Performance Audit of the 2020 Triennial Update of Franklin County

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Executive Summary

As third party consultants with unquestioned expertise in the field of mass appraisal, the professionals from John G. Cleminshaw, Incorporated were provided with the mission of analyzing the degree of equity in valuation assessment achieved with the 2020 Triennial Update of Franklin County. Additionally, our team scrutinized the accuracy in valuation assignment and overall quality of the Triennial Update, unrelated to the objective of fairness and equity.

The scope of our analysis and reporting included examining the typical statistical measurements of central tendency that are routinely applied by the State of Ohio's Department of Taxation, most notably: The median of sales ratios; the weighted mean of sales ratios; the Coefficient of Dispersion; and the Price Related Differential.

It was decided that additional statistical testing and measurement that extends beyond the basic measurement normally pursued by County Auditor's offices and The Ohio Department of Tax Equalization would provide useful insight to the County Auditor and add a valuable dimension to the overall analysis. Therefore, additional, less traditional and routine statistical analysis was performed, and the results can be found within the pages of this report.

We also sought to determine whether the County Auditor's Office applied any of the suggestions from the Audit of the 2017 Sexennial Reappraisal.

In summary, it is our conclusion that the 2020 Triennial Update of Franklin County not only met all minimum standards required by Ohio's Department of Taxation, but also demonstrated significant and very tangible improvement in overall accuracy of valuation and equity in assessment levels when compared to the results achieved by the 2017 Sexennial Reappraisal. We deem the results of the Triennial Update to be impressive and indicative of a concerted and dedicated effort by the County Auditor to improve the quality of the assessment product. The Project can be considered a success as defined by the fact that it can be tangibly demonstrated that accuracy of property valuation as well as overall equity among properties was improved as a result of the Project.

The results of all of our findings can be found in the report that follows this Executive Summary.

Background

Every six years in the State of Ohio, all counties are required by law to have all parcels of real estate reappraised by The County Auditor. This mandate for the Sexennial Reappraisal is undertaken to bring property values to their fair market value for equity and fairness. In the third year after the Sexennial, a Triennial update is performed to bring the sexennial values up to the current market levels. This Triennial update is a trend analysis to bring properties to the current market values, by the way of a factor that is derived by analyzing the last three years of sales transaction. The last Sexennial Reappraisal was completed in 2017 and the Triennial Update was done in 2020.

Franklin County Auditor Michael Stinziano contracted with our appraisal firm to conduct an independent Performance Audit of the 2020 Triennial Update. The goal was to look to improve the accuracy and fairness of assessment moving forward by means of analyzing the effectiveness of what has taken place in the recent past. A careful critique would be orchestrated and areas for improvement would be identified.

The de facto Standards for accuracy and fairness in mass appraisal valuation are provided by the International Association of Assessing Officers (IAAO). Hence, it was mutually decided that the statistical performance standards published by the IAAO would act as the primary foundation for determining accuracy and/or potential inconsistency in value assignments and overall quality of the project, or lack thereof. At the center of the statistical standards recommended by IAAO is the Sales Ratio, which is a measurement of the Auditor's assignment of market value as compared to the actual sales price of individual properties. IAAO has deemed that assessment levels, as defined by the Sales Ratio, should fall within the range of 90% to 110%. The County Auditor has sought a goal of achieving a 92.5% assessment level on average for all property classifications. In other words, if the assignment of values across the entire vast range of properties resulted in an average assessment level of 92.5% of sale price, along with little deviation from this average, this achievement would be considered ideal.

Not all properties will fall within this range, nor could it be expected that all properties fall within the range. Due to idiosyncrasies in individual sales and the fact that the residential real estate market in specific does not always operate in a totally logical fashion, it would be literally impossible for the assessment level of all properties that have recently sold to fall neatly within the ideal parameters.

It is important to note that The State of Ohio's Department of Taxation allows for an overall Level of Assessment that is below 100% of sale price to assessed value. In fact, it is customary for most Ohio County Auditors to shoot for overall assessment levels that are slightly below 100%, thereby giving the benefit of the doubt to taxpayers. Therefore, an overall Level of Assessment which is in the 90s, as opposed to a full 100%, is certainly not considered "inaccurate." As a mass appraisal firm operating exclusively in the State of Ohio, we can corroborate that a targeted sales ratio level of 92% - 93% is a very common goal amongst counties throughout the State.

The Coefficient of Dispersion (COD) measures how tightly grouped the sales ratio is across the entire range of properties. It utilizes Standard Deviations from a central measurement to determine the answer. Results can be expressed visually through the presentation of a bell-shaped curve. The COD is very useful because it demonstrates whether the Median Sales Ratio is acceptable as a whole, but might in fact only be good on average, with results scattered across the broad range of sale properties. Ideally, we want a tight grouping of individual sales ratios, and not just a good average of all the individual sales ratios. A tight grouping suggests consistency in the application of values by the Auditor's Office, and thus equity. COD standards as established by IAAO are a maximum of 15.0 for single family properties. COD measurements that are higher than 15.0 are ***generally*** considered to be outside of ideal ranges, serving as a ***possible*** indication that value assignments are not as consistent from like property to like property as they should ideally be. However, there are a variety of factors that must be considered here, and the results of statistical measurements of assessment are rarely entirely as meets the eye on the surface. The axiom that "it depends" is certainly as pertinent in real estate appraisal as it is in any other discipline, and statistical measurements can be misleading. By way of example, CODs for condominium properties tend to be lower, while the CODs for rural and agricultural properties tend to be higher. Such results are accepted by all within the mass appraisal industry and assessment community.

Furthermore, an acceptable range for Coefficient of Dispersion - one of the primary measurements of whether properties have been appraised and valued in a consistent manner – can vary depending on the property type in question.

Our appraisal team placed specific emphasis on determining whether the further delineations made to the existing neighborhood base by the Franklin County Auditor's

Office improved the accuracy in valuation and consistency in assessment levels that the Triennial Update sought to achieve.

A separate source of evaluation and analysis was attained through the independent study performed by Kyle Wathen, PhD. Dr. Wathen is a statistician who was able to provide scrutiny of the Triennial project through means of additional statistical testing and measurement that extends beyond the basic measurement normally pursued by County Auditor's offices and The Ohio Department of Tax Equalization. Statistical measurements of the results of the Triennial that represent alternative, fresh perspectives were deemed to be able to offer valuable dimension to the analysis. As it turned out, statistical testing that augmented the usual battery of tests did indeed provide additional insight.

One of the primary additional statistical measurements implemented was the Price Related Bias (PRB).

PRB is an index of vertical equity that quantifies the relationship between assessment to sales ratio and the value range that properties fall within. In other words, it measures what happens to the assessment ratio in different value stratums. Are higher value properties under assessed or over assessed in relation to their lower value counterparts?

The PRB is of significant interest to the County Auditor because it is instrumental in determining if equity has been achieved across the broad range of properties within a property class – single family residential properties being the largest of these classes. Additionally, the PRB is useful because it is not heavily influenced by neighborhood outliers where an outlier is defined by neighborhoods with high or low ratios when compared to other neighborhoods.

Dr. Wathen was also able to isolate those property characteristics believed to be of particular importance to buyers in the real estate market and seek to determine through simple linear regression techniques whether there was any disparity in the assessment ratios between properties that possessed these characteristics and properties that did not possess the characteristics. Note: Through the comparison of sales wherein one particular property characteristic can be isolated and all other variables are held constant, the value that the real estate market places on that particular property characteristic or amenity can be measured. Examples of property characteristics that have been shown to be of significant importance and therefore meriting more money paid for a given property are: the condition of the property and the quality of construction. These two property characteristics, in addition to others,

were analyzed as part of the scope of Dr. Wathen's research. The results were extremely impressive, as will be discussed in the following section, **Observations**.

Our staff communicated with the County's Geographic Information Systems (GIS) Manager to ensure that applicable discoveries emanating from our research could be woven into the fabric of the GIS structure.

As was stated in the Executive Summary, we examined whether the Auditor's staff implemented suggestions for improvement of the appraisal process made following the Performance Audit of the 2017 Sexennial Reappraisal.

It is very important to note that the scope of work pursued during a Triennial Update does not permit the implementation of the majority of suggestions emanating from the Performance Audit of the 2017 Sexennial Reappraisal. A Triennial Update Project by its very nature and scope is inherently not conducive to heavy emphasis on "field work" and analysis of properties on an individual parcel by parcel level. Many of the recommendations made as a result of the analysis we conducted of the 2017 Sexennial Reappraisal would involve appraisal of individual properties and inspections of individual properties conducted "in the field."

The results of our findings related to implementation of suggestions from the Audit of the 2017 Reappraisal, as well as findings related to all of the other subjects referenced above can be found in **Observations**, beginning on page 6 of this Report.

Observations

Dividing Large Neighborhoods into Smaller Neighborhoods

The County Auditor's appraisal staff decided that it could be beneficial to break down a variety of larger neighborhoods into smaller sub neighborhoods for the purpose of analyzing valuation trends. The hypothesis was that subdividing some of the larger neighborhoods into smaller units would allow the Auditor's Office to fine tune factors designed to bring values in line with current market trends and market values. The new neighborhoods were given temporary status and were referred to as "Temporary" neighborhoods.

There is a fine line between having neighborhoods that are too large, or conversely too small. If neighborhoods are too large there is the potential that the broad scale value factoring can be applied to properties that perhaps are not prime candidates for the value adjustment factor in question. Much like using a very wide paintbrush to paint an object, when a wide paintbrush is not the appropriate tool for the job, or a shotgun, when a rifle is a better choice. However, if you slice neighborhoods into areas that are too small, often times there is not enough of a volume of sales to make a good, responsible analysis of how to factor the values. For this reason, the Auditor's office had to act very prudently with exactly how they subdivided some of the larger, original neighborhoods.

It is important to note that The Ohio Department of Tax guidance and Ohio law require appraisal neighborhoods to be set only during the full sexennial reappraisal. Auditors have discretion to take additional steps during a triennial update for the best results. Franklin County, based on the audit of the 2017 reappraisal and their own review did significant additional delineations with the intent of continuing that work when they could be made the permanent official neighborhoods. That is why they are referred to as Temporary neighborhoods throughout this report but were used as if they were permanent appraisal neighborhoods for calculated 2020 values.

Residential Properties

It is our conclusion that delineating the original large neighborhoods into smaller "Temporary" neighborhoods overwhelmingly improved the median sales ratios. In approximately 25% of the original large neighborhoods the median ratios improved dramatically after delineating the neighborhoods into smaller units. We consider this improvement significant to the overall quality of the assessment process and value equity.

We believe that the improvement in median ratios occurred because the Auditor's Office was able to analyze smaller sets of data and apply the results of the data to a smaller set of very similar properties. The goal was to create smaller neighborhoods of properties that had less variation in property characteristics and amenities. In essence, the delineation into smaller sets of like properties that shared most all the same property characteristics allowed for customization of the valuation factors and hence, more customized value adjustment. Not surprisingly, fine-tuned customization of adjustments to value yielded better statistical measurements of the accuracy of the valuation as computed through median sales ratios and CODs.

The original large neighborhoods possessed median sales ratios that ranged from 77.02% to 94.35%, with the majority of the original neighborhoods exhibiting ratios in the mid 80 percent range. In approximately 20% of the original large neighborhoods, the CODs of these larger neighborhoods exceeded 10% and therefore were not in conformance with the self-imposed goal of 10% or less for all residential neighborhoods.

The median sales ratios of the Temporary neighborhoods range from 91.75% to 94.16%. However, the overwhelming majority of the Temporary neighborhoods possesses a median sales ratio in the 92% to 93% range, right on the mark of the County's goal of 92.5%.

Additionally, it is a very tight range. The average of all these ratios is 92.88%, and the median of the ratios is 92.85%. The tight range and consistency of these ratios is impressive.

Furthermore, the CODs have undoubtedly improved. The CODs for a significant number of the original large neighborhoods was out of conformance with standards set by the County due to the fact that uniform value adjustment factors applied across a very wide swath of properties that might have dissimilar property characteristics will often exacerbate existing valuation issues and ultimately lead to inconsistent results. Conversely, logic would certainly dictate that the customized value adjustment factors applied to smaller like property groups resulted in more consistent results and much better overall equity, as evidenced by the lower CODs. Due to limitations in the third party software, it is not possible to calculate the CODs for the Temporary neighborhoods. However, all logic would point to the Temporary neighborhoods having superior COD numbers because of the custom adjustments. These inevitable results are assumed here and stand to reason. Therefore, they are not surprising at all.

In summary, breaking these neighborhoods down into smaller subunits of comparison – the Temporary neighborhoods - enabled better overall equity. The refined delineation enabled significant improvement to the initial results of the Triennial Update.

The geographic areas within the County that benefited the most by the further delineation into smaller subset neighborhoods (technically Temporary neighborhoods at this juncture) can be seen in Table A.

Table A can be found on the following page.

Table A

Geographic areas within the County that enjoyed significant improvement

NORWICH TWP	DUBLIN RD TO SCIOTO RIVER
MIDTOWN	E OF 71, TO LONG ST S OF 670
MIDTOWN	E OF 71, 670 TO HUDSON
WORTHINGTON	E OF 71, S OF MORSE
COLUMBUS	E OF 71, 270 TO 161
NORTHEAST	E OF 71, MORSE TO 161
NORTHEAST	W OF 270, MORSE TO 161
NORTHEAST	E OF 71, MORSE TO OAKLAND PARK
NORTHEAST	S OF MORSE, SUNBURY RD TO W-VILLE RD
GAHANNA	E OF 270, N & S OF SR 62
BEXLEY	VERY SMALL NORTH END
COLUMBUS	BROAD TO 70, W OF 270
COLUMBUS	E & W OF ALUM CREEK, 270 TO FRANK
HAMILTON TWP	S HIGH, S OF 270
GROVE CITY	BROADWAY TO 71, S OF 270
COLUMBUS	HILLTOP
COLUMBUS	W OF 71, FRANK TO 270
COLUMBUS	N & S OF BROAD, E OF 270
COLUMBUS	N & S OF BROAD, W OF 270
PRAIRE TWP	TOWNSHIP
COLUMBUS	FRANK TO 270, W OF HARRISBURG PIKE

The tangible improvement as evidenced by the before and after results of splitting the neighborhoods into subsets can be seen in Table B which appears of the following page.

A View of the Tangible Improvements to Assessment Levels Produced by Expanding Neighborhood Delineation

Please note: The COD annotation in the Comments Column points out Original Neighborhoods that had COD measurements in excess of 10%.

Key:

Status "O" = Original Neighborhood

Status "T" = Temporary Neighborhood

Table B

Neigh#	Status	Temporary Median	Original Median	Comments
00900000	O	94.16	88.88	
00902000	T	93.67		
00906000	T	93.05		
01200000	O	94.02	87.53	COD>13
01204000	T	93.02		
01400000	O	93.15	90.77	COD>13
01401000	O	92.48	84.70	COD>13
01402000	T	93.07		
01403000	T	93.21		
01404000	T	N/A		
01405000	T	N/A		
04000000	O	91.84	90.66	
04002000	T	93.43		
04003000	T	92.47		
04300000	O	92.76	86.95	
04301000	O	92.27	77.02	COD>11
04302000	O	93.15	90.16	
04303000	O	93.46	85.70	
04304000	T	92.54		
04305000	T	92.48		
04500000	O	92.76	88.48	
04501000	O	93.42	87.76	

04502000	T	92.34	
04503000	T	91.74	
04504000	T	92.23	
04505000	T	92.74	
04506000	T	91.73	
04507000	T	93.49	
04600000	O	92.76	87.89
04601000	T	93.64	
04602000	T	92.20	
04603000	T	93.73	
04604000	T	92.23	
04605000	T	92.76	
04606000	T	92.79	

Neigh#	Status	Temporary Median	Original Median	Comments
04700000	O	91.89	87.89	
04702000	T	91.88		
04703000	T	93.58		
04704000	T	93.46		
04800000	O	93.48	82.17	
04801000	O	92.64	88.20	
04802000	T	93.51		
04803000	T	93.19		
04804000	T	92.79		
05200000	O	93.52	87.60	
05201000	O	93.52	90.64	
05204000	O	92.19	94.35	
05205000	T	91.75		
05206000	T	92.75		
05207000	T	91.64		
05208000	T	92.46		
05209000	T	91.83		
05210000	T	93.49		
05211000	T	92.67		
05212000	T	93.49		
05213000	T	93.17		
05214000	T	N/A		
06400000	O	92.58	93.00	

06500000	O	92.91	91.14	
06501000	T	92.74		
06800000	O	92.36	91.84	
06801000	T	92.61		
07400000	O	93.55	83.80	
07401000	O	92.61	86.25	COD>10
07402000	T	92.29		
07403000	T	93.16		
07404000	T	92.29		
07405000	T	93.61		
07406000	T	93.26		
07407000	T	93.23		
07408000	T	92.39		

Neigh#	Status	Temporary Median	Original Median	Comments
07409000	T	92.36		
07410000	T	92.78		
07600000	O	92.58	84.10	COD>13
07601000	T	93.42		
07602000	T	93.18		
07603000	T	92.36		
08200000	O	93.46	87.61	
08204000	T	93.62		
08206000	T	92.48		
09500000	O	93.19	88.28	COD>11
09502000	T	93.08		
09503000	T	92.54		
09600000	O	92.28	83.19	
09601000	O	93.16	81.92	
09602000	O	93.04	87.24	
09603000	T	93.49		
09604000	T	93.67		
09605000	T	93.30		
09606000	T	92.30		
09607000	T	92.31		
09608000	T	93.08		
09609000	T	93.58		

09610000	T	92.69		
09700000	O	93.65	79.92	
09701000	O	93.22	89.63	
09702000	T	93.46		
09703000	T	92.58		
09704000	T	93.14		
09705000	T	93.33		

Neigh#	Status	Temporary Median	Original Median	Comments
09800000	O	92.36	88.62	
09801000	O	93.28	84.17	COD>10
09802000	T	93.09		
09803000	T	93.64		
09804000	T	92.24		
09805000	T	93.08		
09806000	T	93.18		
09807000	T	92.30		
09808000	T	92.49		
09809000	T	93.05		
09810000	T	92.43		
09811000	T	92.47		
09812000	T	92.72		

Commercial and Industrial Properties

The Auditor's goal was to perform a more advanced and equitable method for updating Commercial and Industrial property values instead of simply grouping sales ratios by property classification, i.e., either Commercial or Industrial properties. A thorough analysis of Commercial and Industrial properties was performed in mass as well as by each different type of major property type in the Franklin County market. Until recently, the Auditor's Office possessed an antiquated CAMA system that did not have the ability to analyze differing appreciation or depreciation rates in the Commercial and Industrial market by land use codes.

Various property types will tend to display differing levels of appreciation or depreciation in market value over the same timeframe as evidenced by their respective sale prices. All Commercial and Industrial sales were validated by the

Reappraisal Firm and grouped in like land use codes for analyzation. The sales of different land use properties were analyzed by grouping similar uses of properties together.

The Reappraisal contractor's research and value recommendations were based upon 1,521 sales of Commercial and Industrial properties out of a total population of 32,178 properties.

The Reappraisal Firm and the Franklin County Auditor's Office decided to apply value adjustment factors to commercial and industrial properties according to the specific use of the property. Therefore, one customized value adjustment factor was computed for general office space, and another separate value adjustment factor was computed for retail properties, and yet another for apartments, etc. This customized approach has produced much better results, with an overall median sales ratio for all properties of 91.6%. Additionally, the median sales ratios were very consistent across all individual property uses.

Recommendations from the Audit of the 2020 Triennial

As was referenced in the Executive Summary Section of this report, most of the Recommendations emanating from the Audit of the 2017 Sexennial Reappraisal do not lend themselves to adoption in a Triennial Update. The primary reason for this is that Triennial Update Reappraisals do not inherently include much "field" related work. Nearly all of the work performed in a Triennial Update revolves around analysis of data. Appraisal staff with experience analyzing real estate market data identify trends in the market and then adjust values in accordance with what the trends in value indicate. The goal is to reflect the evidence that the market presents.

Specifically, some of the key Recommendations made in the Audit of the 2017 Sexennial Reappraisal: ***application based analytical tools***; ***sketch overlays***; ***greater consistency devoted to assignment of subjective property characteristics; more accurate land valuation***; and ***a team devoted to the appraisal of condominium properties*** are all adaptations to the process that by their very nature will have to be added during the 2023 Sexennial Reappraisal of the County. Through our discussions with the Auditor's office, it is our understanding that these Recommendations have indeed been implemented as a part of the on-going 2023 Sexennial Reappraisal. The point here is that it would have been virtually impossible to meld the adaptations with the normal process of a Triennial Update.

Nevertheless, it is important to mention that the delineations that the County made to existing neighborhoods is a function that is normally not part of the scope of a Triennial Update. The County made this sub-project a priority and a focal piece of the Triennial nonetheless. And the results speak for themselves. As a direct result of the further delineation of neighborhoods, median sales ratios improved significantly, and it can be assumed with a great degree of confidence that CODs improved as well.

Results of Dr. Wathen's Research

As was stated in the **Background** section of this report, Dr. Wathen was able to isolate those property characteristics believed to be of particular importance to buyers in the real estate market and seek to determine through simple linear regression techniques whether there was any disparity in the assessment ratios

between properties that possessed these characteristics and properties that did not possess the characteristics.

It was shown that there were no significant differences in the assessment ratios of properties across all ranges of property variables. By way of example, properties were statistically shown to be treated the same regardless of variables like ***Quality of Construction (Grade)*** and ***Age*** of the dwelling.

It appears quite obvious that the County Auditor's appraisal staff are very cognizant of the salient property characteristics that are clearly important and desirable to buyers in the current real estate market, and that the appraisal staff has implemented valuation techniques which accurately account for these "value drivers." Although it was our aim to identify any areas for improvement in the level of significance – related to value – that certain property characteristics were afforded, we could find no weaknesses in the results achieved. All of the most influential value drivers appear to have been carefully considered by the Auditor's office, and the County appears to have implemented approaches that have provided appropriate weight to these important value drivers. Again, the results of this testing across property characteristic ranges is indeed very impressive and encouraging.

The statistical testing performed by Dr. Wathen proofed to be very useful. Dr. Wathen employed statistical tests that are not a part of the suite of statistical measurements applied by the State of Ohio's Department of Taxation and other County Auditor's offices. An example of these additional statistical measurements is the Price Related Bias (PRB). A discussion of the PRB can be found in Dr. Wathen's findings in the following Section of this report.

Dr. Wathen's work corroborated the results that were shown through the more traditional statistical testing. This fact alone is extremely valuable, because the corroboration further validates the admirable work done by the Auditor's Office. Like ancient mariners who utilized multiple navigational fixes to prove a location point, the different statistical measurements support the accuracy of the assessment performed for the 2020 Triennial Update.

Dr. Wathen's full analysis can be found in "Appendix A" of this report.

Appendix A

Analysis of Franklin County Data

J. Kyle Wathen, PhD, Web Stat Solutions, LLC

Introduction

The data in the SourceData folder are the same as the original but the files and columns in the Excel file have been renamed to remove special characters. Three data sets were provided. The data sets and descriptions are as follows:

1. **Original File Name: 2019 Sales with 2019 values (audit).xlsx** - Which is stored in the OriginalData folder and are unaltered. For the purpose of this analysis the 2019 sales and values data are imported form SourceData/2019SalesWith2019ValuesAudit.xlsx. There are 19,048 rows in the data set with 18,796 unique tax IDs.
2. **Original File Name: 2019 Sales with 2020 values (audit).xlsx** - Which is stored in the OriginalData folder and are unaltered. For the purpose of this analysis, the 2020 values data is imported from SourceData/2019SalesWith2020ValuesAudit.xlsx. There are 19,042 rows in the data set with 18,783 unique tax IDs.
3. **Original File Name: 2019 sales with characteristics.xlsx** - - Which is stored in the OriginalData folder and are unaltered. For the purpose of this analysis the additional characteristics data are imported form SourceData/2019 sales with characteristics.xlsx. This data set contains additional information and characteristics about the parcels.

The data from 2019-2020 were joined based on TAX ID number and CONV number. After combining the data there are 19,311 rows in the data set. There were 269 records found only in the 2019 data, 263 records found in only 2020 data, and 18779 records found in both data sets. After combining the 2019 and 2020 value data sets the additional characteristics were added to the data set for analysis.

Throughout this document the Ratio is defined as 100*Total Value/Sale Price, using the total value from 2020.

Data Validation

This section details possible issues in exploring the data. Table 1 contains a list of parcels that had a different NBHD in the 2019 and 2020 data sets. Additional statistical assumptions may be found in the Appendix.

There are possible issues in the data given the large (greater than 150) or small ratios (less than 50). Abnormal ratios may have a heavy influence on any analysis and need to be addressed. For example, if a parcel has a high ratio, greater than 150, this could be due to new parcel that has an appraised value that is very high compared to the reported sale value. This situation could occur if a parcel was in development resulting in a low sale price but the value is based on a fully constructed parcel. Ratios below 50 could indicate parcels that have a value based on land only and the sale price includes land plus improvement. Values less than 50 or greater than 150 could also indicate issues with data collection, such as incorrect data entry of appraisal/sale values. Table 2 consists of parcels that have a ratio greater than 150 or less than 50.

The remainder of the analysis in this document are done by excluding parcels with a ratio greater than 150 or less than 50. For the purpose of the analysis the neighborhood number in the 2020 data set was utilized.

Data Exploration

Exploration By Parcel

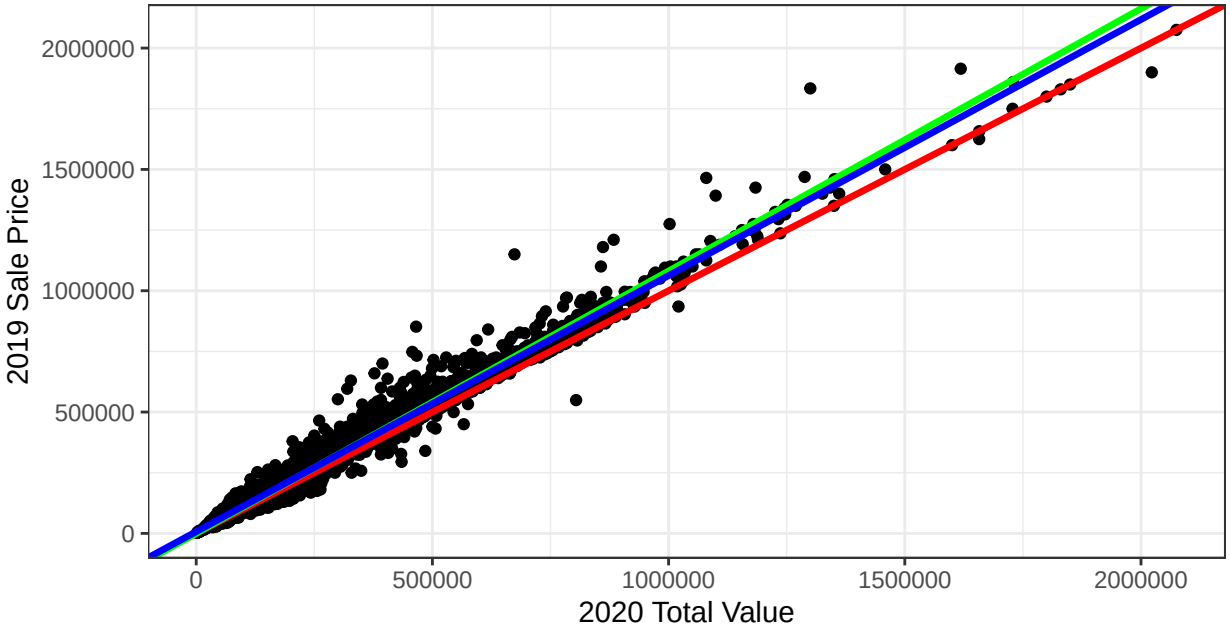
Understanding the sales price and total value of each parcel can be helpful to identify global issues. Figure 1 provides a visualization of the 2020 Total Value vs 2019 total sale price (taken from the 2020 dataset). The **red line** is where Total Value = Sale Price reference line. Points above the red line have a sale price greater than the total value, e.g. ratio < 100, whereas points below the red line have a total value greater than the sale price, e.g. ratio > 100. As an additional reference, the **green line** represents an ideal situation where all parcels have a ratio of 92.5. The **blue** line represents the best fit for the observed data and can be thought of as the estimated ratio. More details are provided below.

The blue line is very close to the ideal ratios of 92.5. This indicates that the ratios across the range of values are very close to the target ratio. If the blue line was above the green line that would indicate a situation where the estimated ratios were less than the desired 92.5. If the blue line was much below the green line, that would represent the situation where the ratios are higher than the desired 92.5.

To explore the relationship between Total Value and Sale Price a simple linear regression was fit assuming the sale price as the dependent variable (y variable) and the total value as the independent variable (x variable). Specifically, Sale Price $= \beta_0 + \beta_1$(Total Value). In this model the Estimated Ratio $= \frac{1}{\beta_1}$ and the estimated ratio is 94.76 with 95% Confidence Interval (94.58, 94.94). The "best" fitting line (regression line) is plotted in Figure 1 as the blue line.

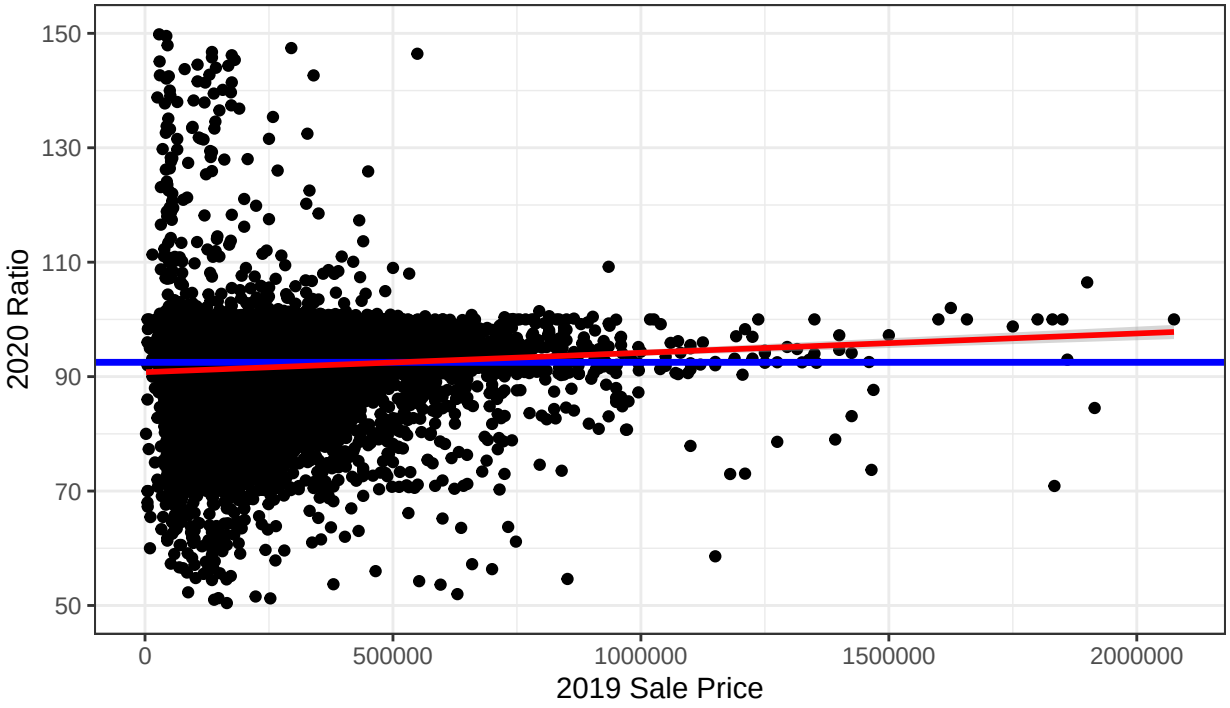
Additional insight can be gained by evaluating 2020 ratios vs 2019 sale price, Figure 2, and 2020 ratios vs 2020 value, Figure 3. Each figure gives a slightly different representation of the data. Figure 2 shows only a small increase in ratio as a function of 2019 sale price. This is apparent because the blue reference line drawn at 92.5 is close to the estimated line shown in red. Figure 3 shows the 2020 ratio vs 2020 value. The red line has a positive slope, increases from left to right and thus higher values have slightly higher ratios. Since the red line is not as close to the blue reference line as in Figure 2, there appears to be a bias or inequity to higher valued parcels having a higher ratio. However, this could be due to the small number of parcels in the value greater than \$1,250,000 that have a ratio of exactly 1 which likely have a large influence on the slope of the red line.

Figure 1: 2020 Total Value vs 2019

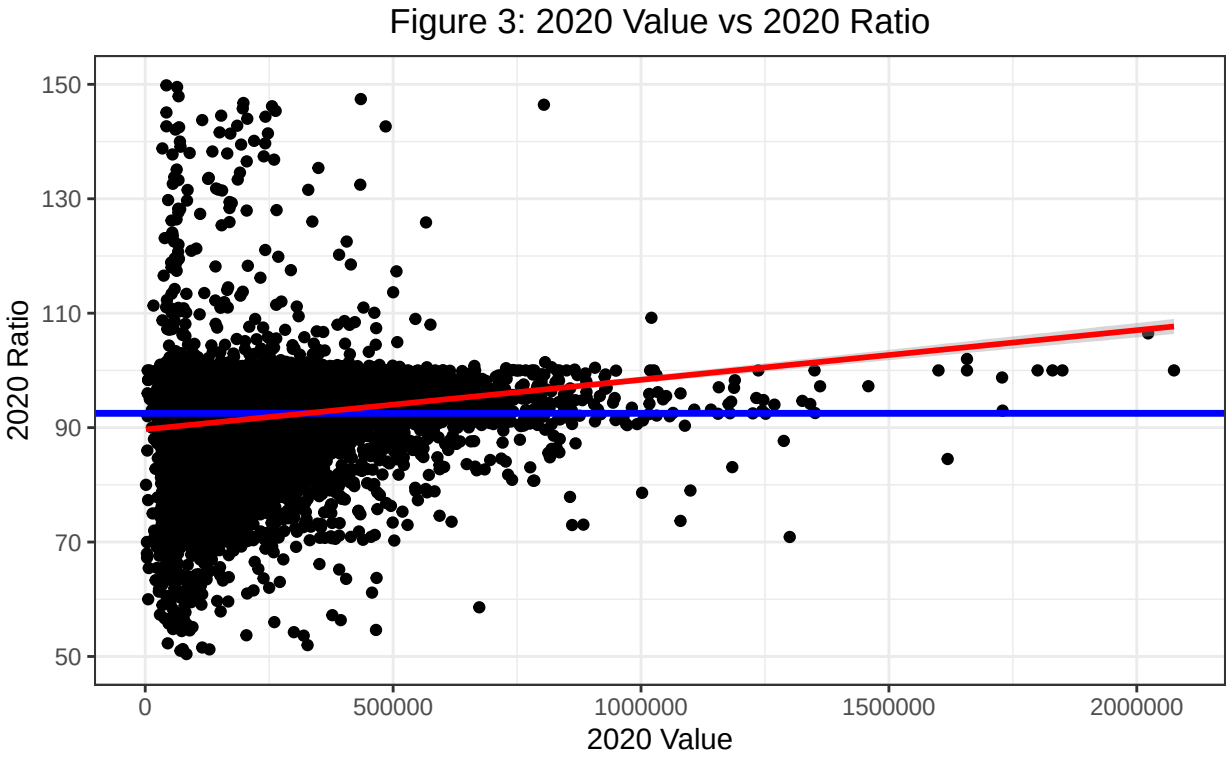


Total sale price taken from the 2020 dataset. The **red line** is a reference line where the Total Value is equal to Sale Price reference. Points above the red line have a sale price greater than the total value, e.g. ratio < 100, whereas points below the red line have a total value greater than the sale price, e.g. ratio > 100. As an additional reference, the **green line** represents an ideal situation where all parcels have a ratio of 92.5. The **blue** line represents the best fit for the observed data and can be thought of as the estimated ratio.

Figure 2: 2019 Sale Price vs 2020 Ratio



The blue line represents the ideal ratio of 92.5 and the red line is the estimated ratio based on analysis. The positive slope of the red line indicates a very small increase in ratio as 2019 sale price increases.

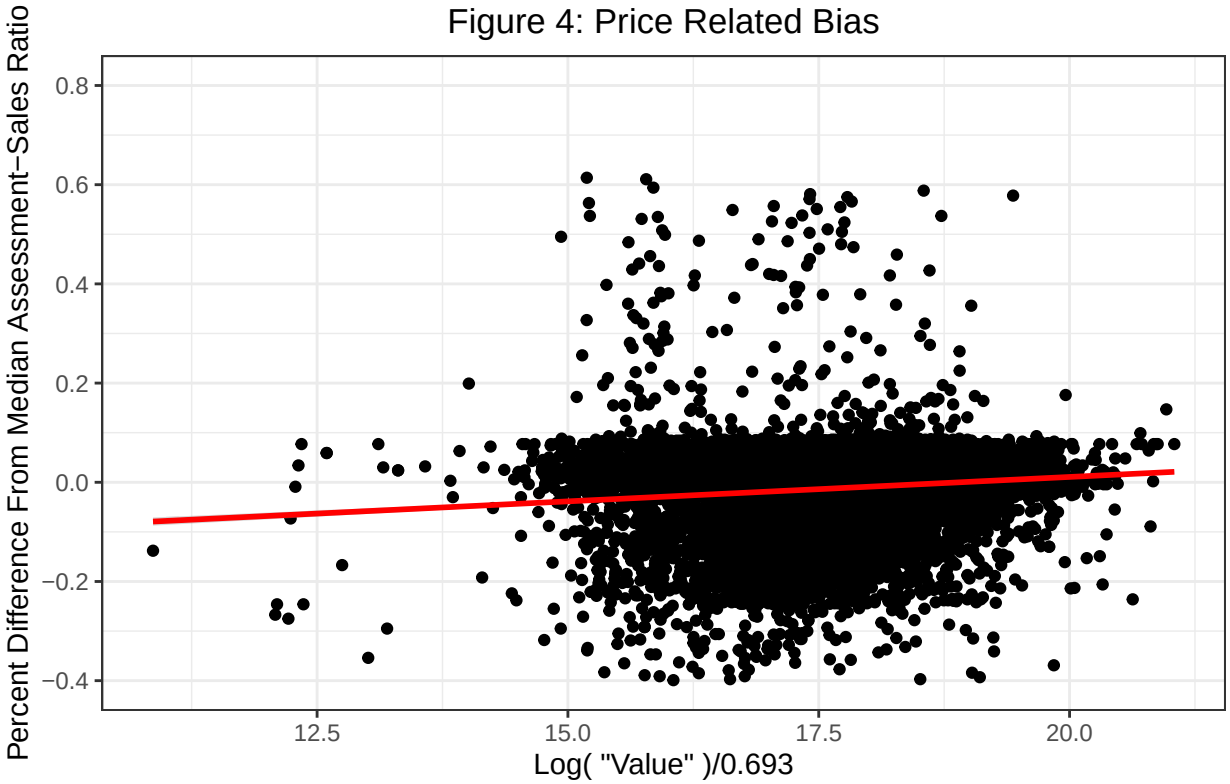


The blue line represents the ideal ratio of 92.5 and the red line is the estimated ratio based on analysis. The positive slope of the red line indicates an increase in ratio as 2020 assessed value increases.

Price Related Bias (PRB)

The coefficient of Price-Related Bias(PRB) is an index of vertical equity that qualifies the relationship between assessment-sales ratio and the value in percentage terms [1]. The PRB is a value that helps to explain how assessment-sales ratios and values are related in a percentage term. For example, a PRB of 0.05 means that, on average, assessment ratios increase by 5% whenever the values double. A positive PRB like 0.05 means that higher valued parcels tend to have a higher assessment-sales ratio. In contrast, a negative PRB like -0.1 would mean that, on average, assessment ratios decrease by 10% when the value doubles, which indicates that higher value parcels have a lower assessment-sales ratio. The underlying methodology of PRB makes it a good measure of vertical equity because it is less impacted by parcels that are outlier parcels with unusual assessment-value ratios.

The PRB was computed for the individual parcels. The estimated PRB = 0.00990 with a significance of < 0.0001, which is statistically significant. However, due to the large sample size of the data set, statistical significance means it is different than 0 but for practical purposes the estimates means that ratios increased by 0.99 when the values doubles. See Figure 4 for the plot of the PRB. The positive value of PRB means that higher value parcels have a slightly higher ratio. Specifically, as the value doubles the ratio increases by less than 1%, on average. This is shown in Figure 4 with the red line that is slightly increasing. If there were substantial inequities in assessed value (or ratios) then the red line have a larger negative or positive slope. In Figure 4, the points being scattered around the horizontal line at 0 indicates there is no bias in the appraised value ratios.



The estimated price related bias is given by the red line which indicates if the parcel value doubles the ratio increases by less than 1%, on average.

Summary

From exploring the individual parcels it is apparent that the exclusion of ratios above 150 or below 50 was helpful in focusing the analysis. However, there tends to be parcels still in the data set that may be in construction or have other issues. Given the figures above and the fact that computation of the estimate of the PRB is very small, the analysis by parcel appears to be consistent across all parcels. Further exploration is given below by other stratification variables including neighborhoods, temporary neighborhoods and other additional characteristics.

Exploring Neighborhoods

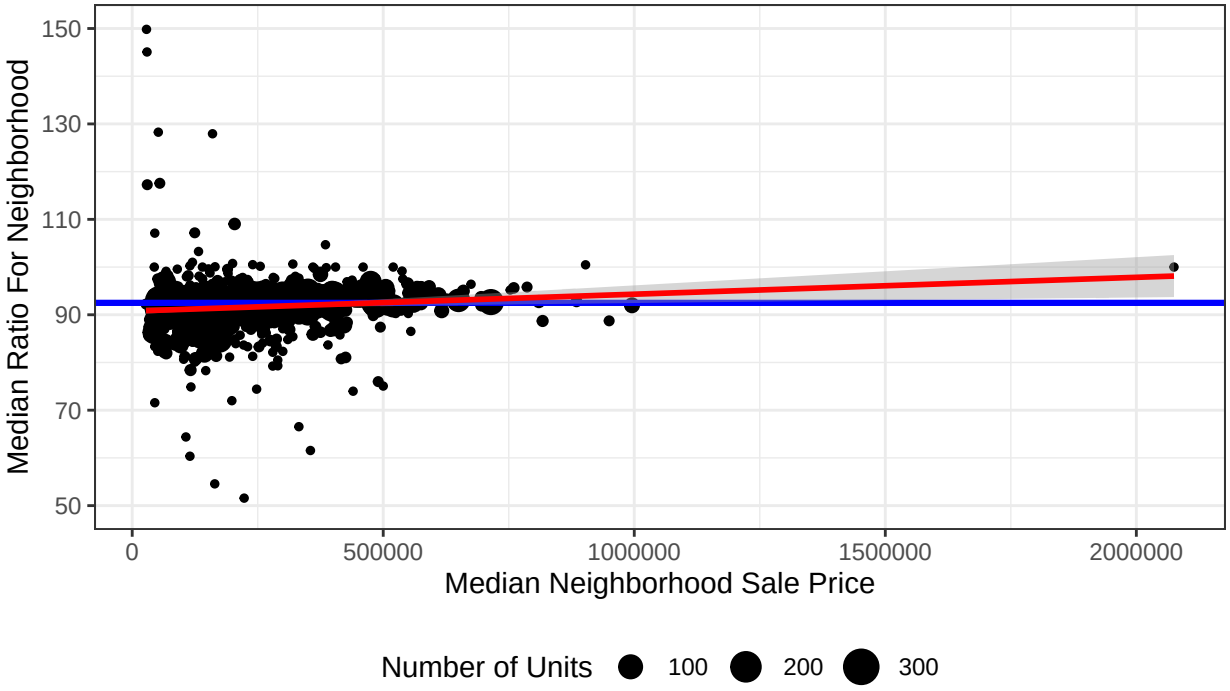
This section provides a summary and analysis by the neighborhoods. In the summary information of a neighborhood, please note that the mean can be influenced by individual values. This is of particular importance when a neighborhood is under construction and the ratios are skewed. The following table provides summaries of the ratio by the neighborhood (NBHD).

Figure 5, explores median sale price in a neighborhood vs median ratio. The **blue line** is drawn at the Ratio = 92.5 as a reference. The size of each point is proportional to the number of parcels in the neighborhood. The **red line** line is the estimated ratio across the median neighborhood sales price with the bands to represent the 95% confidence interval. The slight increase of the blue line across the range of median neighborhood sale prices indicates that the estimated ratio increases slightly as the sale price increases and ranges between about 90 and about 95. This visualization can be helpful to identify potential patterns by neighborhoods. For example, if lower sale price neighborhoods tend to have higher ratios and higher priced neighborhoods

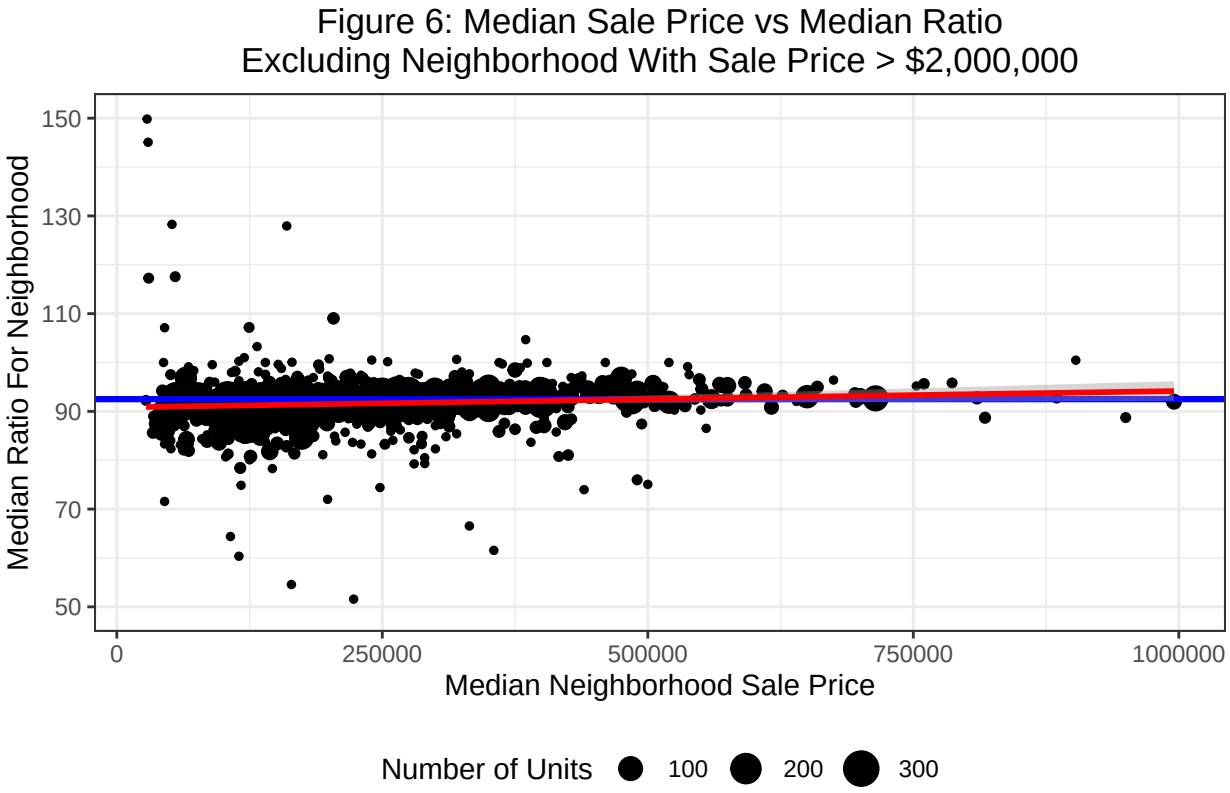
have a lower ratio the points on the left side of the graph would be above the red line and points on the right side below the red line.

A simple linear regression was fit and the red line in Figure 5 shows the estimate. The analysis was statistically significant with a very small coefficient for sale price, however, the neighborhood with the median sale price over $2,000,000 appeared to have a major influence on the fit as it is far from the majority of the other data. As such, a sensitivity analysis was performed and results provided in Figure 6. By removing this neighborhood the coefficient for sale price is no longer significant, p-value > 0.01, and thus the median sale price of a neighborhood does not have a significant impact on the median ratio of the neighborhood. However, by using this fit the estimated ratio increases by 0.354% for every $100,000 increase in Median Sale Price. For example, if the median sale price of a neighborhood increased from $100,000 to $200,000 the estimated ratio would increase from 91.125 to 91.479.

Figure 5: Median Sale Price vs Median Ratio



The blue line is drawn at the Ratio = 92.5 as a reference. The size of each point is proportional to the number of parcels in the neighborhood. The red line line is the estimated ratio across the median neighborhood sales price with the bands to represent the 95% confidence interval.

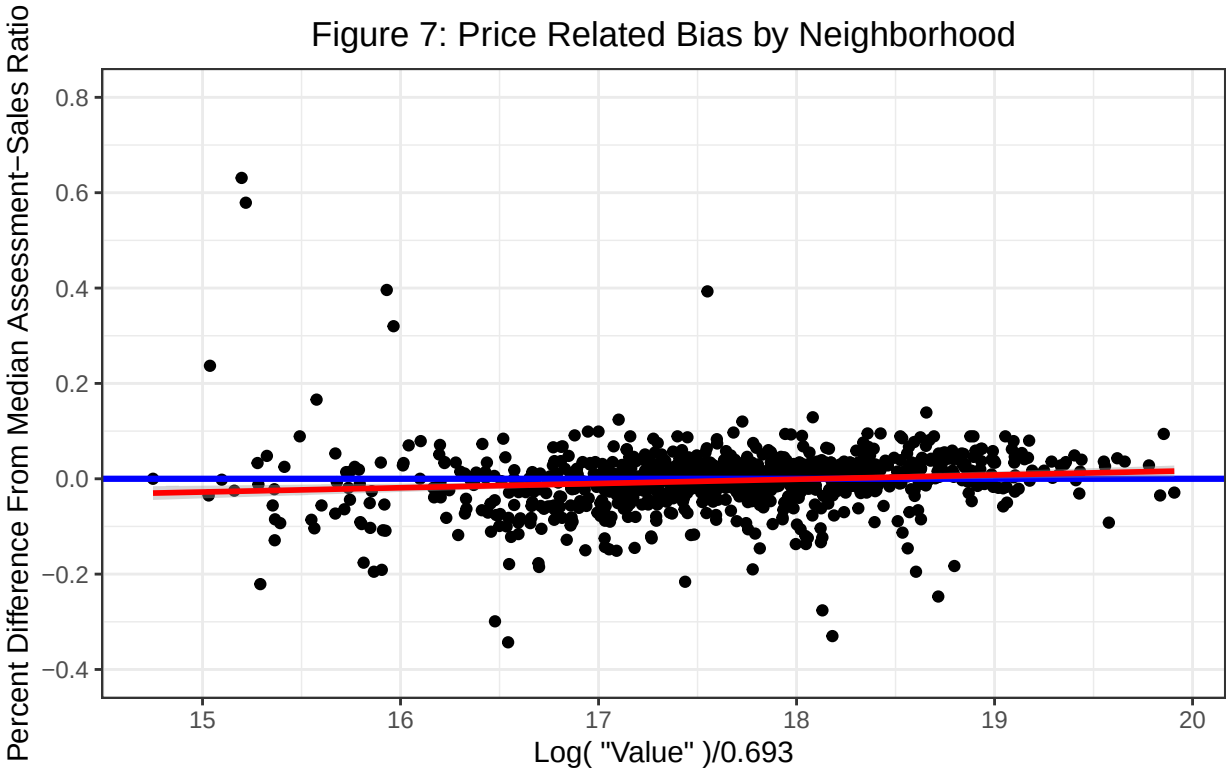


Blue line represents the ideal ratio of 92.5 and the red line is the estimated ratio based on analysis.

Price Related Bias By Neighborhood

The Price Related Bias (PRB) was computed to explore the relationship across the neighborhood. The estimated PRB = 0.00940 with a significance, p-value, of 0.00023, which is statistically significant. However, due to the large sample size of the data set, statistical significance means it is different than 0 but for practical purposes the estimates means that ratios increased by 0.94 when the values double. In other words, higher valued neighborhoods tend to have a higher assessment ratio and specifically the increase in ratio is less than 1% ever time the value doubles, on average. This is shown in Figure 7 with the red line that is slightly increasing. If there were substantial inequities in assessed value (or ratios) then the red line has a larger negative or positive slope. In Figure 7, the points being scattered around the horizontal line at 0 indicates there is no bias in the appraised value ratios.

See Figure 7 for a plot of the PRB by neighborhood.



The estimated price related bias is given by the red line which indicates if a parcel value doubles the ratio increases by less than 1%, on average. The blue line represents an ideal situation where there is no bias.

Summary By Neighborhood

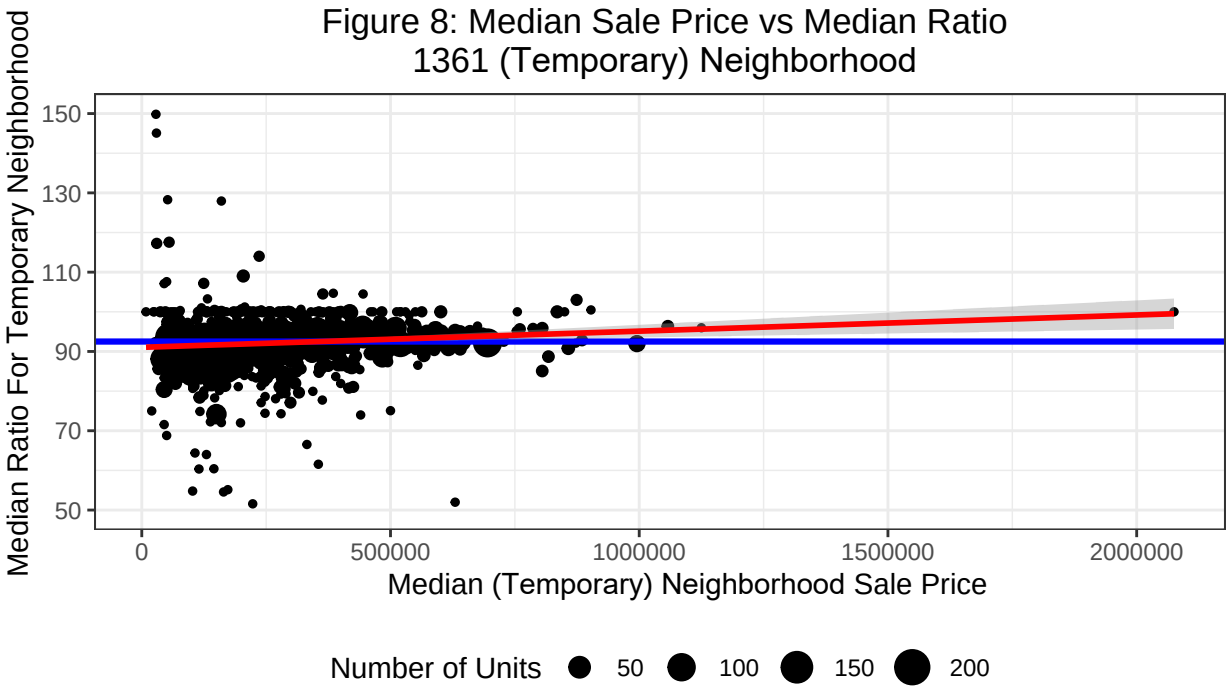
From exploring the parcels grouped by neighborhood there does not appear to be any predictable differences in neighborhood that relates median price and value. Given the figures above and the computation of the estimate of the PRB is very small and the analysis by parcel neighborhood appears to be consistent across all neighborhoods.

Exploring Temporary Neighborhoods

The following table provides summaries of the ratio by the Temporary Neighborhood.

The following plot, Figure 8, explores median sale price in a neighborhood (temporary) vs median ratio. The blue line is drawn at the Ratio = 92.5 as a reference and the red line represents the estimated ratio. The size of each point is proportional to the number of parcels in the neighborhood. This visualization can be helpful to identify potential patterns by neighborhoods. For example, if lower sale price neighborhoods tend to have higher ratios and higher priced neighborhoods had a lower ratio, the points on the left side of the graph would be above the red line and points on the right side below the red line.

Since the estimated ratio, blue line, has a slight positive slope, e.g. it is increasing, the ratio tends to increase slightly as the median sale price of the temporary neighborhood increases.

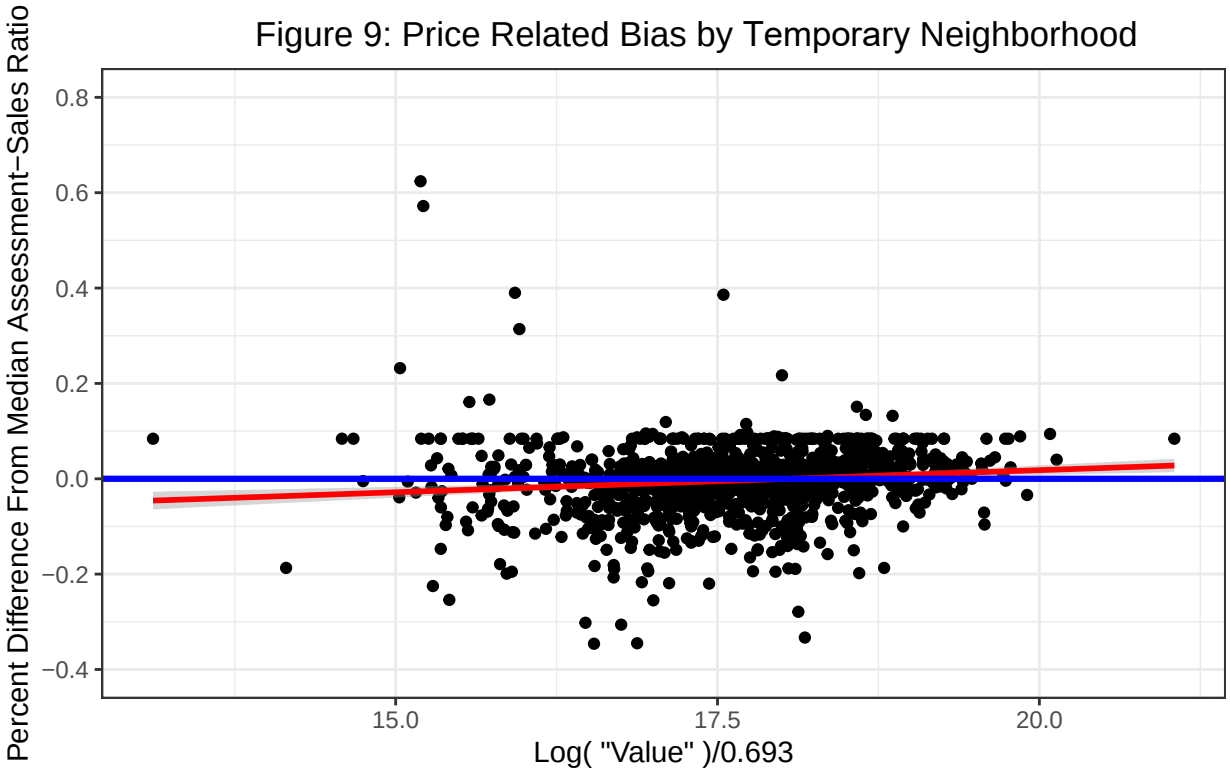


The blue line is drawn at the Ratio = 92.5 as a reference and the red line represents the estimated ratio. The size of each point is proportional to the number of parcels in the neighborhood. The positive slope of the red line, increase from left to right, is influenced by the neighborhood with greater than $2,000,000 sale price with a ratio of 100 and red line would be much closer to the ideal blue line if this point was included.

Price Related Bias (PRB) By Temporary Neighborhood

The Price Related Bias (PRB) was computed for each temporary neighborhood. The estimated PRB = 0.00980 with a significance of < 0.0001, which is statistically significant. However, due to the large sample size of the data set, statistical significance means it is different than 0 but for practical purposes the estimates mean that ratios increased by 0.98% when the values double. In other words, higher valued temporary neighborhoods tend to have a higher assessment ratio and specifically the increase in ratio is less than 1% every time the value doubles, on average. This is shown in Figure 9 with the red line that is slightly increasing. If there were substantial inequities in assessed value (or ratios) the red line would have a larger negative or positive slope. In Figure 9, the points being scattered around the horizontal line at 0 indicates that there is no bias in the appraised value ratios.

Figure 9 plots the PRB for the Temporary Neighborhood.



The estimated price related bias is given by the red line which indicates if the parcel value doubles the ratio increases by less than 1%, on average. The blue line represents the situation where no bias or inequity is present.

Additional Characteristics

This section is intended to explore various parcel characteristic for potential difference. Since these characteristics are not the primary focus of this analysis, visual graphics are utilized to identify characteristics where possible inequities may lie and no statistical tests were conducted.

Introduction to Violin Plots

Violin plots are a useful tool to compare the distribution of data for several groups. For example, suppose you wanted to compare the assessment sales ratios and value of two hypothetical neighborhoods. In order to compare the ratios you could plot a histogram of the ratios for each neighborhood, see Figure 10 A and B, for example, neighborhoods 1 and 2, respectfully. Notice in Figure 10 A, that the majority of the ratios in neighborhood 1 are between 80 and 110 whereas in Figure 10 B the majority of the ratios for neighborhood 2 are between 50 and 120. Histograms are a great way to represent and help understand a small number of categories of data but they become limited for comparing more than 2 or 3 groups of data, e.g. multiple neighborhoods or parcel characteristics. It would be very easy to miss the fact that neighborhood 2 has a lower ratio than neighborhood 1, on average. This issue becomes more apparent if we were comparing more than two neighborhoods.

In contrast, a violin plot captures much of the same information but places the data side-by-side and allows for a visual analysis of potential problems. In the histograms, the bars get taller to indicate more parcels are at a particular value whereas in a violin plot the figure gets wider where more data exists. For example, in Figure 10 C a violin plot is provided to compare the ratio of the two neighborhoods and it is apparent that neighborhood 1 tends to have ratios above the desire value of 92.5, shown as the red line. In addition, neighborhood 2 is typically below the desired value and one can quickly notice that the ratio values tend to be more spread out in neighborhood 2 than in neighborhood 1.

Violin plots can be a useful, less technical, approach to identify parcel characteristics where potential dif-ferences in ratios may occur, especially in cases where the characteristic creates more than 2 or 3 groups of parcels like number of stories or year built. For example, Figure 10 D provides an example where the year built is very predictive of the ratio. In this example, the newer parcels tend to have a higher ratio than older parcels.

Figure 10 A: Distribution of Ratios in Neighborhood 1

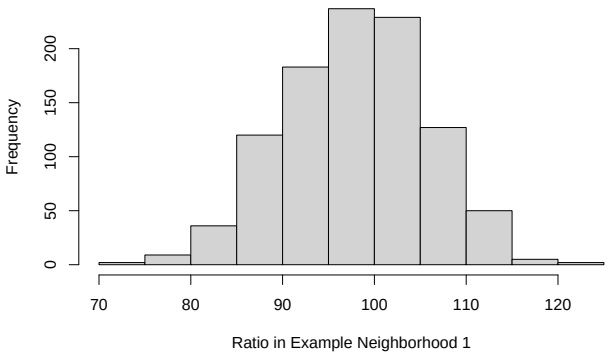


Figure 10 B: Distribution of Ratios in Neighborhood 2

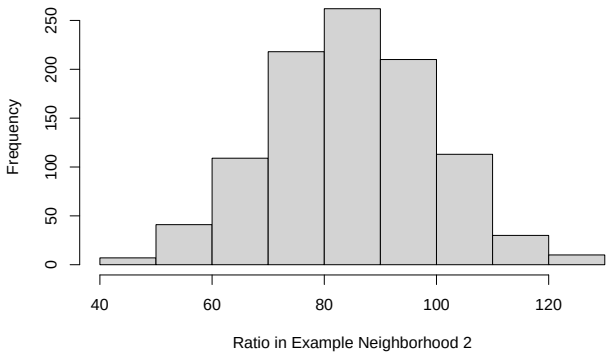


Figure 10 C: Ratios of Example Neighborhood 1&2

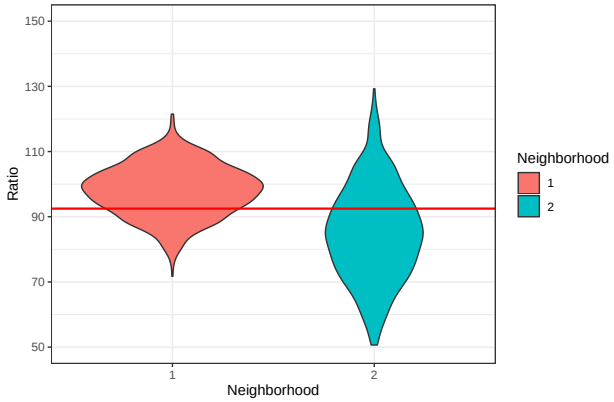
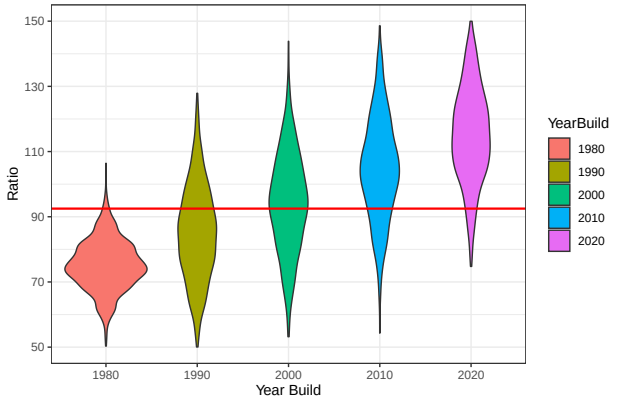


Figure 10 D: Example Parcel Ratios By Year Built



In Figures 11-16, each shape represents the distribution of the Ratio by characteristics and the shapes get wider where the ratio for more parcels exist. For example, in Figure 16, all of the shapes are widest between 85 and 100 which indicates that the majority of the ratio observations were in range 85-100. In addition, the long thin sections of each shape indicate that observed values exist that are higher than 100 and lower than 85, but because the plots are thin in these ranges we can see there were not many values in the extreme ranges. In the graphs, the red horizontal line is a reference Ratio = 92.5.

If a particular characteristic was predictive of the ratio or an inequity existed, then a pattern would exist like in Figure 10 D. For the parcel characteristics of physical condition, land use code, class, number of stories, grade, and year built, all of the violin plots, Figures 11-16, suggest that there are no apparent trend or differences by these parcel characteristics. More specifically, each figure appears to be consistent and the distribution of ratios by each characteristic are very similar for each category within the characteristic. If the ratios were not equal or fair for a given characteristics the graph would be similar to Figure 10 D, where an apparent trend or difference is visually apparent.

Tables 1 - 4 provide summary information with numerical values by each physical condition. There does not appear to be any pattern for the additional characteristics. For example, the median ratio is 96.42 and 95.83 for Physical Conditions of Excellent and Unsound, respectively, whereas Good and Poor categories have a median ratio of approximately 92. If there was an inequity in physical condition then a consistent increase or decrease as the physical condition got better or worse would be present. The apparent lack of pattern in Tables 1-4 was also found in the violin plots, Figures 11-14.

Figure 11: Ratio by Physical Condition

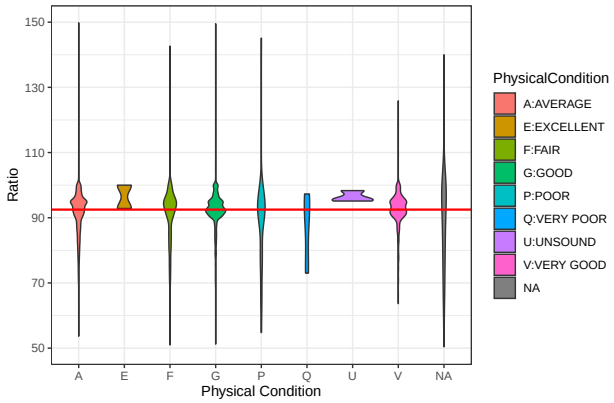


Figure 12: Ratio by Land Use Code

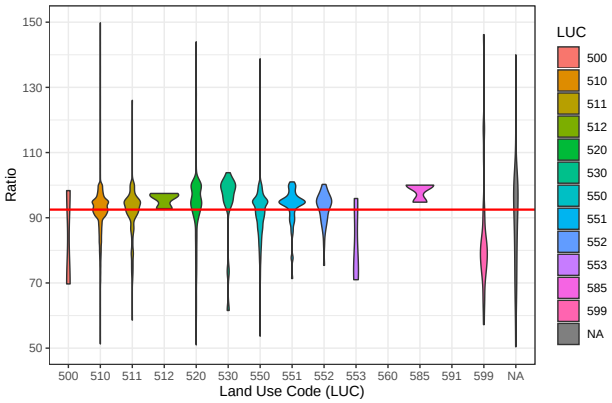


Figure 13: Ratio by Class

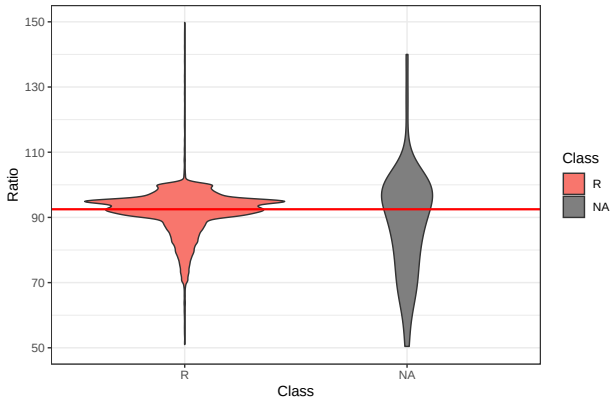


Figure 14: Ratio by Stories

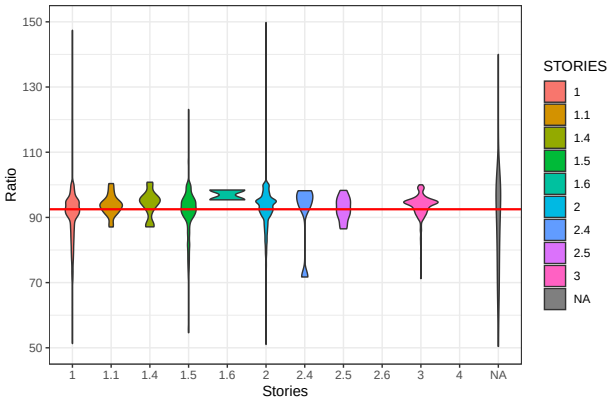


Figure 15: Ratio by Grade

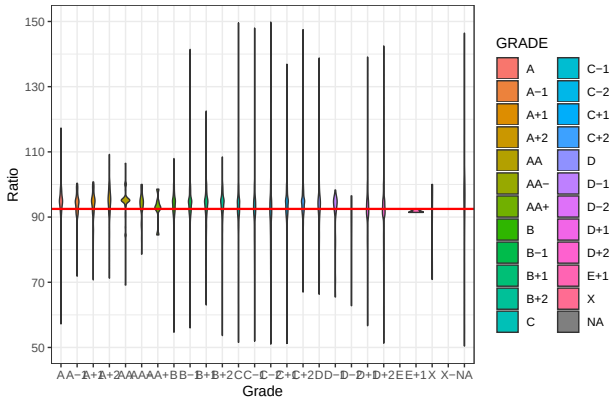


Figure 16: Ratio By Year Built

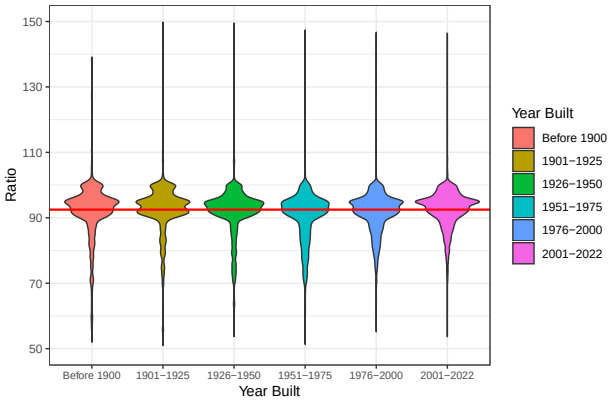


Table 1: Summary of Ratio By Physical Condition

PhysicalCondition	# Parcels	Median Ratio	Mean Ratio	Min Ratio	Max Ratio
E:EXCELLENT	2	96.42	96.42	92.85	100.00
U:UNSOUND	3	95.83	96.43	95.12	98.33
NA	5	94.86	90.01	79.82	97.97
F:FAIR	491	93.14	90.50	51.00	142.67
V:VERY GOOD	579	93.04	92.57	63.65	125.87
A:AVERAGE	13531	92.88	91.38	53.64	149.82
G:GOOD	4157	92.66	92.33	51.24	149.53
P:POOR	41	92.20	88.61	54.79	145.08
Q:VERY POOR	6	91.55	87.33	73.00	97.31

Table 2: Summary of Ratio By Land Use Codes

LUC	# Parcels	Median Ratio	Mean Ratio	Min Ratio	Max Ratio
585	3	100.00	98.26	94.78	100.00
530	15	99.96	94.40	61.55	103.83
512	3	96.53	95.59	92.80	97.46
520	497	94.93	93.47	51.00	143.99
551	66	94.84	93.65	71.36	101.00
552	40	94.76	92.92	75.40	100.24
560	1	94.57	94.57	94.57	94.57
511	350	93.06	91.49	58.59	126.02
510	14170	92.81	91.69	51.28	149.82
550	3630	92.41	90.99	53.64	138.80
500	2	84.02	84.02	69.70	98.33
599	29	79.90	83.81	57.22	146.17
553	8	77.47	82.09	70.99	95.90
591	1	55.14	55.14	55.14	55.14

Table 3: Summary of Ratio By Class

Class	# Parcels	Median Ratio	Mean Ratio	Min Ratio	Max Ratio
R	18815	92.82	91.59	51	149.82

Table 4: Summary of Ratio By Stories

STORIES	# Parcels	Median Ratio	Mean Ratio	Min Ratio	Max Ratio
1.6	2	96.90	96.90	95.40	98.41
4	1	95.37	95.37	95.37	95.37
1.4	15	95.15	94.15	87.10	100.80
2.4	5	95.01	90.97	71.72	98.19
3	181	94.40	93.63	71.24	100.00
1.1	21	93.77	93.76	87.06	100.39
2	10123	93.51	92.50	51.00	149.82
1.5	447	92.62	91.25	54.64	123.12
2.5	16	92.59	92.63	86.50	98.29
1	8003	91.99	90.42	51.28	147.42
2.6	1	70.21	70.21	70.21	70.21

Report Summary

This report analyzes the data by parcel, neighborhood, and temporary neighborhood as well as other characteristics. Based on the analysis in this report there appears to be a very small increase in ratio as the value increases. This means that the lower valued parcels tend to have a lower ratio, about 91, whereas higher values parcels have a higher ratio, e.g. 94-95. Overall, the appraisal seems to be consistent across the value range as some fluctuation is expected.

The slight increase is shown by the slightly increasing red line in Figures 2 and 3 when the data was analyzed by parcel which was in alignment with a small PRB of 0.99% when the values doubled. This was demonstrated again in Figures 5 and 6 by the slightly increasing blue line and PRB of 0.94% when analyzed by neighborhood. Similar results where obtained when analyzed by temporary neighborhoods, Figures 8 and 9, and PRB estimate of 0.98%.

References

1. Standard on Ratio Studies, A Criterion for Measuring Fairness, Quality, Equity and Accuracy. (2013). Available at https://www.iaao.org/media/standards/Standard_on_Ratio_Studies.pdf

For specific topics, the following links can be used to find more details in reference 1.

The Coefficient of Dispersion is computed using the method described on page 13 of https://www.iaao.org/media/standards/Standard_on_Ratio_Studies.pdf#page=14

Price Related Bias (PRB): The coefficient of price-related bias(PRB) is an index of vertical equity that quantifies the relationship between assessment-sales ratio and the value in percentage terms. This computed using the method starting on page 56 of https://www.iaao.org/media/standards/Standard_on_Ratio_Studies.pdf#page=57