise apartments are assessed differently.

Table 8 Kruskal-Wallis Test for Different Property Types

	Assessment ratio
Chi-square value	1432.281
Degrees of freedom	2
P-value	0.000

Table 9 Two-sample Kolmogorov-Smirnov Test for Different Property Types

	Z-value	*P-value*
House vs. Apart.	4.868	0.00
House vs. High-rise apart.	9.884	0.00
Apart. vs. High-rise apart.	16.212	0.00

Assessment Levels over Space

In addition to the comparison between property types, another issue that warrants more attention is the spatial distribution of assessment ratios. All 12 districts of Taipei City are divided into three areas based upon their development stages. They are respectively declining area, stable area and developing area. Table 10 provides details of assessment ratios for individual districts by years and property types. The figures show that across years assessment ratios for the declining area are slightly higher than the stable and developing areas. This is in accordance with the conclusion of most prior studies. For all types of property, the assessment ratios in the declining area are also slightly higher than the stable and developing areas. It is also noted that houses in the declining area tend to be assessed at a higher level. All these evidence gives rise to concerns on assessment equity. Figure 6 shows that districts with a darker color tend to cluster around the western part of Taipei City where the City was first developed. The districts with a lighter color do not seem to exhibit a clear pattern in location, but tend to be within the developing area. The spatial pattern of assessment ratios suggests that the inequity of assessment ratios might be related to development pace of the City.

Table 10 Assessment Ratios for Individual Districts

				1999	*2000*	*2001*	*2002*	*2003*	*2004*	*House*	*Apart*	*High-rise*
declining area	*Zhongzheng*	*Num*	*675*	*128*	*92*	*148*	*98*	*109*	*43*	*11*	*351*	*286*
		Mean	0.63	0.60	0.55	0.65	0.71	0.69	0.60	0.86	0.69	0.55
		SD	0.22	0.24	0.21	0.20	0.21	0.24	0.15	0.33	0.21	0.20
	Wanhua	Num	444	103	89	113	82	101	63	37	368	146
		Mean	0.66	0.57	0.63	0.68	0.70	0.68	0.57	0.83	0.68	0.50
		SD	0.24	0.18	0.16	0.24	0.27	0.27	0.19	0.29	0.22	0.15
	Datong	Num	390	83	69	86	48	68	36	11	232	147
		Mean	0.54	0.54	0.50	0.54	0.56	0.58	0.49	0.73	0.58	0.46
		SD	0.18	0.19	0.18	0.17	0.17	0.20	0.14	0.16	0.19	0.13
stable area	Daan	Num	689	147	137	149	124	82	50	4	321	364
		Mean	0.59	0.56	0.66	0.63	0.58	0.57	0.49	0.88	0.67	0.52
		SD	0.18	0.18	0.21	0.20	0.13	0.17	0.13	0.06	0.18	0.15
	Songshan	Num	575	97	98	134	91	109	46	12	374	189
		Mean	0.58	0.55	0.53	0.65	0.61	0.58	0.52	0.69	0.62	0.50
		SD	0.19	0.21	0.15	0.19	0.20	0.16	0.13	0.16	0.18	0.16
	Xinyi	Num	659	118	142	20	127	78	34	10	403	246
		Mean	0.57	0.60	0.47	0.74	0.58	0.54	0.53	0.63	0.61	0.50
		SD	0.22	0.22	0.16	0.31	0.17	0.19	0.27	0.16	0.22	0.20
	Zhongshan	Num	178	-	178	-	-	-	-	6	88	84
		Mean	0.48	-	0.48	-	-	-	-	0.52	0.54	0.42
		SD	0.17	-	0.17	-	-	-	-	0.12	0.17	0.15
developing area	Wenshan	Num	1478	301	274	318	224	291	70	27	946	505
		Mean	0.55	0.52	0.55	0.59	0.55	0.54	0.52	0.73	0.59	0.47
		SD	0.17	0.16	0.17	0.19	0.17	0.16	0.15	0.13	0.17	0.13
	Beitou	Num	1977	357	380	413	321	342	164	111	1385	481
		Mean	0.55	0.55	0.55	0.57	0.55	0.55	0.53	0.66	0.59	0.43
		SD	0.18	0.15	0.20	0.17	0.18	0.19	0.13	0.14	0.18	0.11
	Sulin	Num	2029	321	405	460	338	380	125	87	1342	600
		Mean	0.58	0.54	0.56	0.60	0.59	0.58	0.55	0.70	0.61	0.48
		SD	0.18	0.17	0.16	0.20	0.18	0.19	0.16	0.21	0.18	0.15
	Nangang	Num	711	122	145	148	93	137	66	15	544	152
		Mean	0.56	0.53	0.54	0.57	0.56	0.58	0.55	0.69	0.57	0.49

	SD	0.16	0.16	0.15	0.16	0.14	0.16	0.17	0.14	0.16	0.12
Neihu	Num	279	-	279	-	-	-	-	4	193	82
	Mean	0.40	-	0.40	-	-	-	-	0.54	0.41	0.35
	SD	0.11	-	0.11	-	-	-	-	0.16	0.11	0.10

Note: --: lack of data.

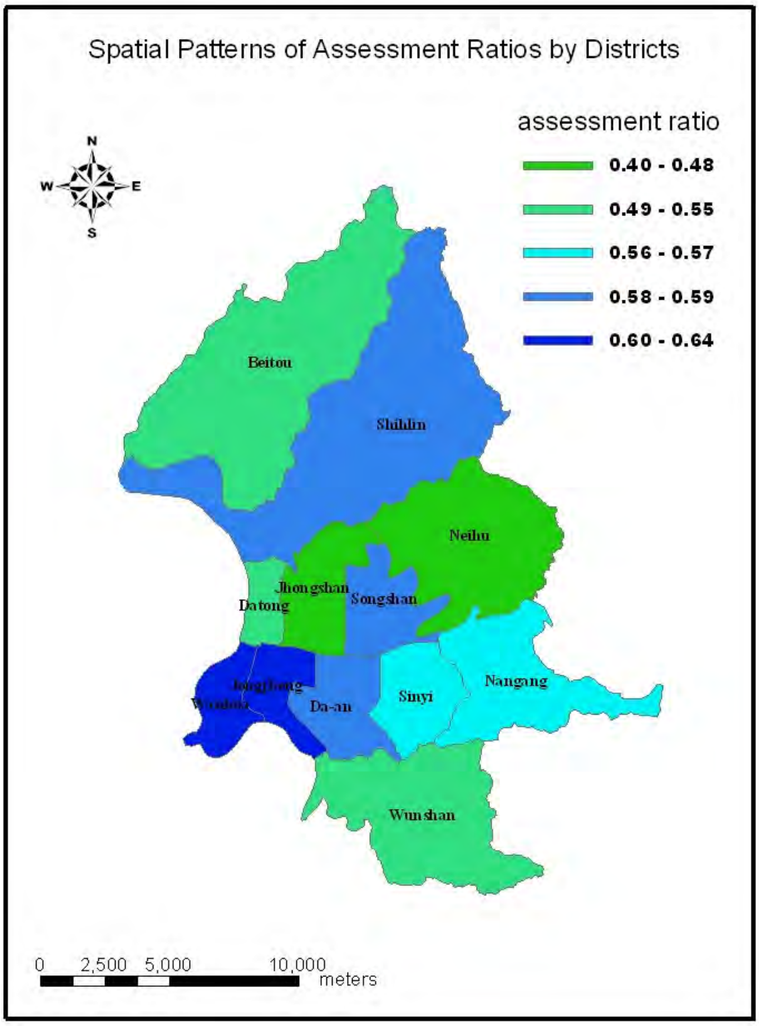

Figure 6. Spatial Patterns of Assessment Ratios by Districts.

Although visual examination helps in detecting spatial pattern of assessment ratios, this pattern can be further explored through explicit spatial analyses. We first define incorrectly-assessed properties as those whose assessment ratios fall over one standard deviation from the mean ratio. Number of properties incorrectly assessed for each year is seen in Table 11, and their locations in space are shown in Figure 7. The visual inspection of Figure 7 indicates that over-assessed properties seem likely to be located in declining and stable areas and under-assessed properties tend to cluster in the developing area. However, a reliable spatial relationship of assessment ratios needs further analysis.

Table 11 Number of Incorrectly-Assessed Properties

	Total Observations	*Over one SD*	*Under one SD*
Entire samples	**10,191**	**1,353**	**1,328**
1999	1,777	252	223
2000	2,343	329	310
2001	2,129	288	261
2002	1,546	201	205
2003	1,699	214	188
2004	697	88	83

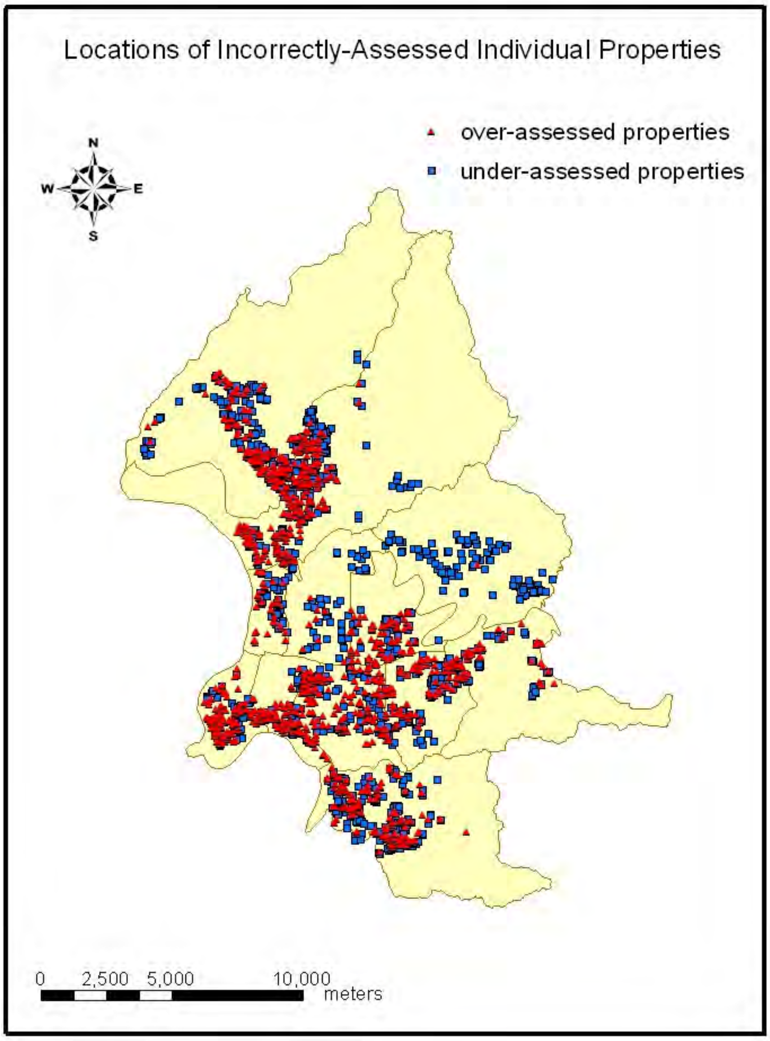

Figure 7. Locations of Incorrectly-Assessed Individual Properties.

It is expected that a recognizable pattern of these incorrectly-assessed properties, expressed as points in space, will be detected if assessment inequity exist. The nearest neighbor analysis uses the concept of area per point (spacing). The nearest neighbor analysis compares the observed average distances between nearest neighboring points and those of a known pattern. Nearest neighbor analysis treats all points as if they are the same; the main concern of the analysis is the location of points. If the observed average distance is greater (smaller) than that of a random pattern, the observed point pattern is said to be more dispersed (clustered) than a random pattern. The R statistic is the ratio of the observed average distance between nearest neighbors of a point distribution and the expected distance of the average nearest neighbor of the region of concern. A value of zero for R indicates a completely clustered pattern, a value of one indicates a random pattern, and a value of 2.149 indicates a completely dispersed pattern. A standardized Z score indicates whether the calculated difference between the observed pattern and the random pattern is statistically significant (Lee and Wong 2001: 72-77). Table 12 provides results of the nearest neighbor analysis. The small R statistic values and large standardized Z scores for samples of all and individual years sample confirm a clear pattern. The incorrectly assessed properties exhibit a distinct clustered pattern at the 0.05 significance level.

Table 12 Results of Nearest Neighbor Analysis

Year	*Observed average distance*	*Expected average distance*	*R statistic*	*Standardized Z score*
1999	68.33	228.97	0.30	56.58
2000	67.43	199.41	0.34	61.29
2001	57.46	209.19	0.27	64.03
2002	73.01	245.48	0.30	52.85
2003	69.70	234.17	0.30	55.39
2004	126.41	365.60	0.35	33.05

Assessment Differences among Sub-markets

The nearest neighbor analysis has uncovered the spatially clustered pattern of assessment ratios. Nevertheless, it is both based on the scale of individual properties. As far as property market is concerned, it is often more suitable to examine the spatial nature at the sub-market level. Data of individual properties are aggregated into data of district and li (smaller administrative units within districts) level to further explore the underlying spatial relationships. There are a total of 12 districts and 435 lis in Taipei as of October 2005. Due to aggregation of point data, assessment ratios for districts and lis are best regarded as attributes associated with areas, or polygons. The contrasts in assessment ratios between districts seem to imply a clustered pattern in Figure 6; this relationship is statistically tested using spatial autocorrelation. As mentioned earlier, the attribute values examined are self-correlated and the correlation is attributable to the geographic ordering of the objects if spatial autocorrelation is found. Moran and Geary indices are applied to examine the underlying patterns of assessment ratios. In the context of assessment ratios for districts and lis, the comparisons are based on the values of neighboring areal units. Table 13 is the statistics of Moran and Geary indices for district levels.

Table 13 Moran and Geary Indices for District Levels

Moran's I Statistic	*Expected Moran's I*	*Standardized Z Score (normality)*	*Standardized Z Score (randomization)*
0.0220039	-0.0909091	0.568552	0.619062
Geary's C Index	*Expected Geary C*	*Standardized Z Score (normality)*	*Standardized Z Score (randomization)*
0.870412	1	-0.726541	-0.797265

Overall, Moran and Geary index suggest a positive spatial autocorrelation. Over the entire study region, similar assessment ratios are more likely than dissimilar assessment ratios between neighbors. However, this relationship is not statistically significant. In conclusion, at the district level, no spatial pattern is found at a statistical sense.

Lis, in contrast to districts, are more likely to be the suitable units of property sub-markets. Indices of Moran and Geary are again employed to detect spatial pattern at li levels. Figure 8 first provides visual inspection of the distribution of assessment ratios at li levels. Table 14 then shows the results.

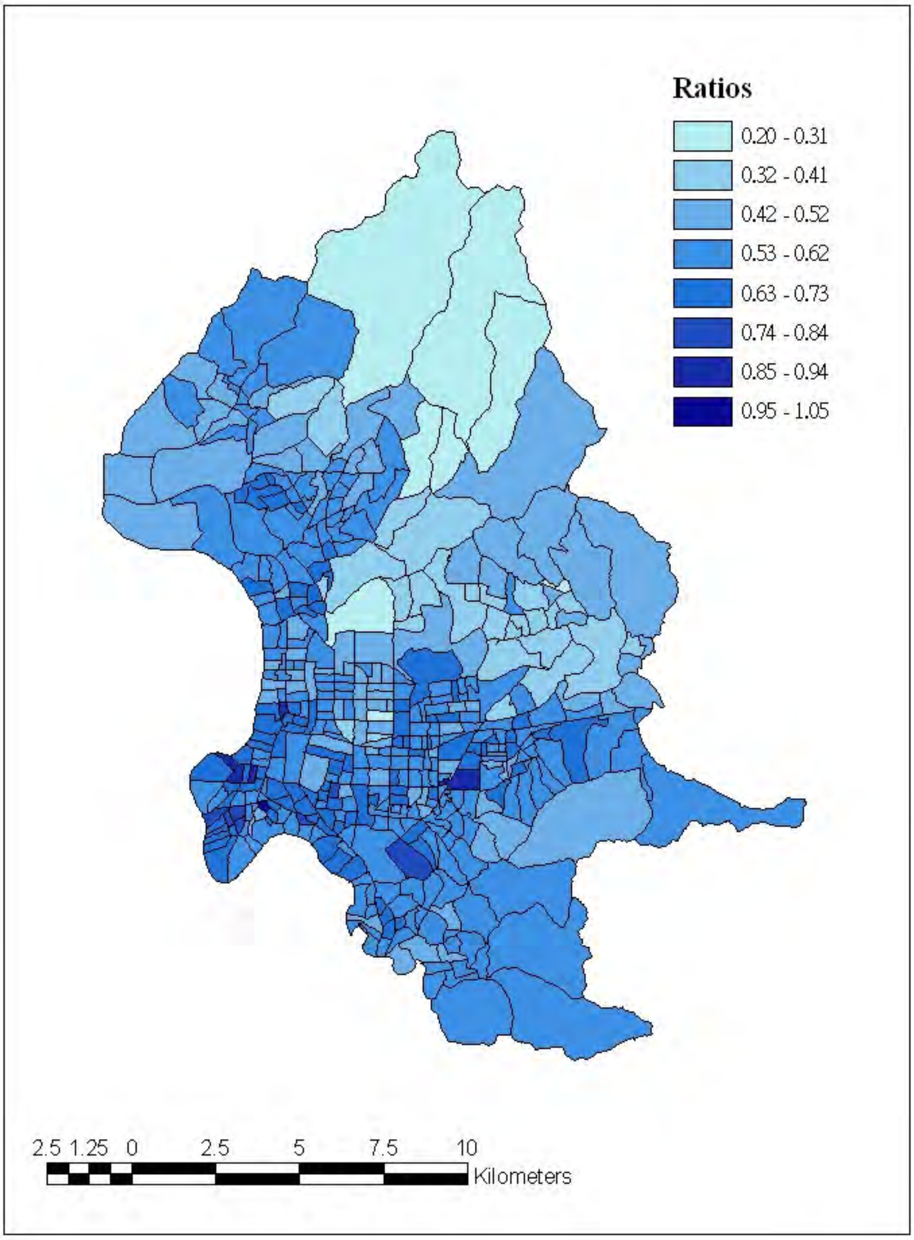

Figure 8. Distributions of Assessment Ratios for Lis.

Table 14 Moran and Geary Indices for Li Levels

Moran's I Statistic	*Expected Moran's I*	*Standardized Z Score (normality)*	*Standardized Z Score (randomization)*
0.444274	-0.00230415	15.8514	15.8933
Geary's C Index	*Expected Geary C*	*Standardized Z Score (normality)*	*Standardized Z Score (randomization)*
0.572184	1	-14.2688	-13.3871

Both Moran and Geary indices suggest a significantly positive spatial autocorrelation. Similar assessment ratios are more likely than dissimilar assessment ratios between neighbors, and this stands for clustering of similar ratios. Taking the results of Tables 13 and 14 together for consideration, it is noted that the positive autocorrelation phenomenon is not significant at the aggregated scale of the district level, but is significant at the disaggregated scale of the li level. This suggests that a spatial pattern might only be detected at a disaggregated scale and be hidden at an aggregated scale. In this case, the significant spatial relationship at li level is of importance for lis correspond better to the concept of sub-markets.

Taking all the empirical evidence into consideration, some conclusions can be drawn. The overall frequency distribution of assessment ratios is slightly skewed towards the right but heavily centered on the mean value. Property assessment as a whole perform reasonably well from an efficiency perspective. Nevertheless, assessment regressivity is detected but its degree is modest. What is more, variations in assessment level are found noticeable among various types of properties. Compared to the mean assessment ratio, houses are over-assessed and high-rise apartments are under-assessed. This will lead to inequity among property owners who hold properties of the same value but different kinds. Spatial analysis is explicitly introduced to evaluate the performance of property assessment. Despite that properties in declining area seem to sustain a higher assessment level and those in developing area a lower level, this conclusion is not supported by spatial autocorrelation analysis on the district scale. A spatial pattern of assessment ratios does not seem to be in place. Nonetheless, when data are disaggregated, a clear pattern of lis with similar ratios clustering is exposed. When data is further disaggregated to the level of individual property, the pattern is again revealed that properties with similar assessment ratios tend to be close to each other. Spatial relationships might be obscured when the data is geographically aggregated. Introduction of a local scale reveals underlying spatial relationships among properties with respect to assessment ratio. Assessment inequity is uncovered in a spatial framework. Even if some degree of assessment errors is unavoidable, clustering of inaccurately-assessed properties in space might not be accepted.

What might have gone wrong with Assessment Rules

In light of the empirical findings, a number of underlying assessment problems are highlighted. The significant difference in assessment ratios over property types and locations reveals that assessed values did not properly reflect sales prices, or present assessed values are not a good proxy for sales price. The factors contributing to the poor relation between assessed value and sales price warrants another research. That research shall attempt to answer whether the discrepancy between assessed values and sales prices are related to specific property characteristics or locational factors. However, our findings have already demonstrated that assessed values seem to have not taken account of the submarket effects. One possible reason for this is that current assessment rules do not estimate land value for individual properties. An average land value for a section is instead estimated and applied to all properties within that section. This averaged land value naturally does not take into account the differences among individual properties within the same section.

This line of argument naturally leads us to pondering over the contrast between market forces and assessment rules specified by legislation. In other words, assessment problems might be due to the divergence between market forces and legislation, which is supposed to reflect the forces correctly. The assessment ratios for properties are in the descending order of house, apartment and high-rise apartment. In theory, levels of assessment ratio shall be independent of property types. Our data suggest that the respective percentages of assessed structure value in total assessed value for houses, apartments and high-rise apartments are 2.2%, 5.8% and 15%. These figures are in sharp contrast to 20%, 30% and 40% found in a recent study (Huan 2005) estimating the percentages from sales price data. Apportionment of land and structure values among an improved property is by no means easy. Our results, however, tend to propose that the current law-specified assessment rules are not working satisfactorily in this regard. For a house, an apartment and a high-rise apartment of the same market price, the house is assessed at a higher value than the other two. Our data indicate that the differences among properties in assessed structure values are fairly small; thus the differences in assessment ratios are primarily due to the differences in assessed land values. The law-specified rules adopt the extraction method—an estimate of the depreciated cost of the improvements (contributory improvement value) is deducted from the total sales price of the property to arrive at the land value. Extraction is often used to estimate the land value of improved properties in rural areas and properties in which the improvements contribute little to total property value (Appraisal Institute 2001: 119). The differences in assessment ratio do not automatically suggest the inappropriateness of extraction method. The ratio differences, however, suggest the likely various degrees of contribution of land element to total property price among property types. Lack of consideration in differing extents of contribution of land to total sales price matters as far as the empirical evidence has demonstrated. Given the 20%, 30% and 40% for structure share of total market price, the 2.2%, 5.8% and 15% seem to suggest the current assessment rules give too much (little) weight to structure value of high-rise apartments (houses), and in consequence, under- (over) estimating the assessed land value of high-rise apartments (houses). Lower costs of land redevelopment (Lin, 2005) justify the higher land value for houses over (high-rise) apartments. The empirical results nevertheless suggest that the assessment rules give too much weight to the price difference between land in single and multi-ownership. Also, the price differences between properties on different floors might not be properly reflected by the current assessment rules. The extraction method contributes the residual of total property value less the depreciated cost of improvements to land. Properties with various prices on different floors of the same building are assigned the same depreciated improvement cost and therefore different land values.

Examination of our data suggests that magnitude of average construction value is in the ascending order of houses, apartments and high-rise apartments. The total assessed construction values are also in ascending order. Official assessment rule regard the construction for high-rise buildings much higher than the other two kinds of buildings. As for the land element, the value for houses is the lowest and high-rise apartments the highest. This reflects the higher contribution of high-density sites to value. However, the sites of houses are substantially larger than the sites of the other two kinds of buildings. The differences in site size offset the differences in average land value, thus resulting in a higher total assessed land value for houses, followed by apartments, and then high-rise apartments. The differences in assessed land values substantially exceed differences in assessed construction values. These differences account for the high (low) assessment ratio for houses (high-apartments).

Ratio of assessed land value to total assessed value (in percentage) is further regressed on sales price and dummy variables with apartment as the base (see Equation 1). Results of the regression are shown in Table 15. The land to total assessed value ratio increases with sales price. Land claims a higher percentage of value from the total assessed value for an expensive property than a cheap one. This suggests that assessment rules assign proportionally more value to land than to improvements. That is to say, land element contributes more value to the property than the improvement element as specified by rules. In addition, for properties of the same sales price, houses command the highest land portion in total assessed value and high-rise apartments commands the lowest portion. The sharp contrasts in land value proportion among houses, apartments and high-rise apartments correspond to our earlier arguments with respect to the high (low) assessment ratios for houses (high-rise apartments). Differences in assessment ratio among houses, apartments and high-rise apartments shall largely be attributable to the assessment rule where the assessed value of houses is inflated by their large site size.

$$\text{assessed land value} \Big/ \text{assessed land value} + \text{assessed improvemnet value} \times 100$$
$$= \text{intercept} + \text{sales price} + \text{house(dummy)} + \text{high - rise apartment(dummy)} ....(1)$$

Table 15 Land Proportion in relation to Market Value (unit: NT 1000)

	Coefficients	*T values*
Intercept	93.1792	1,062.22
Sales price	0.0001	6.32
House	3.3966	12.05
High-rise apartment	-10.2043	-94.40

Adjusted R^2: 0.49

Concluding Remarks

Public assessors are periodically valuing real properties in order to perform certain functions, such as property taxation and eminent domain. How accurate the properties are assessed shall be under constant inspection. Variations of assessment ratios might be in two forms. Anything that acts upon the numerator is an institutional characteristic, whereas anything that affects the denominator is a market characteristic. Institutional characteristics primarily include bias inherent in assessment rules and assessors' undue discretion on value judgments in the process.

Empirical findings of this study suggest no significant assessment regressivity or progressivity. The assessment ratios between houses, apartments and high-rise apartments, however, are found to be significantly different. This ratio difference is demonstrated to be of relevance to assessment rules. The apportionment of land and structure values varies with property types. Application of extraction method in valuing land contributes to this assessment inequity. Owners of properties of the same market price are treated differently because they pay different amount of property tax and are paid different amount of compensation for eminent domain. The extraction method is widely acknowledged in valuing improved land, but it appears here to have aroused inequity issues based on assessment ratio criterion. Appraisal principles seem to be in conflict with assessment equity.

Spatial consideration is explicitly added into this study. No statistically spatial relationship is found at the district level. A distinct clustering of lis with similar assessment ratios is, however, recorded. This non-random pattern infers assessment inequity in a spatial sense. Another recognized clustering of inaccurately assessed properties suggests that the assessment errors shall be related to some socio-economic factors that vary over space. In other worlds, certain location-associated social and economic factors are not properly reflected in assessed value through assessment rules. This underlying relationship between spatially assessment errors and assessment rules certainly warrants another study.

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