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Property tax inequity resulting from inaccurate assessment—The Taiwan experience☆

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ABSTRACT

Real properties are periodically valued by governments in order to perform a variety of public functions. Time and resource constraints have often motivated a government to develop adhoc assessment rules to undertake expeditious valuation. The extent to which the properties are equitably valued, however, should be under constant scrutiny. Valuation equity is defined as properties being valued at the same, or similar, percentage of their sales price in the market. Violation of the equity criterion is deemed as evidence of valuation inequity. This study employs and expands the concept of assessment ratios to detect, and explain where possible, the property valuation inequity in Taipei City. Empirical evidence suggests no significant assessment regressivity or progressivity among individual properties. The assessment ratios between houses, low-rise condominiums, and high-rise condominiums, nevertheless, are found to be materially different. Spatial consideration is also explicitly added into the analysis. A distinct clustering of neighborhoods with similar assessment ratios is found. This non-random pattern infers valuation inequity in a spatial sense. The spatial inequity of assessment ratios suggests that certain location-associated social and economic price-determining factors are not properly accounted for in the assessment rules. The extraction method adopted by assessment rules to apportion land and structure values is believed to be responsible. A likely cause for the malfunction of the extraction method is thought to be the widely documented non-linear site size–land value relationship. After all, high buildings on sites that feature multi-ownership dominate the majority of areas in Taipei.

Property valuation as economic, social, and spatial issues

A variety of studies have examined property assessment issues, primarily in the context of property tax. Two issues are frequently raised that concern horizontal and vertical tax inequity. Horizontal inequity refers to the systematic variations in the assessment level among properties of a similar value. Vertical inequity refers to the systematic variations in the assessment level among properties of different values. The assessment ratio of a property, defined as its assessed value divided by the market value, was introduced to measure tax inequity that results from assessment errors. Horizontal inequity is identified when properties with similar market value are not treated uniformly or are not appraised at the same percentage of market value (Allen and Dare, 2002). In contrast, vertical inequity is present when the assessment ratio is significantly different over varying price ranges of the same type of property (Sirmans et al., 1995).

Horizontal and vertical tax inequities are largely due to assessment bias or the poor correspondence between assessed value and market value. Recent studies, such as Clapp (1990), Sunderman et al. (1990), Birch et al. (1990), and Cornia and Slade (2005), were still inconclusive regarding tax regressivity or progressivity, but had highlighted the importance of a sound property assessment system. In addition to efforts revealing the regressive or progressive nature of the property tax, several works have reported factors that account for tax inequity. Goolsby (1997) found that high-valued and aged properties tend to be undervalued. De Cesare and Ruddock (1998) noted that appraisal errors are significantly related to certain property characteristics such as floor areas and property age. Allen and Dare (2002) concluded that the effects of property age, floor area, and site area on price are not well considered in property assessment. This line of research underscores the adverse consequences of unsatisfactory property assessment. Property assessment is viewed primarily in an economic perspective

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and focus is put upon the unequal tax liability and the contributing factors associated with valuation.

As opposed to the studies in economics and taxation literature, Thrall (1979a) added a geographic element to identifying property–tax assessment inequity. Thrall used 572 single-family dwellings in Hamilton, Ontario, in 1976 as an example to depict a contour map of assessment ratios. One should not be able to observe a significant contour surface if assessments were truly equitable. It was found that areas where properties were over-assessed, contained residents of low income and high population density, and areas where properties were under-assessed were at the fringe of the central business district and at the urban periphery. This study brought spatial perspective into property assessment. Thrall (1979b), again using Hamilton, Ontario, as the study area, reported that assessment ratios vary with respect not only to property price, but to neighborhoods as well. Assessment ratios are not uniform across space. Thrall (1993) explicitly employed geographic information system technology to redo his 1979 works. He argued that if assessors perform their duty perfectly, a frequency distribution of assessment ratios would be a spike.

A criterion for measuring 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 to correspond with the spatial nature of the real estate phenomenon. Property assessment is found to be unequal if observations that fall within the tails of a frequency distribution of assessment ratios are shown to cluster in locations. The measure of skewness indicated that more houses in Hamilton were over-assessed than were under-assessed. Visual inspection of maps with over- and under-assessed properties led Thrall to deduce no apparent spatial regularities. Harris and Lehman (2001) undertook an intertemporal study of property assessment for Hamilton, Ontario. They confirmed the previous research findings that inexpensive houses are often over-assessed and suburban residents are usually favored. They also concluded that the assessment inaccuracies are not random, but instead display a systematic pattern in space.

The assessed value is expected to reasonably reflect its corresponding market value. In other words, a stable relation shall remain between assessed and market values. If a property is not properly assessed, advantages of the ad valorem property tax will be lost and land uses consequently distorted. Property assessment requires an estimate of values on a predetermined date. Nevertheless, the infrequent property transactions and lack of relevant information often pose severe problems to assessors. The identified transactions and information problems have motivated governments to develop a valuation approach in a mass appraisal fashion. Mass appraisal is the systematic appraisal of groups of properties as of a given date using standardized procedures and statistical testing (IAAO, 1996, 285).

Property valuation in Taiwan

The philosophy of regarding land as a gift of nature has led the Taiwanese government to design taxation and valuation systems with different treatments for land and improvements. Thus, the government adopts a split-rate property tax, levied annually with land being taxed at a higher rate than improvements. In contrast to a uniform-rate property tax (land and improvements are taxed at the same rate), split-rate property tax is believed to be able to result in more intensive use of capital and labour, to increase the productivity of land parcels, and to increase land prices (Cohen and Coughlin, 2005). Through the above tax-induced mechanism, land parcels are expected to be directed into a better use. The differentiating treatment of land and improvements naturally calls for the separate valuation of land and improvements. However, the difficulties with valuing land of developed properties are well documented (Colwell and Munneke, 1999; Lin and Jhen, 2009).

As far as land valuation is concerned, the land administration department in each local government is responsible for collecting market data, and for estimating land value for individual parcels based on the data. 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 to make changes to values when members deem it necessary.

The land value assessment committee is composed of governmental representatives and appraisal professionals. The procedure for valuing land is based on the Regulation of Investigating and Estimating Land Value. Jurisdiction of a local government is divided into a number of land valuation zones. Land parcels within a valuation zone are similar in site characteristics and their prices are expected to be influenced by the same market forces. Every year, information with respect to land and improved property sales are collected. For the cases of the improved property sales, current improvements value, decoration and equipment costs, and expected profits from investment in improvements are estimated and then deducted from the sales price to arrive at land value. The current improvements value is estimated through a cost approach: replacement costs new less accrued depreciation. Replacement costs and annual depreciation for different types of building improvements are specified and released by local governments. The median land value per square meter among several collected sales in a valuation zone is taken to be the representative price for all sites within the zone. It is consequently a typical practice that the assessed values for all land parcels within a valuation zone are equal. There are a total of 2878 land valuation zones in Taipei as of 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 governmental representatives and experts in related professions. Materials used, durability periods, and depreciation are all considered when determining improvement value per square meter. Furthermore, supply of and demand for improvements and the market price of substitute improvements in local areas are additional factors to be taken into account. The improvement values are reassessed every 3 years.

To sum up, local governments regularly assess values of land and improvements of individual properties. 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 land and improved property sales data from the market. The residual of property sales price, less specified items of improvements-related value and cost, is attributed to land value. It is an application of the extraction method (Appraisal Institute, 2008, 366) in appraisal literature. The revenue service department is not primarily concerned with the property sales data. It determines the current improvements value based on construction costs. Although land and improvements are assessed separately, the same owner generally possesses the improvement and the site it is built upon.

The aforementioned valuation system has been established in Taiwan for many years. However, performance of this system has received scant attention thus far. The present study aims to provide empirical evidence as a foundation to evaluate this system with particular reference to valuation inequity. The empirical data examined in this study includes 10,191 residential properties transacted between January 1999 and June 2004 in Taipei City. Table 1

Table 1
Statistical summary of sample properties.

	Min.	Max.	Mean	Standard deviation (SD)
Total price (in New Taiwan 1000 dollars)	880	192,000	7076	4970
Structure age (in years)	0	48	19.66	7.94
Building areas (in m^2)	5.00	2795.00	109.21	55.19
Site size (in m^2)	0.85	486.81	32.88	22.08

provides a summary of the main property characteristics. Overall, the sample properties distribute widely over price, structure age, building area, and site size and are therefore suitable for further analysis.

An equitable valuation in this paper is defined as properties being valued at the same, or similar, percentage of their sales price. Violation of the equity criterion is deemed as evidence of valuation inequity. The operational criterion adopted in this study to detect valuation inequity is the assessment ratio. The 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 Jansenn and Soderberg (1999), among others. There will be no significant variations over assessment ratios among individual properties or among properties grouped by their price, type, or location. If assessment ratios vary among different groups of property, they will be treated differently and inequity issues arise.

Valuation performance at the metropolitan level

Table 2 shows the statistics on assessment ratios for the entire sample of 10,191 properties. Fig. 1 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. A vertical inequity is evidenced by a price-related differential. This is a statistic for measuring regressivity or progressivity of assessment ratios over property prices (IAAO, 1990, 539). In this case, the value of 1.05 indicates significant, but mild assessment regressivity. High-value properties tend to be slightly undervalued.

The long-term relationship between the sales price and its corresponding assessment ratio is another concern. Despite his suspicion regarding the policy effectiveness of land value increment tax on curbing residential property price, Shieh (2001), based on the Granger-causality test, concluded that the assessed land values in Taipei were significantly affected by the property sales price in the previous year. That is to say, the public assessors did take account of the market evidence in determining the assessed value in the following year. However, whether the market evidence of recent sales price was considered in a systematic way across the whole city was left unanswered.

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

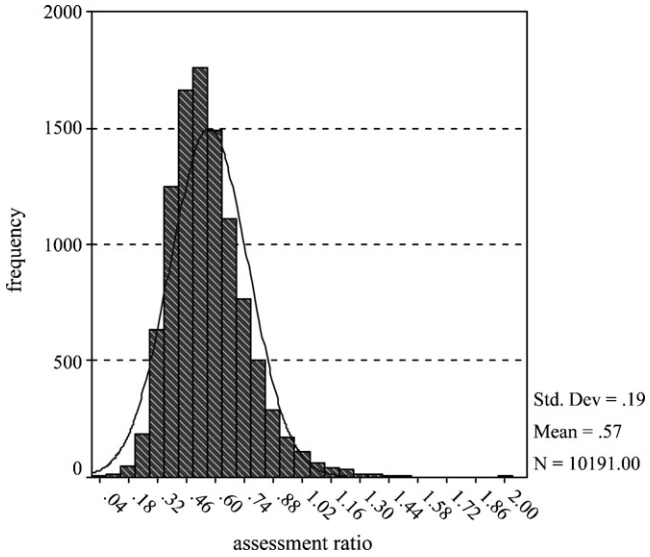

Fig. 1. Frequency distribution of assessment ratios for the entire sample properties.

Table 3 provides the information concerning assessment ratios over the 6-year sample period. The mean assessment ratio over the 6-year period 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 exhibited a leptokurtic distribution. The coefficient of variation (COV), the standard deviation expressed as a percentage of the mean, makes comparisons of assessment ratios between years possible (IAAO, 1990, 539). The values of COV remained stable throughout the 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 indicates a sound assessment performance in terms of stability. However, the values of a price-related differential suggest the persistent regressivity of the assessment ratio. The high-value properties have been in the long run relatively under-assessed. This raises the concern of assessment inequity.

Valuation among different types of properties

As argued earlier, as far as valuation is concerned, no significant assessment difference should be detected among different types of property. The entire property sample is divided into three property types: houses, low-rise condominiums, and high-rise condominiums. A house is a self-standing or detached building with its own entrance. A low-rise condominium refers to a building of five stories or less occupied by several households. A high-rise condominium is a building of over five stories, with elevators, and occupied by more households than low-rise condominiums. A single owner normally owns the site of a house. The site of a low-rise condominium or a

Table 3
Assessment ratios from 1999 through 2004.

Assessment ratio									
	Number	Mean	Min.	Max.	SD	Skewness	Kurtosis	COV	PRD
1999	1777	0.55	0.15	2.00	0.18	1.21	4.07	32.73	1.04
2000	2343	0.53	0.03	2.02	0.18	1.27	4.97	33.94	1.06
2001	2129	0.60	0.05	2.02	0.20	1.15	3.16	33.13	1.05
2002	1546	0.59	0.07	1.99	0.19	1.38	5.45	31.99	1.03
2003	1699	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

Table 4
Assessment ratios for houses, low-rise condominiums and high-rise condominiums.

	Numbers	Mean	SD	Skewness	Kurtosis	COV	PRD
House	335	0.71	0.20	1.05	4.00	28.52	1.03
Low-rise condominium	6574	0.60	0.19	1.13	3.66	31.31	1.04
High-rise condominium	3282	0.48	0.15	2.01	11.78	31.92	1.03

high-rise condominium is typically in multi-ownership held by all households within a given building. These differences pose challenges to property valuation. Houses are generally heterogeneous in property characteristics and feature the smallest share of stocks in the housing market. These elements contribute to difficulties in finding comparables and in making adjustments in values. By contrast, low-rise condominiums and high-rise condominiums are popular dwelling types in terms of their share in housing stock, but they pose problems with valuation as well. It is relatively easy to find comparables for condominiums, 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 condominium units within a building is by no means an easy task. The floor area, allocated site size, and other often-considered variables, in addition to the floor (e.g., second or top floor) a unit occupies, affects price significantly.

Table 4 supplies the relevant evidence. The least number of houses in this 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, 71 percent, and high-rise condominiums at the lowest level, 48 percent. The tax burden for a residential property varies with its property type. Property type related assessment inequity seems to be in place. This assessment inequity has violated the principle of ad valorem property tax. Another statistic that requires some attention pertains to the coefficient of variation. Both coefficients of variation for low-rise condominiums and high-rise condominiums are higher than that of houses. Assessment of properties in multi-ownership is comparatively difficult, reflected in a higher coefficient of variation for assessment ratio. Assessment ratio is not independent of property type, and this implies assessment, and consequently, taxes inequity among different types of properties.

The mean assessment ratio and its coefficient of variation suggest the presence of assessment inequity among houses, low-rise condominiums, and high-rise condominiums. The two-sample Kolmogorov–Smirnov Test (Sprent and Smeeton, 2001) is used to further compare statistically whether any two of the three property groups have the same frequency distribution of assessment ratios. Table 5 indicates that no two of the three property types have the same assessment-ratio frequency distribution. It is therefore clear that houses, low-rise condominiums, and high-rise condominiums are assessed unequally.

Valuation over space and among neighborhoods

Speculation with respect to assessment inequity over space is further explored through explicit spatial analyses. First, incorrectly assessed properties are defined as those whose assessment ratios

Table 5
Two-sample Kolmogorov–Smirnov test for different property types.

	Z-value	*P*-value
House vs. low-rise condominium	4.868	0.00
House vs. high-rise condominium	9.884	0.00
Low-rise condominium vs. high-rise condominium	16.212	0.00

Table 6
Number of incorrectly assessed properties.

	Total observations	Over one SD	Under one SD
Entire samples	10,191	1353	1328
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

fall over one standard deviation from the mean ratio of all properties. The number of properties incorrectly assessed for each year is seen in Table 6 and the property locations in space are illustrated in Fig. 2. Visual inspection of Fig. 2 indicates that over-assessed properties seem likely to be located on the western and inner parts of the city where Taipei was first developed. In contrast, under-assessed properties tend to cluster in the newly developed areas in the eastern part of the city. These findings correspond with those of Thrall (1979a, 1993) and Harris and Lehman (2001). Local assessors seem to be slow to adjust downwards the assessed value in deteriorating areas and to adjust upwards the assessed value in fast-growing areas. However, further analysis of a reliable spatial relationship for assessment ratios is required.

It is expected that a recognizable pattern of these incorrectly assessed properties, reasoned as points in space, will be detected if assessment inequity exists. The nearest neighbor analysis uses the concept of area per point (spacing). 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.

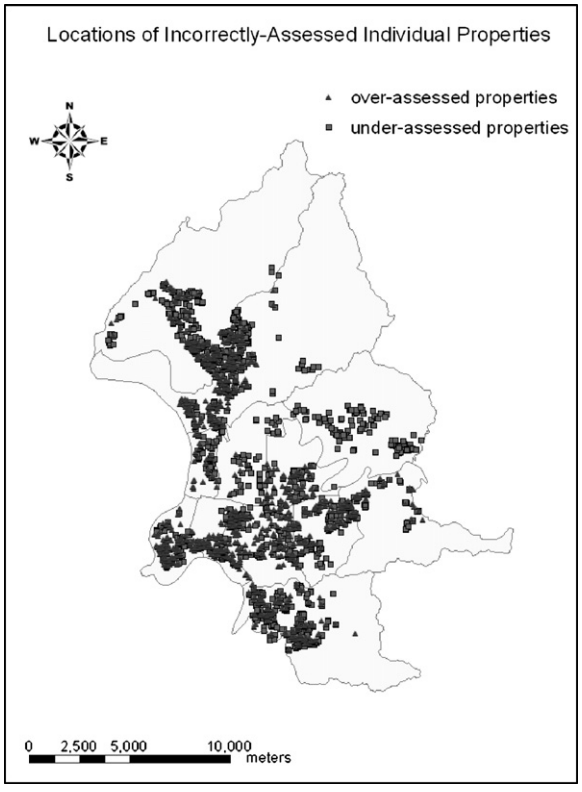

Fig. 2. Locations of incorrectly assessed individual properties.

Table 7
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

A value of zero for *R* indicates a completely clustered pattern, a value of 1 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). The small *R* statistic values and large standardized *Z* scores in Table 7 suggest that incorrectly assessed properties have clustered in location over time.

The nearest neighbor analysis has uncovered the spatially clustered pattern of assessment ratios for individual properties. As far as property assessment administration is concerned, however, it is often more suitable to examine the spatial nature at an aggregate scale. Individual properties are assigned to their respective districts and lis (neighborhoods). Districts and lis are both administrative units in a city, and the li is the smallest one. Properties within the same lis are alike in location and physical characteristics. Lis can in many respects be regarded as neighborhoods and, within each, properties are to a large extent homogeneous. There were a total of 12 districts and 435 lis in Taipei as of October 2005. Assessment ratios for respective 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 and this relationship is statistically tested using spatial autocorrelation. 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 (Lee and Wong, 2001, 78–83) are applied to examine the underlying patterns of district and li-based assessment ratios. The upper part of Table 8 provides the statistics of Moran and Geary indices for district levels.

At the district level, Moran and Geary indices as a whole suggest a positive spatial autocorrelation. Over Taipei City, similar assessment ratios are more likely than dissimilar assessment ratios between districts. However, this relationship is not statistically significant. A district is likely too large an area as an analytical spatial unit to reveal neighborhood differences. An examination of assessment ratios for lis is therefore pursued. Fig. 3 first provides visual inspection of the distribution of assessment ratios at lis levels.

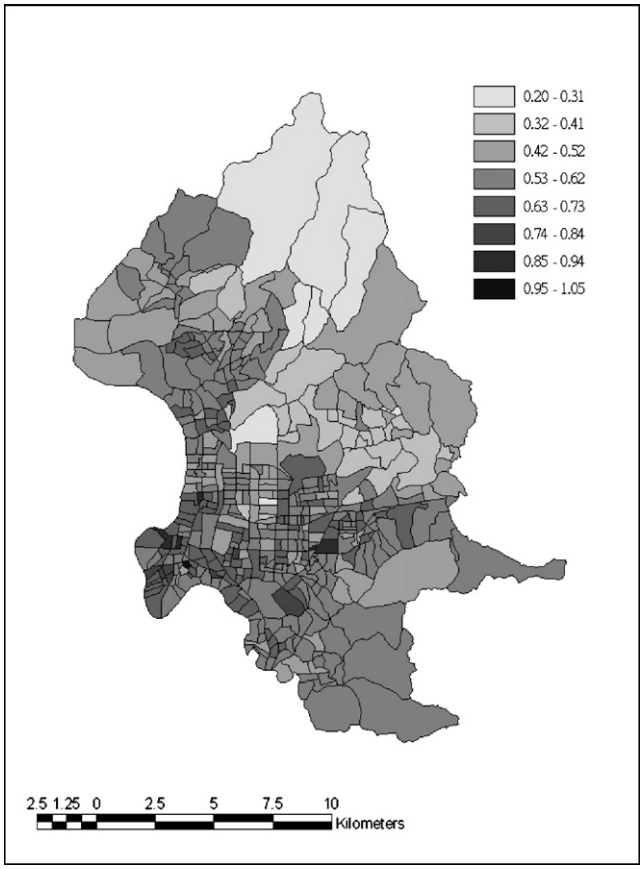

Fig. 3. Distributions of assessment ratios among lis.

Both Moran and Geary indices shown in the lower part of Table 8 suggest a significantly positive spatial autocorrelation among assessment ratios across lis. Similar assessment ratios are more likely than dissimilar assessment ratios between lis and this stands for clustering of similar ratios. The results of Table 8 indicate that the positive autocorrelation phenomenon is not significant at the more-aggregated scale of the district level, but is significant at the less-aggregated scale of the li level.

A number of conclusions can now be drawn from this empirical evidence. The overall frequency distribution of assessment ratios is slightly skewed towards the right, but heavily centered on the mean value. In addition, assessment regressivity is detected to a modest degree. Property assessment as a whole performs reasonably well by conventional standards. Compared to the mean assessment ratio, houses are found to be over-assessed and high-

Table 8
Moran and Geary indices for district and li levels.

Moran's I statistic	Expected Moran's I	Standardized *Z* score (normality)	Standardized *Z* score (randomization)
District level			
0.0220039	−0.0909091	0.568552	0.619062
Li level			
0.444274	−0.00230415	15.8514	15.8933
Geary's C index	**Expected Geary C**	**Standardized *Z* score (normality)**	**Standardized *Z* score (randomization)**
District level			
0.870412	1	−0.726541	−0.797265
Li level			
0.572184	1	−14.2688	−13.3871

rise condominiums under-assessed. This has led to tax inequity. A spatial element is explicitly introduced into the evaluation of property assessment. Properties in deteriorating areas seem to sustain a higher assessment ratio and those in fast-growing areas sustain a lower assessment ratio. The contrast between areas at differing urban development phases is not supported by spatial autocorrelation analysis on the district scale. An evident clustering pattern of assessment ratios is nevertheless uncovered at a disaggregated li scale. Current assessment practices are not able to satisfactorily account for the neighborhood subtlety. Even though some degree of assessment errors is unavoidable among individual properties, a systematic assessment inequity between neighborhoods is hard to justify.

The possible flaws associated with present assessment rules

It is comparatively easy to identify assessment problems than to provide explanations. Empirical evidence produced in this paper has demonstrated that the assessment ratio is not independent of the type and location of a property. The assessors are required to follow the legislation-set assessment rules while valuing properties. In consequence, the unsatisfactory correspondence between assessed value and sales price is expected to be from infelicities in the rules. This line of argument naturally leads to pondering over the contrast between market forces and assessment rules. The price-determining factors depicted in the assessment rules should correspond well with those operating in the market.

The present study has found the assessment ratios to be in the descending order of house, low-rise condominium, and high-rise condominium. The respective percentages of assessed structure value in total assessed value (assessed land value plus assessed structure value) for houses, low-rise condominiums, and high-rise condominiums are 2.2 percent, 5.8 percent, and 15 percent, respectively. These figures are in sharp contrast to 20 percent, 30 percent, and 40 percent found in a recent study (Huan, 2005) that estimated the percentages based on sales price data in Taipei. Apportionment of land and structure values for an improved property is by no means easy. The results, however, tend to suggest that the current assessment rules are not working satisfactorily in this regard. For a house, a low-rise condominium, and a high-rise condominium of equal market price, the house is assessed at a higher value than the other two property types. The 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. In contrast to the 20 percent, 30 percent, and 40 percent for structure share of total market price, the 2.2 percent, 5.8 percent, and 15 percent suggest that the current assessment rules assign a much greater value to the land element than the market evidence suggests. Among the three property types, houses are given the proportionally greatest percentage of land value followed by low-rise condominiums and then high-rise condominiums.

Inspection of the assessment data reveals that the structure value per square meter is in the ascending order of houses, low-rise condominiums, and high-rise condominiums. Assessment rules regard the construction of high-rise condominiums to be much more costly than the other two kinds of structures. The rise of structure value (cost) per square meter with building height is widely assumed. As for the land element, the assessed value per square meter for houses is the lowest and high-rise condominiums the highest. This corresponds to the well-accepted land value–building density relationship. However, the sites of houses are found to be substantially larger than the sites of the two kinds of condominiums. The effects of site size offset the differences in unit land value, thus resulting in a higher assessed land value for houses, followed by low-rise condominiums, and then high-rise condominiums. The differences in assessed land values substantially outweigh differences in assessed structure values. Combinations of assessed land and structure values consequently contribute to the high, medium, and low assessed property values to houses, low-rise condominiums, and high-rise condominiums, respectively, for an equal sales price. This explains the different assessment ratios among the three types of properties.

Table 9
Assessed land value proportion in relation to sales price and property types (unit: 1000 New Taiwan Dollars).

	Coefficients	*t*-Values
Intercept	93.1792	1062.22
Sales price	0.0001	6.32
House	3.3966	12.05
High-rise condominium	−10.2043	−94.40

Adjusted R^2: 0.49.

The percentage of assessed land value in relation to the sum of assessed land and structure values (total assessed property value) is further regressed on sales price and property type dummy variables with low-rise condominium as the base category (see Eq. (1)). Results of the regression are shown in Table 9. 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 for a less expensive property. This suggests that assessment rules assign proportionally more value to land than to structures when sales prices rise. Furthermore, for properties of similar sales price, houses command the highest land portion in total assessed value and high-rise condominiums command the lowest portion. The apparent difference in land value proportion among houses, low-rise condominiums, and high-rise condominiums conforms to the earlier argument of a high (low) assessment ratio for houses (high-rise condominiums). Differences in assessment ratio among houses, low-rise condominiums, and high-rise condominiums can largely, or at least partially, be explained by the assessment rules where the assessed value of houses is inflated by their large site size. As far as an equitable assessment is concerned, the effects of site size on assessed land value are not properly accounted for, or so it appears. In other words, the non-linear site size–land value relationship is ignored in legislation-set assessment rules, which consequently result in assessment inequity. This non-linear relationship was well documented by, among others, Colwell and Munneke (1999) and Lin and Evans (2000).

$$\left(\frac{\text{assessed land value}}{\text{assessed land value} + \text{assessed structure value}}\right) \times 100 = \text{intercept} + \text{sales price} + \text{house} + \text{high} - \text{rise condominium} \quad (1)$$

Concluding remarks

Public assessors are periodically valuing real properties in order to perform certain government functions. How accurate and equitable the properties are assessed should be under constant scrutiny. The time and resource constraints have led the government to develop adhoc assessment rules in order to expeditiously value a great number of properties. The assessment ratio has become a standard tool in detecting valuation inequity and has proven useful in this regard. Variations of assessment ratios might appear in two forms. Anything that affects the denominator of an assessment ratio is a market characteristic, whereas anything that acts upon the numerator is an institutional characteristic. Market characteristics

that might bias sales price away from the fair market value are difficult to ascertain and are not the main concern of this study. In contrast, institutional characteristics primarily include systematically biased assessment rules and an assessor's undue discretion on value judgments.

The conventional assessment ratios study applied to Taipei suggest a mild degree of assessment regressivity and a steady relationship between assessed value and sales price over time. A satisfactory performance of assessment practice at the metropolitan level by the conventional standard has been assumed. Expansion of the assessment ratios study and introduction of an explicit spatial consideration, however, uncover various forms of assessment inequity. The assessment ratios between houses, low-rise condominiums, and high-rise condominiums are found to be materially different. Owners of properties with similar prices are treated unequally in the sense that they pay different amounts of property tax. In addition, a distinct clustering of lis with similar assessment ratios is recorded. This non-random pattern infers assessment inequity in a spatial sense. The spatial inequity of assessment ratios suggests that certain location-associated price-determining factors are not properly reflected in assessment rules. Despite the complicated contributing factors of identified assessment inequity, it has been demonstrated that the extraction method seems to be the one to be held responsible, among other possible causes. The extraction method is widely applied in valuing improved land, but it seems to have aroused assessment inequity in Taipei. A likely cause is the widely documented difficulties of measuring the non-linear effects of site size on land value.

The identified assessment problems also have significant policy implications for the split-rate property tax. The functioning of a split-rate property tax to promote the land use requires land be valued at its highest and best use. In valuation terminology, the land shall be valued as if vacant even though there is already a building on it. The highest and best use of a site in a city might deviate from its current use due to changes in economic and social conditions. A higher tax on land is expected to create pressure on owners to move from the current use to the more efficient (highest and best) use. Despite the theoretical advantages, a land parcel in Taipei City is often jointly owned by a large number of joint-owners. When valuing the site of a condominium, the assessors assume all joint-owners already agree to a redevelopment project and value the site as if vacant and in a single ownership. These assumptions are simply too far from reality. The real situation is that enormous and demanding efforts are needed to acquire the agreements of joint-owners to a redevelopment project. The sales data that assessors acquired were transactions of a condominium unit in a building with the transfer of a small percentage of the site. The above discussion raises at least two intertwined valuation issues: valuing a site at its highest and best use or current use, and valuing a site in a single ownership or in a joint-ownership. The present practices value a site at its highest and best use and in a single ownership. The practices have created a gap between legislation and market forces. It is believed by the author of this study that these two valuation assumptions, specified in legislation, have to a large extent, determined the observed assessment outcomes. Another study is warranted to properly address the effects of the two assumptions.

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