Ratio Study / Trending

Level II Tutorials

2015

Ratio Study

- Primary tool used to measure mass appraisal performance.
- Compares assessed values to “objectively verifiable data.”
- In our case, compares the assessor’s estimate of TTV to indicators of market value in use. (i.e. sales prices and/or independent appraisals)

Ratio Studies

Ratio studies measure certain aspects of assessments:

1. Accuracy – the level of assessment; the overall percentage that TTV represents of market value-in-use.
2. Uniformity – relates to fair and equitable treatment of individual properties; uniformity requires that properties be valued equitably within each major property class, township and that each these groups be valued at the same level of assessment.
3. Regressivity/Progressivity – relates to whether lower valued properties are under or over-assessed in relation to higher valued properties.

Ratio Studies

- An assessment ratio is calculated using the following formula:

  TTV divided by market value = ratio

- Example:

  TTV = $46,500 Sale Price = $50,000

  46,500 / 50,000 = .93 or 93%

Ratio Studies

- Let's calculate the assessment ratio on these two sales.
- Sale 1 – sale price is $218,500; TTV is $232,400.
- Sale 2 – sale price is $98,300; TTV is $96,200.

Ratio Studies

- Let's review the answer to the assessment ratios you worked.
- Sale #1 – $232,400 / $218,500 = 1.064 or 106.4%.
- Sale #2 - $96,200 / $98,300 = .979 or 97.9%.

Ratio Studies

- The measures of central tendency we will be working with in this class are:
  - Median
  - Mean
  - Weighted Mean

Ratio Studies – Median

- The Median is the middle ratio in a rank order of ratios. A rank order lists the ratios in ascending or descending order.

Ratio Studies – Median

- If the sample contains an odd number of sales ratios, the median will be the one which divides the ranked observations into two equal parts.
- If the sample contains an even number of sales ratios, the median will be the arithmetic average of the two ratios in the middle.
- There is a formula for finding the location of the median within the sample once you have ranked the ratios.

Ratio Studies – Median

- The formula is: *n* + 1 divided by 2 = location of the median.

- The letter *n* represents the number of ratios in the sample.

Ratio Studies – Median

Example with "odd" # of sales

Sales Ratio	Ranked Sales Ratios
0.920	0.920
0.920	0.920
1.055	0.983
0.983	1.055
1.075	1.075
Median	.983 or 98.3%

Ratio Studies – Median

Example with "even" # of sales

Sales Ratio	Ranked Sales Ratios
0.920	0.920
0.920	0.920
1.055	0.935
0.935	0.983
0.983	1.055
1.075	1.075
Median	.959 or 95.9%

Ratio Studies – Median

- The median is affected very little by extreme values because it is based on the ranks of the data – it represents only the middle value.

Problem #1

Calculate the Median of these Sales Ratios

Sales Ratio	Ranked Sales Ratios
1.083	
0.975	
1.035	
0.998	
0.939	

Median	

Problem #1 Answer

Calculate the Median of these Sales Ratios

Sales Ratio	Ranked Sales Ratios
1.083	0.939
0.975	0.975
1.035	0.998
0.998	1.035
0.939	1.083

Median	.998 or 99.8%

Problem #2

Calculate the Median of these Sales Ratios

Sales Ratio	Ranked Sales Ratios
0.968	
1.035	
0.998	
0.863	
0.939	
1.075	

Median	

Problem #2 Answer

Calculate the Median of thes Sales Ratios

Sales Ratio	Ranked Sales Ratios
0.968	0.863
1.035	0.939
0.998	0.968
0.863	0.998
0.939	1.035
1.075	1.075

Median	.983 or 98.3%

Median - .968 + .998 = 1.966 divided by 2 = .983 or 98.3%

Ratio Studies – Mean & Wghtd. Mean

- The next things we want to look at are the mean and the weighted mean.

- The mean is the result of adding up all of the ratios and dividing by the number of ratios in the sample.

Ratio Studies – Mean

- The mean is the most common measure of central tendency.

- However, it can be heavily influenced by extreme values.

Ratio Studies – Mean

- Mean (arithmetic average) – The result of adding all the individual ratios and dividing by the number of ratios.
- Mean = sum of ratios ÷ number of ratios

Sale #	True Tax Value	Sale Price	Sales Ratio
1	$ 45,800	$ 49,800	0.920
2	$ 48,200	$ 52,400	0.920
3	$ 42,200	$ 40,000	1.055
4	$ 57,150	$ 58,125	0.983
5	$ 55,300	$ 51,450	1.075
	Total of Sales Ratios		**4.953**
	Total Number of Ratios		**5**
	Mean		**99.05%**

4.953 / 5 = .9905 or 99.05%

Ratio Studies – Wghtd. Mean

- The **weighted mean** is a measure of central tendency in which each item is adjusted/weighted by a factor reflecting its relative importance to the whole before the items are summed and divided by their number.

Ratio Studies – Wghtd. Mean

- Weighted Mean – the total of the TTV's for all sales divided by the total of the sales prices for all sales
- Weighted Mean = Sum of the TTV's ÷ Sum of the Sales

Sale #	True Tax Value		Sale Price
1	$ 45,800		$ 49,800
2	$ 48,200		$ 52,400
3	$ 42,200		$ 40,000
4	$ 57,150		$ 58,125
5	$ 55,300		$ 51,450
	$ 248,650	Divided by	$ 251,775

Weighted Mean	.9876 or 98.76%

Problem # 3

Calculate the Mean

Sale #	True Tax Value	Sale Price	Sales Ratio
1	$ 89,500	$ 93,100	
2	$ 118,300	$ 111,800	
3	$ 103,400	$ 107,500	
4	$ 98,200	$ 91,400	
5	$ 112,600	$ 116,200	
	Total of Sales Ratios		
	Total Number of Ratios		
	Mean		

Problem # 3 Answer

Calculate the Mean

Sale #	True Tax Value	Sale Price	Sales Ratio
1	$ 89,500	$ 93,100	0.961
2	$ 118,300	$ 111,800	1.058
3	$ 103,400	$ 107,500	0.962
4	$ 98,200	$ 91,400	1.074
5	$ 112,600	$ 116,200	0.969
	Total of Sales Ratios		**5.024**
	Total Number of Ratios		**5**
	Mean		**1.005**

Mean = 1.005 or 100.5%

Problem # 4

Calculate the Weighted Mean

Sale #	True Tax Value		Sale Price
1	$ 89,500		$ 93,100
2	$ 118,300		$ 111,800
3	$ 103,400		$ 107,500
4	$ 98,200		$ 91,400
5	$ 112,600		$ 116,200

Weighted Mean

Problem #4 Answer

Calculate the Weighted Mean

Sale #	True Tax Value		Sale Price
1	$ 89,500		$93,100
2	$ 118,300		$ 111,800
3	$ 103,400		$ 107,500
4	$ 98,200		$ 91,400
5	$ 112,600		$ 116,200
	$ 522,000	**Divided by**	**$ 520,000**

Weighted Mean	**1.004 or 100.4%**

Ratio Studies – Absolute Deviation and Absolute Average Deviation

- The **absolute deviation** measures the difference between each ratio and the median. Also the absolute deviation ignores the (+) or (-) differences. (See example on next slide)
- The **absolute average deviation** measures the average difference between each ratios and the measure of central tendency.
- Both can be calculated around any measure of central tendency, but is usually calculated around the **median**.

Ratio Study – Absolute Deviation

When calculating the absolute deviation you need to ignore the (+) or (-) differences of the ratios.

Sales Ratio	Median	Deviation	Abs Dev
0.928	0.995	+0.067	0.067
1.013	0.995	-0.018	0.018

Ratio Studies – Absolute / Average Absolute Deviation

- Example: Absolute Deviation / Average Absolute Deviation Example

Sale #	True Tax Value	Sale Price	Sales Ratio	Median	Absolute Deviation
1	$ 45,800	$ 49,800	0.920	0.983	0.063
2	$ 48,200	$ 52,400	0.920	0.983	0.063
3	$ 42,200	$ 40,000	1.055	0.983	0.072
4	$ 57,150	$ 58,125	0.983	0.983	0.000
5	$ 55,300	$ 51,450	1.075	0.983	0.092
	$ 248,650	**$ 251,775**	**Total Absolute Deviation**		**0.290**
			Average Absolute Deviation		**0.058**

Ratio Studies – COD

- Coefficient of dispersion – based on the average absolute deviation, but is expressed as a percentage of the measure of central tendency.
  - Most often used with the median.
  - **Calculated by dividing the absolute average deviation by the median and multiplying that answer by 100.**

Ratio Studies – Statistics

Coefficient of Dispersion (COD) =

Ave. Abs. Deviation ÷ Median x 100

Sale #	True Tax Value	Sale Price	Sales Ratio	Median	Absolute Deviation
1	$45,800	$49,800	0.920	0.983	0.063
2	$48,200	$52,400	0.920	0.983	0.063
3	$42,200	$40,000	1.055	0.983	0.072
4	$57,150	$58,125	0.983	0.983	.000
5	$55,300	$51,450	1.075	0.983	0.092
	$248,650	**$251,775**	**Total Absolute Deviation**		**0.290**
			Average Absolute Deviation		**0.058**
			Median		**0.983**
			COD		**5.90%**

Ratio Studies – PRD

- There is one other factor that will need to be taken into account when you work with ratio studies – the price-related differential (PRD).

- The PRD is a statistic that measures assessment regressivity or progressivity.

Ratio Studies – PRD

- Assessments are considered *regressive* if high value properties are under assessed relative to low value properties.

- Assessments are considered *progressive* if high value properties are over assessed relative to low value properties.

Ratio Studies – PRD

- **PRD is calculated by dividing the mean assessment to sales ratio by the weighted mean ratio.**

Ratio Studies – PRD

- Mean = Average of the sales ratios. Weighted Mean = Total True Tax Value / Total Sales Price.

Sale #	True Tax Value	Sale Price	Sales Ratio	
1	$ 45,800	$ 49,800	0.920	
2	$ 48,200	$ 52,400	0.920	
3	$ 42,200	$ 40,000	1.055	
4	$ 57,150	$ 58,125	0.983	
5	$ 55,300	$ 51,450	1.075	
	$ 248,650	**$ 251,775**		
			Mean	**.991**
			Weighted Mean	**.988**
			PRD	**1.003**

PRD = 1.003 or 100.3%

Ratio Studies – Statistics

- **Measures of Regressivity/Progressivity**
- PRD's above 103% tend to indicate assessment regressivity; higher valued properties are under-assessed in relation to lower valued properties.

- PRD's below 98% tend to indicate assessment progressivity; higher valued properties are over-assessed in relation to lower valued properties.

Ratio Study

- Now that we have discussed all the terms, let's review a completed Ratio Study.

Ratio Study – Example

Sale	TTV	Sales Price	Sales Ratio	Median	Abs Dev
1	81,900	86,000	0.952	0.958	0.006
2	68,900	72,000	0.957	0.958	0.001
3	66,200	69,000	0.959	0.958	0.001
4	135,200	120,000	1.127	0.958	0.169
			Total Abs. Dev.		0.177
	352,200	347,000	Avg. Abs. Dev		0.0443
			# of sales	4	
			Mean	0.999	(Average of the 4 sales ratios)
			Median	0.958	(Middle sales ratio - Average of .957 & .959)
			Wghtd. Mean	1.015	$352,200 / $347,000
			COD	4.624	Avg. Abs Dev / Median x 100
			PRD	0.984	Mean / Wghtd. Mean

Ratio Study

- Now that we have reviewed the ratio study example, you will now work a ratio study given the following information on the next slide.

- You will calculate the Sales Ratio, Mean, Median, Absolute Deviation, Average Absolute Deviation, COD, Weighted Mean & PRD.

Problem #5

Using the information provided please complete this Ratio Study

Sale	TTV	Sales Price	Sales Ratio	Median	Abs Dev
1	35,000	36,000			
2	34,100	33,200			
3	91,000	86,400			
4	119,800	129,800			
5	136,600	120,000			
6	174,500	145,300			
				Total Absolute Deviation	
Total				Avg. Absolute Deviation	

# of Sales	
Mean	
Median	
Wghtd. Mean	
COD	
PRD	

Problem #5 Answer

Using the information provided please complete this Ratio Study

Sale	TTV	Sales Price	Sales Ratio	Median	Abs Dev
1	35,000	36,000	0.972	1.040	0.068
2	34,100	33,200	1.027	1.040	0.013
3	91,000	86,400	1.053	1.040	0.013
4	119,800	129,800	0.923	1.040	0.117
5	136,600	120,000	1.138	1.040	0.098
6	174,500	145,300	1.201	1.040	0.161
				Total Absolute Deviation	0.470
Total	591,000	550,700		Avg. Absolute Deviation	0.0784
			# of Sales	6	
			Mean	1.052	
			Median	1.040	
			Wghtd. Mean	1.073	
			COD	7.535	
			PRD	0.981	

V. Evaluating Ratio Study Results

The Annual Adjustments and Equalization Standards Rule sets the following standards:

1. **Accuracy** – Median assessment ratio for any class within a township must be between 90% and 110% of TTV.
2. **Uniformity** – The coefficient of dispersion for residential improved must be 15% or less and 20% or less for all other classes within a township.
3. **Regressivity/Progressivity** – The PRD for any class within a township must be between 98% and 103%.

Level II – Ratio Studies

This concludes the Ratio Study tutorial and is a reminder that should you have questions you can email these questions to the DLGF.

Please send emails to Level2@dlgf.in.gov.