Assessment Persistence

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Abstract

An analysis of residential assessment ratios in Cook County, Illinois for 1976 - 2020 suggests that unusually low and high assessment ratios display only a modest amount of persistence over time. Mean and median assessment rates were consistently lower than statutory rates throughout this time, apart from a short period during the Great Recessions. While low-priced properties tend to have higher assessment rates than high-priced homes, they also are much more variable. High assessment rates in one assessment year are frequently followed by lower rates for the same property in subsequent years.

1 Introduction

The property tax is remarkably unpopular despite being the primary source of revenue for local governments in much of the United States. This unpopularity has led to property tax limitation measures in nearly every state (Anderson (2006)). Property taxes can amount to thousands of dollars annually, and the payment structure – homeowners typically pay the tax in one or two large payments annually – assures that the tax is obvious and obtrusive (Cabral and Hoxby (2012)). Moreover, the basis for the tax is not directly observed for all but the small minority of properties that have recently been sold, and must instead be estimated by local assessment offices. The assessment process has the potential to introduce significant degrees of both horizontal and vertical inequity into the tax system (McMillen and Singh (2020)): if similar properties are assessed differently or if high-priced properties are assessed are lower rates than low-priced properties, then property taxes will reflect the same differences.

A long empirical literature documents the existence of significant variation in assessments for comparable properties and of a tendency toward lower assessment rates for high-priced properties. Examples include Amornsiripanitch (2021), Avenancio-León and Howard (forthcoming), Berry and Bednarz (1975), Berry (2021), Cheng (1974), Clapp (1990), Haurin (1988), Hodge et al. (2017) McMillen (2011), McMillen (2013), McMillen and Weber (2008), Paglin and Fogarty (1972), Quintos (2020), Sirmans et al. (1995), and Sirmans et al. (2008). The systematic tendency toward vertical inequity also leads to a tendency toward higher assessment rates and, therefore, higher property tax rates for Black, Hispanic, and other demographic groups who have relatively low incomes that lead them to purchase relatively low-priced homes. This tendency, though long-established in the literature (e.g., Baar (1981) and the citations therein), has recently received a great deal of publicity due to media coverage of the study by Avenancio-León and Howard (forthcoming), who argue that "within the same tax jurisdiction, black and Hispanic homeowners bear a 10-13% higher property tax burden than white homeowners" (p. 1).

A critical point that has been neglected in the literature is that the procedure used to measure regressivity may itself be biased toward regressivity. McMillen and Singh (2021) show that standard regression methods such as regressing assessed values on sales prices can mechanically produce a finding of regressivity. The importance of this bias is demonstrated in the study by Amornsiripanitch (2021), who finds that approximately 75% of the measured regressivity in his sample is associated with attenuation bias when regressivity is measured using a regression of the log of the assessment ratio (the assessed value divided by the sale price) on sale price. When a regression has sale price as the explanatory variable and sale price also serves as the denominator for the dependent variable, the estimates are very likely to indicate that assessment ratios decline with the sale price.

While early studies focused on a single jurisdiction, more recent studies have taken advantage of data providers such as CoreLogic to analyze multiple jurisdictions. Multi-jurisdiction studies include Amornsiripanitch (2021), Avenancio-León and Howard (forthcoming), Berry (2021), McMillen and Singh (2020), and McMillen and Singh (2021). Although having data from multiple jurisdictions has the advantage of establishing that patterns of horizontal and vertical inequity are not confined to one location, they suffer from the shortcoming that institutional details are ignored. The variation across the U.S. in statutory assessment rates and the timing of assessments is enormous. For example, Cook County, IL assesses properties every three years while neighboring DuPage County assesses properties every four years. All properties are supposed to be assessed at 1/3 of market value in DuPage County, while the statutory assessment rate differs for residential and non-residential properties in Cook County – 10% for residential and 25% for non-residential. Illinois is not unusual: state practices are reviewed in the Lincoln Institute of Land Policy online publication, "Significant Features of the Property Tax", and the variation is remarkable. Properties are supposed to be assessed at 100% of market value in Massachusetts, 35% in Ohio, and 19% in Missouri. Counties, municipalities, and even townships may be responsible for assessments, and some counties have multiple taxing authorities. The origination date of assessments is often not specified in large data sets provided by commercial providers, making the calculation of assessment ratios problematic in times when property values are rising or falling.

This study is the first to analyze changes in assessments for properties over multiple assessment cycles. Although regressivity in any assessment cycle causes undue financial burdens for owners of low-priced homes, the problem is more serious if assessment rates are persistent over time. Existing studies are essentially cross-sectional. While they indicate that assessments tend to be regressive at a given time (albeit using biased measures of regressivity), they provide no information on assessment persistence. High rates may be followed by lower rates in the following cycle if assessment offices attempt to correct mistakes, whether through appeals or simple updates to their models and data.

Our study takes advantage of two administrative data sets for Cook County, IL. The first includes all residential property sales for both Chicago and suburban Cook County for 1980 - 2021. This data set provides the sale price and date, along with the assessed value for the year prior to the year of sale. The data set allows us to analyze changes in assessment ratios for properties that sell more than once over the course of four decades. The second data set includes annual assessed values for all properties in the county for 1998 - 2020, whether the homes sell or not. We use this data set to determine whether rates of change in assessed values are lower for homes that had high assessment rates at the time of the last sale.

Our results indicate that assessment rates have consistently been lower than statutory rates in Cook County throughout this time, and have tended to decline over time, the main exception being a brief period during the Great Recession when assessments failed to keep up with the sharp decline in prices. While there is a tendency for low-priced homes to have higher assessment rates than high-priced properties, a more salient feature is the degree of variability in assessment rates for low-priced homes. However, assessments are not highly persistent over time. Properties with very high assessment rates are nearly as likely to have below-median rates in a subsequent assessment cycle as to have an above-median rate. In our repeat sales data set, the probability that a property falling in the highest group of assessment rates at the time of its first sale will continue to be in that category in the second sale is only about 27%. While nearly 40% of the properties in the lowest group of assessment ratios continue to fall in that category after the second sale, over 28% of them have above-median assessment rates in the later year. Assessments are persistent, but the degree of persistence is not high.

2 The Assessment System in Cook County

From 1960 to 1986, Cook County was divided into four assessment districts, with some townships in Chicago being combined with neighboring suburban townships (The Civic Federation (1997)). Each district was reassessed every four years. By 1990, the county was realigned into three districts – Chicago, the North Suburbs, and the South Suburbs. From 1987 - 1989 the townships were reassessed at various times to make the transition to the new three-year assessment cycle. Since then, the new assessment years for Chicago are in three-year intervals from 1991 to 2021. Assessments for the North Suburbs take place the following year, and South Suburban properties are assessed the year after that. To meet state requirements, the Cook County Assessor reports assessed values at the township level. There are 8 townships within Chicago, 13 in the North Suburbs, and 17 in the South Suburbs. The population of the county was 5.17 million in 2018, at which time there were approximately 1.86 million assessed properties. Chicago had 882,701 parcels in 2018, the North Suburbs had 454,079, and the South Suburbs had 526,709.

Cook County has a classified tax system that allows various classes of properties to be assessed at different statutory rates.[1] In 1974, the statutory rates were 22% for residential properties with 6 or fewer units (Class 2), 33% for residential properties with more units (Class 3, or "apartment"), and 40% for commercial and industrial properties (Class 5). Other classes at the time included Vacant land (Class 1, 22%) and Not-for-Profit (Class 4, 30%). More classes have been added and statutory rates have been lowered occasionally over time The Civic Federation (1997). After one year at 17% in 1976, the statutory rate for Class 2 residential properties remained at 16% from 1977 to 2008. Beginning in 2009, the statutory rate for Class 2 properties was reduced to 10%. Although rates varied more for other classes, they consistently were higher for apartments, commercial, and industrial properties. The rates were gradually reduced to 10% for apartments beginning in 2009 and to 25% in 2009 for commercial and industrial properties.[2] Since the tax rate is required to be equal across all classes, the statutory average property tax has consistently been higher for non-residential properties than for residential throughout this time.

To this point, the description of Cook County's assessment system could apply to other states with classified property tax systems in which statutory assessment rates vary by property class. A quirk of Illinois' system is that the total assessed value across all properties in a county must equal 1/3 of the total market value (as estimated by the assessors). An "equalization factor" (or "multiplier") is applied to the assessment to

[1] The system is discussed in The Civic Federation (2010). The Illinois Constitution allows counties with more than 200,000 residents to adopt a classified system. To date, only Cook County has chosen to do so. All other counties in the state have statutory assessment rates of 1/3.

[2] The 2.5 to 1 ratio is not an accident: it is the maximum ratio permitted by the Illinois Constitution between the class with the largest and smallest statutory tax rate.

produce an "equalized assessment" that assures that this constraint holds. The equalization factors, which are produced annually by the IDOR, typically equal 1 in the 101 counties that assess properties reasonably accurately at 1/3 of market value. The equalization factor must be greater than 1 in Cook County because residential property, which is the largest portion of the assessment roll, lowers the average by being assessed at rates far below 1/3 of market value. In 2020, the equalization factor was 3.2234 in Cook County, up from 2.9160 in 2019.

The final item needed to calculate the basis for a property's tax base is the homestead exemption. While homestead exemptions can vary across households, most homeowners file for the standard exemption, which currently is $10,000 in Cook County.[3] The same tax rate then applies to all properties within a tax jurisdiction (and the number of tax jurisdictions within the Chicago metropolitan area is second only to the New York area).

Letting t represent the tax rate, A the assessed value, m the equalization factor, and E the exemption, a homeowner's tax is a simple linear function of assessed value when the equalized assessed value is greater than the exemption: $T = max(t(mA - E), 0)$. If properties are assessed at the statutory rate, r, this expression is also a piecewise linear function of market value, P: $T = max(t(mrP - E), 0)$. The effective tax rate, ETR, is a declining function of market value due to the exemption: $ETR = T/P = max(t(mr - E/P), 0)$. However, McMillen and Singh (2020) find that the pattern of assessment regressivity is sufficient in Cook County to reverse this statutory progressivity: since the assessment ratio is very high at low values of P, the ETR is higher for these properties than for low-priced properties.

Although the measures commonly used to evaluate assessments are biased toward a finding of regressivity, the pattern is nonetheless well documented in a host of studies over time, including the recent studies by Amornsiripanitch (2021), Avenancio-León and Howard (forthcoming), Berry (2021), McMillen and Singh (2020), and McMillen and Singh (2021). However, the pattern is only pronounced at quite low sales prices – in the case of Cook County, at prices under about $80,000. As a result, the excess financial burden induced by regressivity could largely be eliminated by increasing the homestead exemption.

[3] Homeowners may qualify for additional exemptions if they are are 65 years or older, have a disability, are returning veterans, or have made improvements to their home that added to its value. Exemptions are only available to owners of Class 2 properties.

Most Class 2 residential properties are assessed using linear regressions.[4] Code provided by the Cook County Assessor's Offices for early 2000-2008 shows that the regressions are estimated using data from 5-7 years prior to the January 1 assessment date. The dependent variable is the nominal sale price, which always enters in linear form. The regressions are typically estimated separately for each township for which properties are being reassessed, although smaller townships are sometimes combined with neighbors to increase the sample size. The explanatory variables include various structural characteristics such as square footage and the number of rooms, along with the lot size, controls for the sale date, and controls for neighborhoods that are defined by the Assessor's Office. An elaborate set of interactions between the explanatory variables is included, with the final set being chosen using a stepwise regression procedure.

The predicted values from these regressions provide estimates of market values for the properties in this sales sample. A standard ratio analysis is then conducted for the properties that sold in the year prior to the assessment date. Since the statutory assessment rate was 0.16 during this time, the ratio analysis proceeds by comparing 16% of the predicted sale price to the actual sale price. However, the predicted sales prices are then debased using an "adjustment factor," which is used to assure that the median assessment ratio for the sample is 10% rather than the statutory rate of 16%. If the median assessment ratio as calculated using the unadjusted predicted values happens to be 16%, the adjustment factor will be 0.625. The assessed market values for these properties will be 62.5% of the predicted sale price, after which the final assessed value is 16% of this debased assessment of market value. The estimated coefficients and the adjustment factors are then applied to all properties in the sample area, including those that did not sell, to calculate the assessed values for all properties.

Although this debasement of the estimates of market value violated Illinois statutes, it accomplished the intended purpose of producing median nominal assessment ratios of 10% for the specific sample of properties that sold in the year prior to the assessment year. Actual median assessment ratios would then typically be lower than this rate because, among other factors, subsequent appeals lead to reductions in some assessments.

While this procedure assured that median assessment ratios would be closer to 10% than the statutory rate of 16%, there is nothing in the procedure that would appear at first

[4] The major exception is minor class 299, which comprises condominiums.

glance to produce a systematic bias toward higher assessments for low-priced properties. The regressions produce reasonably high values for the R^2, and there is no explicit reference to low or high prices anywhere in the computer code apart from a tendency to drop very high and very low prices from the regressions. However, McMillen and Singh (2021) show even unbiased regressions produce high assessment ratios for very low-priced properties, and this problem is likely exacerbated by the fact that the small number of sales that often exists in low-priced areas makes it more likely that they will be combined with sales from neighboring high-priced areas to provide reasonably large samples. If the controls for location are inadequate, market values are likely to be over-predicted for low-priced homes beyond the degree caused mechanically by linear regressions.

The assessment procedure also has implications for the persistence of assessment rates over time. If important structural characteristics are unobserved or recorded inaccurately in one assessment period, they are likely to continue to be missing or incorrect in later years. However, mitigating this tendency is the fact that the Assessor's Office recalculates the regressions every three years and occasionally even redefines the neighborhoods.

3 Data

Our primary data source is the Illinois Department of Revenue (IDOR), which conducts annual reviews of assessment practices for every assessment office in the state. Sellers are required by law to report the sale price of properties in order to transfer the deed from the seller to the buyer. In addition to the sale price and date, the declaration includes information that allows the IDOR to determine whether the sale is considered to be arm's length and suitable for inclusion in a ratio study (International Association of Assessing Officers (2017)), e.g., whether the buyer and seller are related; if the sale was ordered by a court, was a foreclosure or a condemnation; or if one of the parties to a sale included an auction, relocation company, or a financial institution. The type of deed is also recorded. Importantly for our purposes, the IDOR adds information on the assessed value from the year prior to the year of sale. Together, the IDOR data file provides the data necessary to conduct a thorough analysis of residential assessments for sales taking place between January 1980 and June 2021.

Our second data set includes annual assessed values for every property in the county for

1998 - 2020. This data set allows us to construct an unbalanced panel tracking individual properties across years. Since the triennial assessment system means that assessed values typically remain the same for three years, we restrict the data set to properties that have been newly assessed in a given year. For example, the assessed values observed in 1998 are all in the South Suburbs, while observations for 1999 are in the North Suburbs, and observations for 2000 in Chicago. Lagged values of assessments are from three years prior to an assessment year.

We restrict the sample to Class 2 residential properties. In the case of repeat sales, we restrict the sample to properties that remain in the same class over time. We use the IDOR data to drop observations that may not be arm's length sales that are reflective of current market conditions, following which we use a standard nonparametric trimming procedure to drop sales with outlier ratios (International Association of Assessing Officers (2017)).

Most academic studies of assessment ratios fail to address the issue of the timing of the assessment cycle. In times of rising prices, failing to adjust the sale price for the time between the assessment and the sale will cause assessment ratios to be biased downward. Since the origination date of the assessments is January 1 of the year prior to the year of sale in our IDOR data set, the time between a sale and the assessment date can be as large as 24 months. This problem is exacerbated by the fact that the assessments themselves may have been put in place one or two years before the nominal assessment date, making the time between the sale of the property and the actual origination date of the assessment as long as four years.

Since our IDOR data set includes all Class 2 sales in the county, we have the information needed to estimate a price index that is specific to Cook County. After dropping observations that have undergone major renovations over time (or demolitions followed by new construction), we use a standard Case-Shiller (Case and Shiller (1989)) methodology to construct the index using the set of homes that sold at least twice over the 1980-2021 period.[5] We then use the price index to adjust the time of sale for all observations in our two data sets to the origination date of the assessment, taking into account the variations of the

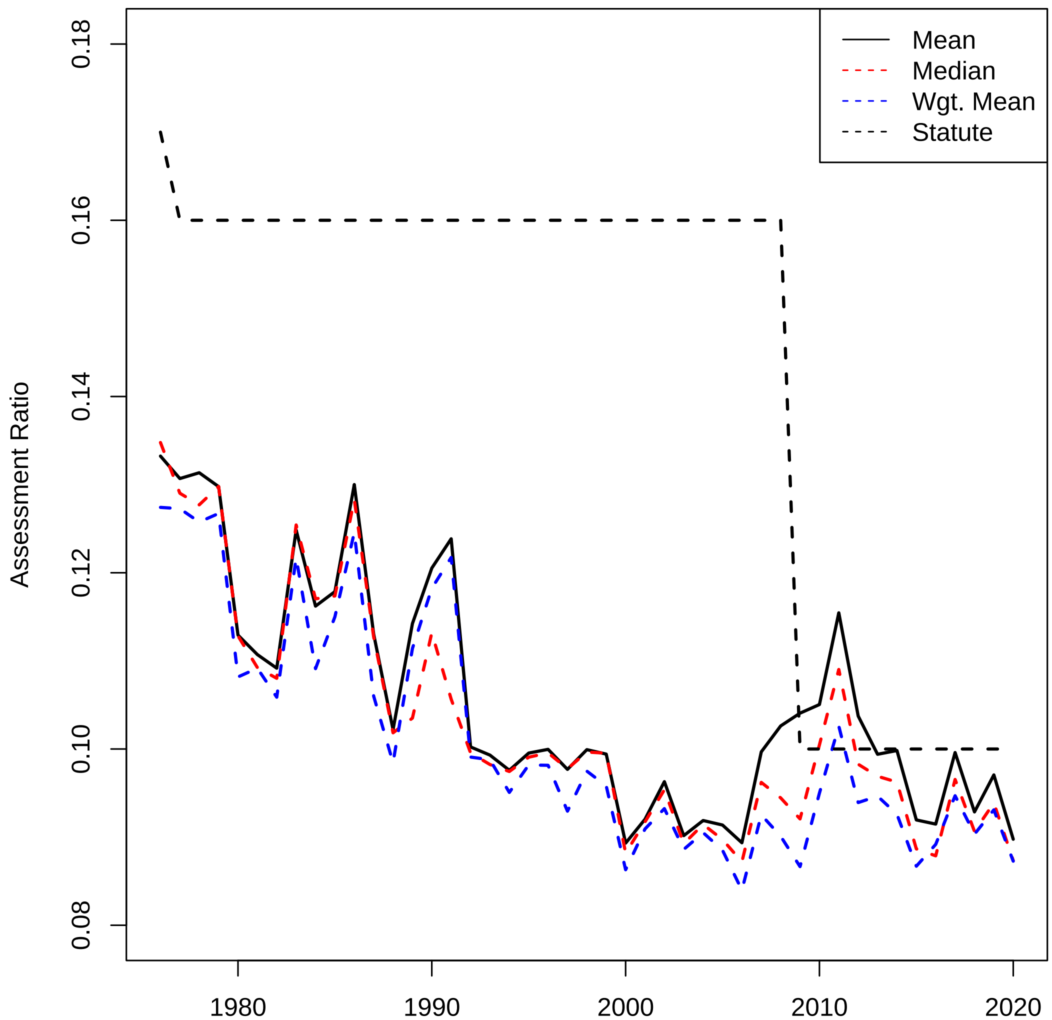
[5] Given the long time period, we restrict the sample of repeat sales to pairs for which the time between the two sales is no longer than 15 years. The price index is estimated using quarters as the unit of time, and the estimates are interpolated to form a monthly index.

assessment cycle across townships over 1980-2021. The base for the price index is January 2000. Since properties were reassessed every four years up to 1987 and the assessed values in the IDOR data set date from the year prior to the year of the sale, the origination dates of the assessments in the IDOR file range from 1976 to 2020.

4 Traditional Assessment Ratio Statistics

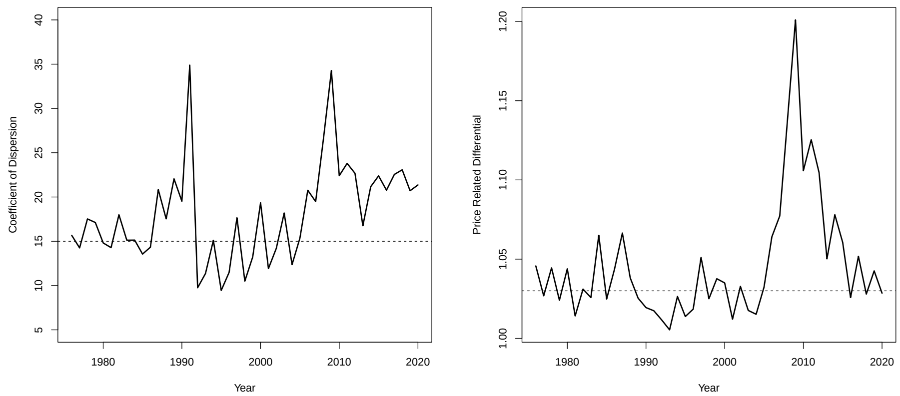
The International Association of Assessing Officers (IAAO) is a professional organization that promulgates standards for conducting studies of assessment performance (International Association of Assessing Officers (2017)). The traditional measures used to compare actual assessment ratios to statutory rates include the simple arithmetic mean, the median, and the value-weighted mean (i.e., weighting each ratio by the sale price). Figure 1 compares the path of these statistics over time to statutory assessment rates in Cook County for the IDOR data set. Actual rates are well below statutory rates for all but the time immediately following the sharp reduction in the statutory rates in 2009. Whether the increase during this time is due to a change in assessment policy or simply an artifact of the large decline in sales prices during the Great Recession is unclear. The trend toward a gradual downward drift of assessment ratios that is evident prior to the Great Recession returns beginning about 2011.

Figure 1: Assessment Ratio Means, Medians, and Value-Weighted Means



The tendency toward lower than statutory assessment ratios is not unique to Cook County, but it also is not ubiquitous (e.g., McMillen and Singh (2021)). Note that the equalization factors for other counties in Illinois would exceed 1 if properties were systematically over-assessed, whereas they typically equal 1 for nearly every other county other than Cook. The tendency toward lower than statutory assessments is explained partly by the fact that our sample includes only post-appeal assessments. But as shown in McMillen (2013), appeals lead to a small reduction in average assessment ratios – far from the amount required to produce the discrepancy between actual and statutory rates shown in Figure 1. The systematic tendency toward low assessment rates is more likely the result of a purposeful policy on the part of the Cook County Assessors over time.

Figure 2: Coefficients of Dispersion and Price-Related Differential



(a) Coefficient of Dispersion **(b)** Price-Related Differential

The Cook County Assessor is an elected position, and research by Ross (2011) suggests that assessment rates tend to be lower when a county's assessor is elected rather than appointed. Far more voters own Class 2 residential properties than other property types, and low assessments may help to reduce the number of appeals.

Figure 2 shows the paths for two other statistics suggested by the IAAO for measuring assessment performance. The Coefficient of Dispersion (COD) measures the average absolute percentage difference between actual assessment ratios and the median value for the year. IAAO standards call for CODs below 15% for residential properties. The price-related differential, or PRD, is the ratio of the arithmetic mean to the value-weighted mean. IAAO standards call for a PRD between 0.98 to 1.03 for residential properties, with values in excess of 1.03 indicating that high-priced properties have lower assessment rates on average than low-priced properties. While Figure 1(a) shows that both the COD and the PRD for Cook County exceeded IAAO standards more often than not during this time, there are long periods when they meet or are close to IAAO standards. The main exceptions are the sharp rises near the 1990-1991 and 2007-2009 recessions. As measured by the PRD, assessment regressivity was an especially serious problem only during the Great Recession.[6]

Figure 3 presents kernel density estimates for assessment ratios for five periods defined roughly by the times served by the various assessors. Density functions provide a much

[6] The results in McMillen and Singh (2021) suggest that the PRD is much preferable to regression-based methods for evaluating assessment regressivity because it is subject to much lower bias.

more complete depiction of the accuracy of assessments than a small number of descriptive statistics (McMillen (2013), McMillen and Singh (2021)). The density functions show that assessment ratios were much more variable in 1978 - 1986 than in later periods, although the similarity of the peak of the function for 2011 - 2020 implies a return to a high degree of variability during this time. Ratios display the lowest degree of variability in 1998 - 2010, which also is the time with the lowest density of very high assessment ratios.

Figure 3: Assessment Ratio Kernel Densities, All Sales

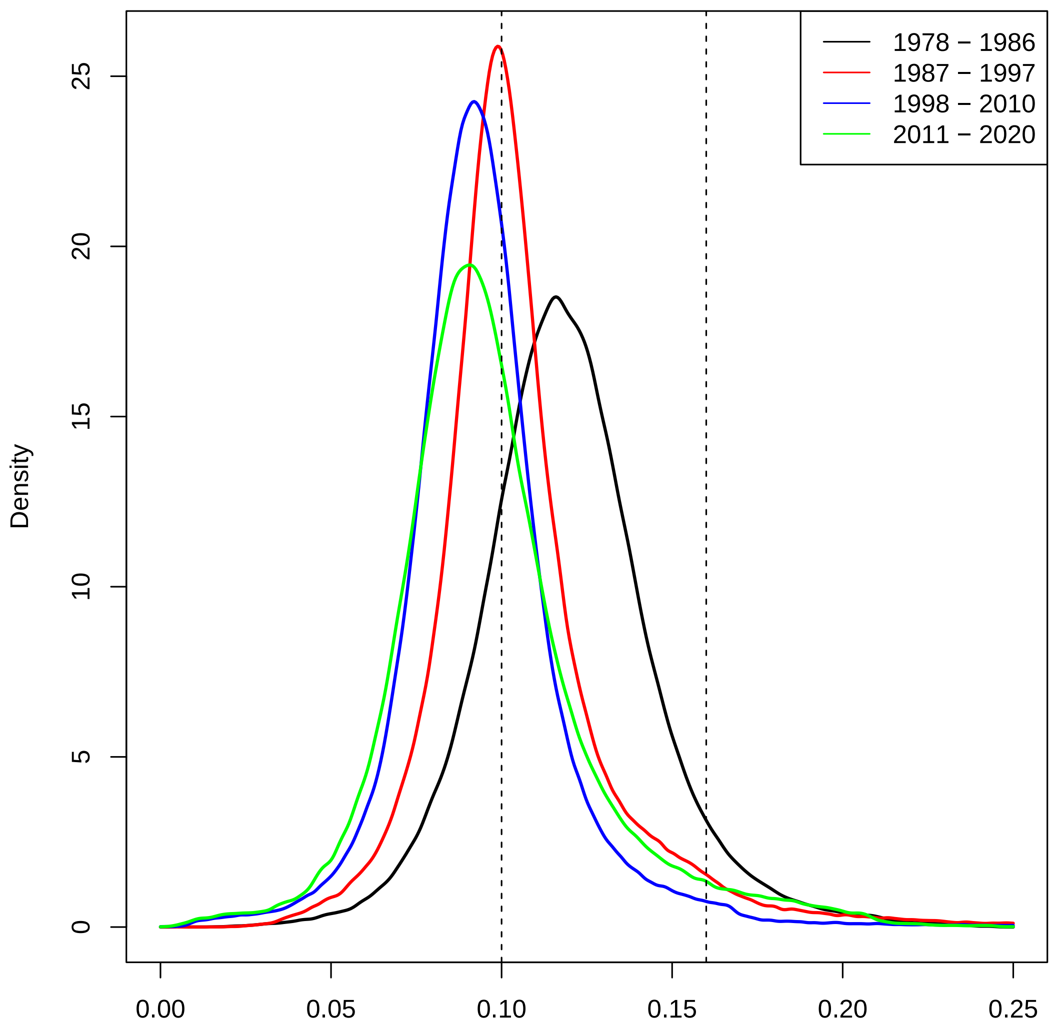
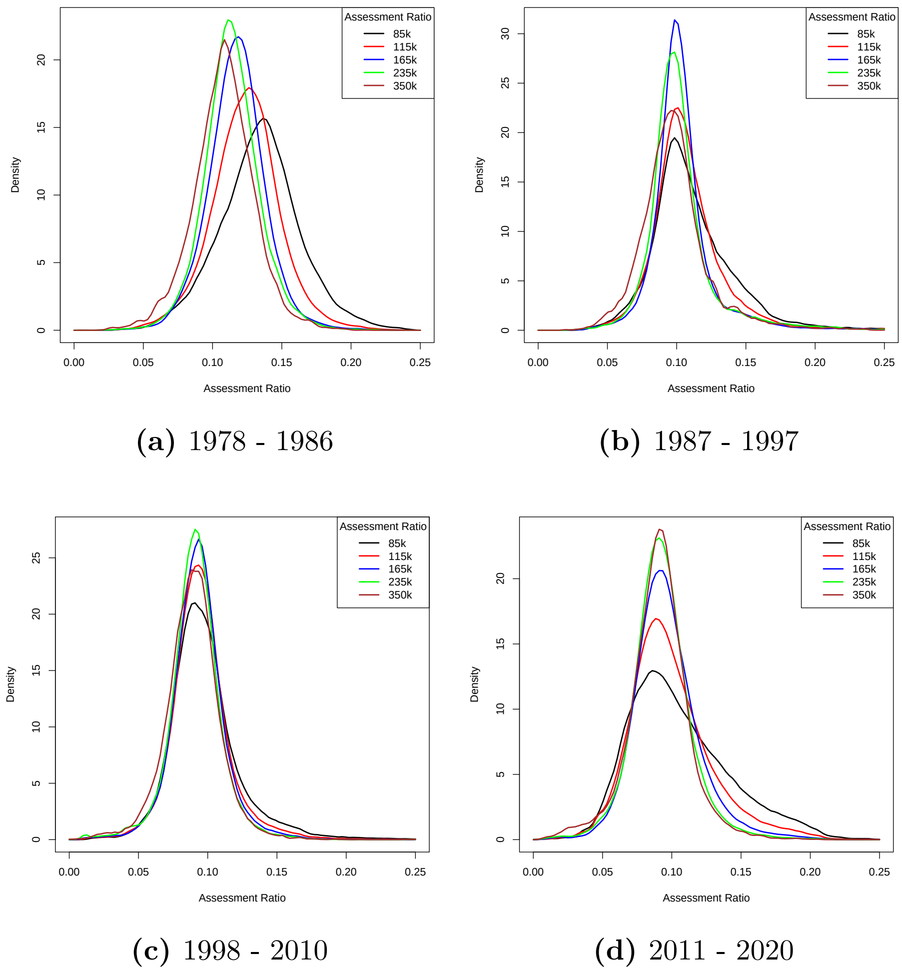


Figure 4 presents estimates of the density of assessment ratios conditional on the real sale price for the full sample and for various time periods.[7] The conditional densities for an

[7]Letting x represent the real sale price and y the assessment ratio, the kernel conditional density function estimate at $x = x_0$ and $y = y_0$ is $\frac{1}{nh_x h_y} \quad {}_i K(\frac{x_i - x_0}{h_x}) K(\frac{y_i - y_0}{h_y}) / f(x_0)$, where $f(x_0) =$

Figure 4: Assessment Ratio Densities Conditional on Real Sales Prices



(a) 1978 - 1986

(b) 1987 - 1997

(c) 1998 - 2010

(d) 2011 - 2020

$85,000 home consistently have a large right tail, and the variability of assessment ratios is clearly lower for higher-priced homes. The right tail shifts to the left as the price increases, and the degree of variability tends to be lower for homes with prices closer to the middle of the real sale price distribution. The degree of variability is consistently lower in 1998 - 2020 than during other time periods.

Despite some variation over this extended time period, several consistent patterns emerge. First, most assessment ratios are well below the statutory rate except during the time near the trough of the Great Recession. This pattern of under-assessment was clearly intentional during 2000 - 2008. Second, there is a clear tendency toward a gradual reduction

$\frac{1}{nh} \quad {}_i K(\frac{(x_i - x_0)}{h})$ We use a Gaussian kernel and a standard rule of thumb bandwidth (Henderson and Parmeter (2015)). We set x_0 to values close to the quintiles of the real sale price – 85,000, 115,000, 165,000, 235,000, and 350,000, while y_0 is set at 100 values ranging from 0 to 0.25.

of median assessment rates over time. Third, the degree of variability and the tendency toward regressivity appears to rise during recessions. Fourth, the tendency toward a large number of very high assessment rates is most pronounced for very low-priced properties. In general, there is significant variation in assessment rates for all property values.

5 Changes in Assessment Ratios Over Time

The major difficulty in determining whether assessment ratios are persistent over time is that they are only observed near the time when a property sells. The IDOR data set allows us to trace assessment ratios over time for homes that have sold at least twice over 1976 - 2020. To control for the fact that median ratios change over time and that there was a large decrease in the statutory rate in 2009, we conduct most of the analysis using ratios that have been normalized by calculating the percentage difference of each ratio from the median value for the origination year of the assessment. The medians are calculated using the full IDOR sample, including properties that only sold once. Over the full sample period of repeat sales, the average percentage difference of the assessment ratios from their yearly medians is 1.280% for the first sale and 0.514% for the second sale in a pair. The corresponding medians are -0.216% and -1.719%.

Table 1 presents a contingency table showing the degree of persistence of the percentage difference of assessment ratios from their medians across the first and second sale of a repeat sale pair. The six categories are based roughly on the quintiles of the percentage differences. The table shows the actual number in each cell, followed by the number that would be expected to occur if the transition from first-sale to second-sale cells were random, and then by the t-value for the difference between the two values (Agresti (2013)). Properties are always much less likely to fall in the same category in the second period than to move to a category with a higher or lower percentage difference. However, they are more likely to transition to one of the neighboring categories than to move to a much lower or much higher percentage difference. Focusing on the 112,358 properties with the highest assessment ratios in the first sale, only about a quarter (30,325, or 26.99%) remain in this highest category in the second sale. 19.22% fall into the 5% - 15% category for the second sale, while the percentages in the following four lower categories of ratio differences are 11.17%, 10.63%, 15.77%, and 16.21%. Fully 42.62% of the properties with percentage differences in the 15% - 80% range in the first sale have assessment ratios below the median in the second sale. Assessments are more persistent than would occur randomly, but there is a great deal of movement in assessment ratios over time.

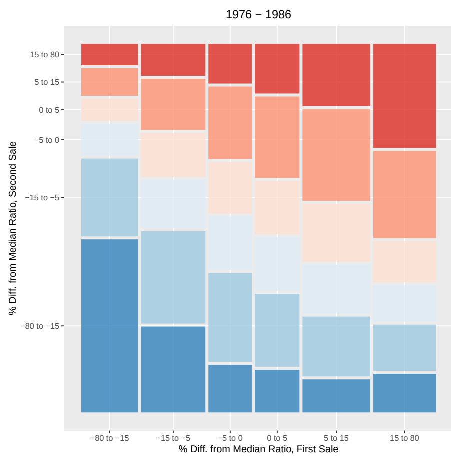
Table 1: Contingency Table for Percentage Difference from Median Assessment Ratio, Sale 1 v. Sale 2

First Sale	Second Sale						
	-80 to -15	-15 to -5	-5 to 0	0 to 5	5 to 15	15 to 80	Sum
-80 to -15	44409	25060	11043	8712	10778	12657	112659
Exp. Num.	23945.62	23789.5	14292.41	13378.81	18487.5	18765.17	
T-Value	165.36	10.29	-32.28	-47.69	-68.82	-54.2	
-15 to -5	27044	30213	16454	14000	15975	14218	117904
Exp. Num.	25060.44	24897.05	14957.81	14001.68	19348.21	19638.8	
T-Value	15.75	42.32	14.61	-0.02	-29.59	-47.27	
-5 to 0	12684	17874	11354	10179	12736	10299	75126
Exp. Num.	15968	15863.89	9530.81	8921.58	12328.28	12513.44	
T-Value	-31.31	19.21	21.37	15.16	4.29	-23.18	
0 to 5	10772	15581	10903	10547	14238	11564	73605
Exp. Num.	15644.71	15542.71	9337.85	8740.96	12078.68	12260.09	
T-Value	-46.87	0.37	18.51	21.97	22.94	-7.35	
5 to 15	14333	20181	14377	15223	23084	20822	108020
Exp. Num.	22959.6	22809.91	13703.89	12827.91	17726.23	17992.47	
T-Value	-70.86	-21.64	6.8	24.88	48.61	25.52	
15 to 80	18218	17720	11946	12553	21596	30325	112358
Exp. Num.	23881.64	23725.94	14254.22	13343.07	18438.1	18715.03	
T-Value	-45.81	-48.7	-22.95	-8.08	28.22	103.12	
Sum	127460	126629	76077	71214	98407	99885	599672

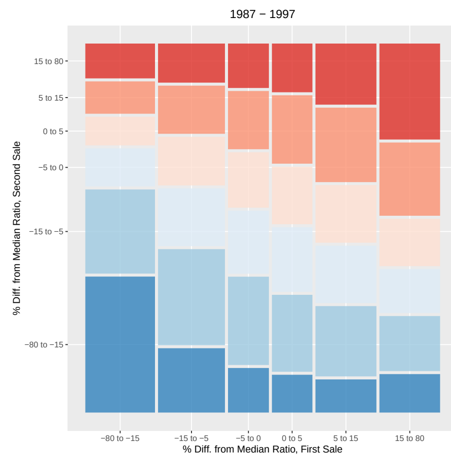
Figure 5 shows similar information in the form of a mosaic plot. The categories are the same as in Table 1, but the four panels of the plot show how the transition probabilities vary over time. The width of the columns is proportional to the number of properties falling in each category in the first sale (the widths are all roughly the same because the definition of the categories is based on quintiles), and the height of the cells reflects the percentage of the properties in that column that fall into the category indicated for the second sale. The figure provides a clear picture of the degree to which properties are likely to fall in different categories of assessment ratio differences in the second sale than in the first. It also is clear that there is not a sharp change in the transition probability across the four time periods: assessments are persistent, but not highly so.

Figure 6 shows a contour plot of estimated kernel bivariate density functions for the percentage differences of the assessment ratios from their median in the first sale v.

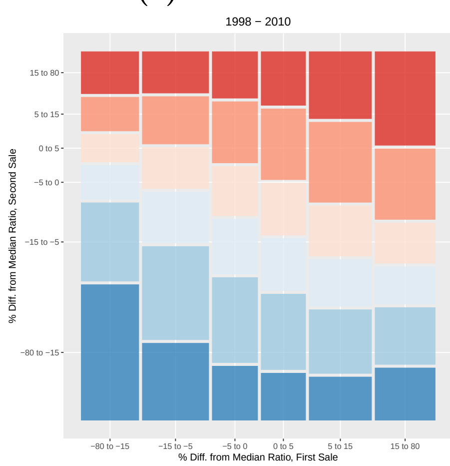
Figure 5: Mosaic Plots for Percentage Difference from Median Ratio, Sale 1 v. Sale 2



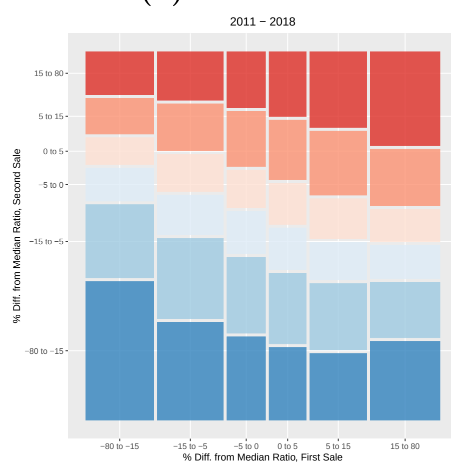
(a) 1978 - 1986



(b) 1987 - 1997



(c) 1998 - 2010



(d) 2011 - 2020

the second sale. The highest densities are in a small region near the (0,0) origin. The upward slope of the contours is evidence of some persistence in assessment ratios: very low assessment ratios in the first sale are also relatively likely to be followed by low ratios in the second sale, and high assessment ratios in the first sale are also relatively likely to be followed by high ratios in the second sale.

Figure 6: Bivariate Densities for Percentage Difference from Median in Assessment Year, Sale 1 v. Sale 2

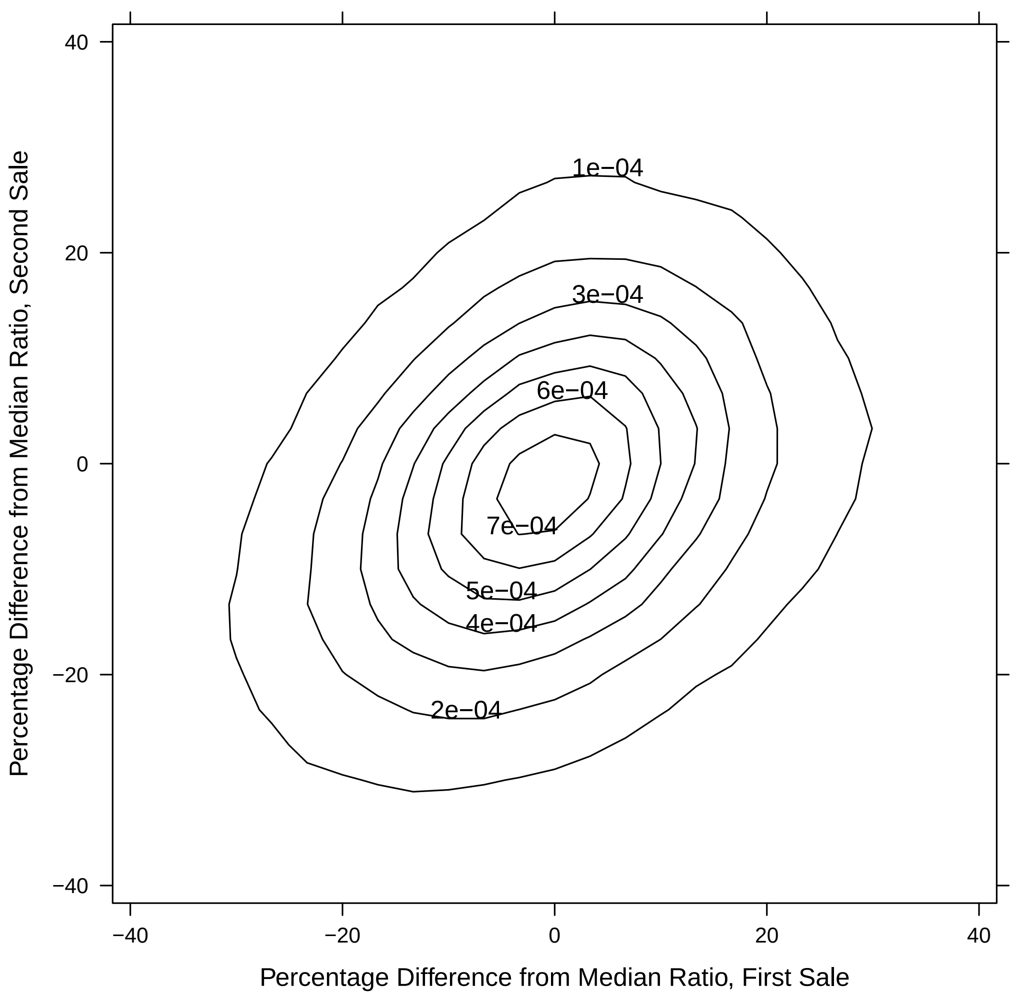


Figure 7 presents similar evidence of assessment persistence. The figure shows conditional density functions for the percentage difference of assessment ratios from their median level in the second sale conditional on the percentage difference being -25%, -10%, 0, 10%, or 25% for the first sale. Properties with very low percentage differences (-25%) in the first sale are also relatively like to have low assessment ratios in the second sale. Similarly, properties with very high percentage differences (25%) in the first sale are also relatively likely to have high assessment ratios in the second sale. The variance of second-sale percentage differences is much higher when the absolute percentage difference is very high in the first sale: the density functions for second-sale values are more tightly clustered around 0 when the first-sale percentage differences are equal to -10%, 0, or 10%. There is a great deal of overlap across all five conditional density functions, with a large number of both positive and negative percentage differences regardless of the value in the first sale.

Figure 7: Densities for the Percentage Difference from Median Assessment Ratio in Sale 2 Assessment Year Conditional on the Sale 1 Percentage Difference

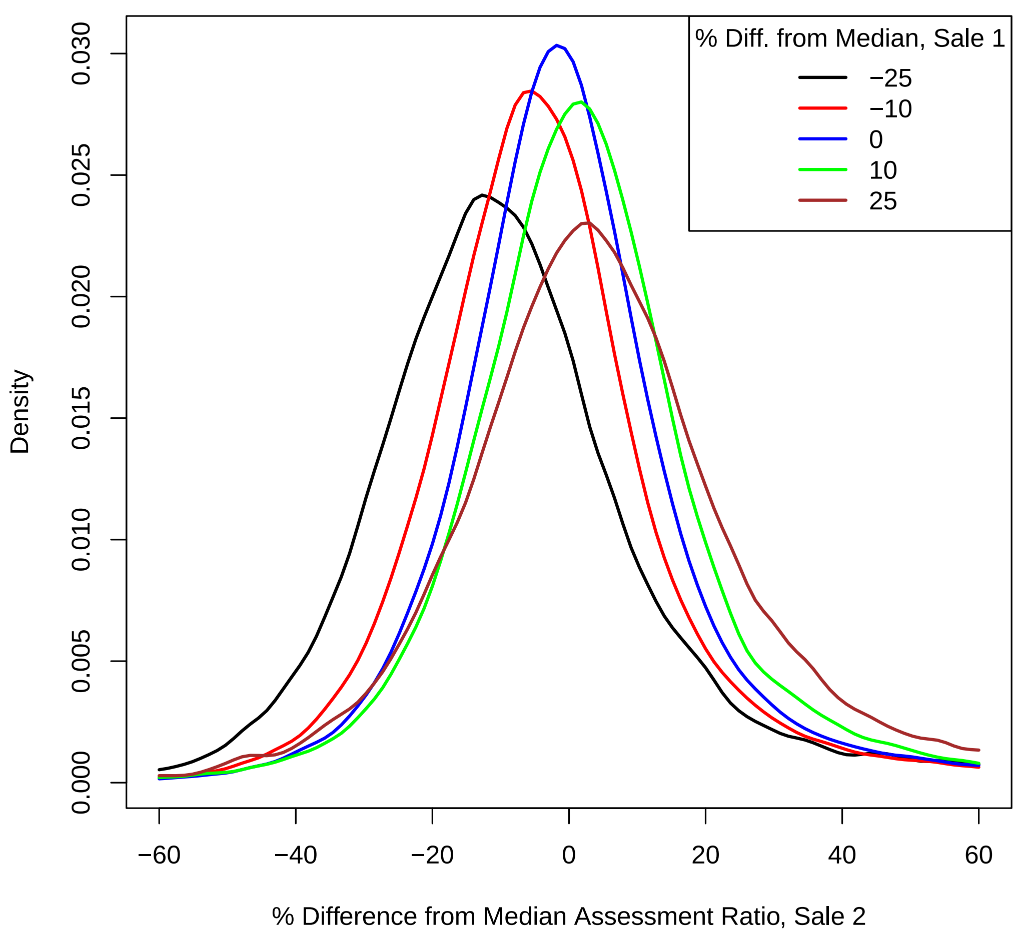


Figure 8 presents comparable conditional density functions when the conditioning variable is the real sale price for the first sale rather than the first-sale percentage difference of the property's assessment ratio from the median. We showed in the previous section that low-priced properties are more likely to have very high assessment ratios than low-priced homes. Figure 8 shows that a property with a very low real sale price ($85,000) at the time of the first sale is actually more likely to have a relatively low assessment ratio at the time of the second sale than are higher priced properties. However, these properties are also relatively more likely to have very high assessment ratios at the time of the second sale. In others words, the variability of second-sale assessments is much higher for $85,000 homes than for more expensive properties. The distribution of percentage differences from median second-sale ratios tends to peak near zero for homes with higher first-sale prices, and the variability of the differences is lowest for homes with first-sale real sales prices of $165,000 or $235,000. Overall, Figure 8 suggests that the rate of persistence of assessment ratios is not highly correlated with sale price: low-priced homes may be more likely to have high assessment ratios at a point in time, but they are not more likely than a comparably over-assessed high-priced home to have high assessment ratios in later years.

Figure 8: Densities for the Percentage Difference from Median Assessment Ratio in Sale 2 Assessment Year Conditional on the Sale 1 Real Sale Price

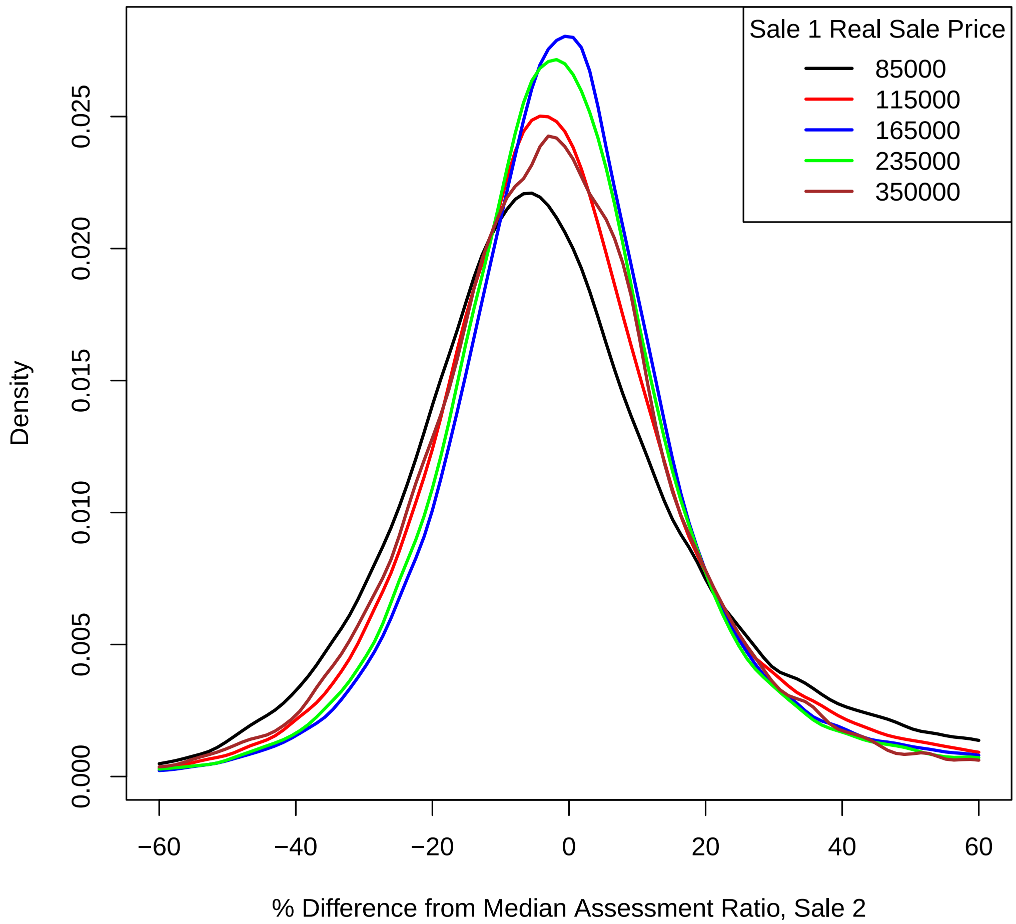


Table 2 presents the results of regressions that summarize much of the information presented in the figure. The dependent variable is the percentage difference of the second-sale assessment ratios from the median in their assessment year, and the primary explanatory variables is the comparable variable for the first sale. The typical estimated coefficient is in the 0.20 - 0.25 range when no additional controls are included in the regression, which is far below the value of 1 that would be expected if assessment ratios did not change over time. The R^2 for this regression indicates that only 6.67% of the variation in the second-sale assessment ratios are explained by the first-sale values. The R^2 rises but there is little change in the estimated coefficients when controls are added for the origination year of the assessments. The R^2 rises only to 0.2087 when census tract fixed effects are included in the regression, while the estimated coefficients decline to still lower values.

Table 2: Estimated Regression Coefficients for Sale 1 Difference of Assessment Ratio from the Median

Sample	(1)	(2)	(3)
All Observations (n = 599,672)	0.2155	0.2146	0.1712
s.e.	0.0013	0.0013	0.0013
R^2	0.0460	0.0504	0.0895
Sale 1 Real Price Under 85k (n = 47,291)	0.1350	0.1379	0.0816
s.e.	0.0044	0.0044	0.0046
R^2	0.0191	0.0843	0.1829
Sale 1 Real Price 85k to 115k (n = 81,637)	0.2126	0.2147	0.1720
s.e.	0.0035	0.0035	0.0039
R^2	0.0424	0.0733	0.1377
Sale 1 Real Price 115k to 165k (n = 165,826)	0.2385	0.2401	0.1938
s.e.	0.0025	0.0026	0.0028
R^2	0.0501	0.0701	0.1231
Sale 1 Real Price 165k to 235k (n = 156,856)	0.2565	0.2544	0.2168
s.e.	0.0026	0.0027	0.0028
R^2	0.0568	0.0651	0.1194
Sale 1 Real Price 235k to 350k (n = 92,552)	0.2669	0.2708	0.2361
s.e.	0.0033	0.0033	0.0034
R^2	0.0671	0.0960	0.1525
Sale 1 Real Price Over 350k (n = 55,410)	0.2495	0.2575	0.2164
s.e.	0.0040	0.0039	0.0040
R^2	0.0667	0.1508	0.2087
Controls	None	Assessment Year	Assessment Year and Census Tract

Note. The dependent variable is the percentage difference of the sale 2 assessment ratio from the median. The regressions in (2) and (3) include controls for the assessment year of the second sale. The column (3) regression also includes controls for the census tract.

6 Panel Data, 1998 - 2020

Our second data set allows us to analyze changes in assessed values for properties that do not sell more than once as well as for repeat sales. The panel data sets includes triennial assessments for Class 2 residential properties for each assessment cycle for 1998 - 2021. The main question addressed in this section is whether changes in assessed values are higher for properties that previously had high assessment ratios. We combine the observations for which no assessment ratios are observed with the observations that have sold, and calculate the change in the natural log of assessed values for all properties over the three-year assessment cycle.

Figures 9 and 10 show the plots of the traditional statistics over time for the panel data set. These figures are directly comparable to Figures 1 and 2. The results show again that assessments were far below their statutory rate prior to 2009, and subsequently drifted down again after the change to an official rate of 10% had been in place for some time. The ratchet pattern evident in Figure 10 is a result of the triennial assessment system: Chicago consistently has higher coefficients of dispersion and price-related differentials than the suburbs.

Figure 9: Panel Data Set Assessment Ratio Means, Medians, and Value-Weighted Means

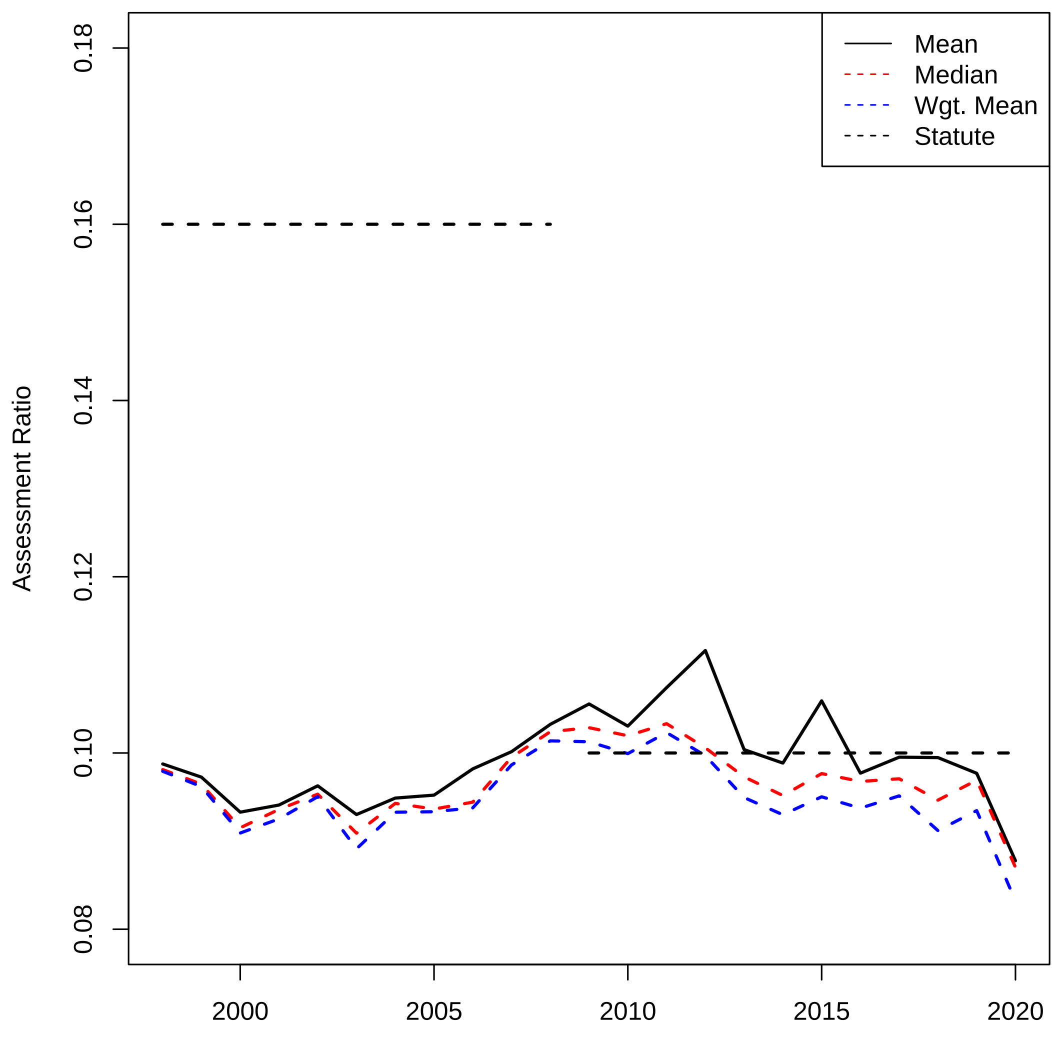
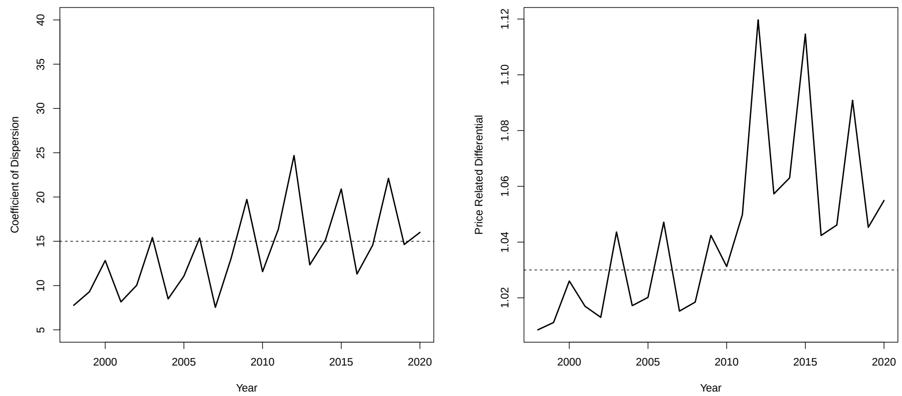


Figure 11 presents kernel density functions for the change in log assessed values between

Figure 10: Coefficients of Dispersion and Price-Related Differential



(a) Panel Data Set Coefficient of Dispersion

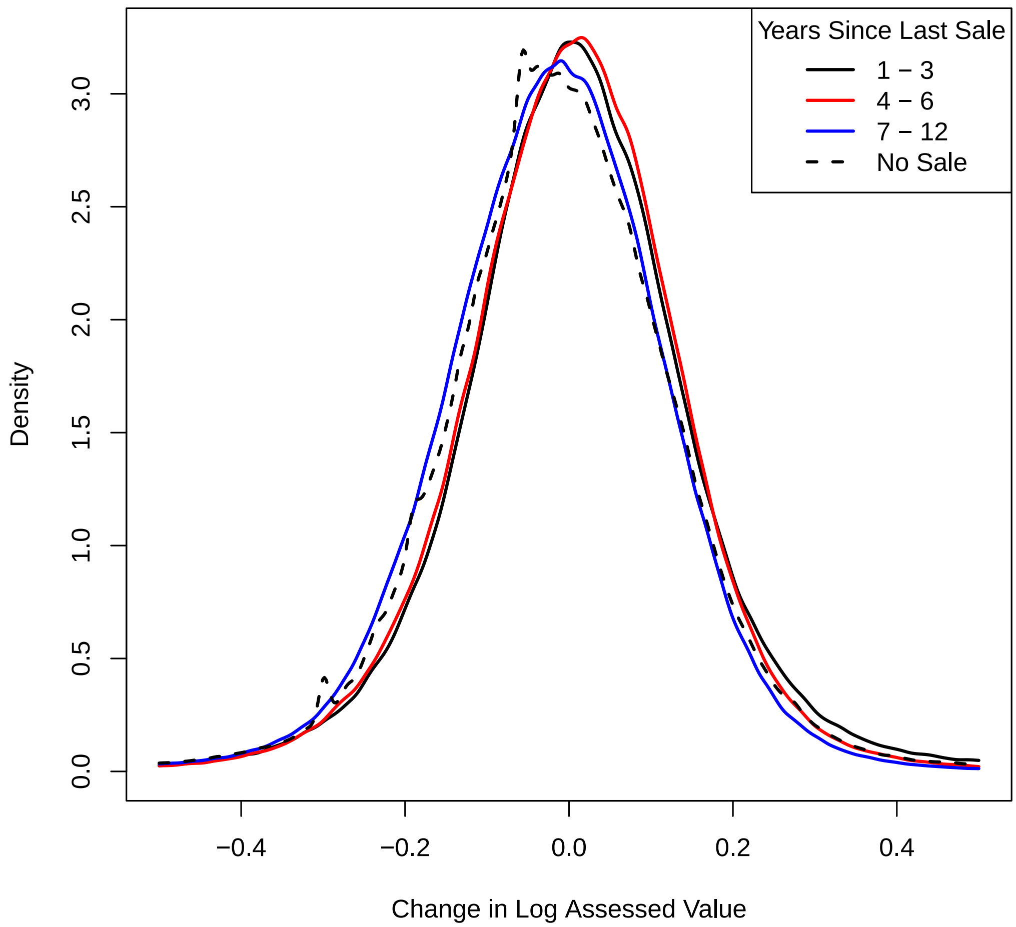
(b) Panel Data Set Price-Related Differential

assessment cycles (i.e., $\Delta ln(a_t) = ln(a_t) - ln(a_{t-3})$). All assessed values are adjusted for nominal price changes using the repeat sales price index. Having a sale within the last 1-3 years of the current assessment year implies that the home sold during the course of the most current assessment cycle, while a sale within the last 4-6 years means that the sale occurred between the times of the previous two assessment years. A kernel density function is also shown for homes that never sold over the 1998 - 2020 period covered in the panel data set. The kernel density function for sales dating more than 12 years before an assessment year is not shown because it cannot be distinguished from the "no sale" function.

The main thing to note from Figure 11 is that there is not a large difference between the density of assessed values depending on the time of the last sale. Since assessments are expressed in real terms, the density of differences in log assessed values is centered near 0. There is some tendency for a greater probability of real assessment decreases for homes that last sold more than two assessment cycles ago or not at all, but the differences are not pronounced. The main insight from the density functions is that home buyers do not appear to need to worry that their purchase of a home will automatically trigger an increase in its assessments in Cook County.[8]

[8] The density functions would clearly look much different in a states like California and Michigan that have binding limits on assessment increases.

Figure 11: Densities for Difference in Log Assessments by Years since Last Sale



The density functions look much different when they are calculated conditional on the percentage difference of the assessment ratio from its median at the time of the most recent sale. Figure 12 shows the conditional density functions of the log assessment changes conditional on differences from the median being -25%, -10%, 0, 10%, 25% at the time of the last sale. The density function of log assessment changes for homes that did sell during this period is also shown in the figure. Homes that were 25% below the median assessment level at the time of the last sale are much more likely to have very high changes in log assessed values than any other group. Similarly, homes that are 25% above the median assessment level at the time of the last sale are much more likely to have decreases in their real assessed values. The assessment changes for other categories, including homes that did not sell during the sample period, are more tightly clustered around a value of 0.

Figure 12: Densities for Difference in Log Assessments by % Difference of Assessment Ratio from Median at Time of Most Recent Sale

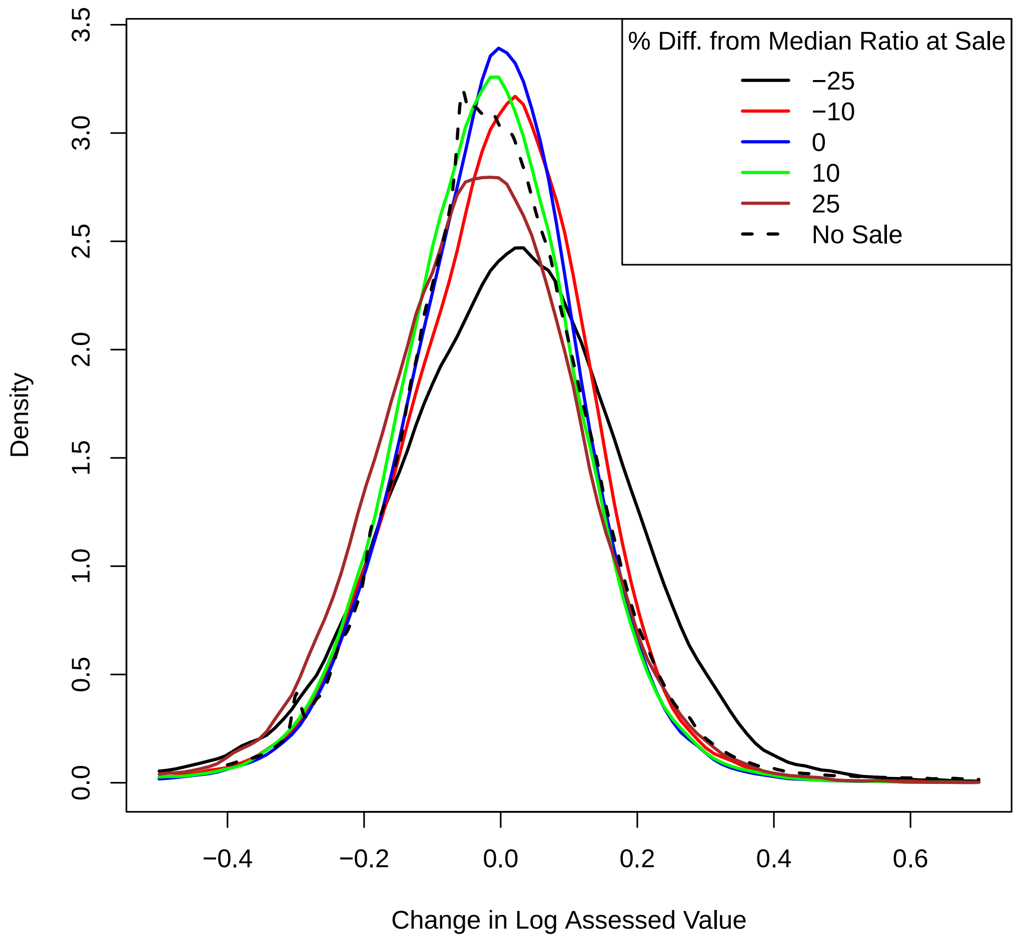


Figure 13 addresses the issue of regressivity by presenting kernel density estimates for properties whose real sale price at the last time of sale were in the lowest or high decile of real prices across the full sample period. The density function for the full sample is also shown. Very low-priced homes are much more likely to have decreases in their real assessed values than other properties. Very high-priced homes are somewhat more likely to have very high assessment increases than other properties, but overall the distribution of very high-priced homes is not much different from the distribution across the full sample.

Figure 13: Densities for Difference in Log Assessments by for Sales Prices in the Lowest and Highest Deciles

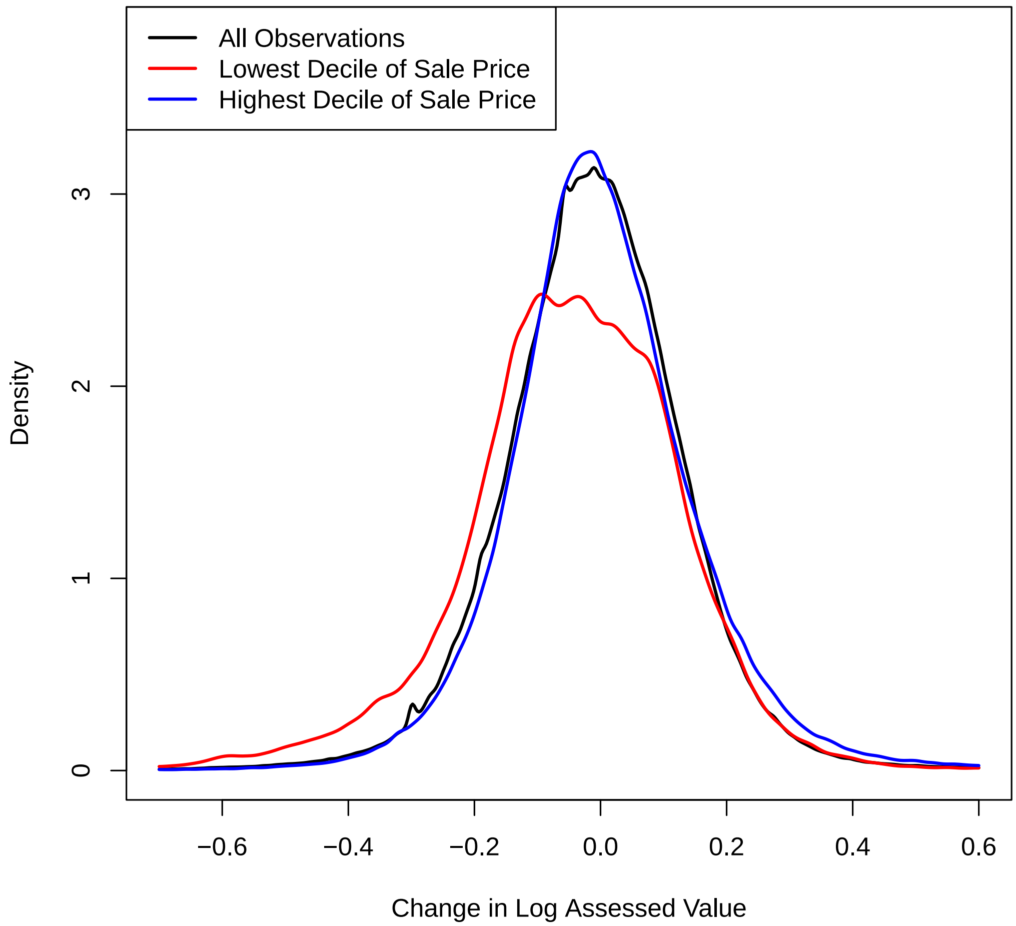


Table 3 presents the results of regressions that summarize the results shown in the figures. The dependent variable is the change in the log of the real assessed value across assessment years. All observations in the panel are included in the regressions. The explanatory variables listed in the table all equal zero for the base category, which comprises properties that did not sell during the sample period. Thus, the coefficients are interpreted as the difference in the change in log assessed value relative to a property that did not sell. Regression (1) implies that a home that sold 1-3 years prior to the new assessment year has a growth rate in real assessed value that is approximately 1.22% higher than a home that did not sell. This coefficient does not change greatly when new explanatory variables and census tract fixed effects are added. In contrast, a property that sold at times longer than 6 years before the new assessment year is estimated to have somewhat lower growth rates in assessed values than a no-sale property. This pattern implies that there is a slight upward adjustment in assessed values shortly after a sale, but then there is a readjustment downward.

The percentage difference between the assessment ratio at the time of sale enters the equations separately for positive and negative values. For homes that sold and had below-median assessment ratios at the time, smaller absolute differences in ratios are associated with higher growth rates in assessments. Similarly, for high assessment ratio properties, growth rates in assessments are estimated to decline as the percentage difference of the assessment ratio from its median increases. Homes with real sales prices in the lowest decile are estimated to have much lower growth rates in sales prices than no-sale homes, but this estimate drops in value and is statistically insignificant when census tract fixed effects are included in the regression. Homes in the highest decile of real sales prices are estimated to have higher growth rates in assessed values, but again the estimate is statistically insignificant (with a negative sign) after adding controls for census tracts.

Table 3: Regression Results for Change in Log Assessed Value

	(1)	(2)	(3)	(4)	(5)	(6)
Sale 1-3 Years Before Assessment	0.01222	0.014713	0.015152	0.0102	0.012674	0.013077
	(0.000244)	(0.000318)	(0.000321)	(0.000243)	(0.000316)	(0.00032)
Sale 4-6 Years Before Assessment	-0.009323	-0.007308	-0.006731	-0.010439	-0.008446	-0.008062
	(0.000257)	(0.000307)	(0.000309)	(0.000255)	(0.000305)	(0.000308)
Sale More than 6 Years Before Assessment	-0.005078	-0.004308	-0.003215	-0.004147	-0.003414	-0.003089
	(0.000147)	(0.00016)	(0.000163)	(0.000149)	(0.000162)	(0.000168)
% Difference of Ratio from Median, Difference < 0		0.012033	0.010945		0.008269	0.008411
		(0.000248)	(0.000248)		(0.000246)	(0.000246)
% Difference of Ratio from Median, Difference > 0		-0.017195	-0.014226		-0.013517	-0.0136
		(0.000248)	(0.000249)		(0.000246)	(0.000248)
Real Sale Price in Lowest Decile			-0.030591			-0.000281
			(0.00033)			(0.000359)
Real Sale Price in Highest Decile			0.012902			-0.003373
			(0.00031)			(0.000348)
R^2	0.160605	0.162306	0.163651	0.184749	0.185686	0.185698
No. Obs.	6775524	6775524	6775524	6775524	6775524	6775524

Notes. Standard errors are in parentheses. The regressions include controls for the assessment year. The regression results reported in (4) - (6) also include controls for the census tract.

7 Conclusion

Recent studies using large national data sets have appeared to confirm the long-established wisdom that assessments in large urban areas exhibit high degrees of both horizontal and vertical inequity. Similarly priced properties often have much different assessed values, and high-priced properties tend to have lower assessment rates than properties with very low prices. Although much of the evidence for assessment regressivity is derived using biased measures of vertical inequity, it clearly is the case that very low-priced properties have much more variation in assessment ratios than other properties, and are more likely to have very high assessment rates. The tendency for regressions to over-predict very low-priced sales and the lower probability of appeals for low-priced homes are the most likely culprits leading to vertical inequity.

Taking advantage of high-quality administrative data in an exceptionally large assessment district, Cook County, IL, we show that over the course of more than 40 years, assessment ratios have consistently been lower than the statutory rate for low-priced properties, and the level has tended to drift down over time. Simple means and medians conceal significant variation. In any given year, assessment rates may well be as high as twice the statutory rate. And this tendency toward over-assessment is greatest for very low-priced properties – those in the lowest decile.

That assessment rates are high in one year does not automatically imply that they are high again following the next assessment cycle. Our study is the first to analyze this issue of assessment persistence. A high assessment rate for a low-priced property is a problem at any time because it can lead to a very high tax bill for a low-income family. However, a high assessment rate is a much more serious problem if the rate persists over time. Although we do find evidence of persistence, assessment rates display remarkable variation over time for individual properties. The simple correlation between assessment rates for homes that sell more than once is only 16.8%. Low-priced homes are not more likely than comparably over-assessed high-priced properties to have high assessment ratios in later years. High assessment rates are often followed by low rates in subsequent years, and low assessment rates are often followed by high rates. Following assessments over time in a panel data set, we find that very low-priced homes have a much higher incidence of decreases in real assessed values than is the case for higher-priced homes. But a clear pattern that emerges from the analysis is that the degree of variability in assessments, as well as for assessment changes, is much higher for very low-priced homes.

The low degree of persistence in high assessment rates serves as a caution to calls for radical changes in the property tax because of its perceived regressivity. High degrees of assessment regressivity are associated only with very low property values, and they do not automatically translate into property tax regressivity if homestead exemptions are set at even moderate levels. The property tax has significant advantages over many other taxes: in addition to providing local governments a reliable source of revenue, it serves partly as a tax on wealth and the base rises with inflation. Regressivity can be reduced both by improving assessment methods and by increasing homestead exemptions. Assessment practices can potentially be improved by estimating assessed values for smaller geographic areas. Moreover, homestead exemptions can make the statutory incidence of the tax progressive, and departures from progressivity induced by excessive assessment rates for low-priced properties are likely to be temporary.

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