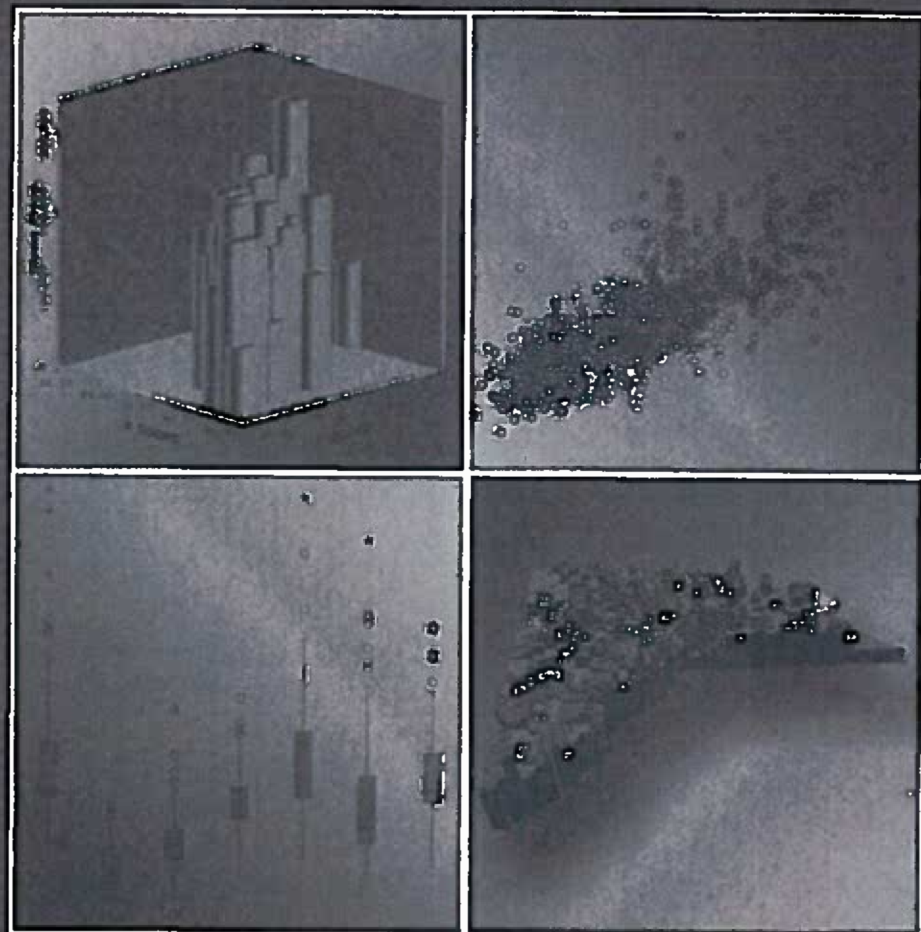
Appendix Q

Fundamentals of Mass Appraisal



International Association of Assessing Officers

Fundamentals of Mass Appraisal

Robert Gloudemans
Richard Almy

International Association of Assessing Officers
Kansas City, Missouri

Spatial Data

Spatial data consist of maps, both hard copy and digital, that depict the location and geographic relationships among objects, namely, parcels and surrounding influences. These influences include political boundaries, market areas and neighborhoods, roads, rivers, lakes, greenbelts, mountains, and other relevant natural and man-made features. They can be displayed on maps and in geographic information systems (GIS). They can be turned on and off and represented by various colors or symbols. Maps that depict the size, degree, or relationship among objects in this matter are termed *thematic* maps.

Although spatial data are not used directly in modeling, they can be used to create variables used in modeling, for example, to determine the average elevation of parcels or to determine which properties abut or lie within a specified distance of a selected feature (e.g., lake, rivers, and major streets).

Market and property characteristics data maintained in traditional tabular format can be interfaced with spatial data and displayed thematically. For example, sales data can be linked to GIS data by parcel number and displayed in various colors depending on price. Estimated values and sales ratios can be similarly displayed.

Legal and Administrative Data

Legal and administrative data include legal description, property owner, billing address, assessment status, allowable exemptions, prior values, and appeals history. These data are not used in modeling but are needed to compute taxable values, notify property owners, and generate tax bills. How efficiently this information is maintained affects the cost and responsiveness of the assessment system.

Modern computer-assisted mass appraisal (CAMA) systems make data readily available to users, facilitate retrieval and integration of the data, and provide the public with convenient access to nonproprietary information.

Types of Variables

Independent variables used in model building represent or, more often, are based upon property characteristics. For modeling, it is helpful to categorize variables and the underlying data from which they were created as one of three types: (1) quantitative, (2) qualitative, or (3) binary. Different graphs and statistical analyses are appropriate for certain types of variables.

Quantitative

Quantitative data or
or counts, for examp
Quantitative data te
statistical analyses. T
modelers need to be
units. For example, t
fall as size increases a

During modelin
variables. For exam
ranges, as follows:

1 = 0–10 years
2 = 11–25 years
3 = 26–50 years
4 = more than

Qualitative

Qualitative data or
features or attribut
grade, condition, l
normally assign c
data often are subj
programs explain

Wherever poss
and assigning vag
These categories
because they are
property values.

Binary Vari

Binary variables r
waterfront locatic
binary variables a

Binary varial
contribution of
other variables;
exterior from ext

Quantitative Variables

Quantitative data or variables, also known as *continuous*, are based on measurements or counts, for example, lot size, square feet of living area, or number of bathrooms. Quantitative data tend to be objective and verifiable and thus are well suited to statistical analyses. These data also are easily incorporated into models, although modelers need to be aware that value may not change in proportion to number of units. For example, the contribution of each additional square foot of living area may fall as size increases and a second fireplace may add less to value than a first fireplace.

During modeling, quantitative data sometimes are used to construct qualitative variables. For example, construction year could be converted to decades or to age ranges, as follows:

1 = 0–10 years
2 = 11–25 years
3 = 26–50 years
4 = more than 50 years.

Qualitative Variables

Qualitative data or variables, also termed *categorical* or *discrete*, represent property features or attributes that fall into predefined categories. Examples are construction grade, condition, building style, and type of heating or cooling. Data collectors normally assign codes for such features from a predefined list. Since qualitative data often are subjective, it is important that data collection manuals and training programs explain proper, consistent coding of such data.

Wherever possible, designers and users of CAMA systems should avoid creating and assigning vague or open-ended categories such as *other* or *to be determined*. These categories are exceedingly hard, if not impossible, to use in modeling, because they are unlikely to be bear any consistent, explainable relationship to property values.

Binary Variables

Binary variables represent the presence or absence of a specific feature, for example, waterfront location, corner lot, air conditioning, or swimming pool. In modeling, binary variables are usually coded 1 if present and 0 if not.

Binary variables provide an effective way for models to determine the contribution of property attributes to market value. They are often created from other variables; for example, a modeler could create a binary variable for brick exterior from exterior wall type (a qualitative variable).

The IAAO *Standard on Ratio Studies* (2010c) recommends the following standards for jurisdictions in which *current* market value is the legal basis of assessment. Individual jurisdictions may adopt tighter or alternative standards appropriate for their situation.

Appraisal Level

While the desired level of appraisal is 100 percent of market value, IAAO standards for measuring the level of appraisal allow a 10 percent variation. Based on the assumption that the law mandates appraisal at market value (before application of assessment ratios), this implies that the overall appraisal level should be between 0.90 and 1.10. The analyst can conclude that this standard has *not* been met when a 95 percent confidence interval (or other specified interval) about a chosen measure of central tendency fails to bracket either 0.90 or 1.10, or when a statistical test shows that the analyst can conclude with 95 percent confidence that the level of appraisal is not in this range.

The *window* of 10 percent about the market value standard provides a reasonable range in which measures of central tendency should fall in ad valorem mass appraisal. As long as this range is upheld and assessors are vigilant in reappraising property based on market value standards, property owners can use their appraisal as a reasonable indication of their property's true worth. Strict enforcement of a 100 percent standard is neither cost-effective nor practical. Such a policy could force assessors to make trivial annual adjustments in appraisals and encourage the loathsome and inequitable practice of sales chasing to achieve compliance. If strictly followed, such a policy would also force virtually half of properties to be appraised above market value, which tends to breed protracted and costly appeals and exacerbate inequities. The IAAO standard provides a reasonable, constructive, and cost-effective basis for ensuring that appraisals approximate market values. Of course, assessment officials can choose to enforce a more rigorous standard, such as 0.95 to 1.05, but a strict 100 percent standard is not recommended.

Appraisal Uniformity

As has been discussed, the three facets of appraisal uniformity are uniformity among strata, uniformity within a stratum, and value-related bias (regressivity and progressivity).

Uniformity among Strata

Each major stratum should be appraised within 5 percent of the overall level of appraisal for the jurisdiction. Thus, if the overall level is 0.900, each property class and area should be appraised between 0.855 and 0.945:

$0.900 - (0.05 \times 0.900) = 0.855;$

$0.900 + (0.05 \times 0.900) = 0.945.$

This aspect of appraisal performance is extremely important because it relates to systematic equity (or lack) thereof among major property groups.

Uniformity within a Stratum

IAAO recommends that the uniformity standard for a stratum vary with the type of property. This reflects differences in the difficulty of the appraisal task. IAAO recommends the following standards for the COD:

1. *Single-family residences.* CODs should generally be 15.0 or less and for newer and fairly homogeneous areas, 10.0 or less.
2. *Other residential property* (rural, seasonal, recreational, manufactured housing, 2- to 4-unit family housing). CODs generally should be 20.0 or less.
3. *Income-producing property.* CODs should be 20.0 or less, and in larger, urban jurisdictions, 15.0 or less.
4. *Vacant land and other property.* CODs should be 25 or less.
5. *Other real property and personal property.* Target CODs should reflect the nature of the properties, market conditions, and the availability of reliable market indicators.

While low CODs generally indicate good performance, note that the *Standard on Ratio Studies* (IAAO 2010c) regards a COD of 5.0 or less in any property category to be a possible indication of sales chasing or a nonrepresentative sample.

In general, low CODs are more difficult to achieve for heterogeneous property groups, very low- or high-value properties, and properties with older buildings or little market activity. Empirical work has shown that the ability to achieve good CODs is particularly affected by age of buildings. Difficult market conditions, in which prices are less rational and more difficult to predict, can also complicate achieving usual CODs. For example, while sales by financial institutions of previously repossessed property may constitute a significant portion of the market, use of such sales in ratio studies cannot be expected to produce CODs as good as when market conditions are more normal. Assessment officials may want to consider building such factors into performance measures or requirements.

For unique, very low-value or extremely high-value properties (outliers) and for transitional properties, even CODs of 20.0 may not be achievable. On the other hand, as indicated, CODs near zero are also not achievable and may indicate sales chasing.

Value-Related Bia

As stated in the *St*
0.98 and 1.03. As
for the measureme
graphs or formal st
in Appendix B) pr
Calculated m
not proof, that
sample sizes are
of sampling erro
tests, should be

Evaluatio

The objective
population of
valuation mod
are used in th
difference in
however, sold
other criteria
and ratio stat
tendency are
very low CC
Fortunat
unsold prop
discussed in
(1) the twc
comparisor
mass appra
If it is
central ten

Commu

Ratio stu
based on
ratio stu

Chapter 10
Evaluating the Reliability of Ratio Study Statistics

This chapter focuses on statistical tests applicable to ratio studies and the formal evaluation of assessment performance. Assessors usually do not need to go beyond the ratio study analyses and statistics presented in Chapter 5, "Ratio Studies in Mass Appraisal," and supplemental feedback on valuation accuracy obtained through field reviews, the continuous monitoring of price trends, and informal inquiries and appeals. However, ratio study findings, particularly those of assessment oversight agencies, often have substantial fiscal implications, such as the distribution of school aid or equalization grants or the need to issue reappraisal or equalization orders. In such cases accurate estimates of appraisal level and performance are paramount. This chapter describes techniques for evaluating the reliability of computed ratio study statistics and making appropriate decisions based on ratio studies. It also describes methods for evaluating performance on unsold properties.

Confidence Intervals

As stated in Chapter 5, "Ratio Studies in Mass Appraisal," ratio study statistics can provide misleading indications of the true level and uniformity of appraisals when samples are inadequate. Fortunately, there are several methods for evaluating the reliability of a statistic. One method is to compute confidence intervals; another is to conduct an appropriate test, as discussed in the section on "Hypothesis Testing," below.

A *confidence interval* is an estimate of the range of values in which a population parameter lies depending on the analyst's specified confidence level. As discussed below and as with point estimates generally (the realized values of statistics or estimators from the sample in question), confidence intervals depend on the confidence level (confidence coefficient) chosen and on the sampling process. The *confidence level* is an expression of the probability that interval does in fact contain the parameter. The most commonly used confidence levels are 90, 95, and 99 percent. The higher the confidence level, the broader the range of the confidence interval. A 95 percent confidence level is well suited to most ratio study analyses, although other levels can also be appropriate depending on the application at hand. In summary, a confidence interval provides an indication of the margin of error in a statistic.

At any level of confidence, the width of the confidence interval is a function of the sample size and the distribution of the ratios. Larger samples and lower measures of dispersion are associated with tighter confidence intervals, as illustrated in Table 5-4 in Chapter 5.

To understand the role of confidence intervals, it is important to recall the difference between *statistics* (such as the mean and standard deviation) and *parameters*. Statistics are calculated from samples and serve as *point estimates* of corresponding population parameters. The true value of the parameters is unknown and must be estimated. Confidence intervals quantify the range in which the analyst can conclude that population parameters lie with a stated level of confidence.

Confidence intervals can be calculated about the mean, median, and weighted mean ratios. The formulas assume that sales randomly represent the population of parcels. If sales are concentrated in areas in which appraisal levels are unusually low or high or if sold and unsold properties are appraised differently, measures of central tendency and confidence intervals will not be representative.

Mean Confidence Interval

A confidence interval for the mean assumes a normal distribution. The formula is

$$CI(\overline{A/S}) = \overline{A/S} \pm (t)(s) \div \sqrt{n}, \quad (1)$$

where

$CI(\overline{A/S})$ = the abbreviation for the confidence interval about the mean
t = the t-value corresponding to the desired confidence level and sample size (see Appendix A)
s = the standard deviation
n = the sample size.

Note that the t-value is based on *degrees of freedom*, which, in this case, is the sample size less 1. Since confidence intervals are two-tailed, use the t-value corresponding to a two-tailed test and the desired confidence level. For a 95 percent confidence level and 60 degrees of freedom, the t-value is 2.00. For very large samples, the t-value is 1.96 (equivalent to a z-value).

As an example, assume that a sample of 25 sales yields a mean sales ratio of 1.014 and a standard deviation of 0.132. The 95 percent confidence interval is

$$1.014 \pm (2.064 \times 0.132) \div \sqrt{25} = 1.014 \pm 0.054.$$

Thus, the lower confi
confidence limit is 1.01
Although not neces
to reflect the size of th

$$\sqrt{\frac{N-n}{N-1}},$$

where
N = the size of th
n = the sample s
Assume there we
correction factor is

$$\sqrt{\frac{1000-25}{1000-1}} = $$

and the confidence

1.014 ± (0.988

The adjusted conf
0.053) = 1.067, re
relative to the pop

Median Co

Unlike the mea
assumption of a
found by arrayi
to the lower an
(j) that the ana
and upper confi

j = (1.96 ×

when n is odd,

j = (1.96 ×

when n is eve
Consider
Round this n
even, the low
with the 20

Thus, the lower confidence limit is 1.014 – 0.054, or 0.960, and the upper confidence limit is 1.014 + 0.054, or 1.068.

Although not necessary in ratio studies, the confidence interval can be adjusted to reflect the size of the sample relative to the population. The correction factor is

$$\sqrt{\frac{N-n}{N-1}}, \qquad (2)$$

where

N = the size of the population

n = the sample size.

Assume there were 1,000 parcels in the population in the above example. The correction factor is

$$\sqrt{\frac{1000-25}{1000-1}} = \sqrt{\frac{975}{999}} = 0.988,$$

and the confidence interval could be refined as follows:

$$1.014 \pm (0.988 \times 0.054) = 1.014 \pm 0.053.$$

The adjusted confidence limits are 1.069 (1.014 – 0.053) = 0.961 and (1.014 + 0.053) = 1.067, respectively. The correction is minimal as long as samples are small relative to the population and can be ignored in most ratio studies.

Median Confidence Interval

Unlike the mean, the median confidence interval does not depend on the assumption of a normal distribution, nor is it as affected by outlier ratios. It is found by arraying the ratios and identifying the ranks of the ratios corresponding to the lower and upper confidence limits. The equation for the number of ratios (j) that the analyst must count up and down from the median to find the lower and upper confidence limits is

$$j = (1.96 \times \sqrt{n}) \div 2, \qquad (3)$$

when n is odd, and

$$j = (1.96 \times \sqrt{n}) \div 2 + 0.5, \qquad (4)$$

when n is even.

Consider the example of the 40 ratios in Table 10-1. The value of j is 6.70. Round this number to the next largest integer (7). Since the number of ratios is even, the lower confidence limit is found by counting *down* seven ratios beginning with the 20th-largest ratio (0.950) to obtain 0.890, and the upper limit is found