Performance Testing – Statistical Analysis

The International Association of Assessing Officers, in the text titled Property Assessment Valuation © 2010, page 403, defines Mass Appraisal as,

"…The systematic appraisal of groups of properties, as of a given date, using standardized procedures and statistical testing."

Further, IAAO defines Single Property Appraisal as, "…Single-property appraisal, or fee appraisal, is the valuation of a particular property as of a given date."

Alternatively:

Mass: a gathering of people that come together to pray.

Appraisal: an opinion of value

A gathering of appraisers
praying for an opinion of value.

With the proper application of market data, both Mass Appraisal and Single Property Appraisal should result in similar results.

Equal

Statistical testing is used in Mass Appraisal for the purpose of performance testing of the preliminary results of an assessment roll.

The reliability of data requires data accuracy beginning with field inspections and data entry into Computer Assisted Mass Appraisal (CAMA) systems.

The process of performance testing begins, and ends with a sales ratio study.

A sales ratio study divides the assessing officer's determination of market value as it appears on the assessment roll and divides by the validated selling price of the property.

Ratio studies are used to measure appraisal uniformity and uniformity with groups.

Appraisal uniformity is the evaluation of equitable treatment of individual properties.

Uniformity <u>within</u> groups measures the differences between each ratio and the average ratio.

Uniformity <u>between</u> groups compares the average between each group of properties. Groups of properties may be developed by neighborhood, property type, class, effective age, etc.

The statistical testing measures include:

1. Measures of Central Tendency:

Mean: A mean is a simple average of a group of data.

Median: The median is the midpoint of a group of arrayed data.

Weighted Mean: A weighted mean is the average determined by summing the totals of the variables in a sample set, and calculating the average based on the totals within the sample.

Mode: The mode is the most often occurring data point.

2. Standard Deviation (SD):

The primary measure of dispersion.

In ratio studies, the larger the standard deviation, the wider the range within a given portion of properties are appraised in relationship to the market value.

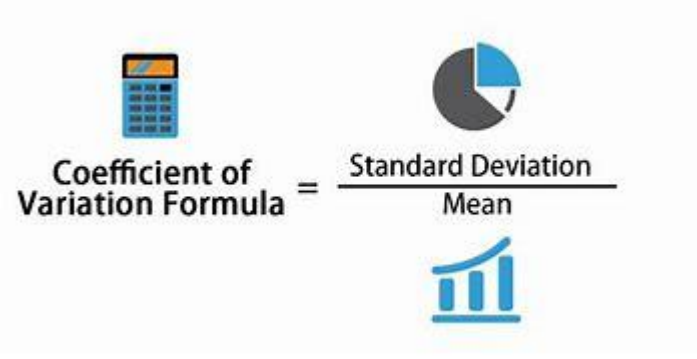
Sample Standard Deviation Formula

$$\sigma = \sqrt{\frac{\sum_i^n (x_i - \bar{x})^2}{n - 1}}$$

3. Coefficient of Variation (COV):

The COV is the ratio of standard deviation to the mean expressed as a percentage.

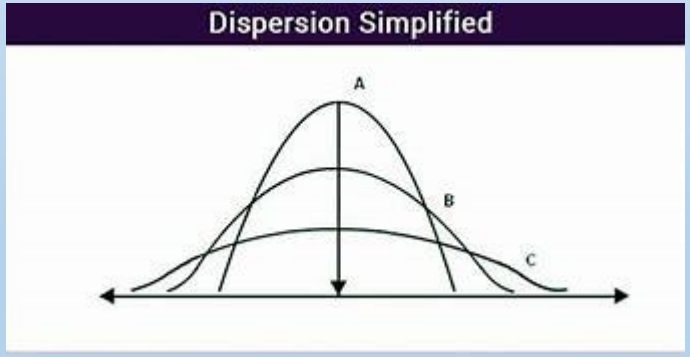
COV is a measure of *relative* variation which enable the comparison among groups with different means.



4. Coefficient of Dispersion (COD):

Used to measure uniformity in sales ratio studies.

The COD is expressed as a percentage, allowing comparisons among property groups.



5. Price Related Differential (PRD):

A statistic for measuring regression or progression.

Regressive if high-value properties
are under-valued
in relationship to low value properties.

Progressive if high-value properties
are over-valued
in relationship to low value properties.

A PRD greater than 1.00
indicates that
high-value properties are under-appraised.

A PRD less than 1.00
indicates that
high-value properties are relatively over-valued.

The acceptable range of PRD
as recommended by the
International Association of Assessing Officers is
.98 to 1.03.

The following sales ratio study will be used to illustrate each the above statistical measures:

Sale	Sales Price	Appraised Value Per Assessor	Ratio
1	$240,000	$204,000	.85
2	$245,000	$232,750	.95
3	$220,000	$198,000	.90
4	$265,000	$291,500	1.10
5	$225,000	$270,000	1.2

1. Measures of Central Tendency: Mean, Median, Weighted Mean, and Mode.

Mean: A simple average computed by adding the values and dividing by the number of values.

Median: The mid-point of the data.

Weighted Mean: The aggregate ratio determining by summing the assessors appraised value, summing the sale prices, and dividing the total of the assessors appraised value by the total of the sales prices.

Mode: The most often occurring data point.

2. Standard Deviation (SD):

1. Begin by finding the mean of the Sales Price:

$240,000 + $245,000 + $220,000 + $265,000 + $225,000 =

$1,195,000 / 5 = $239,000

2. Subtract the mean from each individual Sales Price:

Sale	Sales Price	Mean	Difference
1	$240,000	$239,000	$1,000
2	$245,000	$239,000	$6,000
3	$220,000	$239,000	-$19,000
4	$265,000	$239,000	$26,000
5	$225,000	$239,000	-$14,000

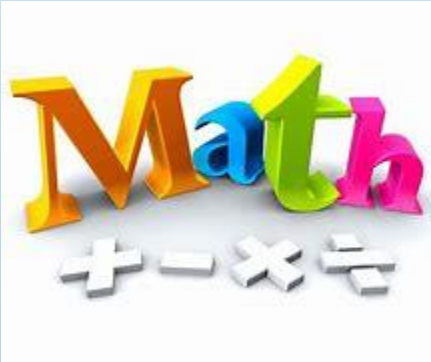
3. Square the difference:

1	$1,000 x $1,000 =	1,000,000
2	$6,000 x $6,000 =	36,000,000
3	$19,000 x $19,000 =	361,000,000
4	$26,000 x $26,000 =	676,000,000
5	$14,000 x $14,000	196,000,000

4. Sum the Squared Differences:

1,000,000 + 36,000,000 + 361,000,000 + 676,000,000 + 196,000,000 =

1,270,000,000



5. Divide the sum of the squared differences by the number of sales, less 1:

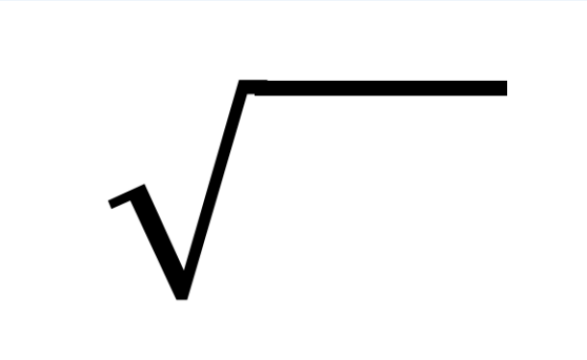
$1,270,000,000 / 4 (5 sales less 1) = 317,500,000

-1

6. Calculate the square root:

Square Root of 317,500,000 =

17818.5297 (17,800 Rounded)



Normal Bell-Curve Distribution:

68% of the data is within one standard deviation from the mean,
95% of the data is within two standard deviations from the mean, and
99% of the data is within three standard deviations of the mean.

3. Coefficient of Variation (COV):

1. Begin with the SD of 17,800.

2. Divide by the mean of $239,000

3. Multiply by 100.

$$(17{,}800 / 239{,}000) \times 100 = 7.45\%$$

COV

4. Coefficient of Dispersion (COD):

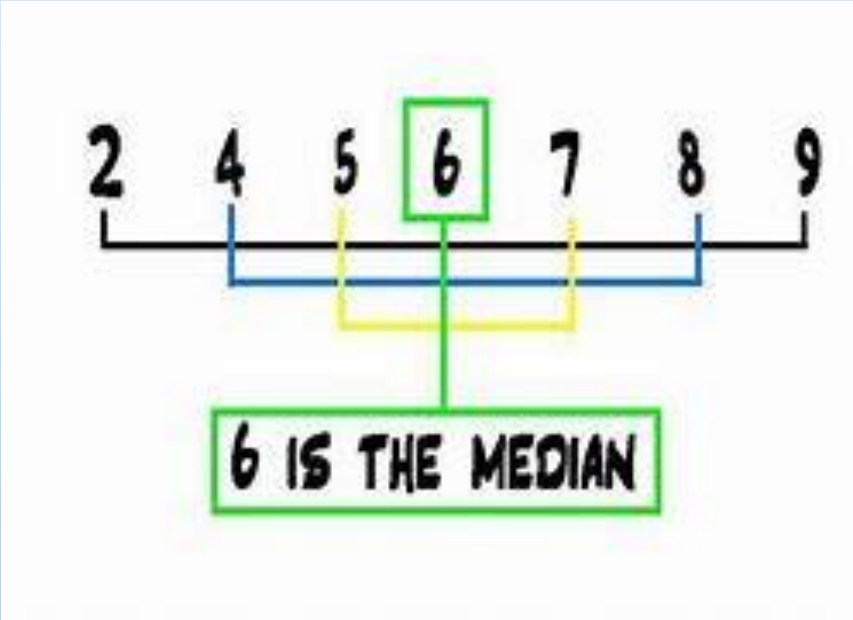
1. Array (place in order) the ratios from the sales study:

.85
.90
.95
1.1
1.2

COD

2. Find the Median:

Midpoint is .95



3. Calculate the absolute difference between the median and each ratio in the sample:

Sales Ratio	Median	Absolute Difference
.85	.95	.10
.90	.95	.05
.95	.95	0
1.1	.95	.15
1.2	.95	.25

4. Sum the Absolute Differences:

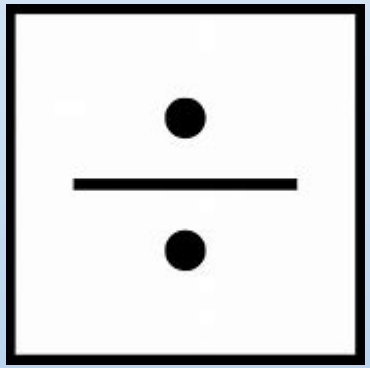
.10 + .05 + 0 + .15 + .25 = .55

5. Divide by the number of sales to calculate the average absolute deviation:

.55 / 5 = .11

6. Divide the average absolute deviation by the median and multiple by 100 to convert to a percentage:

$$(.11 / .95) \times 100 = 11.5789\%$$



5. Price Related Differential (PRD):

1. Calculate the mean ratio:

$$.85 + .90 + .95 + 1.1 + 1.2 = 1$$

PRD

2. Calculate the weight mean ratio:

Sale	Sales Price	Appraised Value Per Assessor	Ratio
1	$240,000	$204,000	.85
2	$245,000	$232,750	.95
3	$220,000	$198,000	.90
4	$265,000	$291,500	1.10
5	$225,000	$270,000	1.2
	$1,195,000	$1,196,250	.9989

3. Divide the mean ratio by the weighted mean ratio:

1 / .9989 = 1.0011

A PRD greater than 1.03 indicates that high-value parcels are under-appraised by the assessor.

A PRD of less than .98 indicates that high-value parcels are relatively over-appraised by the assessor as compared to low-value properties.

The performance testing
of an assessment jurisdiction may suggest
that a revaluation is necessary to correct deficiencies.

It may further suggest that
changes in the valuation model are required to improve the quality of assessments.

Model Specification
reflects the relationship of certain property characteristics to market value.

Poor statistical testing
may suggest that Model Calibration,
defined as the process of adjusting the mass appraisal model
is required by the assessing officer.

Conclusion:

Mass Appraisal requires statistical testing to validate the assessment results.

Appraisal statistics are used to evaluate the accuracy and consistency of property values and assessments.

Assessing Officers have a responsibility for the fair and equitable distribution of the property tax burden.

Performing statistical analysis can identify specific areas that may require improvement, or additional evaluation.

Lisa A. Hobart, CAE, PPS, FIAAO, ASA

Lhobart59@comcast.net

248.703.6834