Review of Valuation Procedures

for

Valuation Office Agency

by

Robert J. Gloudemans

22 December 2004

Acknowledgements

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Inadequacies and any remaining errors in the report are the authors alone.

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1. Executive Summary

1.1 Purpose of Project

The Valuation Office Agency (VOA) is charged with undertaking a revaluation of all 22 million domestic properties in England for purposes of determining a more accurate, equitable, and transparent base for the levy of council taxes to support local government services. The comprehensive revaluation must be completed by 30 June 2006 in order to publish a preliminary valuation list by 1 September 2006. The valuation date (AVD) is 1 April 2005. As in the prior revaluation, the valuation basis will be capital value, that is, what a property would most likely sell for in an open market transaction between a willing, knowledgeable buyer and a willing, knowledgeable seller, each under no undue coercion to buy or sell. The last domestic revaluation was completed in 1993 with values placed in bands for rating purposes (the current revaluation will likely employ bands, although they probably will not to be decided before final values have been determined).

The revaluation, the largest ever undertaken[1], will require unprecedented effort and coordination. The VOA will provide the bulk of staff resources. The agency has an ongoing contract for IT support with Capgemini (a French-based company), which in turn has a contract with Cole-Layer-Trumble (CLT) a division of Tyler Technologies, Inc. (a U.S.-based company), to provide modelling software, training, and mentoring.

CLT and VOA have developed a number of pilot models in an effort to identify optimal modelling strategies and methodology. Using existing data, CLT has developed broad "global" models to help determine general market relationships, data integrity, and optimal algorithms. VOA staff have concentrated on specific pilot areas for which various refinements have been tested. The VOA asked the author, under the auspices of the International Association of Assessing Officers (IAAO), to conduct a review of the modelling strategies being implemented and the results achieved in two of the pilot areas, Hillingdon and North Tyneside.

The author visited the VOA's offices in early October 2004, interviewed key VOA and CLT staff, toured one of the pilot areas (Hillingdon), and examined available documents relating to the revaluation and model development. In addition, VOA provided requested data files for the two test areas and the author conducted an independent review of models for the two areas. This report contains the author's findings and recommendations.

[1] Russia is currently undertaking a revaluation of all privatized land. That revaluation, whose subject is land only, stands in contrast to the current project, which focuses on dwelling units or hereditaments.

1.2 Summary of Findings and Recommendations

While the revaluation of 22 million domestic properties is a daunting challenge, we find that the project has basically set out on course, albeit with a long road ahead. Key staff are well qualified, plans have been laid, and valuation tools are adequate. However, before valuation can begin in earnest, massive amounts of data capture and clean-up work must be accomplished, and the key task of building modelling capacity has only begun. In short, while this report was commissioned to address and comment on technical issues (which we do), success rests more on data capture and capacity building.

Section 2 below addresses data capture issues, section 3 discusses modelling, and section 4 addresses staffing and resources, value reviews, systems integration, and organization culture. Section 5 summarizes the specific conclusions and recommendation. The appendices contain results for the two pilot areas, Hillingdon and North Tyneside. Overall results for these areas are reasonably good, particularly given the limited data for valuation. Better results will require better data.

2. Data Adequacy

2.1 Importance of Data

All appraisals begin with data and the adequacy of data is the primary determinant of mass appraisal accuracy and fairness. There are two components of data accuracy: completeness and accuracy. That is, are the right items being collected? And are they being collected accurately? Relevant data for residential properties falls into three broad categories: property characteristics data, sales data, and location data.

2.2 Property Characteristics Data

Property characteristics data encompasses land and building features that impact property values. Some of these, such as the type and quality of construction and building size, are universally important. The importance of others, such as basement area and plot size, varies among markets depending on the homeowner preferences and the nature and diversity of properties found in the area. Mass appraisal models developed across North America suggest that the following housing characteristics are most important in explaining market value:

- House size (usable living area)
- Construction type and quality
- State of repair (including remodeling and renovations)
- Plot size (particularly important when plots vary significantly in size, as is frequently the case in suburban and rural areas)

These items, along with location (see 2.4 below) typically explain 85 percent of the value of domestic properties. Thus, adequately accounting for these items is crucial. Currently, VOA maintains data on house size, construction type, and era built. Construction type is represented

in three overlapping variables: group, era, and type. Generally *Group* incorporates information on type of property (e.g., house, flat, or cottage), era, and type of construction (e.g., private or public built, small or large, quality of construction). *Type* indicates the general housing type (e.g., house, bungalow, or flat) and specific design (e.g., detached, semi-detached, end terraced or mid-terraced). There is also a separate variable for *Era*, which may or may not be consistent with the era implicit in *Group*. This complex and overlapping coding scheme invites inconsistency and complicates analysis. A particular problem is renovations, which have become increasing common in recent years. What happens when a property that falls in a particular Group and Type is substantially improved (versus an otherwise similar property with only typical repairs and maintenance)?

In the long run, the current coding scheme should be overhauled in favor of a system that provides separate variables for general category of property (houses, flats, etc.), type of design (detached, semi-detached, terraced, etc.), quality of construction (which can be updated in the case of renovations), and era or year built[2]. In addition, there is nothing in the existing database to identify public versus private housing[3], although the VOA is preparing to capture this information (perhaps from data maintained by other government agencies) at least for public housing "estates" and possibly "infill" properties as well. The existing data should be converted to the new format, reviewed, and clarified over a specified timeframe. For the current revaluation the VOA has no choice but to maintain and work with the existing system, resolving major inconsistencies and updating data where possible. Fortunately, the agency has already developed a series of flags for properties missing key attributes or with inconsistent entries for group, type, and era variables. These properties are excluded in pilot models and the data will be reviewed and corrected prior to value generation.

In addition to group, type, and era, current VOA data provide for total living area; number of rooms, bedrooms, and bathrooms; conservatory type and area; number of floors and floor level (apartments); parking; and outbuilding. The following items have been used in pilot models: group, type, era, living area, rooms, bedrooms, baths, and floor level. Properties are modeled as long as there are data on at least group, type, and area (as of 1st December 2004 it is estimated that up to 15% of properties have missing or inconsistent data for at least one of these three variables or for construction era).

Plot size, which can be an important value determinant in suburban and rural areas where land often varies in size, is not part of the current database. However, VOA has embarked on a pilot project to capture plot sizes through GIS. Many North American jurisdictions have completed similar programmes with success and this project should be pursued to completion. If necessary, resources can be prioritized to focus on those suburban and rural areas where land varies significantly in size. Plot size is far less important in urban areas where all properties of a given type in a given neighborhood reside on similar-size plots.

A problem is the absence of much of the data for properties constructed during the community charge or "poll tax" era and for many other properties due to record keeping deficiencies. Together these properties account for 6-7% of domestic properties (well over 1 million

[2] In Northern Ireland construction quality has already emerged as an important variable in pilot area models.
[3] This variable has proven very important in Northern Ireland's pilot models.

properties). Data for these properties will be added during the course of the project and should be coordinated with valuation efforts so that all properties in a market area can be valued en masse to facilitate quality control and value review.

State of repair is another issue. The Local Government Act of 1992 provides that properties are to be valued on the assumption "that the dwelling was in a state of reasonable repair." The requirement relieves the VOA from trying to capture or value routine variations from the norm for a given type of property and neighbourhood. As regulations acknowledge, however, there are instances, such as major damage or renovations, in which this assumption would lead to totally erroneous values. "Similarly, if a dwelling has been so substantially improved and extended, so as to become wholly different in character from those around it, the state of repair which it is appropriate to assume may well differ from that which attaches to its previously similar neighbours." Thus, VOA must monitor and capture significant improvements or damage to property. In the long run VOA will need to provide appropriate variables and standard operating procedures for capturing renovations or abnormal deterioration. For purposes of the present revaluation VOA will have to endeavor to capture significant renovations or disrepair through a combination of methods: local authority plans, external and drive-by inspections, and questionnaires and follow-up telephone contact. Steps have already been taken toward coding renovations

Because a property's band is fixed until sold or until the next revaluation, until now it has not been important to collect updated data for renovated or extended properties. Most of these properties reside on "logged reports" and await field review. Present plans call for sending questionnaires to such properties, as well as those missing building data. Experience in North America suggests that property owners cannot be relied on to provide the required information consistently and accurately. However field checks of information reported on questionnaires in the recently completed Council Tax Revaluation in Wales and trials completed in North Tyneside have shown that there is a good level of accuracy in the reported information. From this experience, the VOA estimates a return rate of 50-60%. Although questionnaires can provide a good starting point, we recommend traditional field inspections to supplement questionnaires and verify reported information that appears questionable, incomplete, or in conflict with information available from building permissions.

2.3 Sales Data

In addition to data on property characteristics, the success of a domestic revaluation depends crucially on sales data and related market evidence. Fortunately, in England sales prices are stated on official transfer documents and are public information[4]. Importantly, however, depending on the circumstances, some sales provide valid market value proxies while others do not. Thus, it is important that transfer documents be examined to determine whether the sale meets the requirements of an open market, arm's-length transfer between willing and informed parties. For example, a sale should be rejected if the buyer and seller are related, if the seller is motivated by duress or philanthropy, or if the buyer does not obtain a freehold or equivalent interest. It is also important to ensure the property characteristics used in modelling reflect the

[4] This is also true in the large majority of North American states and provinces. In the past the VOA entered sales data manually, but it is now beginning to receive the information electronically.

status of the property at time of sale. For example, if a property is sold and then extended by the new purchaser, the property as sold should be used in modelling, although it is the extended property that must be valued.

Unfortunately, it is often impossible to determine from a transfer document alone whether a sale provides valid evidence of market value. In North America valuation agencies often obtain supplemental information through mail questionnaires, personal contact, phone calls, or various third party sources. The Government has given VOA the authority to send out as many as 3.5 million questionnaires requesting information on property characteristics and transfers. The initial response rate was 50-60%. However, except in certain problem areas VOA may not go forward with questionnaires to sold properties unless there is a "logged report" or other information indicating that the property is new or has been substantially extended or altered (see previous comments).

A current project, involving access to the data held by an Internet "estate agency" web site in ten postal code groups, is seeking to verify and update property attribute data for sold properties. This site provider covers approximately half of the domestic sales market and carries various attribute data and "offer price" information. The outcome of this trial should help develop a sales verification strategy, involving fieldwork, estate agent information and questionnaires.

Thus far, however, no cohesive strategy has emerged and, by default, the burden of screening sales has largely fallen to modelers. A better approach would be a comprehensive programme of validating sales through a combination of methods, including electronic edits testing the reasonableness and logical consistency of data and follow-up questionnaires or inspections where sales fail such edits. Electronic edits could include crosschecking prices and conceivably property characteristics with the real estate agents' database[5]. As a general matter, sales should be screened and validated up-front, not during modelling, although some additional checks to eliminate outliers during modelling are standard procedure (if sales have been adequately screened, modelers should have to spend little time addressing outliers)[6]. To the extent that resources permit, unless data can be verified against the real estate agents' database, VOA should field inspect and photograph at least "key" sales, that is, those selected most frequently as comparable sales or closest to the AVD date.

2.4 Location Data

Along with size and construction quality/condition, location is the most important determinant of property values. There are a number of aspects to location: the region in which the property is located (market area), the specific neighbourhood, and specific location of the property with respect to view, traffic, or so forth. In the case of flats, the latter can vary even within a building, e.g., one side of an apartment block may have a desirable view while the other is on a busy street. In addition, the geographic (x-y) coordinates for a property can be used to identify the closest sales.

[5] Some North American assessment agencies electronically screen property characteristics for sold properties against databases maintained by real estate agents.
[6] Sales used in pilot models have been validated exclusively through electronic edits.

The VOA plans to define market areas based largely on billing authorities, of which there are approximately 350. Some smaller market areas will be combined, while some larger ones (e.g., Manchester) will be split. In all, there are expected to be between 400 and 450 market areas. Separate models will be developed for each market area (except for very high end homes).

Market areas are divided into neighbourhoods, which constitute relatively homogeneous areas of, typically, several hundred or more properties (as an example, Hillingdon with approximately 100,000 properties has 67 neighbourhoods). Neighbourhoods serve as variables in models and are also used to help identify comparable sales. Neighbourhoods are further consolidated into *neighbourhood groups* for comparable sales selection[7]. If sufficient comparable sales cannot be found in the neighbourhood, neighbourhood groups are searched.

Neighbourhoods were not used in the past and VOA staff is working to construct them. Valuers draw neighbourhood boundaries on paper maps and then with GIS. All properties in the same polygon are then assigned to a common neighbourhood. For the most part public and private sector properties are assigned to different neighbourhoods. As of early October, staff had completed approximately 20 market areas.

While this procedure for encoding neighbourhoods is excellent, some assessment agencies, including the VLA in Northern Ireland, have found it tedious and overly time-consuming. Consequently the VLA has turned to combining Census Output Areas (COAs) into neighbourhoods, which facilitates the process since there is already a GIS layer for COAs. The VOA might explore whether there is a similar potential in England and, if so, whether it would be advantageous to adopt in remaining market areas. If not, the VOA's current direction is excellent and should be continued.

Regardless of how drawn, staff should draw neighbourhoods that are sufficiently large to provide adequate sales for modelling and comparable sales selection. As a general rule, there should be at least 15 usable sales and desirably 30 or more (the more, the better).

Unfortunately, VOA also lacks data on site amenities and decrements, such as waterfront, view, and heavy traffic. These features can also impact value significantly, sometimes by 50% or more in the case of waterfront views.

VOA has recently developed a series of "value significant codes" to identify potentially important features not provided for in the current database. These include such site influences as premium view, location adjacent to a golf course, and traffic, as well as many other location and building-related features. Codes for these various influences might be entered into open-ended fields (prior discussions suggested that five such fields may be provided). However, using one field to represent many potential features complicates quality control and modelling (see prior discussion regarding property group and type). We recommend that the VOA create separate variables for each commonly occurring feature. Seldom occurring features, such as an indoor pool or equestrian facilities, can be open-ended and may best be captured as a factor (e.g., 0.85

[7] A spreadsheet programme has been written to help amalgamate neighbourhoods based on similarity in average sale price, size, price per-square meter, and other factors, which offers significant support to the user in defining neighbourhood groups.

or 1.20) with an accompanying reason code or comment field. While shortcuts are justified given the exigencies of the revaluation, data structures once put in place are not easily undone.

3. Modelling

VOA's chosen valuation approach is a comparable sales approach based on CLT's OASIS Automated Valuation software. Initially a house model and an apartment model will be built for each market area. The highest end homes will be assigned to separate "global" models[8]. Final value estimates will be based largely on comparable sales. Pilot studies have used sales from January 2002 forward. Sales from July 2003 through June 2005 will be used for the revaluation.

3.1 MRA Models

All models will use multiplicative multiple regression analysis (MRA)[9]. Multiplicative models make percentage adjustments, discount outliers, and are adept at capturing nonlinearities. They have shown improved results over prior additive models and easily provide the optimal approach for VOA.

Thus far only pilot models have been developed. These have followed two tracks. First, CLT is building global models for each billing authority or group thereof for which data are available. House models use property group, type, and era; living area; number of rooms, bedrooms, and baths; parking and garage spaces; and date of sale variables. The apartment models use these same variables plus number base floor level, presence/absence of a lift, and purpose built vs. converted/renovated flats. These models are scheduled for completion in January 2005.

Working in parallel, VOA's in-house modelling team has developed a number of pilot models (13 as of 1 October 2004) using these same variables but with neigbourhoods defined through local knowledge and created with GIS rather than based on postal code sectors.

These models have been important in helping to determine modelling strategies and procedures and in indicating potential success based on exiting data. Note, however, that only existing variables have been used, that data have been screened only electronically, and that properties with missing data for key attributes (group, type, and living area) have not been included.

Some variables used in pilot models merit discussion and comment. Group is represented in the model both through (a) a pre-weighted or "linearized" variable with standard weights based on user experience and exploratory models and (b) supplemental binary variables for groups with sufficient sales. Group 31 (dwellings built after 1953) is the "base" group and is assigned a value of 1.00. The other groups have been scaled up or down based on perceived relative desirability. The model develops a market-derived exponent for the variable, which either collapses or expands the weights, although their underlying relationship remains unchanged. If significant in the model, the binary variables modify the weights calibrated for the linearized variable.

[8] Tentatively there may be approximately 20 such premium-housing models based on broad geographic groups.
[9] "Backward" variable selection is used to remove statistically insignificant variables.

Property type is handled in a similar manner with a predefined linearized variable supplemented by binaries as sales permit. In this case, semi-detached homes constitute the base. The approach to handling property group and type is technically excellent, combining generally observed market relationships with local refinement where available sales permit.

The handling of neighbourhoods is more problematic. Once defined, neighbourhoods are linearized by comparing the median sale price per-square meter of the neighbourhood with the median price per-square meter of the market area[10]. Unlike treatment of group and type, only the linearized value is included in the model. The problem with this approach is that price-per square meter reflects much more than neighbourhood desirability (it also reflect property type, house size, effective age or condition, plot size, site amenities, etc). A better approach would be to include binary variables for each neighbourhood (or neighbourhood group where there are too few sales at the neighbourhood level). This would better capture neighbourhood desirability and ensure an overall assessment level of approximately 1.00 for each neighbourhood

A further problem is that to date only one linearization factor has been developed for both houses and flats. Clearly, however, the desirability of a neighbourhood may differ between houses and flats. For example, an area may be quite desirable for flats use but less desirable for houses due to the preponderance of apartment properties. Neighbourhood linearization factors should be separately calculated for houses and flats.

In addition to property characteristics, models include date of sale variables to control for the obvious effects of time on price. The variable, DOS (number of months prior to the valuation date) represents the underlying time trend. It is supplemented by a series of "spline" variables which indicate the number of months prior to the valuation date less 3, 6, etc. One or more of these variables might prove significant in the model if price trends have changed over the time frame of sales used in the model. There is also a supplemental date of sale variable for terraced homes (TerrDS), which represents any increment in price trends for terraced (versus detached and semi-detached) homes.

While a bit complex, this approach effectively captures price trends over the study period, so that coefficients for the other variables will reflect market value as of the appraisal valuation date (AVD). We recommend that VOA make it standard operating procedure to graph the resulting trends against date of sale to ensure that they are reasonable. It would also be good practice to express the indicated trends on an average monthly basis for review by management and others and for potential use in other applications.

In addition, VOA plans to develop a "control model" for each market area. Control models will have only two characteristics: existing band and date of sale. The models will provide a crude estimate of market value based on a property's current capital-value band. Large discrepancies between actual value estimates and control values could flag properties for review. While the

[10] Sales prices are adjusted based on preliminary time-adjustment factors, and square meters of living area is multiplied by the pre-defined property type linearizations. While this is conceptually appropriate, it builds in additional assumptions that could be avoided through the binary approach, in which neighbourhood factors are developed during regular model calibration.

idea of have an independent check on model accuracy is desirable, control values are themselves so problematic that we wonder if their use will prove productive. Time saved in targeting reviews may be more than offset by time spent pursing flags falsely raised by renovations, extensions, and other data inadequacies. In addition, existing capital-value bands are so wide and few that, combined with the other problems just cited, "reasonable" agreement between actual values and control values provides little assurance as to the probable accuracy of either. We suggest that it may be more productive to sever the tie to existing bands and base value reviews on other criteria (see section 4 below). The issue could be explored during further mini-reval work.

Finally, the VOA's current approach appears to regard model specification as an essentially global exercise with the result that specification and calibration of individual models is largely mechanical. All models have the same structure and variables (although group and type binaries will vary with sale counts). This has the advantage that modelers can complete models more quickly with less danger of inadvertent errors. The downside is that models may not capture local variations or pass the "seems reasonable" test (see comments on North Tyneside models in appendices 3 and 4). To be sure, since final values are based primarily on comparable sales (see 3.2 below), this is not as much of a problem as in systems where MRA models predict values directly. Still, models provide the adjustments made to comparable sales and, particularly if models are open to scrutiny, it is important to ensure that adjustments are explainable and that systematic equities have been addressed.

3.2 Comparable Sale Algorithms

In the CLT schema, the completion of model calibration only begins the valuation process. Calibration is followed by comparable sales selection and adjustment and determination of final value estimate.

The process begins by finding the five "best" comparable sales for each subject property. Comparable sales are selected from the same neighbourhood as the subject. If there are insufficient comparables within the neighbourhood, the search expands to the neighbourhood group. Each potential comparable sale is weighted based on user-defined weights[11] and similarity to the subject property. These weights can be viewed as penalty points, e.g., a penalty of 3 points per square meter, 30 points per era, and 50 for being in a different property type group. Weights are also assigned to date of sale (DOS) and distance in square meters between the subject and sale properties[12]. Because each variable is in different units (square meters, number of bedrooms, eras, months, etc.) assignment of weights is difficult and problematic. A more straightforward approach would be to assign a simple percentage weight to each variable, such that their total summed to 1 (e.g., 30% to living area, 10% to bedrooms, 10% to era, etc).

[11] Preliminary plans call for one set of weights per property type (houses vs. flats) and maybe for each of 20 regional valuation groups. This may be fine given the current data, but if plot size and location data (view, etc) can be added, the relative importance of these items could be expected to vary considerably among market areas.
[12] Consideration is also being given to assigning weight to street name.

In any case, each potential comparable is weighted using a standard Euclidean distance metric and the five most comparable sales selected[13]. The sales prices for the selected comparables is then adjusted for differences from the subject property to produce five value estimates. Next, a weighed average of the five is computed (with the weights being inversely proportionate to their calculated distance metrics). The MRA value provides a seventh estimate. The two lowest and two highest estimates are discarded and the remaining middle three are averaged to produce the final estimate.

This process merits comment. Many jurisdictions in North America (including all in Canada) use the calibrated MRA value directly (subject to usual value review). Use of MRA estimates has the advantage that values will be consistent from property to property with differences being directly explainable by differences in property attributes. It also gives the modeler full control over valuation algorithms and results. Comparable sale adjustments add another layer to the valuation exercise, the intent being to fine-tune each value estimate based on the most comparable sales. Of course, the sword cuts both ways: the best comps may have bad data that can worsen the value estimate. Happily, removing the two lowest and highest value estimates helps guard against this possibility. Comparable sales also provide well-accepted support for the final estimated value. Still, incorporating the most comparable sales into the valuation algorithm precludes their being used as independent checks on the model estimate. Certainly one can argue that either approach is more transparent and explainable.

While the above discussion puts the automated comparables sales approach into the context of alternative, accepted approaches, it is not meant to discredit it. The method is firmly rooted in traditional appraisal techniques, well accepted and widely used, and VOA is comfortable with the presentation format, which can assist in value review and explanation. One caveat is that, being highly dependent on several sales, value estimates can be more impacted by bad data than direct MRA, in which data errors tend to be washed out by the law of large numbers. All of which brings us back to the importance of good data discussed at the onset in section 2.

3.3 Beacon Values

As mentioned, the VOA plans to use two years of sales in valuation models. As might be expected, questions have arisen over what to do when there are too few sales in a neighbourhood or when sales do not adequately represent the mix of properties found in the neighbourhood. Fortunately MRA does not require proportionate representation of each property type in each neighbourhood. Relationships are presumed to extent across the market area so that, for example, better-built homes will command a premium across all neighbourhoods - even in those with no sales of given construction class.

More serious is a dearth of sales altogether in a neighbourhood. This should be addressed first and foremost by defining neighbourhood boundaries such that adequate sales can be expected. In the CLT system neighbourhood groups provide a further means of addressing the problem.

[13] The Euclidean distance metric sums the weighted squared distances for each variable: distance = 3 [w_i * (x_{is} - x_{ij})^2], where w_i = weight for variable *i*, x_{is} = value of variable *i* for sale property, and x_{ij} = value of variable *i* for subject property). In instances where the five sales with the lowest weighted distance do not meet a specified comparability threshold, as few as three comparables may be selected.

Some have proposed that appraisals of "beacon" properties should be made in areas with inadequate or seemingly unrepresentative sales and added to the database for valuation purposes. While this would be helpful, such "single property" appraisals are time-consuming and subject to the usual variations inherent in appraisals. Except perhaps for premium homes and other select pockets, a better use of resources would be to validate and inspect available sales to ensure that data for sold properties are reliable.

3.4 Sales Ratios and Confidence Intervals

The OASIS modelling tool produces standard sales ratio statistics. Ratio studies are produced on holdout samples of sales (every eighth sale has been assigned to the holdout group in pilot models). This ensures that reported results are objective and unbiased[14] and consequently we find ratio study measures to be valid and reliable. Ratio study reports break out results for each model by current band, property group, property type, and era.

Confidence intervals provide a measure of the likely accuracy of estimated values[15]. Although MRA provides confidence intervals for value estimates, VOA's final value estimates are based on the average of seven estimates, including five comparable sales adjusted for differences from the subject property. This precludes the computation of standard confidence measures. Nevertheless, CLT has developed an algorithm for estimating 90% confidence intervals based on (1) the standard error of estimate of the regression model, (2) the comparability distances of the five selected comparables, (3) the consistency of value estimates provided by the five comps, and (4) the average difference between control model values and actual estimates[16].

Confidence intervals will be used to signal the reliability of generated values and thus help target field reviews. Interestingly, however, the real issue is not the reliability of the value estimate itself but the reliability of the value band to which a property is assigned. Much field effort could be avoided if bands were known up-front, which would permit targeting reviews only on properties whose proper band was in reasonable doubt. However, since the banding scheme will not be determined until values have been finalized, VOA is obligated to strive to assure the reasonable accuracy of each value, even where there will be no question as to a property's proper band. Clearly an early decision as to the banding scheme would be welcome in terms of efficient allocation of staff resources.

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[14] A sale of a subject property is used as a comparable for itself, which would normally bias performance measures. However, such sales are not included in developing value estimates for holdout sales.

[15] Confidence intervals form the range in which one can have a specified degree of certainty (often 90% or 95%) that the parameter being estimated lies, e.g., the 90% confidence interval for a value estimate of , 200,000 might range from , 160,00 to , 240,000.

[16] It might be noted that the development of such confidence intervals is complex and heuristic. Errors for holdout sales are regressed on the four components noted above to generate a model that can in turn be used to estimate confidence intervals for both sold and unsold properties. Presumably one such model would be developed for each market area and property type (which would eliminate the need to include the standard error as a variable in the model), although there are concerns about the practicality of this approach. The use of control values as a quality control measure has already been discussed.

In any case, while the underlying calculations are complex and heuristic, we find the proposed confidence intervals easily adequate for the purpose at hand. However, we also again caution against blind reliance on statistics when data are incomplete or inaccurate. If a subject property has, say, a premium view and the selected comparables do not (because view is not collected and thus not available as a selection criterion), the selected comps may be otherwise physically similar to the subject and provide consistent value estimates, but they will be consistently wrong and, further, the error will be masked by the seemingly acceptable confidence interval. It is imperative that the database be put in order before credence can be placed on statistics generated from it.

4. Resources, Quality Control, and Capacity Building

Although not the subject of this study per se, we believe it is important to address key issues related to project resources, quality control, systems integration, and organization culture.

4.1 Staffing and Training

The success of any revaluation project is critically dependent on adequate, well-trained staff. Approximately 700 to 900 VOA valuation staff members have been or will be assigned to the project. This implies and average of about 25,000 to 30,000 properties for each valuer, an exceedingly high ratio. VOA will attempt to overcome these limitations through the intensive use of technology for modelling and quality control. Obviously this will require heavy investments in technology and training. As discussed in section 3, we are reasonably confident that the required valuation technology is available. Training is more problematic.

At the heart of the valuation effort, additional to the valuation project team of the Project Manager, Statistician and GIS manager, is a core modelling team of nine VOA employees chosen for their backgrounds in valuation and statistical analysis (five were in place as of 1 October and four were to be added). The core team will set valuation policy and provide training, feedback, and mentoring to the other modelers. Two modelers from each of 20 billing authority groups will calibrate the models. Thus, there will be a total approximately 49 modelers (9 core team staff and 40 regional staff). Each two-person regional team will calibrate an average of 20+ models.

During 2005-6 the VOA plan to supplement each regional team, such that each of VOA's 70 or so locations in England have resident "secondary" modelers who will have access to the software, under the direction of the regional team leader. These additional staff will undertake the same IAAO training course as the 49 people mentioned above.

We believe this plan is adequate. The problem at this point, however, is lack of training and experience. CLT has provided hands-on training to the five initial members of the core team and all modelers have completed IAAO or in-house statistical training. There are also plans for IAAO to conduct additional "train the trainers" classes and for participants to provide follow-up training to other staff. All this is good and to be encouraged. The simple fact, however, is that only four persons (give or take) have been involved in pilot studies. Modelling skills cannot

simply be taught; they must be learned through use and experience. Further, while very powerful and well suited to the job at hand, when compared to general statistical packages like SPSS and SAS, the OASIS modelling tool is not easy to learn or use. Mastery takes time and experience.

Thus, early 2005 will be a make-or-break time for the project in terms of skills development and transfer. The project schedule calls for most model development to be completed in the six-month window from April - September 2005. This time frame is achievable provided that the necessary skills are in place. Right now, aside from the initial core team, staff skills are nowhere near that point.

4.2 Quality Control

Although quality control in mass appraisal has many facets, for our purposes there are two main ones: data capture and value review. Section 2 above discussed data issues in some detail. As discussed, VOA is undertaking a number of projects to complete and improve the accuracy of existing data, including electronic edits, fieldwork, GIS, and data questionnaires. The current goal is to have data capture completed by 31 March 2005, so that valuation work can begin in April.

In effect, these various projects are an attempt to substitute for a traditional "recanvass" or physical review of all properties to ensure that data are complete, current, and consistent, as well as to capture new items (plot size, renovations, premium views, excess traffic, etc.). Time and staff simply did not permit so comprehensive an approach. The fallout, however, is that considerable data quality problems are likely to persist at time of valuation with the consequence that value review will be highly important.

VOA plans to perform value review roughly as follows:

- Values will be generated by market area and packaged at the neighbourhood level.
- Neighbourhood packets will be assigned to caseworkers according to neighbourhood complexity, model performance, sales density, and caseworker ability and experience.
- The caseworker will perform a desk review and make a decision to accept, adjust, or reject estimated values (if a value is adjusted, a reason code must be applied). Unfortunately, in most cases property photos will not be available to assist in this exercise.
- When the review is complete, the caseworker will return the packet to the office manger, who will perform some additional quality control (to be determined).
- The manager will return the packet to the caseworker to field review properties with rejected values or without values due to missing data. The caseworker will assign values to the rejected properties, collect missing data, and make any other necessary corrections.
- The caseworker will return the completed packet for final quality control and data entry.

Value reviews will give more attention to problem areas and to properties with wide confidence intervals or other flags. Particularly in that all properties will not have been physically reviewed in the first place, we would urge at least in problem areas that all properties be reviewed in the field for reasonableness and consistency.

To date values have been desk reviewed in 20 pilot areas and field reviews are planned to take place in January 2005 in five of them. In these 20 areas, fully 35% of model-generated values were either adjusted or rejected. Given the data accuracy and value consistency problems inherent in so low an acceptance rate, in such areas only a systematic review of all properties can be expected to provide satisfactory results. In fact, one might argue that trying to target specific properties might actually produce less consistency than a well-planned systematic review of all properties in a given area. Unfortunately, VOA simply does not have the staff to conduct traditional field reviews in most cases. Again, further mini-reval work should help better determine the probable accuracy of data and values and the relative efficacy of alternative value review methods. Given modern technology, GIS and digital photos can often substitute for physical reviews, at least in less problematic areas.

When values are overridden or changed due to other than data corrections, it is important to document the reason for the change (as has been done in the pilot areas reviewed to date). Rather than simply change the value, it is good practice to provide a "correction factor" and accompanying code or comment (e.g., an override factor of 0.85 due to restricted access). This will serve to document the problem and provide a mechanism for addressing the same condition going forward.

4.3 CAMA Systems Integration

As already discussed, we find the OASIS modelling tool adequate and appropriate for the task at hand. However, we would like to raise the issue of interface between OASIS and VOA's Oracle database. Data is exported to OASIS for modelling via text (csv) files. Models are developed in OASIS and results passed back to the VOA database for value review, etc. Although pursuit of this issue is outside the scope of our review, we are concerned that the two systems, while compatible, do not act as one, or at least that the integration is not sufficiently seamless. For example, are values simply exported back from OASIS to Oracle, or are the models exported to and thus resident in Oracle, so that correcting or changing characteristics for a property triggers a value recalculation? (Of course, it is the latter that is desired.)

Although these issues do not affect the accuracy or reliability of values, we recommend that VOA be alert to them and address shortcoming in CAMA systems integration or functionality as time and resources permit.

4.4 Organization Culture

It is important that VOA staff understand and are committed to the success of the project. This begins with education on the purpose, importance, and tasks of the project. For example, it is important that data collectors and reviewers understand how data quality directly impacts value quality. And value reviewers must understand how values were generated and the strengths and limitation of mass appraisal. They should also understand how changes to data and values would affect future value calculations.

The implementation of new software and valuation methods is a major transition for most staff. In order to work confidently and effectively, they must understand the new tools and procedures.

It is imperative that staff have and feel "ownership". Again this begins with training and continues with participation in pilot project and the like, and ultimately in generation, review, and defense of values. Thus, our previous comments concerning the importance of training modelers and involving them in pilot exercises. At a broader level, all staff must become comfortable and proficient with new and expanded roles. While an evaluation of steps and procedures to build ownership or buy-in is far outside the scope of this project, we wish to emphasize its importance in any major revaluation involving new systems and methods.

5. Conclusions and Recommendations

VOA has made great progress but still has a long road to travel. Results for the Hillingdon and North Tyneside models are discussed in appendices 1-4 below. By way of summary, the results generally comply with IAAO Standards (an exception being North Tyneside flats). We regard the overall results as good given the data available. Review of the models suggests that model calibration is a largely mechanical process with limited emphasis on the reasonableness of coefficients and analysis of uniformity among property categories or attributes (neighbourhoods, property group and type, floor, value range, etc.). As explained earlier, this is not as important as when models are used to predict values directly (subject to location refinements and value review). Still, aside from the always-important caveat of data quality, good values start with sound models and modelers should be trained to ensure that models are consistent with appraisal theory and the local market.

The following summarizes the various conclusions and recommendations discussed in sections 2 (data capture), 3 (modelling), and 4 (resources, quality control, and capacity building). For convenience they are numbered sequentially in the order discussed in the report and an "action" column has highlights the timing and importance of the conclusion or recommendation.

5.1 Data Capture

No.	Action	Conclusion/Recommendation
1	This Reval	*The data capture and valuation projects should be closely coordinated*. The success of the revaluation is highly dependent on the right data being available on a timely basis. Each project reports to a separate manager, who maintains a separate implementation schedule. The schedules seem in harmony, since there is a programme manager who co-ordinates all the projects within the revaluation exercise. Still, it is imperative that the database manager keep abreast of the needs and expectations of the valuation manager and that the valuation manager stay abreast of the processes and progress of the data capture exercise to ensure that data needed for the valuation are complete and accurate and are provided in a timely manner. The programme manager will have to ensure that this important liaison and coordination is maintained.
2	Post Reval	*Data on property group, type, and era must be rationalized*. These redundant and often inconsistent fields will need to be reconciled for the

		present revaluation and should be overhauled for the next revaluation. Separate fields should be created for property type, subtype, era or year built, construction quality, and public versus private-sector housing.
3	Post Reval	*The issue of renovations must be addressed*. Renovations, extensions, and remodeling can have a major impact upon property values. They appear to be a forgotten child in the current data structure. Immediately after the present revaluation is completed, the VOA should develop procedures for handling renovations, which might include assigning a revised construction quality variable or capturing the type and year of renovation. For the present, revaluation field staff should ensure that existing variables are accurate and monitor (and possibly override) value estimates for properties with major work.
4	This Reval	*Plot sizes should be captured*. Plot size, which currently is not provided for in VOA's database, can significantly impact value in rural and suburban areas. Fortunately, GIS affords the ability to capture plot sizes with acceptable accuracy at minimal cost. VOA should proceed with current plans to capture plot size in this manner for the current revaluation, at least for geographic areas with substantial variations in plot size.
5	This Reval	*Data must be captured on such important location influences as premium waterfront, view, and heavy traffic*. Some of these data may be captured through GIS if present or implied in existing layers. The present plan is to capture these and other attributes not presently provided for (such as public sector housing) through a set of five open-ended variables. Although the idea of providing for these various items is laudable, providing a separate variable for each attribute would improve data consistency, quality control, and use in modelling.
6	This Reval	*Data for properties built during the poll tax era or otherwise missing or residing on logged reports (extensions and major renovations) should be captured through field reviews*. Although questionnaires and plans filed with local authorities can help in this process, field reviews will be required to provide missing data and to make required corrections or revisions.
7	This Reval	*The VOA should adopt a comprehensive approach to sales screening and validation.* Sales data represents virtually the sole market value proxy for domestic properties, so that a successful revaluation depends critically on accurate sales information. Unfortunately, for various reasons sales frequently do not provide valid indications of market value. Such sales must be detected and purged or flagged. To some extent this process can be automated, although it is best practice to contact parties to the transfer (mailers could be used for this purpose) and/or physically visit sale

		properties to ensure that property characteristics data are also correct. The latter can sometimes also be accomplished through an electronic comparison with data maintained by real estate agents. In any case, the VOA should ensure that all sales used in the revaluation have been validated electronically and through additional follow-up for at least those that fail routine edits. Data should be largely clean once it is passed to modelers.
8	This Reval	*The approach being taken to define market area and neighbourhoods is sound*. Market areas are based on billing authorities, which appear to provide adequate market differentiation and sample size. Neighbourhoods are defined by valuers, drawn on paper maps, and then converted to GIS. This process may prove quite time-consuming for a project of this scope, and the VOA might explore the use of census output areas (as they are termed in Northern Ireland) to expedite the process. However, staff have already made good initial strides and should continue on the present course (which is optimal from a modelling standpoint since no prior constraints are imposed) unless they determine that another is more cost-effective. Neighborhoods should be sufficiently large to provide adequate sales for modelling.

5.2 Modelling

No.	Action	Conclusion/Recommendation
9	None - endorsement of approach	*The underlying modelling approach using multiplicative MRA with one model for houses and one model for flats per market area is sound*. The number of tentative market areas (400 to 450) seems entirely reasonable.
10	None - endorsement of approach	*The approach to treating property group and type (one linearized variable supplemented by binaries as sales permit) is technically excellent*.
11	This Reval	*The approach to treating neighbourhoods (one linearized variable based on price per square meter) is problematic*. A better approach would be to include binaries for neighbourhoods or neighbourhood groups. Separate adjustments should be developed for houses and flats.
12	This Reval	*Time-adjustment procedures are valid*. The indicated trends should be graphed against date of sale to ensure that they are reasonable and expressed on an average monthly basis for better understanding and potential use in other applications.
13	This Reval	*Appraising "beacon" properties should be given low priority*. A better use of staff time is ensuring that sales prices and descriptive data for sold

		properties are accurate.
14	This Reval - For consider-ation	*Control models can be expected to make little contribution*. These models, based only on existing capital-value band and date of sale, provide such crude estimates of current market value that they are of little value as an independent check on the reasonability of full value estimates and, if fact, may raise more false flags than valid ones. VOA should seriously consider severing the use of current bands. Perhaps a pilot study would shed empirical light on the issue.
15	None - word of caution	*The comparables sales algorithms are sound*. Although the algorithms discard the two lowest and two highest value estimates and average the middle three, dependence on a small number of comparables for each subject property underscores the importance of good data and systematic reviews to ensure the consistency of final values.
16	For consider-ation	*The weighting of variables in comparable sales algorithms is not user-friendly*. A more straightforward approach would be to assign percentage weights.
17	None - endorsement of approach	*Ratio study statistics are valid and reliable*. The statistics are calculated from holdout groups of sales, which ensures objectivity and lack of bias.
18	None - word of caution	*Proposed confidence intervals are easily adequate for the purpose at hand*. While the generation of confidence measures is complex and not mathematically exact, they will serve to gauge adequately the relative reliability of value estimates. We caution, however, that all such estimates assume complete and accurate data (consistency in comparable sales is not helpful if they differ in key features from the subject property in important attributes that are either uncollected or inaccurate).

5.3 Resources, Quality Control, and Capacity Building

No.	Action	Conclusion/Recommendation
19	None - word of caution	*The CLT OASIS modelling tool is adequate for the task at hand*. OASIS provides powerful modelling capabilities customized for the mass appraisal industry. However, it has a longer learning curve than "off-the-shelf" statistical software and, like any software package, effective use requires hands-on practice and experience.
20	None - endorsement of approach	*The modelling plan is adequate in terms of number of modelers and time frames*. The plan calls for a core team of nine, supplemented by 20 regional teams of 2-persons each. The core team would provide planning, direction, training, and mentoring, while the regional teams

		perform model development and calibration activities.
21	This Reval	*The required modelling skills are not present*. Only five VOA staff have had training in OASIS and even fewer have developed pilot models. Additional modelers must be quickly trained and begin participating in modelling exercises.
22	This Reval	*To the extent possible, field reviews should be systematic rather than piecemeal*. Because of resource constraints, data capture has been necessarily piecemeal, targeting properties missing key features or with obvious inconsistencies. Pilot projects have shown a widespread need to reject or override model estimates. Consequently, while VOA lacks the staff to field review all values, it should strive to do so in at least the most problematic areas. GIS and (if available) digital images can help facilitate desk reviews in other areas.
23	This Reval	*Review appraisers should apply adjustment factors rather than simply overriding values*. Along with an accompanying reason code or comment, this will serve to document the change and provide a way of handling the feature or condition in the next revaluation
24	This Reval	*VOA should evaluate integration of OASIS with its other systems*. Specifically, database and valuation systems should work in concert, so that data changes trigger value changes. Although such issues do not affect valuation accuracy per se, integration problems will affect overall efficiencies and customer support.
25	This Reval	*Staff buy-in is essential*. Success of a revaluation, especially one using new tools and procedures, depends on staff understanding, commitment, and capacity. Management must take the steps necessary to ensure that staff understand the overall project and their individual roles and responsibilities, as well as have the necessary training and skills to effectively execute those responsibilities.

Appendix 1
Model for Hillingdon Houses

As discussed in the main body of this report, the VOA provided data and models for two of its test areas, Hillingdon and North Tyneside. The file from which the models were built contained 15,980 sales. Every eighth sale (1,997) was assigned to a holdout group for model evaluation and testing. The other 13,983 were available for model development. However, 1,323 of these 13,983 cases (9.5) were flagged as having inconsistent or incomplete data for modelling and another 35 were flagged as premium homes, which are to be modeled separately.

The remaining 12,625 sales were used to develop initial models. Of these, 1,060 (8.4%) were tagged as outliers, leaving 11,565 sales to calibrate the four models: houses and flats in Hillingdon and houses and flats in North Tyneside.

The final model for Hillingdon houses was based on 4,614 sales. It contained the following variables.

- Neighbourhood. Neighbourhood numbers for Hillingdon range from 1 to 71. Sixty-five neighbourhoods have sales, of which 23 (33%) have less than 30 sales, 13 (20%) have less than 15 sales, and 4 (6%) have less than 5 sales. Clearly, some neighbourhoods are too small (or possibly have missing data for most sales).

  As discusses in the report, a single linearized variable was used for neighbourhood. The variable has an exponent of .803, meaning that the linearizations were compressed moderately from their initial linearizations while leaving the relative rankings of the neighbourhoods unchanged.

- Group. Sixteen property groups had sales. Group 31 (dwellings built after 1953) is the base and binary variables were created for other groups. Eleven group binaries were significant in the model. Adjustments range from a slight negative for one group to a 33% premium for group 24 (better quality estates built between 1919 and 1939).

- Type. Type "HS" (semi-detached) is the base type. Binary variables were created for other housing styles and adjustments ranged from –8% (mid-terraced) to 27% (detached).

- Era. Homes built in the 1930s constitute the base era. Adjustments range -3% for homes built in the 1920s or from 1973 to 1982 to +11% for homes built after 1999.

- Living area. The variable has an exponent of .598, implying that value per square meter declines significantly with size.

- Extra baths. Baths greater than one add approximately 3% each.

- Parking. Garages add approximately 4% per space and open parking spaces 2% each.

- Date of sale. The model indicates inflation at the rate of approximately 1.2% per month from January - March 2002, 2.3% per month from April – June 2002, 1.4% per month from July – December 2002, 0.8% per month for the first six months of 2003, and no inflation for the last six months before the hypothetical appraisal valuation date (AVD) of 1 January 2004 (there are no December 2003 sales and 48 November sales). The rates are all slightly higher for terraced homes.

In all, the model coefficients appear reasonable. Anomalies in age adjustments are probably explained by construction quality, style, buyer preferences, and correlation with group variables. The discontinuities and lack of a time trend after June 2003 is questionable, but the overall adjustments are obviously in the right direction.

Once models were developed, VOA generated final predicted values for both the model and holdout sales using the comparable sales algorithms described in section 3.2. Estimated values were then divided by sales prices to compute sales ratios.

Recall that every eighth sale (1,997) was assigned to the holdout group. However, 194 of these (9.7%) were rejected due to incomplete or inconsistent data and another 5 were premium homes. In addition, VOA excluded another 24 holdout sales where the ratio of the predicted to actual price was less than 0.50 or greater than 2.00[17]. This left 1,798 holdout sales for analysis, of which 713 were Hillingdon homes.

We ran sales ratio analyses on the resulting values. The overall results are as follows:

Sales	713
Median	1.006
Weighted Mean	.998
Std. Deviation	.141
Price Related Differential	1.020
Coefficient of Dispersion	.093

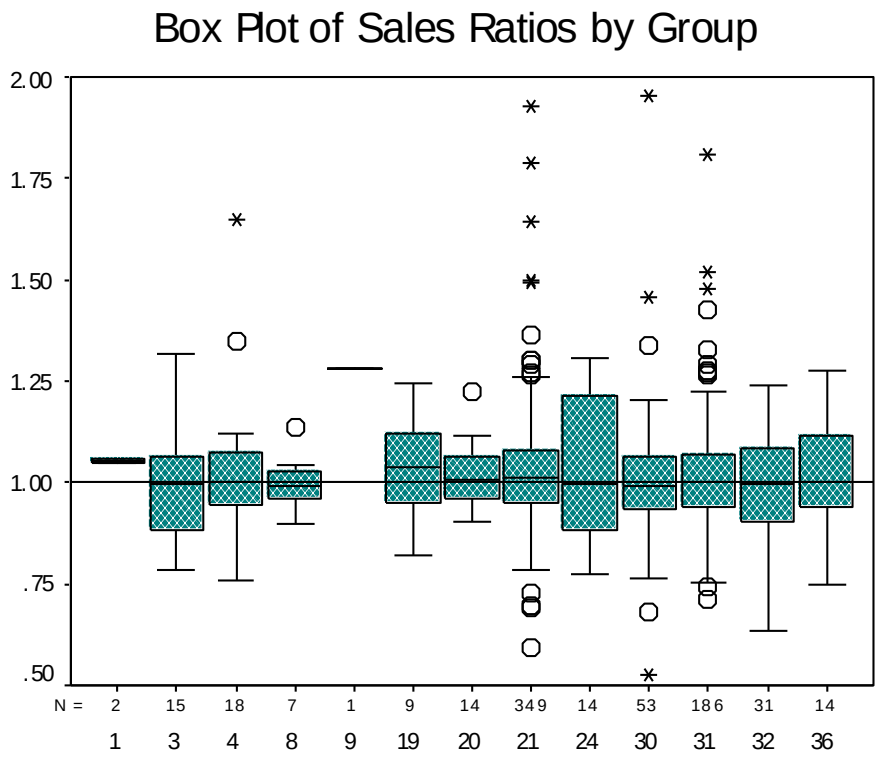
The median and weighted mean are both on target.[18] The COD (coefficient of dispersion) is .093, indicating that the ratios differ from the median ratio by an average of 9.3%. The price-related differential (PRD), a measure of equity between lower-value and higher-value homes, is a reasonably good 1.020. The International Association of Assessing Officers (IAAO) calls for CODs of 10% to 15% (depending on property age and homogeneity) for single-family residential properties and for PRDs between 0.98 and 1.03[19]. Thus, the pilot study results for Hillingdon homes easily meet IAAO standards.

[17] The 24 sales represented a modest 1.3% of the remaining 1,798 sales

[18] The median ratio is simply the middle ratio. The weighted mean ratio is calculated by dividing the sum of the estimated sales prices by the sum of the actual sales prices.

[19] PRDs of less than 0.98 indicate a systematic tendency to over-value higher-value properties relative to lower-value properties termed "assessment progressivity". PRDs greater than 1.03 indicate a tendency to relatively over-value higher-value properties, termed "assessment regressivity". However, the PRD can be impacted by outlier ratios, particularly those that might occur for high-value properties.

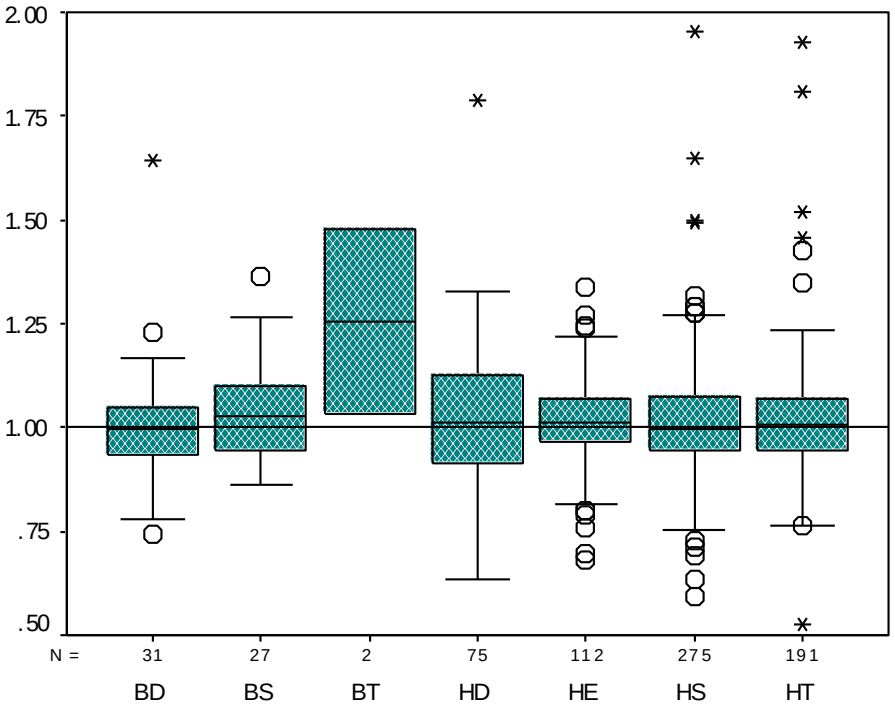
We also plotted sales ratios against key variables. Box plots[20] were used to plot ratios against group, type, era, bedrooms, neighbourhoods with at least 15 sales, and current band. Scatter graphs were used to plot ratios against size (square meters of living area) and value[21]. The results, shown below, show very good equity across most property attributes. Ratios for 1 and 2 bedroom homes are slightly high and those for 4+ bedroom homes are somewhat low. Note, however, that 100 holdout sales are missing bedroom count and that the variable was not included in the model. The box plot of ratios with current band and the scatter graph of ratios with value suggest mild regressivity (although the PRD is within IAAO guidelines).



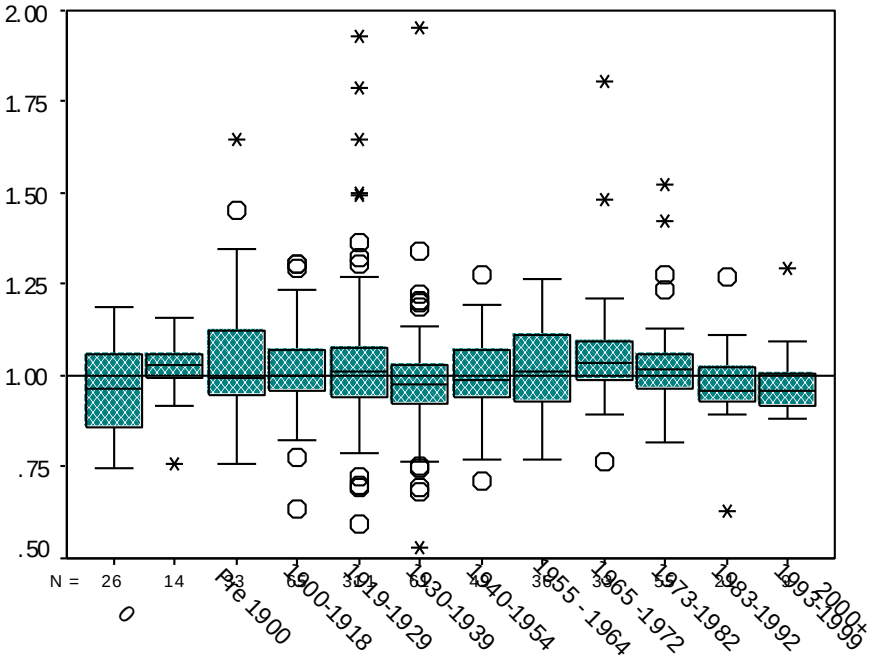
[20] The boxes in a box plot contain the middle 50% of the data and the line in the box represents the median ratio. Circles represent "outliers" and asterisks denote "extremes."

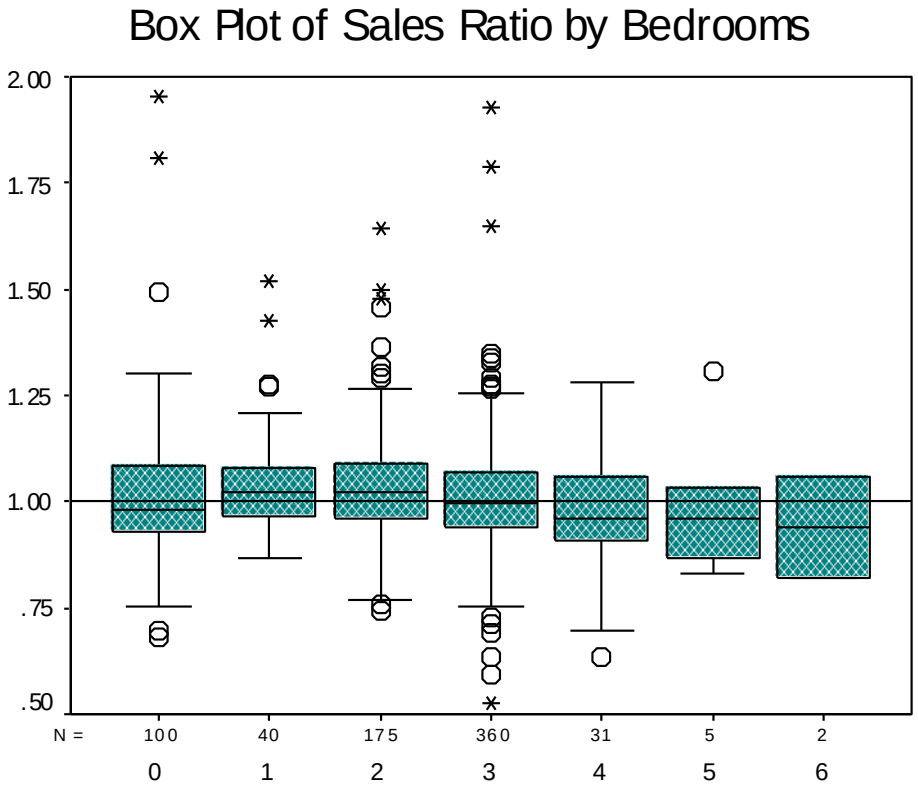
[21] Value was computed as ½ of predicted price + ½ of actual price to prevent bias in the results (see, Robert J. Gloudemans, *Mass Appraisal of Real Property*, IAAO, 1999, pp 300-306).

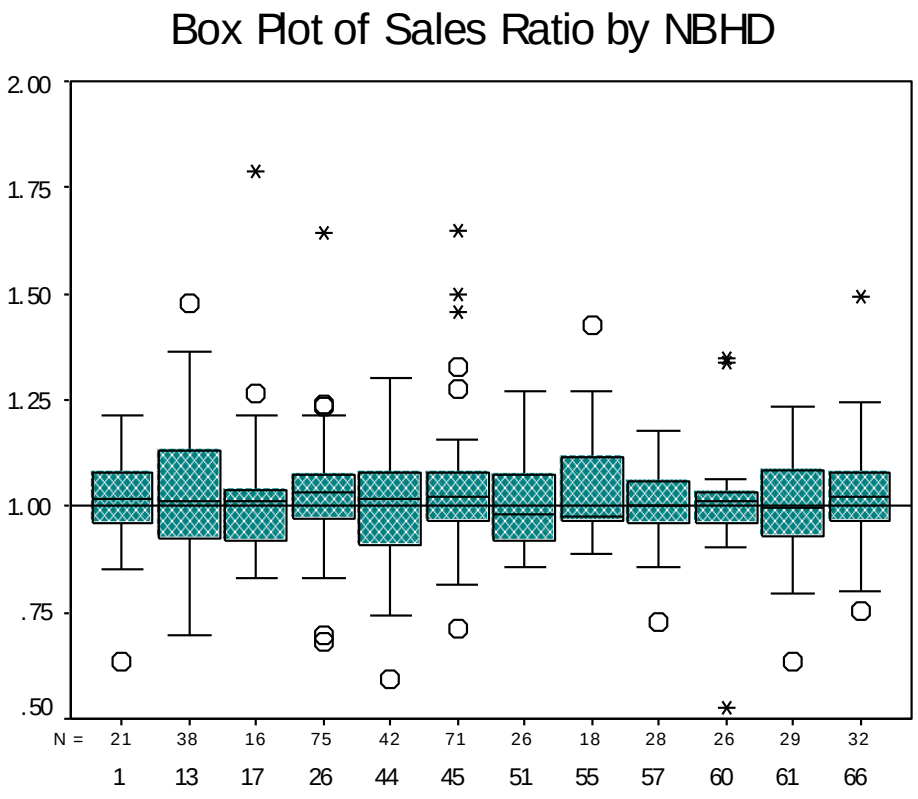
Box Plot of Sales Ratios by Type

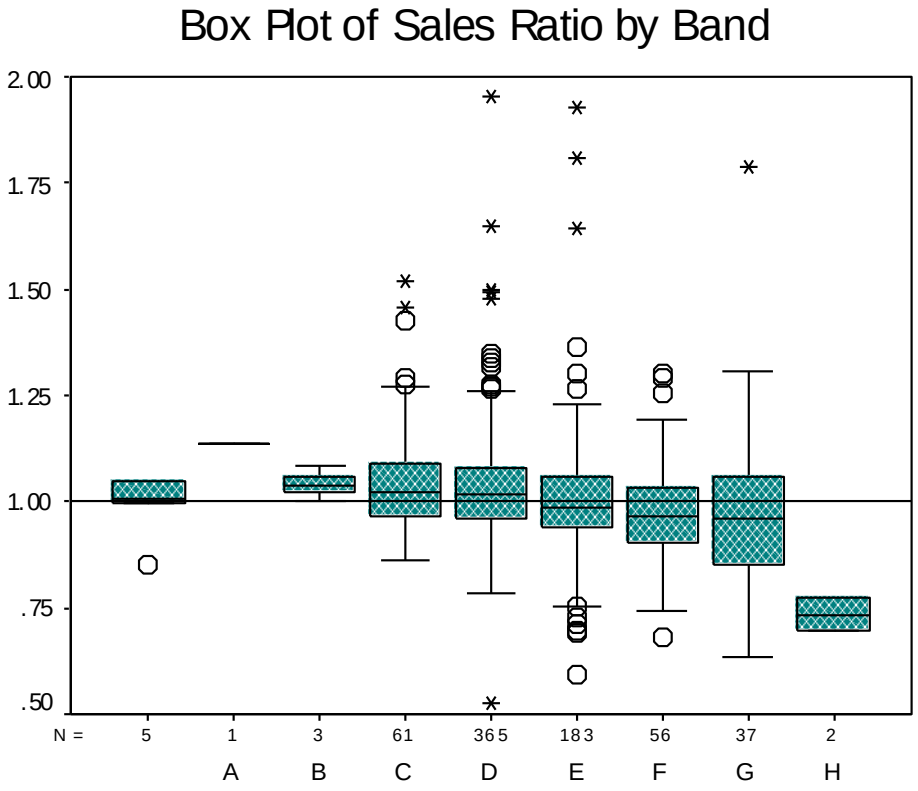


Box Plot of Sales Ratio by Era




Box Plot of Sales Ratio by Bedrooms
2.00
1.75
1.50
1.25
1.00
.75
.50
N =
100
40
175
360
31
5
2
0
1
2
3
4
5
6


Box Plot of Sales Ratio by NBHD
2.00
1.75
1.50
1.25
1.00
.75
.50
N =
21
38
16
75
42
71
26
18
28
26
29
32
1
13
17
26
44
45
51
55
57
60
61
66


Box Plot of Sales Ratio by Band
2.00
1.75
1.50
1.25
1.00
.75
.50
N =
5
1
3
61
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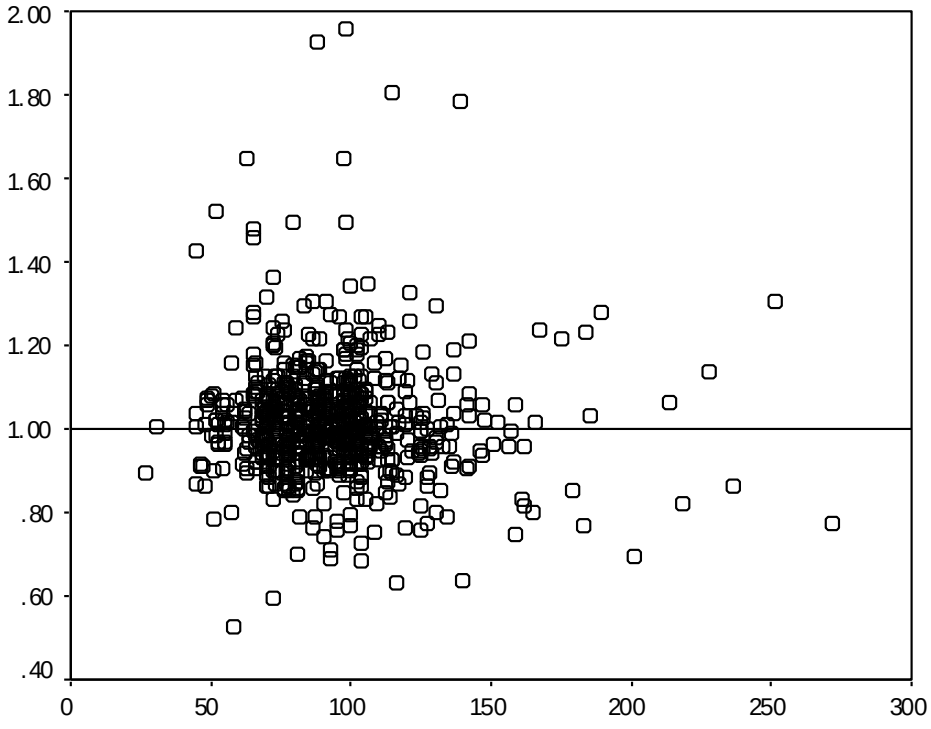
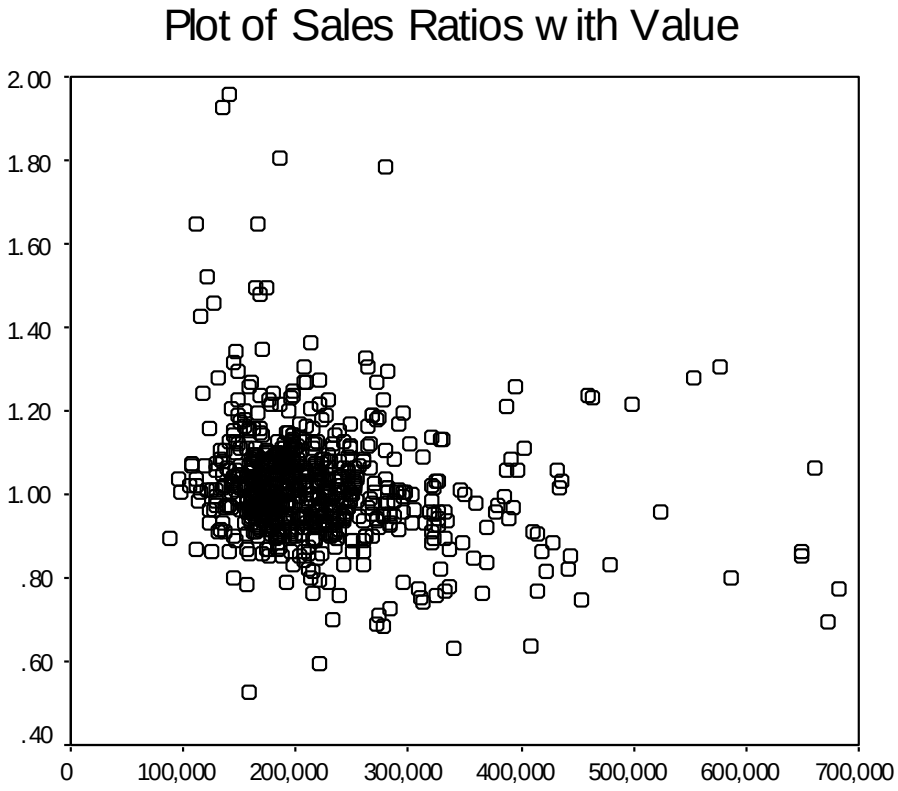
B
C
D
E
F
G
H


Plot of Sales Ratios with Size
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
0
50
100
150
200
250
300


Plot of Sales Ratios with Value
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
0
100,000
200,000
300,000
400,000
500,000
600,000
700,000

Appendix 2
Model for Hillingdon Flats

The model for flats in Hillingdon contained 1,399 sales and included the following variables.

- Neighbourhood. As with houses, neighbourhood numbers for Hillingdon range from 1 to 71. There are 60 neighbourhoods with sales of flats. Only 46 (over 3/4) have less than 30 sales, 29 (over ½) have less than 15 sales, and 12 (20%) have less than 5 sales. The linearized neighbourhood factor has an exponent of .661.

- Group. Eleven property groups had sales. Group 56 (flats and maisonettes in 3+ storey blocks built after 1945) is the base. Adjustments range from -17% to +18%.

- Type. Ten property types had sales. Type "FO" (purpose-built, self-contained flats) is the base. Adjustments range from -14% to +5%.

- Era. As with homes, the base era is 1930-1939. Perhaps paradoxically, older eras have an 8% positive adjustment while flats built from 1940 through 1972 have negative adjustments. Flats built from 1973 to 1982 have no adjustments and those built after 1982 have increasingly positive adjustments. Era is missing for 6% of cases (by default, such cases are treated as equivalent to the base).

- Living area. The variable has an exponent of .66, implying that value per square meter declines significantly with size, although not quite as rapidly as for houses (exponent of .60).

- Extra baths. Baths greater than one add approximately 17% each, much higher than the 3% adjustment observed for homes.

- Parking. Garages add approximately 6% per space and open parking spaces 2% each.

- No lift. No adjustment is indicated for building without a lift.

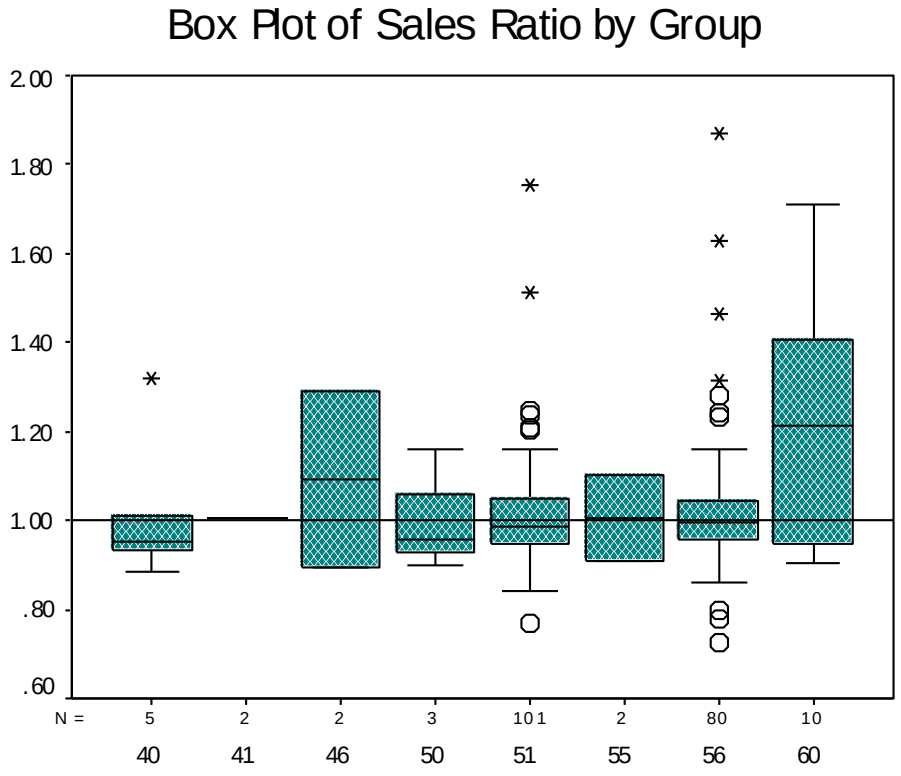
- Floor level. First floor is base. A positive adjustment of 22% is indicated for ground level, -2% for second floor, and -4% for third floor. It should be noted, however, that floor level is missing for 47% of the sales.

- Date of sale. The indicated inflation rate is approximately 1.8% per month during 2002, -0.4% per month during the first quarter of 2003, and 0.8% per month during the last three quarter of 2003.

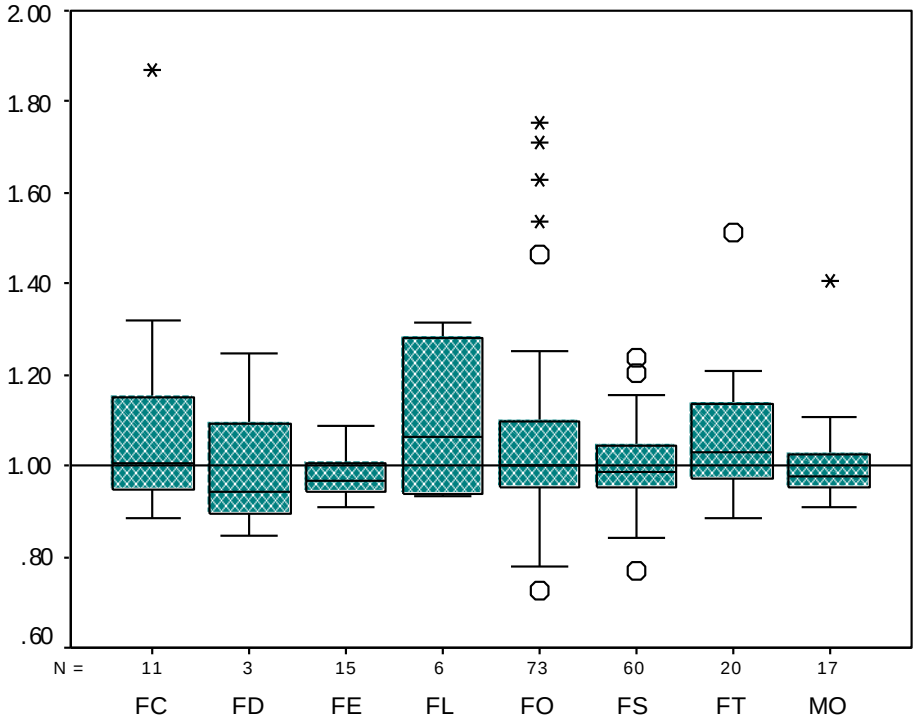
As with homes, VOA next ran comparable sales algorithms and calculated predicted values for both the model and holdout groups. Sales ratio results for the holdout group are as follows.

Sales	205
Median	.997
Weighted Mean	1.013
Std. Deviation	.154
Price Related Differential	1.017
Coefficient of Dispersion	.093

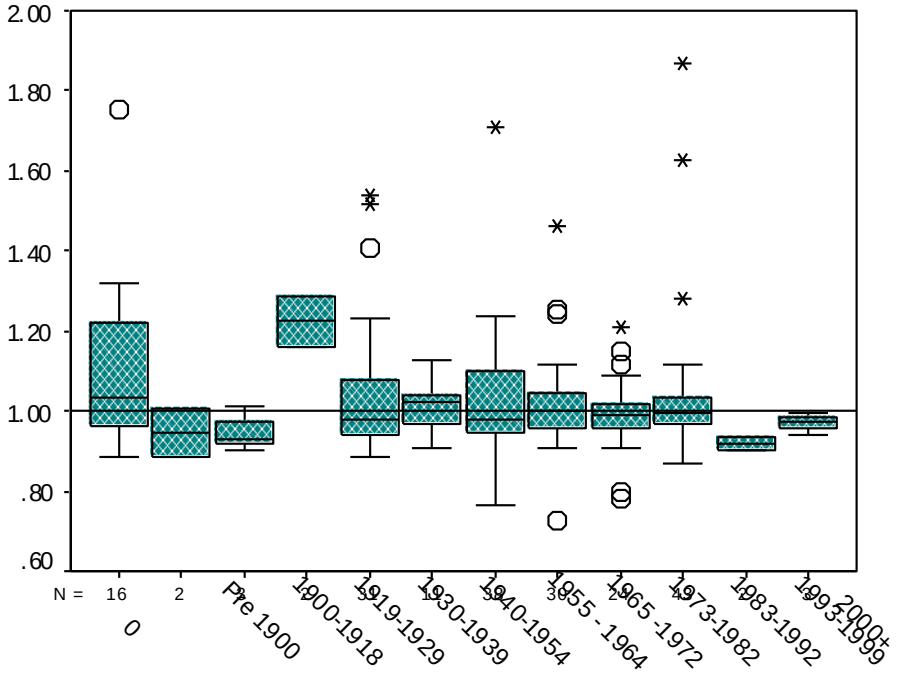
The results are very similar to Hillingdon homes and again indicate good performance. Sales ratios plots are shown below for group, type, era, bedrooms, baths, floor level, neighbourhoods with at least 5 sales, current band, size, and value. Equity across property attributes is good. Flats with 2+ bedrooms are slightly under-valued relative to one-bedroom flats and ratios appear to be generally low for the highest value properties. Note the relatively high dispersion for properties missing data (e.g., era, baths, and floor level).



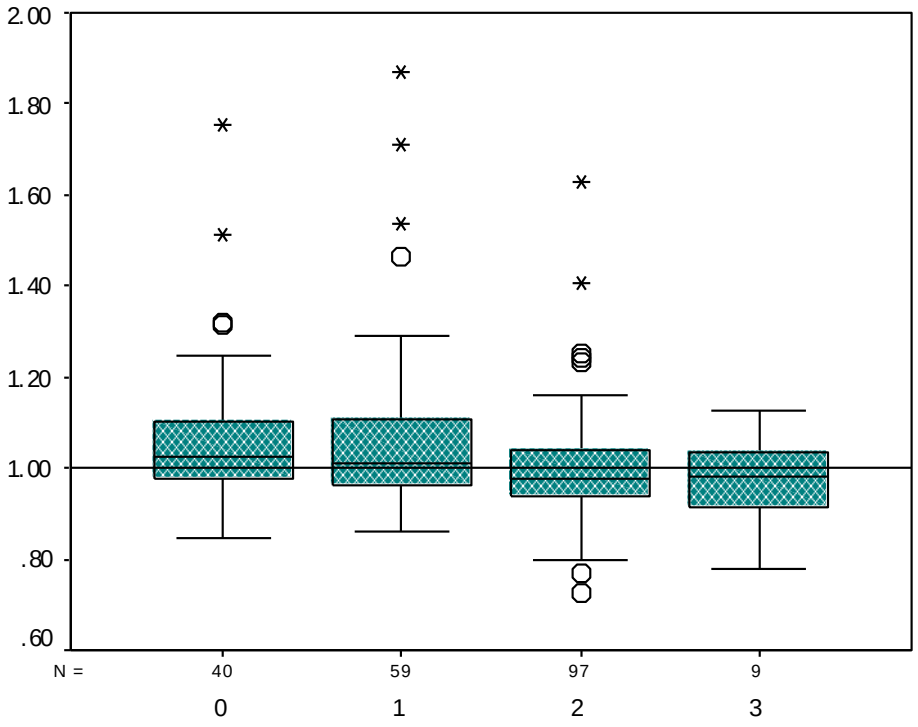
Box Plot of Sales Ratio by Type



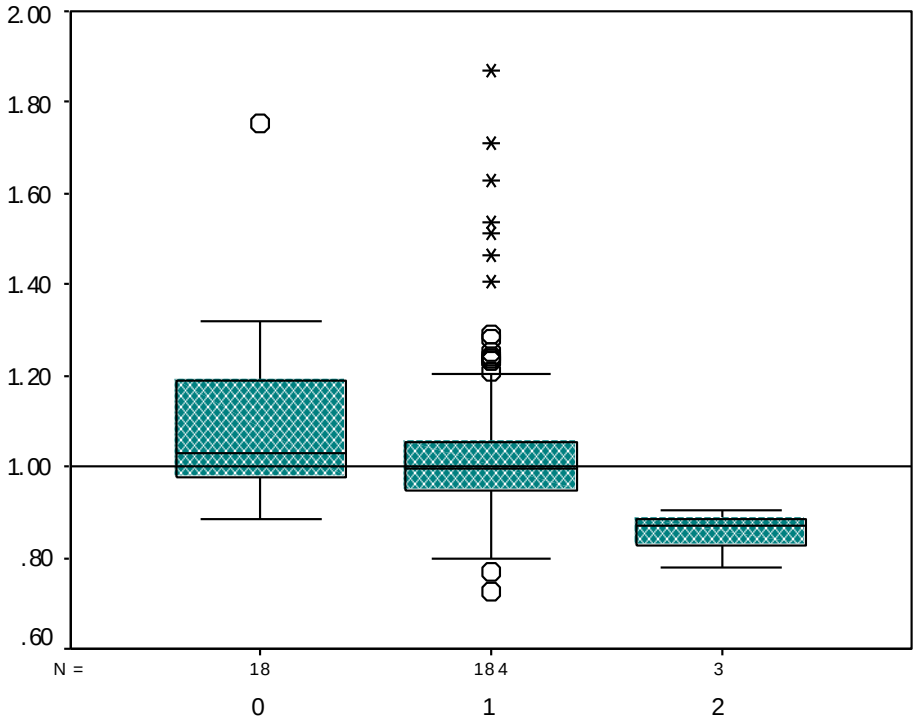
Box Plot of Sales Ratio by Era

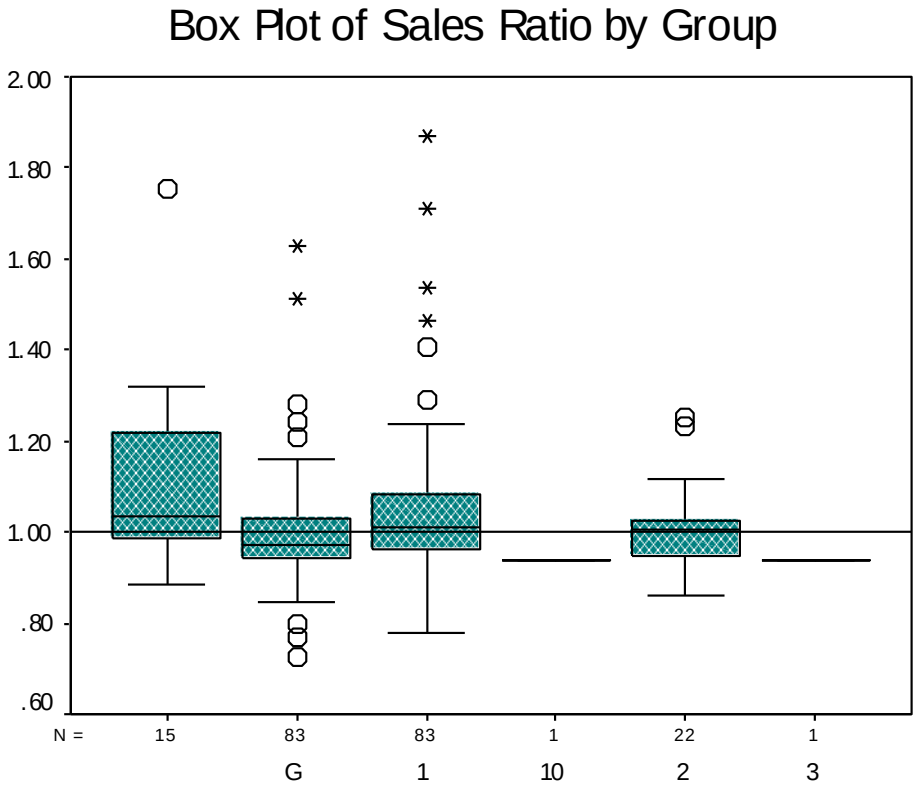


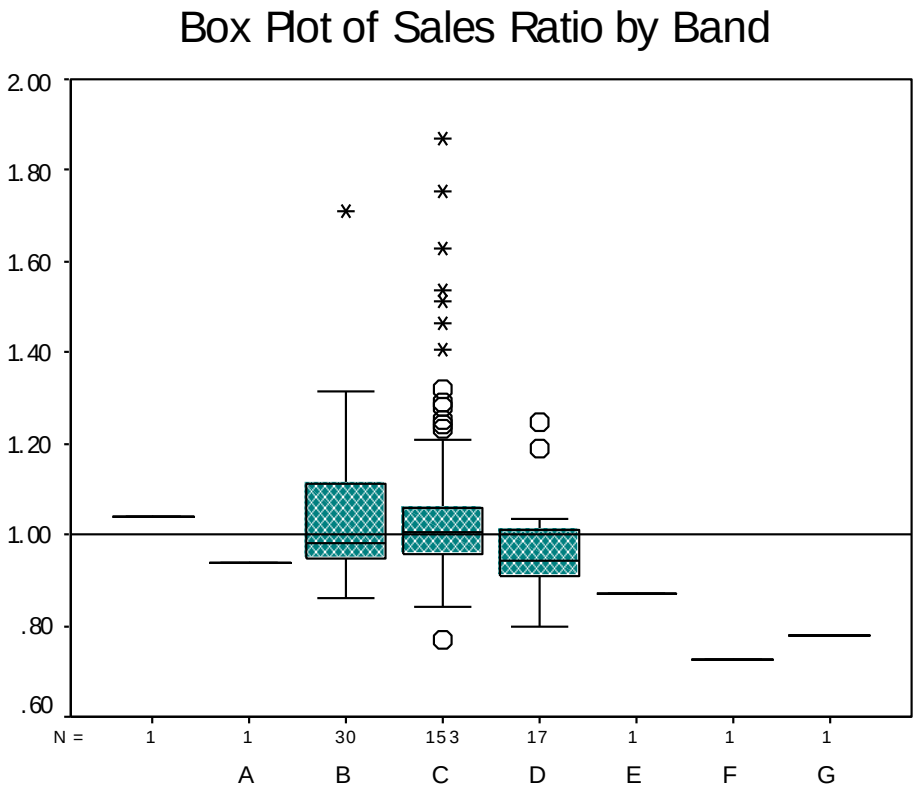
Box Plot of Sales Ratio by Bedrooms

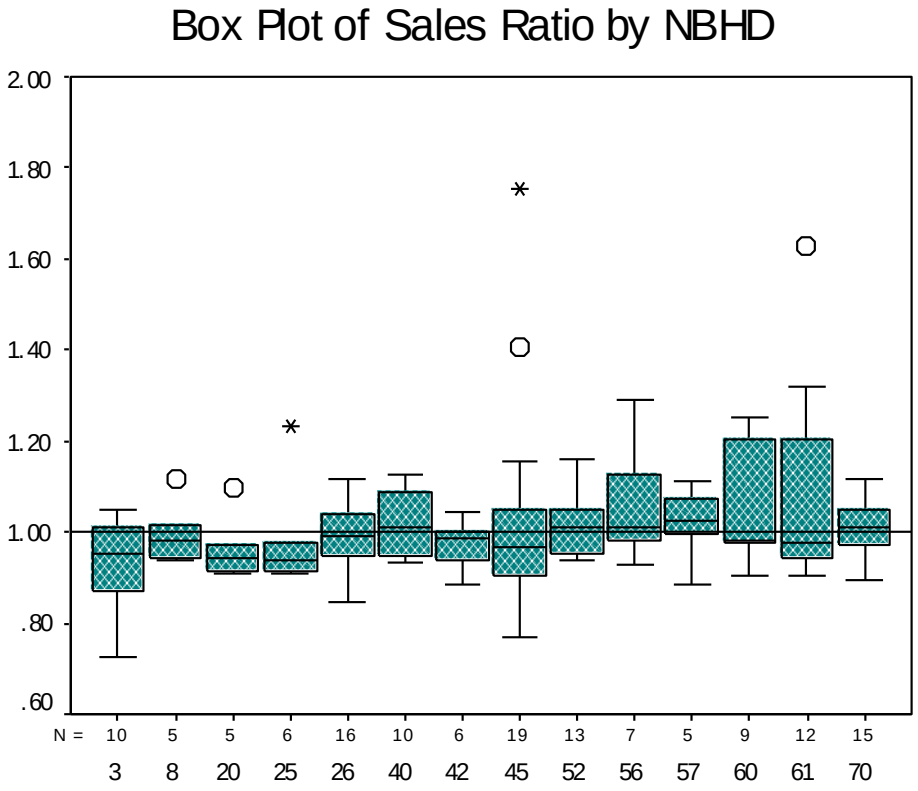


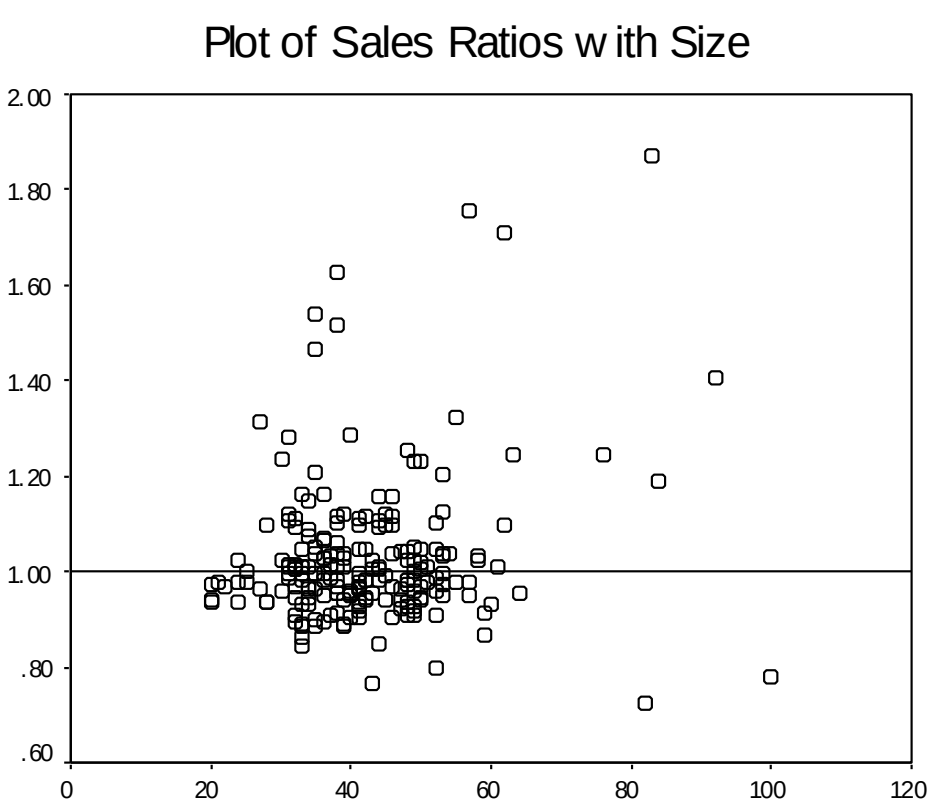
Box Plot of Sales Ratio by Baths

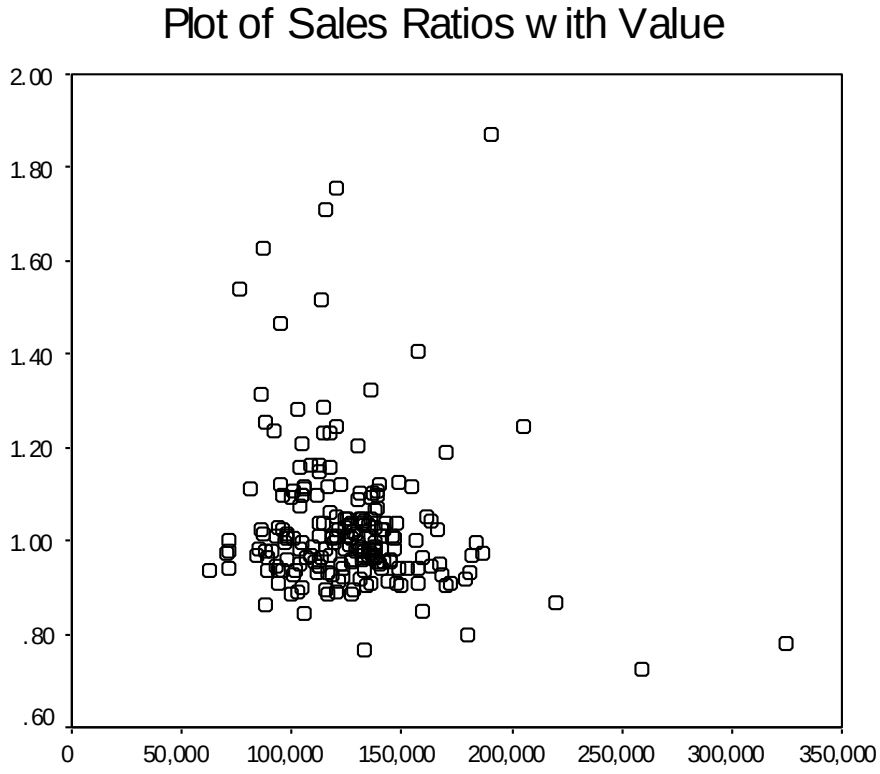



Box Plot of Sales Ratio by Group
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
N =
15
83
83
1
22
1
G
1
10
2
3


Box Plot of Sales Ratio by Band
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
N =
1
1
30
153
17
1
1
1
A
B
C
D
E
F
G


Box Plot of Sales Ratio by NBHD
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
N = 10 5 5 6 16 10 6 19 13 7 5 9 12 15
3 8 20 25 26 40 42 45 52 56 57 60 61 70


Plot of Sales Ratios with Size
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
0
20
40
60
80
100
120


Plot of Sales Ratios with Value
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000

Appendix 3
Model for North Tyneside Houses

North Tyneside is characterized by much more modest values than Hillingdon, with an average sale price a bit above £100,000 for houses and slightly above £60,000 for flats, both less than half of comparable figures for Hillingdon.

North Tyneside Homes

The model for North Tyneside houses was based on 4,141 sales from January 2002 through November 2003. The following summarizes the coefficients in the model.

- Neighbourhood. Neighbourhood numbers range from 1 to 85, of which 82 have sales. Twenty-six neighbourhoods (32%) have less than 30 sales, 15 (18%) have less than 15 sales, and 4 (5%) have less than 5. The linearized neigbourhood variable has an exponent of .586, indicating that prior linearizations had to be substantially compressed.

- Group. Seventeen property groups had sales and nine group binaries were significant in the model. Adjustments range from -26% for group 3 (3+ storey terraced homes built before 1919 to +23% for group 20 (large villa type homes built before 1919).

- Type. Type "HS" (semi-detached) is the base type. Binary variables were created for other housing styles and adjustments ranged from –10% (mid-terraced homes) to 25% (detached homes).

- Era. Homes built in the 1930s constitute the base era. The model indicated *positive* adjustments of 4% to 8% for older homes and *negative* adjustments of 3% to 10% for homes built from 1940 through 1982. Homes built from 1983 to 1992 show no adjustment and homes built after 1992 have small positive adjustments.

- Living area. The variable has an exponent of .663, implying that value per square meter declines significantly with size.

- Extra baths. Baths greater than one add approximately 16% each, much greater than the adjustment of 3% in Hillingdon.

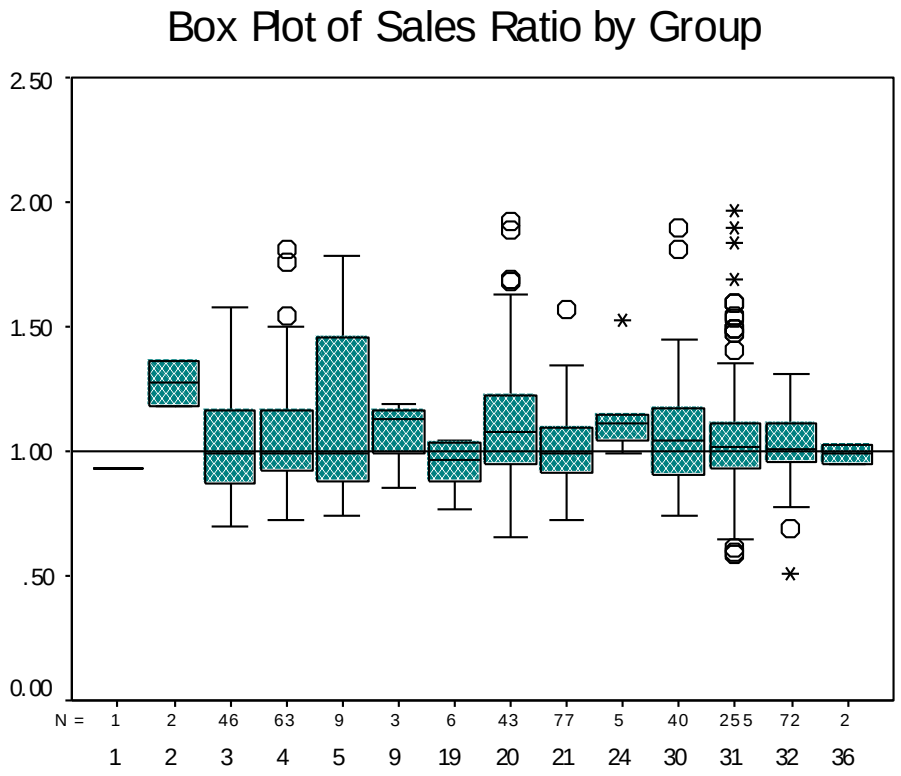
- Parking. Garages add approximately 6% per space and open parking spaces 2% each.

- Date of sale. The model indicates inflation at the rate of approximately 2.9% per month during 2002, slight deflation in the first quarter of 2003, and inflation of 0.8% per month during the remainder of 2993. No difference is indicated for terraced homes.

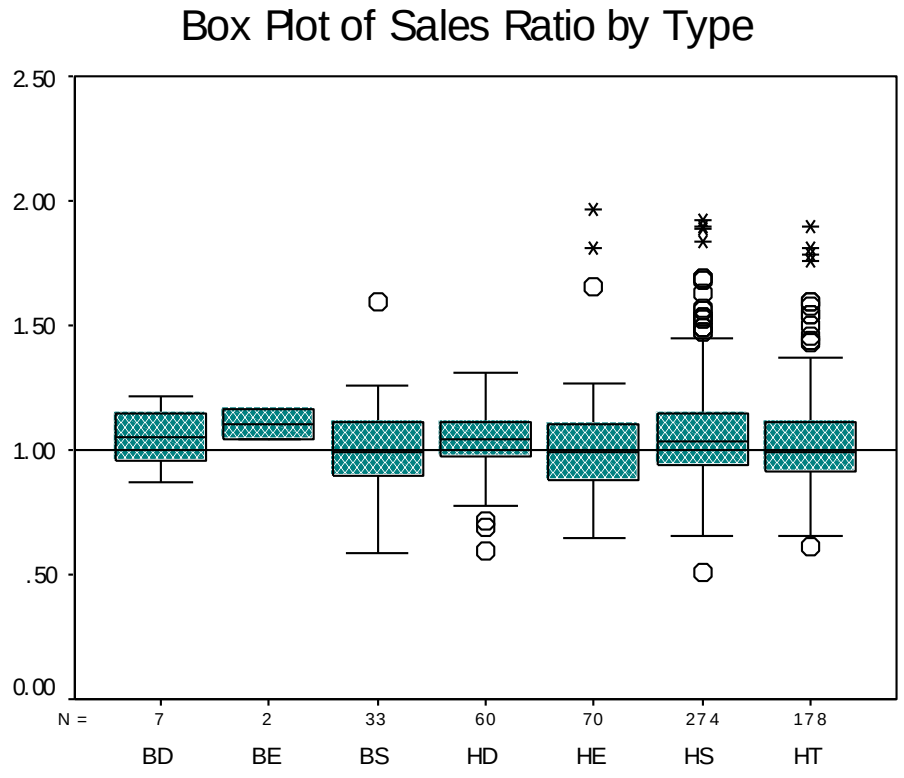
There are 624 sales in the holdout group, which produces the following sales ratio statistics. The COD is marginally in compliance with IAAO standards and the PRD indicates regressivity.

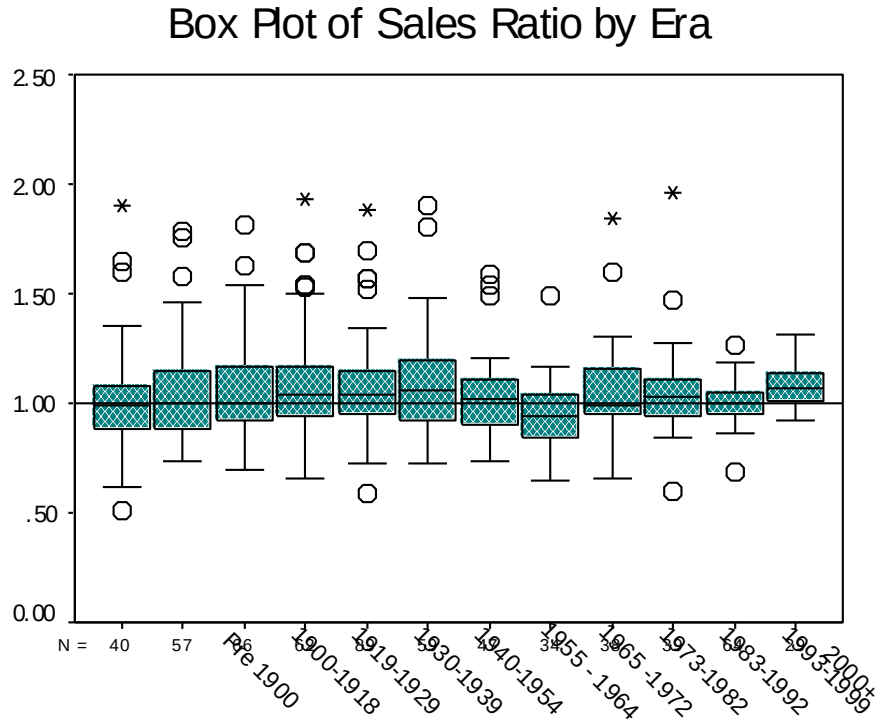
Sales	624
Median	1.013
Weighted Mean	1.015
Std. Deviation	.207
Price Related Differential	1.032
Coefficient of Dispersion	.141

Below are graphs of ratios with group, type, era, bedrooms, baths, value band, neighbourhoods with at least 15 sales, living area, and value. Aside from categories with few sales, uniformity is good with respect to groups (except for group 20), types, bedrooms, size, and current value band. Some eras are slightly low or high and ratios for 2-bath homes are rather high, indicating that the adjustment of 16% may have been a bit high. More problematic, however, is neighbourhood where median ratios often lie 5-10 points above or below the overall median. Although the ratios are not seriously out of line, neighbourhood linearizations obviously did not work as well as in Hillingdon[22]. The final graph of ratios with values shows that the regressivity indicated by the PRD of 1.032 is due largely to a scattering of high ratios for lower-value properties. The problem is *not* systematic. In all, we regard the results obtained for North Tyneside homes as reasonably good for a diverse, modest-value area.

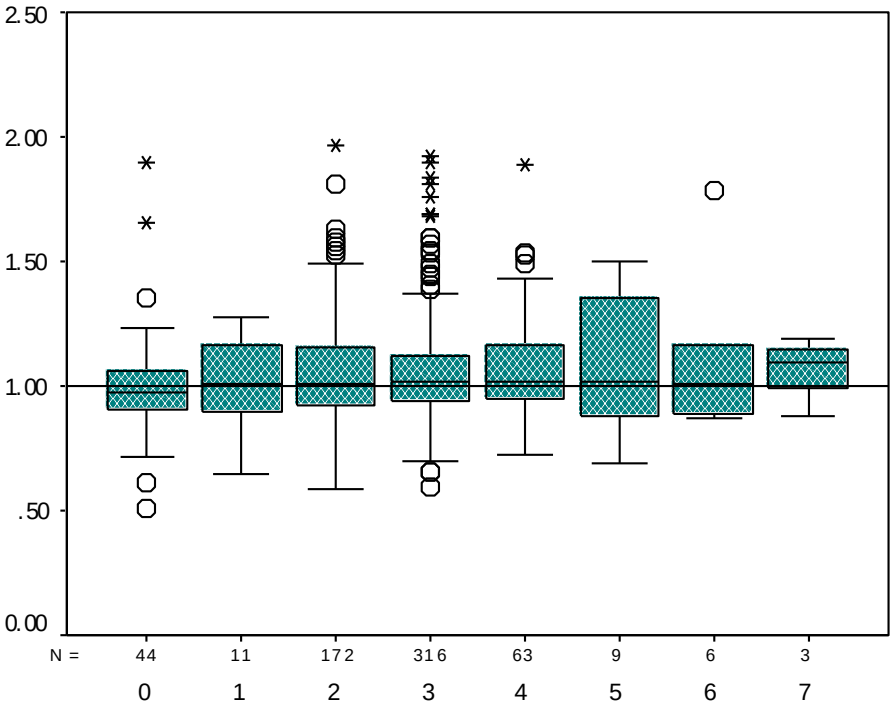


[22] As previously noted, unlike group and type, VOA has not employed binaries for neighbourhoods. Use of binaries for neighbourhoods, at least those with 15+ sales, would have improved the results observed here.

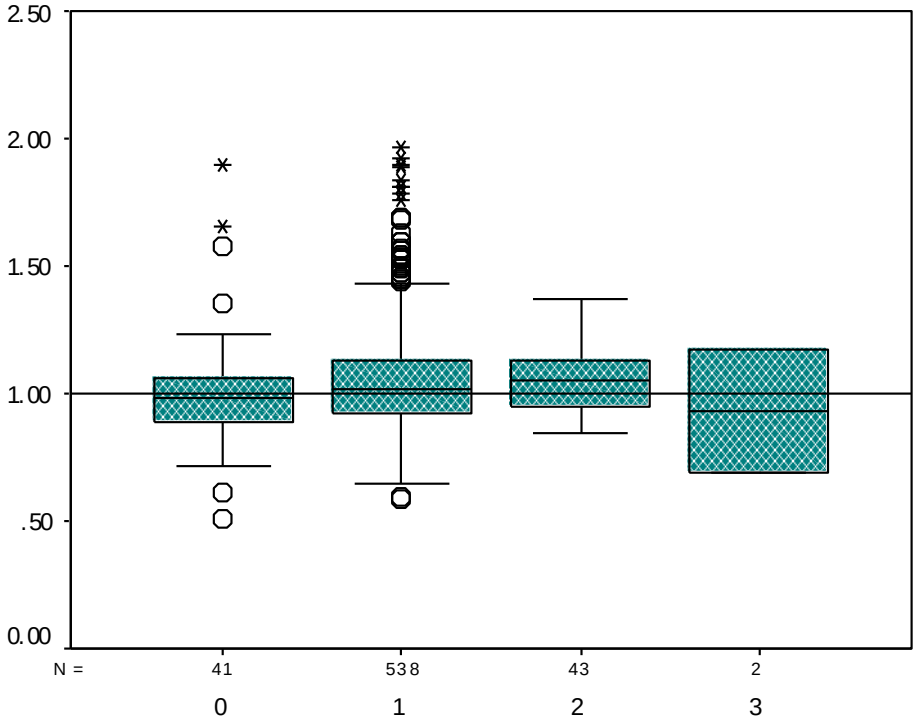

Box Plot of Sales Ratio by Type
2.50
2.00
1.50
1.00
.50
0.00
N =
7
2
33
60
70
274
178
BD
BE
BS
HD
HE
HS
HT

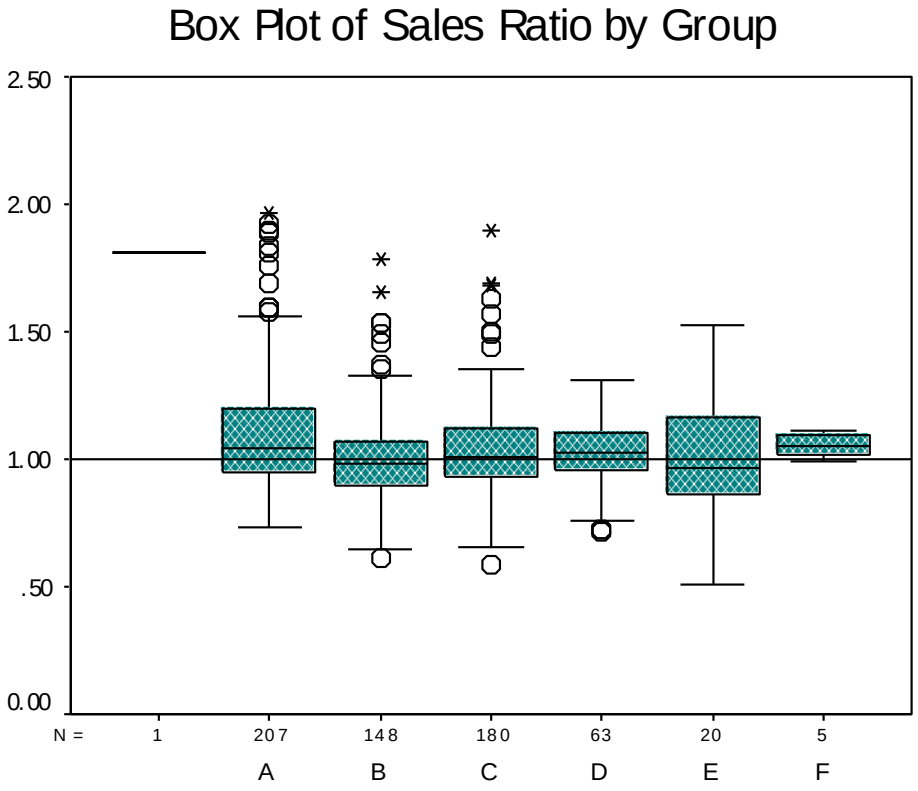

Box Plot of Sales Ratio by Era
2.50
2.00
1.50
1.00
.50
0.00
N =
40
57
Pre 1900
1900-1918
1919-1929
1930-1939
1940-1954
1955 - 1964
1965 -1972
1973-1982
1983-1992
1993-1999
2000+

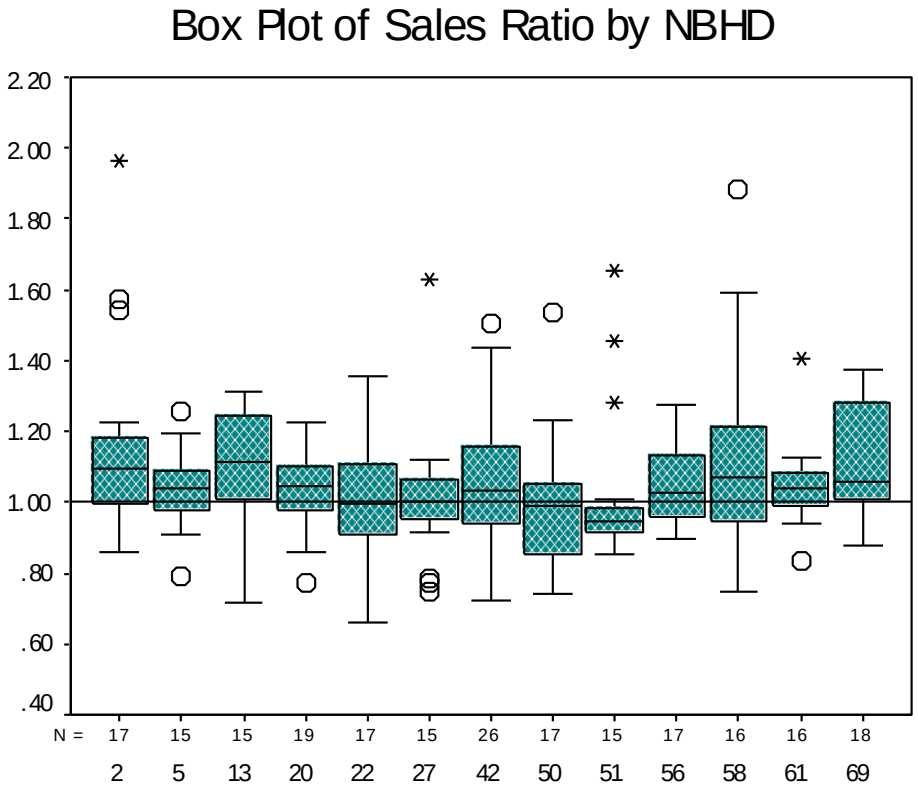
Box Plot of Sales Ratio by Bedrooms

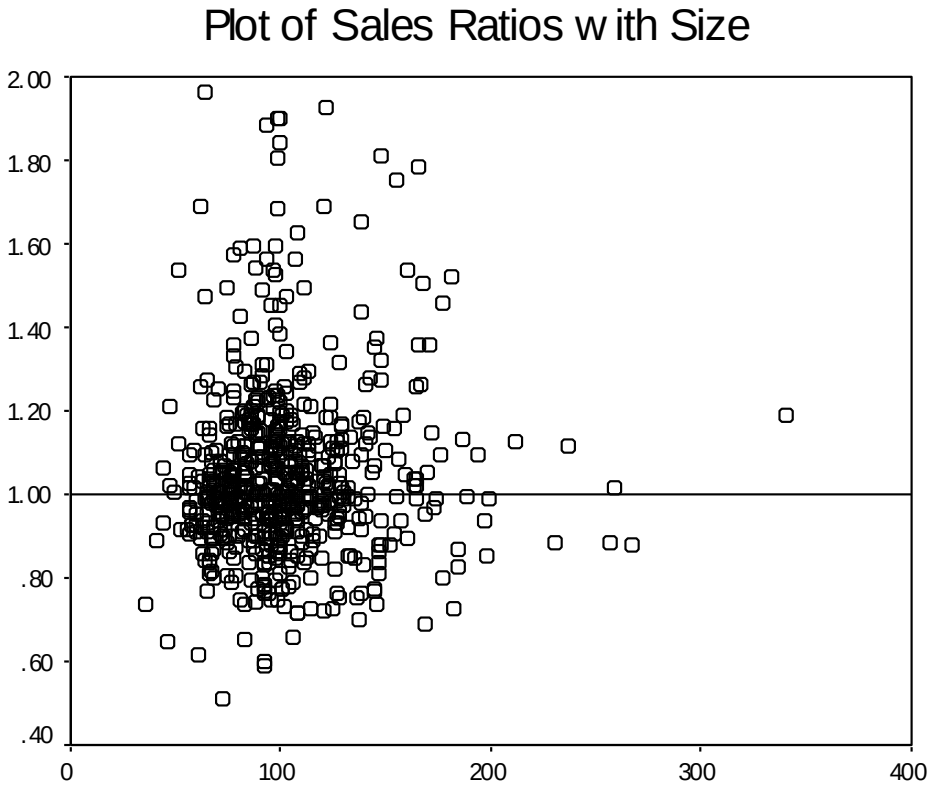


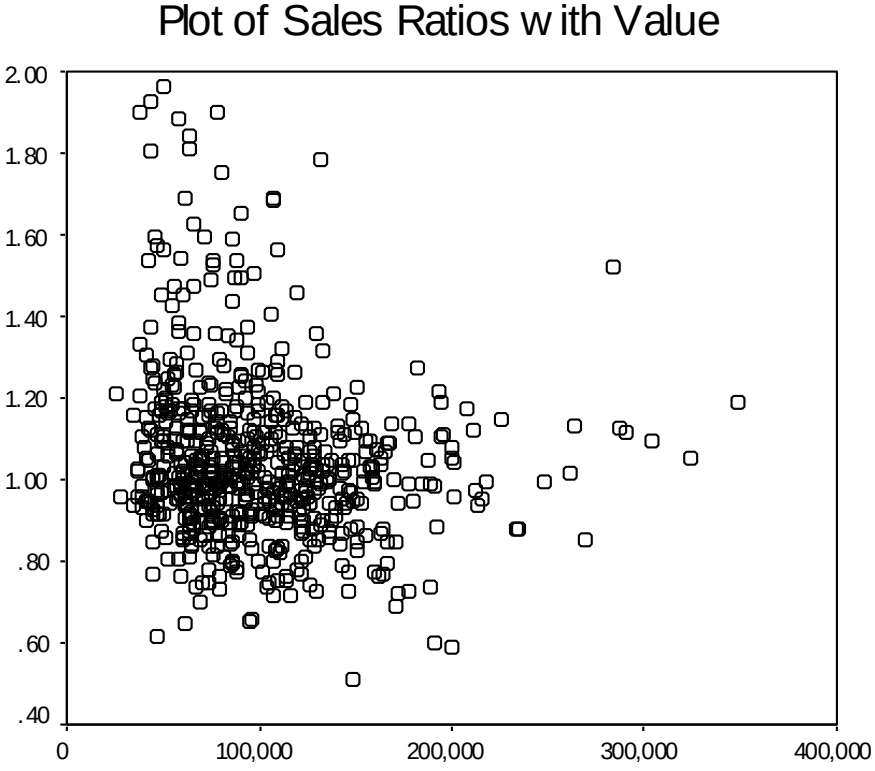
Box Plot of Sales Ratio by Baths




Box Plot of Sales Ratio by Group
2.50
2.00
1.50
1.00
.50
0.00
N =
1
207
148
180
63
20
5
A
B
C
D
E
F


Box Plot of Sales Ratio by NBHD
2.20
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
N =
17
15
15
19
17
15
26
17
15
17
16
16
18
2
5
13
20
22
27
42
50
51
56
58
61
69


Plot of Sales Ratios with Size
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
0
100
200
300
400


Plot of Sales Ratios with Value
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
0
100,000
200,000
300,000
400,000

Appendix 4
Model for North Tyneside Flats

There were 1,411 sales in the NorthTyneside model for flats (slightly more than in Hillingdon). The model is summarized below.

- Neighbourhood. Neighbourhood numbers range from 1 to 84, of which 61 had sales. Only 10 had at least 30 sales. Thirty-four (59%) had less than 15 sales and 12 (20%) had less than 5 sales. The chosen neighbourhoods, while perhaps suitable for houses, are problematic for flats in that there are several neighbourhoods with over 100 sales, while many others have very few sales. The linearized neighbourhood variable has an exponent of 0.75.

- Group. Twelve property groups had sales. Group 56 (flats and maisonettes in 3+ storey blocks built after 1945) is the base. Only groups 40 (certain converted houses) and 60 (flats in commercial premises) had adjustments: 33% and 8%, respectively. Interestingly, the latter had a -14% adjustment in Hillingdon.

- Type. Thirteen property types had sales (some as few as one). Type "FO" (purpose-built, self-contained flats) is the base. Adjustments range from -9% for type FE (end flats in 2-storey terraced blocks) to +22% for type FC (commercial conversions with lifts).

- Era. The base era is 1930-1939. Flats built from 1919 through 1929 and from 1965 to 1972 have -7% adjustments. Those built from 1955 through 1964 have a -22% adjustment.

- Living area. The variable has a very low exponent of .281, indicating that value increases only moderately with size. This can be partly explained by the fact that, except for a few larger properties, most flats in North Tyneside are between 30 and 90 square meters.

- Extra baths. Baths greater than one add approximately 22% each, which may partially explain the low size exponent.

- Parking. Garages add approximately 6% per space and open parking spaces 4% each.

- No lift. A -26% adjustment is indicated for lack of a lift (no adjustment was indicated in Hillingdon).

- Floor level. First floor is base. Adjustments are -6% for ground level, -11% for the third floor, and +15% for higher floors. (The jump from -11% to +15% is based on only seven sales of floors 4 and above.)

- Date of sale. The indicated inflation rate is approximately 2.4% per month for the full two-year period, except that a rate of 5.9% per month is indicated for the first quarter of 2002 (the later seems implausibly high).

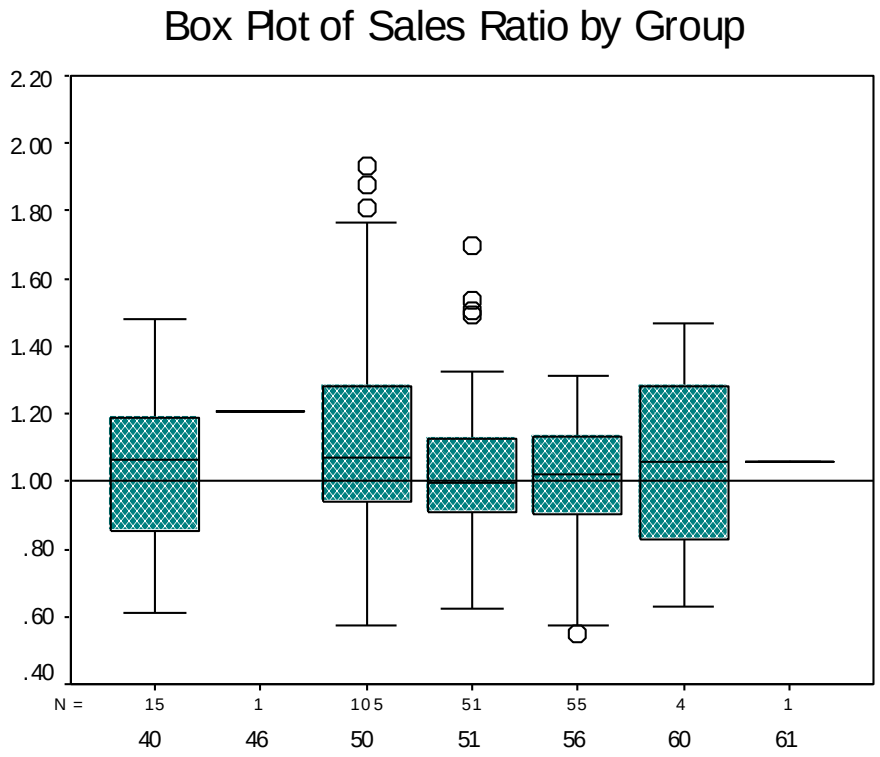
There are 232 holdout sales of flats in North Tyneside. Ratio statistics are shown below.

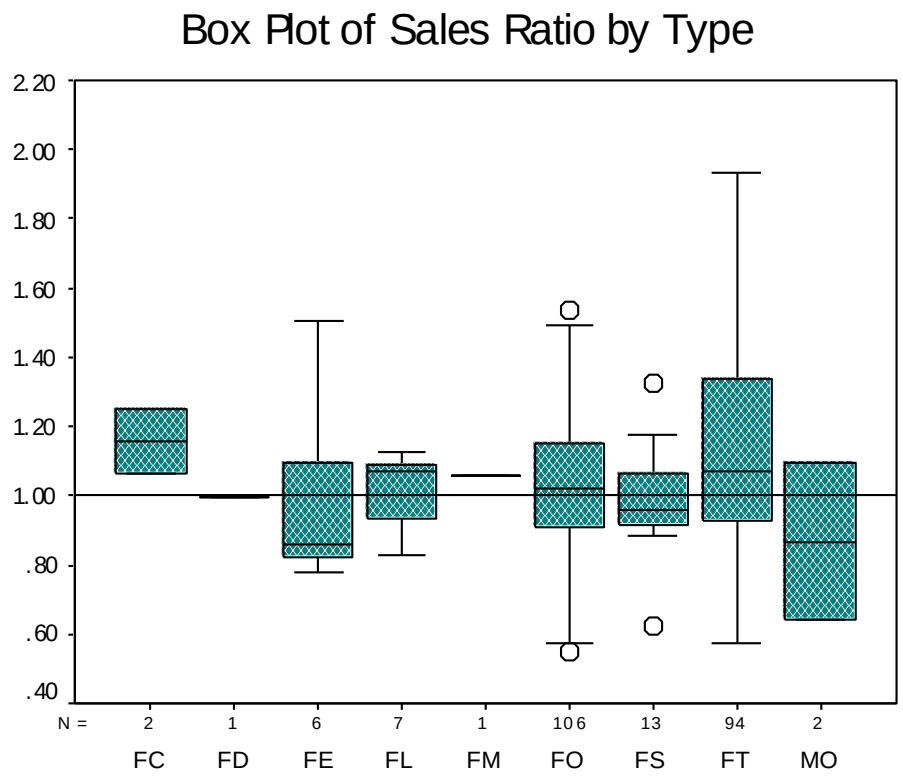
Sales	232
Median	1.049
Weighted Mean	1.011
Std. Deviation	.243
Price Related Differential	1.059
Coefficient of Dispersion	.170

The median ratio is a slightly high, the COD is outside IAAO standards, and the PRD indicates unacceptable regressivity. The following graphs indicate uniformity by property attributes. A review of the charts will reveal a number of problem areas. For example, ratios are relatively high for group 50 (105 sales), type FT (94 sales), flats built before 1900 or built from 1993 through 1999 (85 sales), one and three bedroom flats (67 sales), and in neighbourhoods 51, 55, and 74 (55 sales). On the positive side, regressivity is limited to a scattering of high ratios for very low-value properties and does not appear to be systematic. Close examination of the charts will reveal that properties missing data (era, baths, beds, etc.) generally have low ratios and high dispersion, suggesting that adding missing attributes (and correcting erroneous data) stands to improve results.

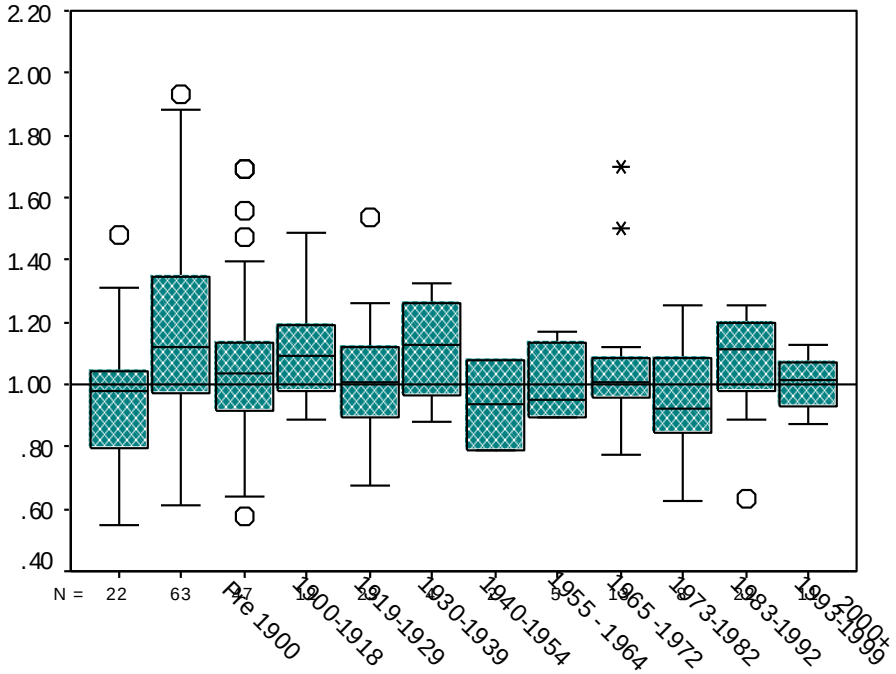
Finally, in order to dissect performance still further, sales ratios were plotted against: (a) average distance from subject to comps, (b) average comparable index, and (c) confidence intervals. As an examination of the final three plots will reveal, there is little relationship between these measures and resulting ratios[23]. That is, it makes little difference how close selected comparable sales are to the subject property (presumably as long as they are in the same neighbourhood or neighbourhood group), the extent to which they must be adjusted to the subject, or how consistent their adjusted sales prices are. This all reinforces prior observations that statistical analysis cannot substitute for good data. Where ratios are poor, likely it is because data for the subject or selected comparable sales was poor.

[23] Similar plots for the other models also showed little (if any) pattern.

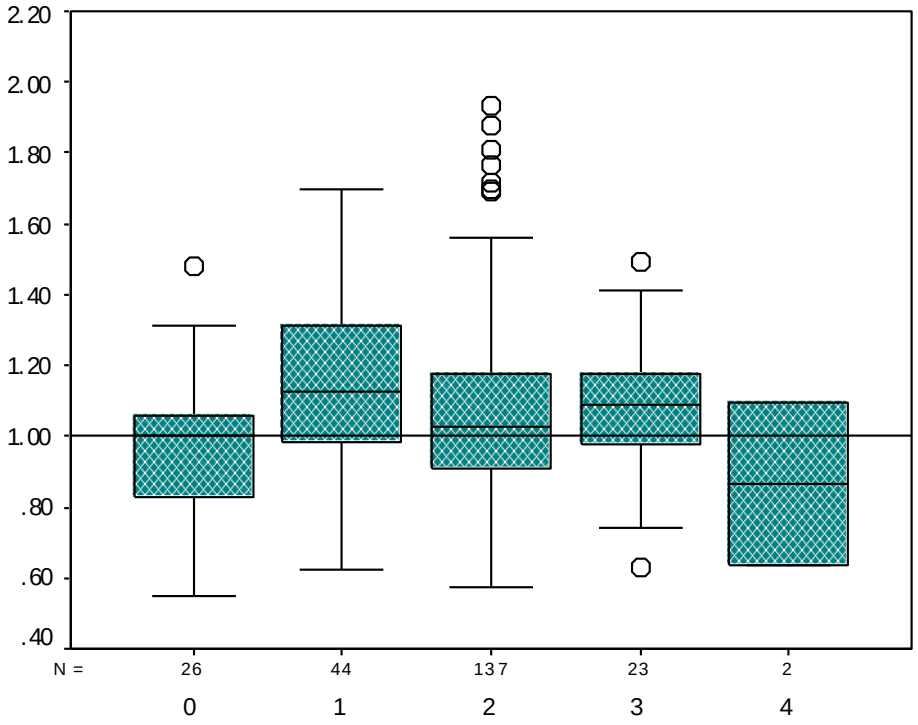

Box Plot of Sales Ratio by Group
2.20
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
N =
15
1
105
51
55
4
1
40
46
50
51
56
60
61

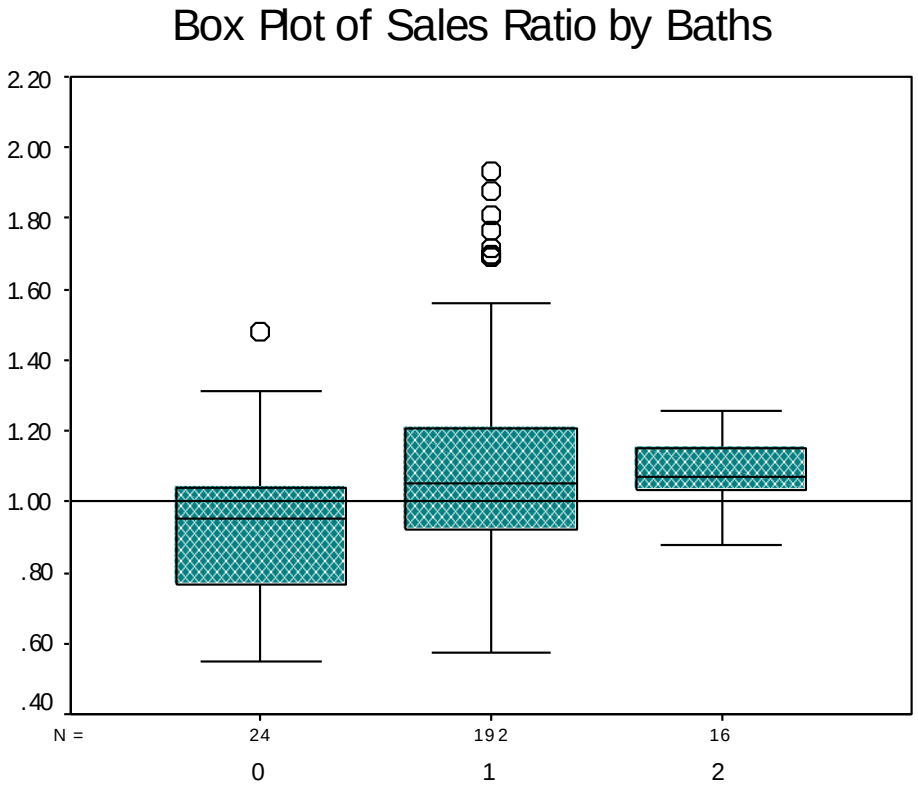

Box Plot of Sales Ratio by Type
2.20
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
N =
2
1
6
7
1
106
13
94
2
FC
FD
FE
FL
FM
FO
FS
FT
MO

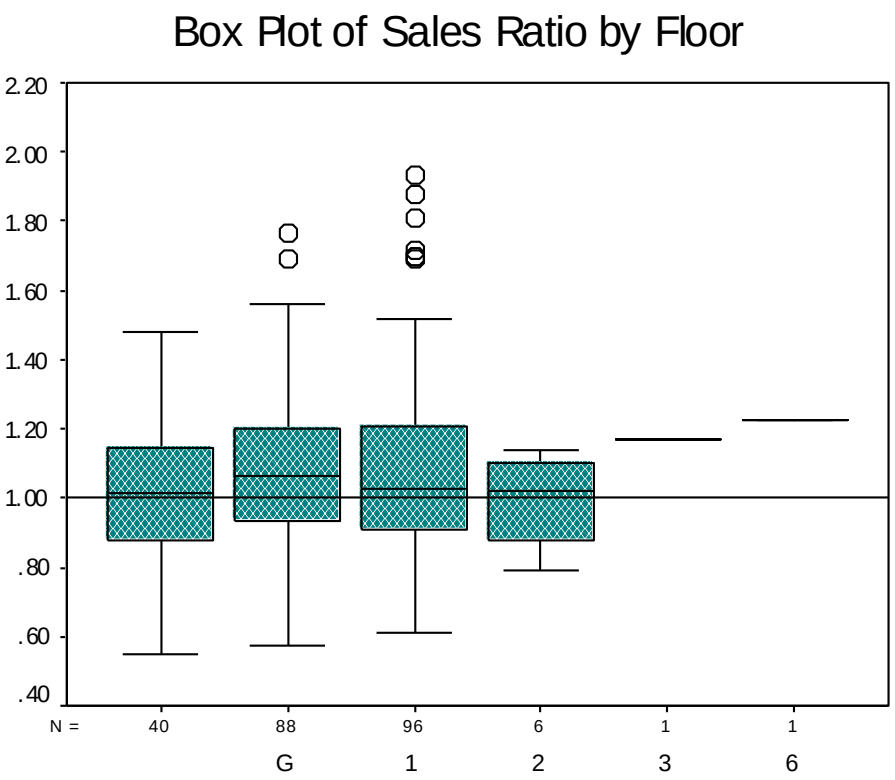
Box Plot of Sales Ratio by Era

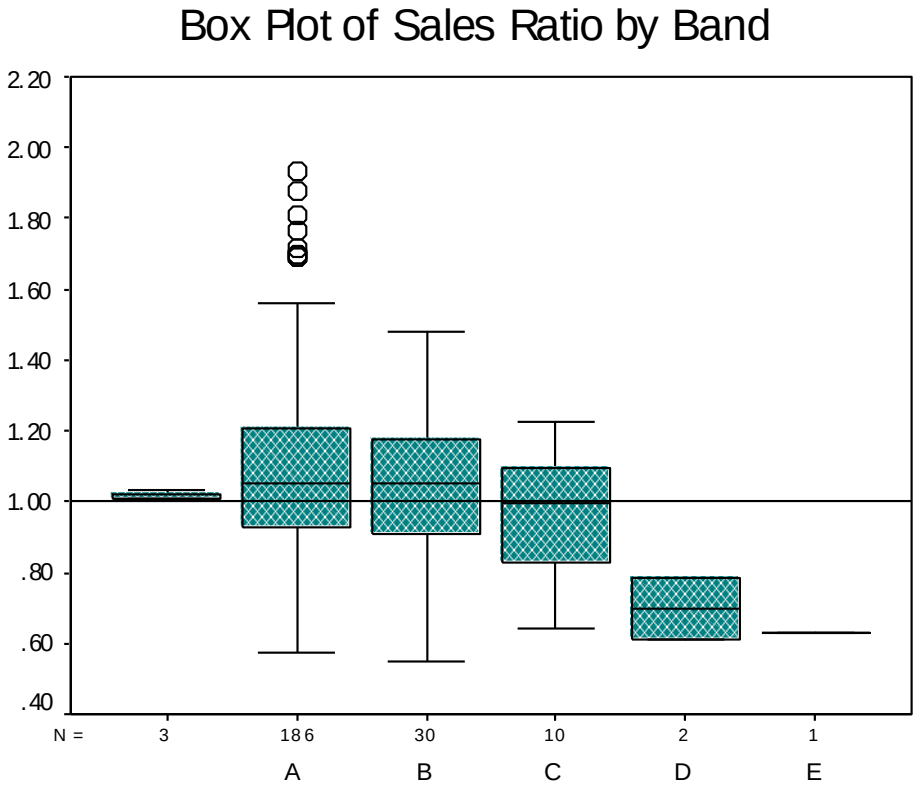


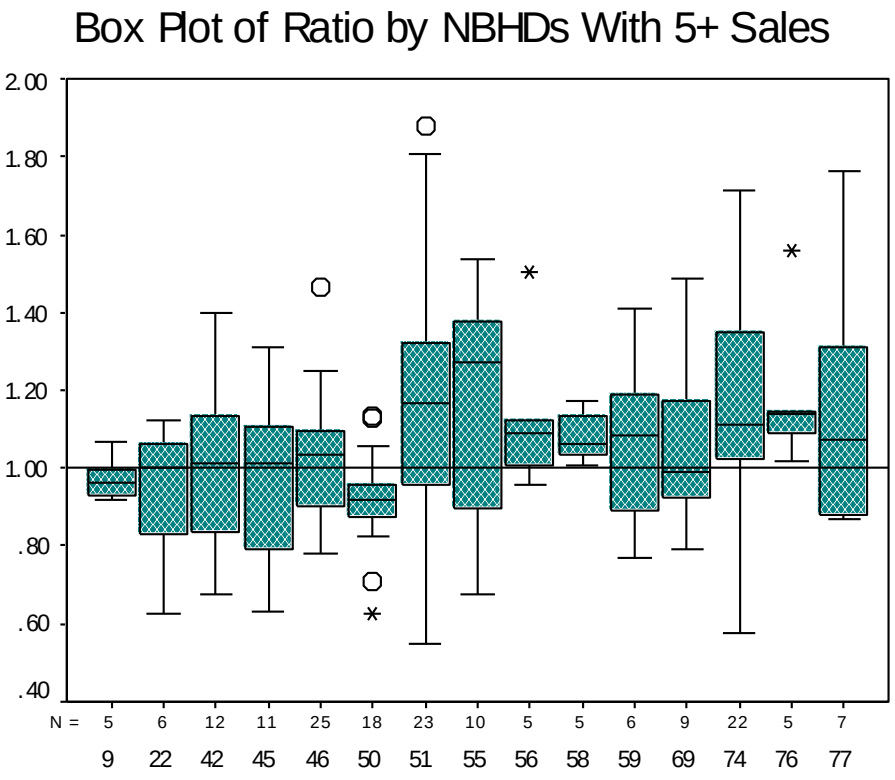
Box Plot of Sales Ratio by Beds

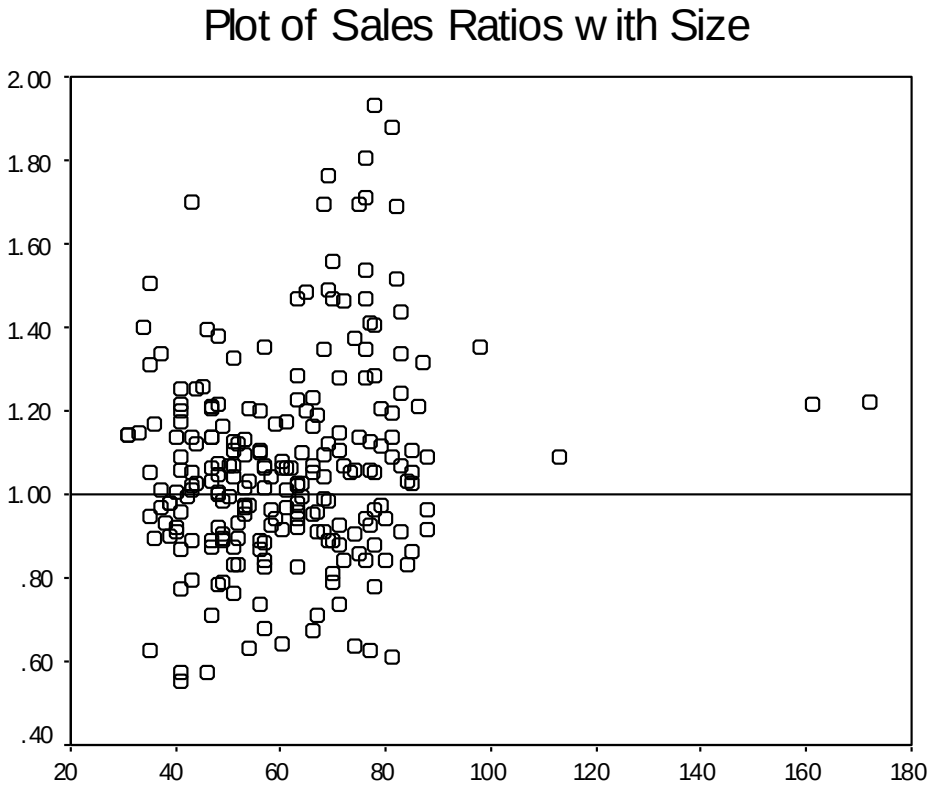


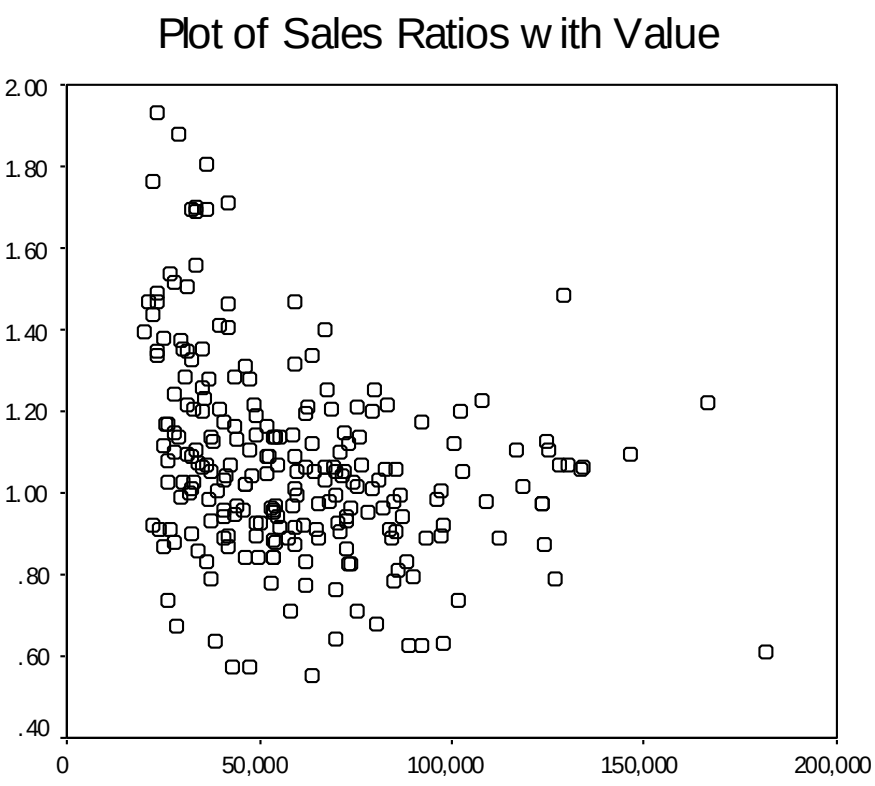

Box Plot of Sales Ratio by Baths
2.20
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
N =
24
192
16
0
1
2

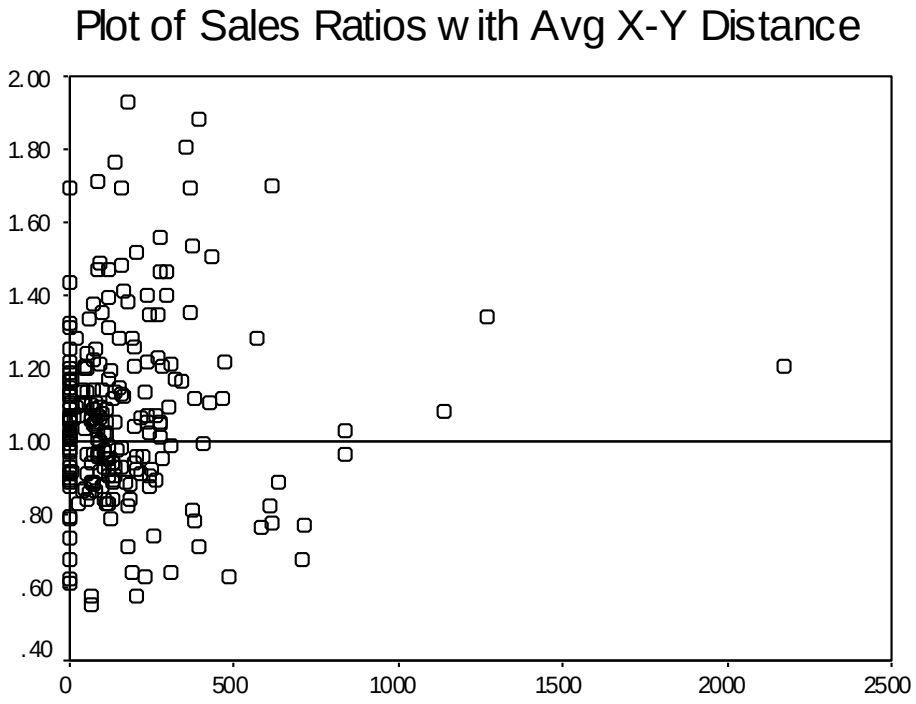

Box Plot of Sales Ratio by Floor
2.20
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
N =
40
88
96
6
1
1
G
1
2
3
6

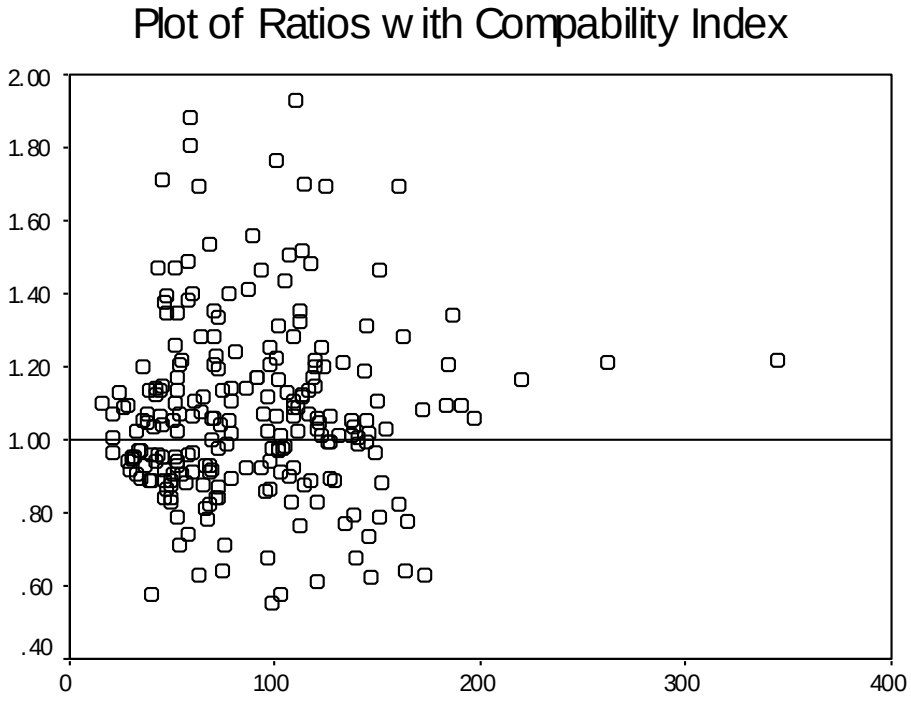

Box Plot of Sales Ratio by Band
2.20
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
N =
3
186
30
10
2
1
A
B
C
D
E

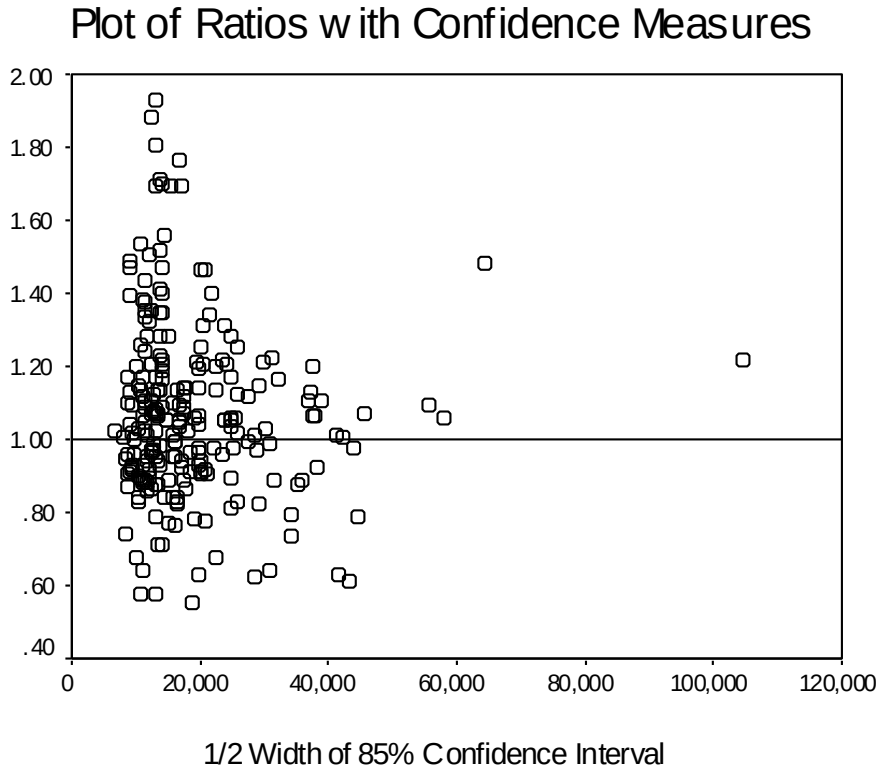

Box Plot of Ratio by NBHDs With 5+ Sales
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
N =
5
6
12
11
25
18
23
10
5
5
6
9
22
5
7
9
22
42
45
46
50
51
55
56
58
59
69
74
76
77


Plot of Sales Ratios with Size
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
20
40
60
80
100
120
140
160
180


Plot of Sales Ratios with Value
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
0
50,000
100,000
150,000
200,000


Plot of Sales Ratios with Avg X-Y Distance
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
0
500
1000
1500
2000
2500
Average Distance of Selected Comparable Sales


Plot of Ratios with Compability Index
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
0
100
200
300
400
Average Comparability Index of Selected Comps


Plot of Ratios with Confidence Measures
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
0
20,000
40,000
60,000
80,000
100,000
120,000
1/2 Width of 85% Confidence Interval