



## **2016 Level II Tutorials**

### **Ratio Study / Trending**



# Ratio Study

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- 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

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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

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- 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

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- 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

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- 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

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



# Ratio Studies – Median

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- 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

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- 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

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- 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

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Example with "odd" # of sales

## Sales Ratio

0.920

0.920

1.055

0.983

1.075

Median

## Ranked Sales Ratios

0.920

0.920

**0.983**

1.055

1.075

**.983 or 98.3%**



# Ratio Studies – Median

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Example with "even" # of sales

## Sales Ratio

0.920

0.920

1.055

0.935

0.983

1.075

Median

## Ranked Sales Ratios

0.920

0.920

**0.935**

**0.983**

1.055

1.075

.959 or 95.9%



# Ratio Studies – Median

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- 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	
<b>Median</b>	





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**Problem #1 Answer**  
**Calculate the Median of these Sales Ratios**

<b>Sales Ratio</b>	<b>Ranked Sales Ratios</b>
1.083	0.939
0.975	0.975
1.035	0.998
0.998	1.035
0.939	1.083
<b>Median</b>	<b>.998 or 99.8%</b>



## 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	
<b>Median</b>	





**Problem #2 Answer**  
**Calculate the Median of these Sales Ratios**

<b>Sales Ratio</b>	<b>Ranked Sales Ratios</b>
0.968	0.863
1.035	0.939
0.998	<b>0.968</b>
0.863	<b>0.998</b>
0.939	1.035
1.075	1.075
<b>Median</b>	<b>.983 or 98.3%</b>

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



# Ratio Studies – Mean & Wghtd. Mean

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- 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

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- 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
<b>Total of Sales Ratios</b>			<b>4.953</b>
<b>Total Number of Ratios</b>			<b>5</b>
<b>Mean</b>			<b>99.05%</b>

$$4.953 / 5 = .9905 \text{ or } 99.05\%$$





# Ratio Studies – Wghtd. Mean

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- 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	
<b>Total of Sales Ratios</b>			
<b>Total Number of Ratios</b>			
<b>Mean</b>			





### 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
<b>Total of Sales Ratios</b>			<b>5.024</b>
<b>Total Number of Ratios</b>			<b>5</b>
<b>Mean</b>			<b>1.005</b>

**Mean = 1.005 or 100.5%**



**Problem # 4**  
**Calculate the Weighted Mean**

<b>Sale #</b>	<b>True Tax Value</b>	<b>Sale Price</b>
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**

<b>Sale #</b>	<b>True Tax Value</b>		<b>Sale Price</b>
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
	<b>\$ 522,000</b>	<b>Divided by</b>	<b>\$ 520,000</b>

**Weighted Mean** **1.004 or 100.4%**



# Ratio Studies – Absolute Deviation and Absolute Average Deviation

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- 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

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

<u>Sales Ratio</u>	<u>Median</u>	<u>Deviation</u>	<u>Abs Dev</u>
0.928	0.995	+0.067	0.067
1.013	0.995	-0.018	0.018



# Ratio Studies – Absolute / Average Absolute Deviation

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- 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
	<b>\$ 248,650</b>	<b>\$ 251,775</b>	<b>Total Absolute Deviation</b>		<b>0.290</b>
			<b>Average Absolute Deviation</b>		<b>0.058</b>





# Ratio Studies – COD

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- 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
<b>\$248,650</b>		<b>\$251,775</b>	<b>Total Absolute Deviation</b>		<b>0.290</b>
			<b>Average Absolute Deviation</b>		<b>0.058</b>
			<b>Median</b>		<b>0.983</b>
			<b>COD</b>		<b>5.90%</b>





# Ratio Studies – PRD

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- 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

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- 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

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- **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	
	<b>\$ 248,650</b>	<b>\$ 251,775</b>		
			<b>Mean</b>	<b>.991</b>
			<b>Weighted Mean</b>	<b>.988</b>
			<b>PRD</b>	<b>1.003</b>

PRD = 1.003 or 100.3%



# Ratio Studies – Statistics

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- **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

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- 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
		<b>352,200</b>	<b>347,000</b>	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

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- 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				Total Absolute Deviation	
				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
				Avg. Absolute Deviation	0.0784
Total	591,000	550,700			
				# of Sales	6
				Mean	1.052
				Median	1.040
				Wghtd. Mean	1.073
				COD	7.535
				PRD	0.981





# Evaluating Ratio Study Results

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- 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

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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](mailto:Level2@dlgf.in.gov).