



Massachusetts Chapter of IAAO
Special Webinar – June 2020

**IAAO Standard on Ratio Studies
(Revised April 2013)**

Presented by Gary J. McCabe, CAE

1

1

Part 1: Guidance for Local Jurisdictions

Part 2: Equalization & Performance Testing



2

2




Part 1: Guidance for Local Jurisdictions

1. Scope; design & use of ratio studies
2. Overview; market value & appraisals
3. Steps in Ratio Studies
4. Timing & Sample Selection
5. Ratio Study Statistics & Analyses

3

3



Part 1: Guidance for Local Jurisdictions

6. Sample Size & Representativeness
7. Reconciliation of Ratio Study Results
8. Presentation of Findings & Training
9. Ratio Study Performance Standards
10. Personal Property Ratio Studies
 - Details contained in Section 12 of Part 2

4

4

Part 2: Equalization & Performance Testing

1. Scope; examine assessment accuracy
2. Oversight Ratio Studies
 1. Monitoring Assessment Performance
 2. Equalization (direct & indirect)
3. Steps in Ratio Studies
4. Timing & Sample Selection

5

5

Part 2: Equalization & Performance Testing

5. Acquisition & Analysis of Sales Data
6. Ratio Studies Statistics & Analyses
7. Sample Size; measures of reliability
8. Appraisal Ratio Studies
9. Estimating Performance of Non-Sales
10. Presentation of Findings & Training

6

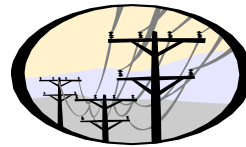
6

Part 2: Equalization & Performance Testing

11. Ratio Study Standards

1. Level of Appraisal/Assessment
2. Appraisal/ Assessment Uniformity
3. Natural Disasters & Ratio Studies

12. Personal Property Ratio Studies



7

7

Other Features of the Standard



- Definitions (expanded)
- References
- Additional Resources (articles)
- Appendix A: Sales Validation
- Appendix B: Outlier Trimming
- Appendix C: Confidence Interval Tables
(For Small Samples)

8

8

Other Features of the Standard



- Appendix D: Price-Related Bias
- Appendix E: Sales Chasing Detection
- Appendix F: Alternate Uses of ASR's
- Appendix G: Legal Aspects of ASR's
- Appendix H: Sales Questionnaire

9

9

Part 1: Guidance for Local Jurisdictions

1. Scope of Ratio Study

- Quality assurance measures using assessed value or appraised value to sale price ratios for groups of properties:
 - Assessment Level & Uniformity Analyses
 - Data Accuracy & Revaluation Priorities
 - Time Trend Analysis
 - Interim Year Adjustment Analysis

10

10

Sales Ratios

- | | |
|---------------------------|---------------------------|
| □ Assessed Value | □ Assessed Value |
| ■ \$532,500 | ■ \$451,500 |
| □ Sale Price | □ Sale Price |
| ■ \$560,500 | ■ \$430,000 |
| □ A/S Ratio | □ A/S Ratio |
| ■ $\$532,500 / \$560,500$ | ■ $\$451,500 / \$430,000$ |
| = 0.95 or 95.0% | = 1.05 or 105.0% |

11

11

Part 1: Guidance for Local Jurisdictions

2. Overview

1. Market Value

1. Legal Definition (Statutory or Judicial)
2. General Appraisal Definition (IAAO, AI)

2. Value Reconciliation [USPAP Standard 5-7(b)]

“Employ recognized mass appraisal testing procedures and techniques to ensure that standards of accuracy are maintained.”

12

12

Part 1: Guidance for Local Jurisdictions

2. Overview (cont.)

3. Uses of Ratio Studies:

1. Testing Mass Appraisal Models
 1. Assessment Levels
 2. Assessment Uniformity
2. Quality Assurance & Model Change Priorities
3. Regulatory Compliance
4. Determine Time Trends
5. Value Adjustment Between Revaluations

13

13

Part 1: Guidance for Local Jurisdictions

3. Steps in Ratio Studies

1. Define Purpose, Scope & Objectives
2. Design Study
3. Determine Stratifications
4. Collect & Prepare Data
5. Match Values & Calculate Ratios
6. Perform Statistical Analyses
7. Evaluate Results



14

14

Part 1: Guidance for Local Jurisdictions

4. Timing & Sample Selection

1. Nature of Property Population (Neighborhoods, etc.)
2. Date of Analysis (Assessment Date)
3. Period from Which Sales are Drawn
 1. Ideally 12 months or less
 2. May require longer periods for representativeness within selected strata
 3. Sale prices may require adjustment
4. Sales Sample Representativeness
 - See IAAO Standard, Part 1, Section 4.5 (page 11)

15

15

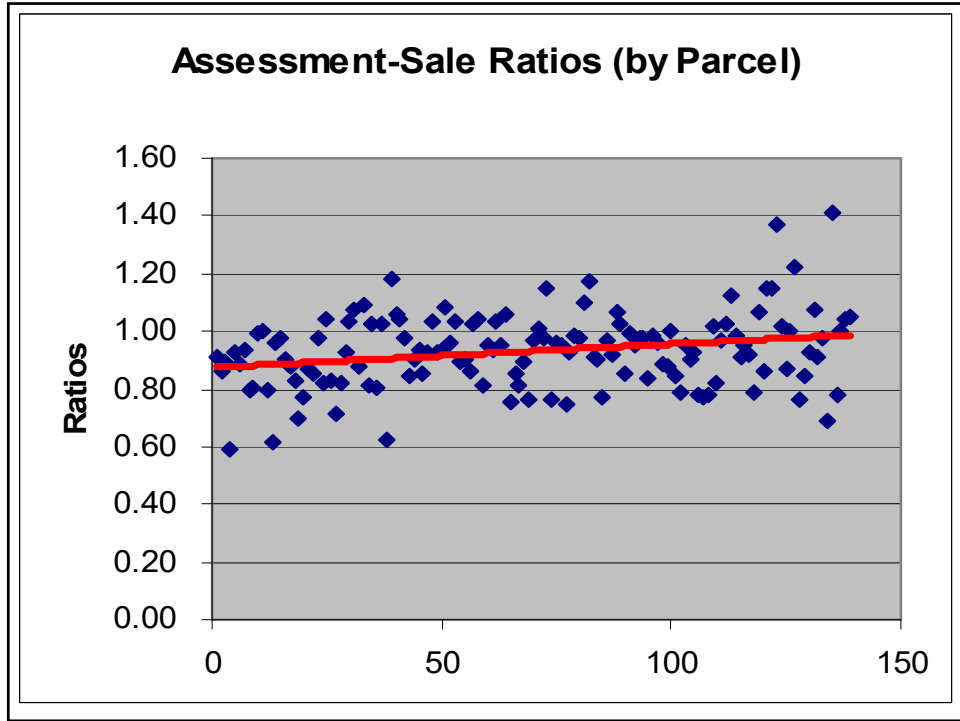
Part 1: Guidance for Local Jurisdictions

5. Ratio Study Statistics & Analyses

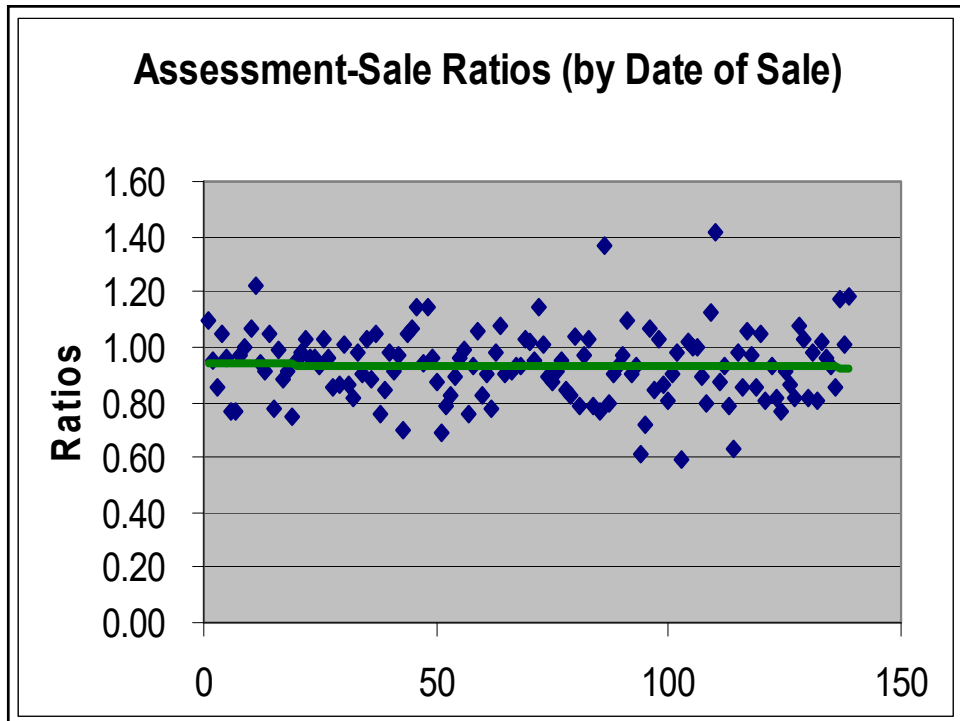
1. Data Displays (worksheets, graphs, maps)
 2. Treatment of Outliers (minimize influence)
 3. Selecting Performance Measures
 1. Level (Median), Uniformity (COD)
 2. Variability (testing for vertical & horizontal equity)
 3. Reliability (degree of confidence in statistics)
- Q. What do the following graphs tell you?

16

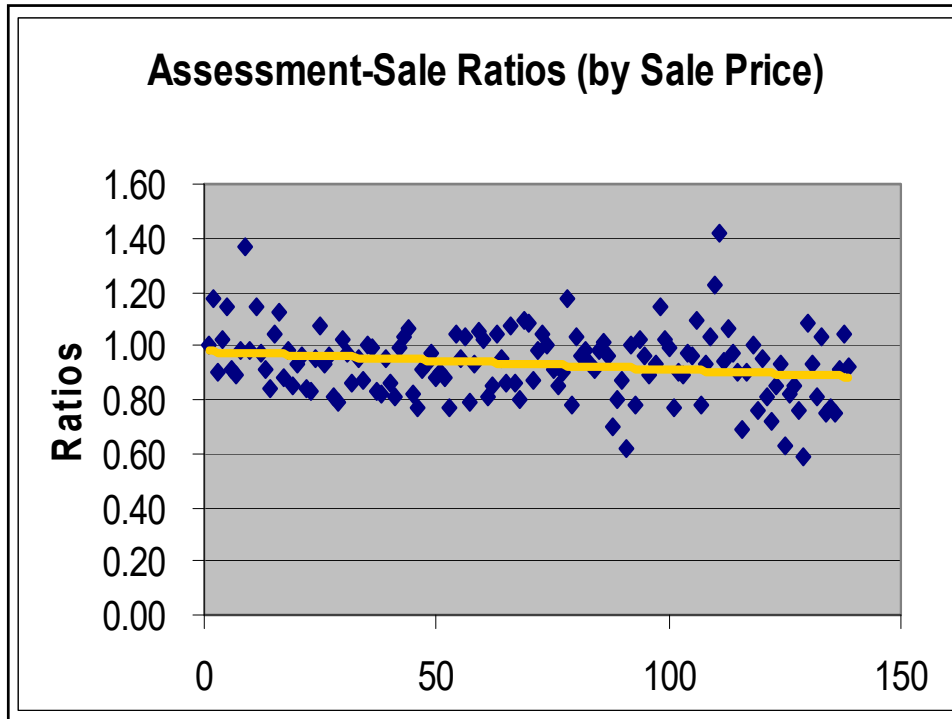
16



17



18



19

Confidence Intervals (Sec.5.3, pg.13)

- Median Confidence Interval (Appendix 20-4, PAAA)
 - A confidence interval is a range that contains a population parameter, such as the median level of appraisal (assessment), with a specified degree of confidence. **95% is used for Sales Ratio Studies**
 - The range is determined by calculating the number of ratios up and down from the median to establish the **confidence limits at selected level.**

20

20

Median Confidence Interval @ 95% Confidence

- When the number of ratios (n) is odd
 - $j = \frac{1.96 \times \sqrt{n}}{2}$
- When the number of ratios (n) is even
 - $j = \frac{1.96 \times \sqrt{n}}{2} + 0.5$
- $j =$ the ratios up & down from Median

21

21

Sales Ratio Study: Brookline, MA

- 2008 Single Family Sales (post assessment)
- Assessment Date 1/1/2008
- Total Sample = 139 Valid/Arms-length Sales
- Median ASR = 0.93 (point estimate)
- COD = 10.50
- Confidence Intervals = 0.91 <-> 0.96 @ 95%
 - $j = 1.96 \times \sqrt{(n) 139 / 2} = 11.55 (12)$

22

22

Testing Confidence Limits



- ?? Does a different sample change the results?
- B: remove every 10th sale (1,11,21..)
 - C: remove every odd # sale (1,3,5..)
 - D: remove every even # sale (2,4,6..)

Sample	Sales	Med	COD
A (all)	139	0.93	10.50
B	125	0.93	10.54
C	69	0.91	9.90
D	70	0.95	10.95

Sample Sorted by Parcel ID

23

23

Part 1: Guidance for Local Jurisdictions

6. Sample Size [from Part 1, Section 6.2, pg.24]
- “The adequacy of a given sample size can be evaluated by computing measures of reliability. If the confidence interval is sufficiently narrow, the sample is large enough. If the confidence interval is too wide, the assessor must either accept less precision or enlarge the sample, if possible.”

24

24



Part 1: Guidance for Local Jurisdictions

6. Sample Size- Remedies for Inadequate Samples:
 1. Re-stratification
 2. Extending the period from which sales are used.
 3. Enlarging the sample by validating previously rejected sales, including adjusting sale prices for time or conditions
 4. Imputing assessment measures from other strata if similar & appraised by the same model.

25

25



Part 1: Guidance for Local Jurisdictions

6. Sample Representativeness Issues
 1. Isolating over-represented groups, i.e. sales within the same subdivision or condo complex, into substrata.
 2. Re-defining the sales period for over-represented groups (change or shorten).
 3. Randomly removing sales from sample.

26

26

Part 1: Guidance for Local Jurisdictions

7. Reconciliation of Ratio Study Performance Measures to Mass Appraisal Valuation Model
 - This is also a USPAP Standard 5 requirement
 - 1. Use ratio study results in a quality assurance program, including checks & audits of data.
 - 2. Use results to recalibrate valuation model coefficients & variables, including; land values, RCN & depreciation tables.
 - 3. Use results to review neighborhood & class (grade) factors.

27

27

Part 1: Guidance for Local Jurisdictions

8. Presentation of Ratio Study Findings, Documentation & Training
 - This is a USPAP Standard 6 requirement
 - 1. Description of Study (Text)
 - 2. Exhibits (data used)
 - 3. Analyses & Conclusions
 - 4. Documentation of Procedures Used
 - 5. Training & Education

28

28

Part 1: Guidance for Local Jurisdictions

9. Ratio Study Standards

- Local Standards should be consistent with state or provincial standards.
- Standards should include Assessment Level requirements and Assessment Uniformity requirements among & between classes of property.

29

29

Part 1: Guidance for Local Jurisdictions

○ Assessment Levels at Market Value

1. All Classes of Property should be between 0.90 & 1.10 Assessment Ratio
2. Each Class (or sub-class) of Property should be within 5.0% of the overall level of assessment for the jurisdiction or, could be based on the most predominant class.
3. “It can be concluded that this standard has been met if 95% confidence intervals for each strata fall within 5% of the overall level.” 9.2.1

30

30

Part 1: Guidance for Local Jurisdictions

Ratio Study Standards: Uniformity Tests

- The preferred uniformity test is the Coefficient of Dispersion (COD) about the Median Assessment Sale Ratio
 - “The average deviation of a group of numbers (ASR’s) from the median expressed as a percentage of the median.
 - $COD = (100 * AAD) / \sim \text{median A/S}$

31

31

Assessment Uniformity (Table 1-3)

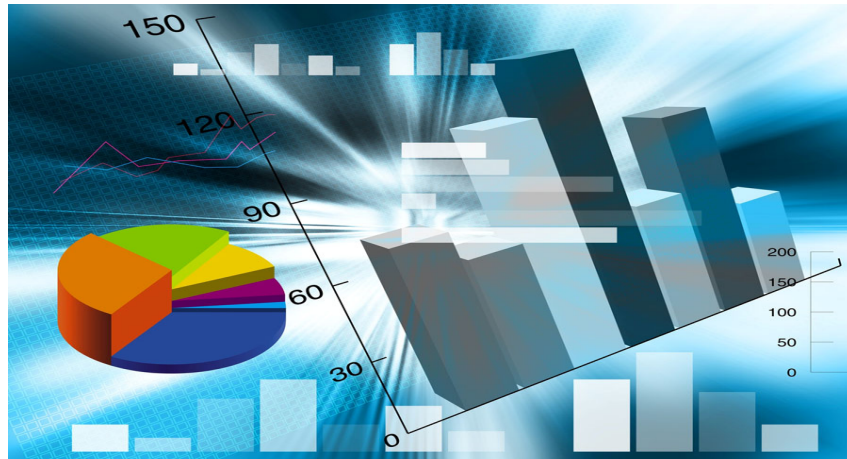
General Class	Specific Property Type	COD range
Single Family	Newer/Homogenous areas	5.0 - 10.0
Single Family	Older/Heterogeneous areas	5.0 - 15.0
Other Res.	Rural, Seasonal, 2-4 Family	5.0 - 20.0
Investment	Larger/ Urban Areas	5.0 - 15.0
Investment	Smaller/ Rural Areas	5.0 - 20.0
Vacant Land	All Classes	5.0 - 25.0

Note: COD’s lower than 5.0 warrants review

32

32

Part 2: Ratio Studies for Oversight & Equalization Agencies



33

33

Part 2: Equalization & Performance Monitoring (Using Ratio Studies)

1. Scope: “Oversight or equalization ratio studies are designed to examine the overall degree of accuracy of assessments within or among categories of property, market areas, assessment jurisdictions or political subdivisions, such as school districts, municipalities, counties, states or provinces.”

34

34

Part 2: Equalization & Performance Monitoring (Using Ratio Studies)

2. Oversight Ratio Studies:

1. Monitoring Assessment/Appraisal Performance
2. Equalization
 1. **Direct Equalization:** Adjust assessments by broad strata such as major property class or geographic area using ratio study results.
 2. **Indirect Equalization:** Used to determine distributions of state funds based on apportionment formulas or to levy intergovernmental payments.

35

35

Part 2: Equalization & Performance Monitoring (Using Ratio Studies)

3. Steps in Ratio Studies

1. Define Purpose, Scope & Objectives
2. Design Study (Level of Sophistication & Detail)
3. Collect & Prepare Data
4. Determine Stratifications (Strata)
5. Match Data & Calculate Ratios
6. Perform Statistical Analysis
7. Evaluation & Use of Results



36

36

Part 2: Equalization & Performance Monitoring (Using Ratio Studies)

4. Timing & Sample Selection

1. Date of Analysis (Assessment Date)
2. Representativeness of Sales Sample
 1. Direct Equalization & Performance Review
 1. Distribution of ratios in sample = population.
 2. Example: 50% single family, 25% condos, etc
 2. Indirect Equalization
 1. Distribution of ratios of dollars of property value.

37

37

Part 2: Equalization & Performance Monitoring (Using Ratio Studies)

5. Acquisition & Analysis of Sales Data

[See Appendix A for Validation Guidelines]

1. Independent Sales Verification, or
 1. Audit of Local Validation Practices
2. Outlier Ratios
 1. See Appendix B for Outlier Trimming
 2. Test for Influential Sales
 3. Use Confidence Intervals & PRD's

38

38

Part 2: Equalization & Performance Monitoring (Using Ratio Studies)

6. Ratio Studies Statistics & Analysis

1. Measures of Assessment Level

- Median (middle of arrayed ratios)
- Mean (average of ratios)
- Weighted Mean (sum\$/sum\$)

Total Assessed Value of Sales = \$4,500,000

Total Sale Price of Sample = \$5,000,000

Weighted Mean = 0.900

39

39

Measures of Assessment Level Table 2-2

Measure of Central Tendency	Indirect Equalization	Direct Equalization	Performance Monitoring
MEDIAN	----	X	X
MEAN	----	----	----
WEIGHTED MEAN	X*	----	----

Note: Caution should be exercised when sample contains value outliers or indicates value bias based on PRD.

40

40

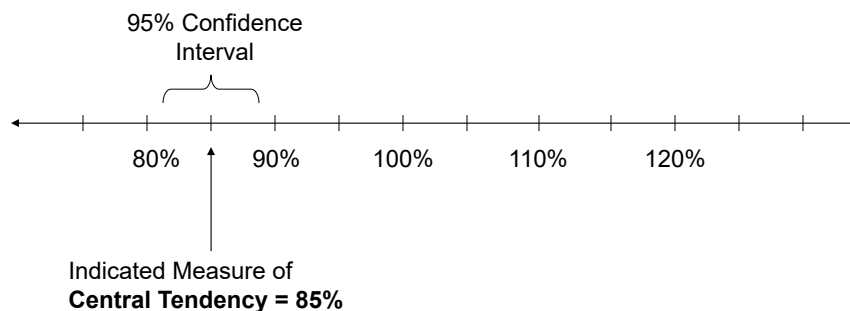
Level of Appraisal Standards (Part 2, Section 11.1)

“The calculated measures of central tendency are point estimates and provide only an indication, not proof, of whether the level meets the appropriate goal. Confidence intervals and statistical tests should be used to determine whether the appraisal (assessment) level differs from the established goal in a particular instance.”

41

41

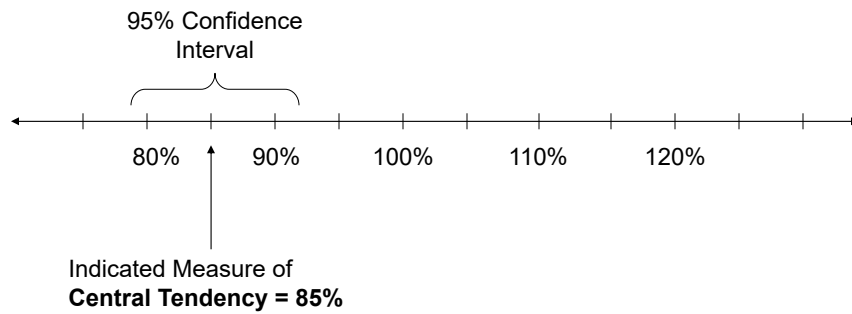
Confidence Interval Example 1



42

42

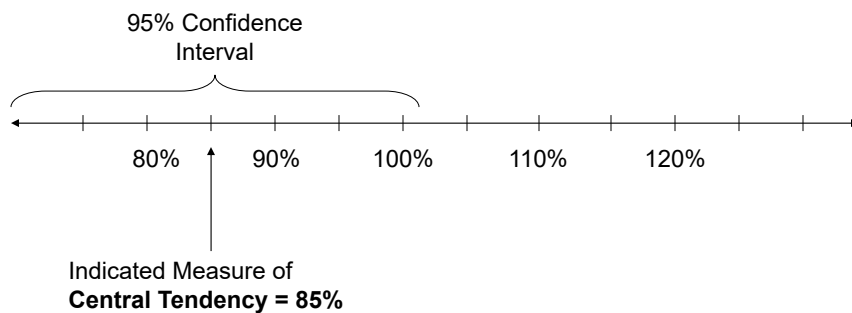
Confidence Interval Example 2



43

43

Confidence Interval Example 3



44

44

Contrasting the Three Confidence Interval Examples

Example	Point Estimate 90% - 110%*?	Confidence Interval overlaps 90%?	Confidence Interval overlaps 100%
1	NO	NO	NO
2	NO	YES	NO
3	NO	YES	YES

45

45

Uniformity Standards – Table 2-3

General Property Class	Jurisdiction Size	Max COD
Residential Improved	Very Large	10.0
	Large to Mid-size	15.0
	Rural or Small	20.0
Investment Properties	Very Large	15.0
	Large to Mid-size	20.0
	Rural or Small	25.0
Residential Vacant Land	Very Large	15.0
	Large to Mid-size	20.0
	Rural or Small	25.0

46

46



Appendices

- Sales Validation Guidelines (A)
- Outlier Trimming Guidelines (B)
- Median Confidence Interval - Small Samples (C)
- Coefficient of Price Related Bias (D)
- Sales Chasing Detection Techniques (E)
- Alternative uses for Ratio Studies (F)
- Legal Aspects of Ratio Studies (G)
- Sales Validation Questionnaire (H)

47