THREE ESSAYS IN MICHIGAN PROPERTY ASSESSMENT

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ABSTRACT

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This dissertation consists of three essays examining and analyzing Michigan property assessment practices. The first essay estimates the property assessment expenditure function for Michigan local government (townships and cities) using panel data with 1,310 governmental units for years 2015 through 2017. Results show that assessment expenditure is related to district size and government type, but not related to assessor type or the required assessors certification level.

The second essay measures and compares the performance of different types of Michigan property assessors. By analyzing over five million properties in Michigan from 2008 through 2016, I find that neither private nor public property assessors are always superior to the other. Both approaches have relative strengths depending on community characteristics. My analysis and subsequent comparison between the existing and a more optimal arrangement of assessor types suggests a potential misallocation in Michigan. Scenario forecasts suggest that merging small assessment jurisdictions coupled with moving toward a more optimal arrangement would improve assessment performance by as much as 32 percent.

The third essay uses detailed parcel level housing price and property tax data during and following the financial crisis for five counties that comprise the Detroit Metropolitan Area in Michigan to evaluate the relationship between changing housing prices and property assessments. My findings are generally consistent with previous

research in that there is about a three-year lag between the housing price changes and changes in property assessments for tax purposes. However, I also find that before the crisis-hit struggling communities tended to over-state assessments to support property tax revenue streams. Assessment adjustments to market declines in these places also lagged in other fiscally healthier cities. On a positive note, the evaluation shows that local authorities in these struggling communities used the financial crisis period to align assessments more closely to actual market conditions as per Michigan property assessment policies.

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CHAPTER 1:

Introduction

My objective in writing this dissertation is to evaluate several aspects of property assessment in Michigan, including the determinants of local government expenditures on property assessment, measuring assessment quality, the determinants of quality, and how assessments respond to housing price fluctuations. My dissertation consists of three essays.

The first essay (Chapter 2) focuses on the expenditure side of Michigan property assessment. This chapter estimates the expenditure function of property assessment for Michigan local governments (townships and cities) using panel data with 1,310 government units for years 2015 through 2017. Results show that assessment expenditures are related to district size and government type, but unrelated to assessor type or assessor certification level. For a local unit with 1700 parcels (an average size local unit in my dataset), a one percent increase in the number of parcels reduces the per-parcel assessment expenditure by 0.53 percent. A one percent increase in average assessed value is associated with a 0.54 percent decrease of assessment expenditure per parcel. Interestingly, the hiring of private or county-level assessors as alternatives to in-house local government assessors does not reduce assessment expenditure. Furthermore, requiring a higher level of assessor certification does not significantly increase assessment expenditure.

The second essay (Chapter 3) focuses on the performance side of Michigan property assessment. I measure the assessment performance of each Michigan local

government using panel data that includes most residential parcels in Michigan (over 5 million parcels) from 2008 through 2016. Following the discussion on the impact of assessor type on the assessment expenditure in the first essay, this essay analyzes the impact of assessor type on assessment performance. I attempt to identify the optimal allocation of the three types of Michigan assessors: "in-house" assessors, private assessors, and county assessors. My goal is to determine who performs better in what communities and then compare the existing allocation of assessor types to a more optimal arrangement to determine the degree of potential assessor misallocation. My analysis suggests that: (i) None of the three kinds of assessors is always superior or inferior to the others, and they all have relative strengths within different types of communities; and (ii) there is a potential misallocation of assessors in Michigan. The analysis suggests that private contractors perform better in communities with more parcels but are often employed in communities with fewer parcels.

The third essay (Chapter 4) evaluates the relationship between changing housing prices and property assessments. Using housing transaction and property tax data for 120 Michigan assessing units in the five-county region surrounding Detroit (Macomb, Monroe, Oakland, Washtenaw, and Wayne counties) from 2008 through 2016, I find a three-year lag between housing price changes and changes in property assessments for tax purposes. However, I also find that before the 2008 crisis, struggling communities tended to over-state assessments with the likely objective of supporting property tax revenue streams. Assessment adjustments to market declines in these places also lagged in other fiscally healthier cities. On a positive note, the evaluation shows that local authorities in these struggling communities used the financial crisis period to align

assessments more closely to actual market conditions as per Michigan assessment policies.

Chapters 2 through 4 include the analyses summarized above, respectively, and Chapter 5 concludes with a summary of my main findings.

CHAPTER 2:

Determinants of Property Assessment Expenditures in the State of Michigan

2.1 Background

Attempting to minimize public expenditure while maintaining quality public services has been a significant issue in the U.S. and worldwide. As the primary revenue source for local governments in the U.S., the property tax requires significant expenditures for managing and collecting revenue. This research seeks to identify, measure, and rate the determinants of expenditures related to property tax administration. More specifically, I evaluate the determinants of property assessment and equalization expenditures using panel data of more than 1000 local governments (townships and cities) in Michigan for the years 2015 through 2017.

2.1.1 Property tax in a glance

Property tax is applied to homes, land, farms, and other forms of real estate. In the U.S., the property tax is a state and local tax imposed by different levels of subnational government and is a principal source of local government revenue. In 2015, state and local property tax revenue accounted for 31.1 percent of all state and local government general tax revenue, ranging from 13.3 percent in North Dakota to 65.7 percent in Massachusetts.[1]

In Michigan, property tax revenue accounts for 34.5 percent of total state and local general tax revenue, which shows a slightly higher dependency on property tax than

[1] State & Local Government Finance Data Query System. http://www.taxpolicycenter.org/statistics/property-taxes-percentage-state-and-local-taxes. The Urban Institute-Brookings Institution Tax Policy Center. Data from U.S. Census Bureau, Annual Survey of State and Local Government Finances, Volume 4, and Census of Governments (1977-2015). 2015 data.

the national average of 31.1 percent.[2] Michigan administers the property tax at the township, city, and village levels. Each township, city, or village decides its own tax rate for different property classes, and the state average rate for all properties is 41.7 mils for 2016.[3] The assessed value is equal to 50 percent of fair market value in the State of Michigan.

The basis of the property tax in the U.S. is the appraisal of property value. Property values are usually re-assessed periodically to 1) fairly and correctly reflect depreciations or improvements for each property; 2) incorporate inflation into property valuation, and 3) correct inaccurate evaluations in previous assessments. State laws usually regulate reassessment cycles and assessment forms (whether a physical inspection is required). See Table 2.1 in Appendix E for a detailed assessment cycle and form by state.[4]

The authority of the Michigan government to levy property taxes is contained in Article 9 of the Constitution of the State of Michigan. In 1994, Proposal A amended the Constitution to restrain the increasing reliance on property taxes. Growth on the taxable value of each parcel of property is capped to the rate of inflation or five percent, whichever is lesser. Please see Appendix A for a detailed evolvement of Michigan property tax statutes.

[2] As above.
[3] 2016 Ad Valorem Property Tax Report. Doc No. 625 (Rev. 02-17). County governments and school districts also apply a tax rate.
[4] Significant Features of the Property Tax. http://datatoolkits.lincolninst.edu/subcenters/significant-features-property-tax/state-by-state-property-tax-in-detail. Lincoln Institute of Land Policy and George Washington Institute of Public Policy. (State-by-State Property Tax in Detail; accessed: 6/18/2018 1:59:52 PM).

2.1.2 Property Assessment Process in Michigan

In Michigan, property assessment is carried out annually by townships, cities, and villages, with county equalization and state government oversight. The process of Michigan property assessment includes three steps: 1) The local assessor (township assessor or city assessor) determines the assessed value of each property by determining the market price of the property, and produces the taxable value (TV); 2) The board of commissioners in each county equalization department equalizes, or applies an adjustment factor, to ensure that property owners in all cities, townships, villages, or school districts in the county pay their fair share of that unit's taxes; 3) The State Tax Commission applies an adjustment factor to the county assessments to bring the total valuation across counties as close to the 50 percent level as possible, and produces the property's state equalized value (SEV). More details on the three-step property assessment process are provided in Appendix B.

In-house assessors traditionally do the first step. However, in order to cut assessing department staff, many local units contract for this service with a for-profit company or an individual contactor. Many individual private assessors contract their services either in whole or in part to multiple local units.[5] During this step, county equalization usually stays out of the local assessing process. However, townships and cities could request county equalization to assess every property when they do not have an assessor with the proper certification. The data show that Wayne, Oakland, and Macomb counties (Metro Detroit) regularly hire contractors to provide assessment services.

[5] D. Rowley, MAAO, Michigan Assessor Association Past President, personal communication, May 1, 2018

Michigan is among the 19 states in the U.S. which require annual reassessment (see Table 2.1 in Appendix E for the required assessment cycle of each state). Michigan guidelines require physical inspection of a minimum of 20 percent of property parcels in any given assessment year, which requires extra time and effort (see Appendix B for more details). Therefore, analyzing and controlling administrative expenditure of assessment is a more pressing issue in Michigan than in the states requiring less frequent assessments.

2.1.3 Local Assessors Variation

Local Assessors in Michigan (township assessors and city assessors) vary in two main aspects: certification level and hiring type.

There are four different levels of certification for property assessors: 1) Michigan Certified Assessing Technician (MCAT); 2) Michigan Certified Assessing Officer (MCAO); 3) Michigan Advanced Assessing Officer (MAAO); 4) Michigan Master Assessing Officer (MMAO). More training and experience are required to obtain a higher level of certification, which grants certification holders greater eligibility and authority on assessments. Only level two to level four certification holders are granted eligibility to be an assessor. Details on assessing eligibility and training requirements of different levels of certification are provided in Appendix C.

The State Tax Commission is responsible for the education and certification of assessing officers and publishes an annual guideline for required certification level for each township, village, city, and county based on their State Equalized Value (SEV) from the previous year.

Based on hiring type, Michigan local assessors can be classified into three categories: in-house assessors, private contractor assessors, and county contractor assessors. Traditionally, local government units (townships and cities) tend to hire their own assessors as government employees, with a preference to have an assessor who is a part of the community. However, with cuts to assessing department staff, local governments have increasingly contracted this service to for-profit companies or with a contract assessor. Currently, most townships and cities in Michigan hire contract assessors, and some may share the same contractor. Contract assessors charge local governments by the hours they work and/or per parcel.[6] This is a way for townships and cities to share assessment costs. For local units having contract assessors, contractor costs account for only a part of assessment office expenditures.[7] Note that a number of townships and cities still have in-house assessors, though it is less common. Assessors typically charge an annual salary, but the assessing office also covers other related expenditures for assessments and related functions of the local assessment office. Suppose a local assessing district does not have an assessor with an adequate certification level and has not employed a certified assessor. In that case, the local government shall request the county equalization department to perform assessments. The expenditure of preparing the rolls shall be charged to the local assessing district. There are criticisms of county equalization performing local assessing duties because both assessment and

[6] D. Rowley, MAAO, Michigan Assessor Association Past President, personal communication, May 1, 2018

[7] One of the local units of government interviewed pays their assessor around $75,000 a year. The entire department budget is approximately $195,000. The difference would then be for other staff and other expenses to run the department (retirement & health benefits, supplies, transportation, conferences & training, Michigan Tax Tribunal hearings, and any other miscellaneous).

appraisal will be conducted by the same assessors/appraisers. A conflict of interest may arise, especially when one reviews his/her own assessments.[8]

By state statute, each township or city, regardless of whether it is using a private contract assessor, county assessor, or in-house assessor, must maintain an assessing office. Please see more details of local assessing office functions in Appendix D.

2.2 Literature Review

There are limited systematic analyses in the literature on minimizing the property assessment expenditure while maintaining the quality of assessment and collection. However, a number of studies attempt to estimate the effects of several economic and governmental factors on public good and service expenditures. For example, the studies of economies scale in the provision of government goods and services date back to the early 1960s. Hirsch (1965) conducted the first studies investigating the effect of various factors on the expenditure of municipal refuse collection services. Ahlbrandt (1973) extended the study of economies of scale to fire services provision, Deller et al. (1988) conducted similar research on the rural low-volume roads, and Walzer (1972) studied police services. The studies of economies of scale were extended to property assessment in the 1990s. Sjoquist and Walker (1999) estimated property tax assessment expenditures using a translog expenditure function over a sample of 138 county-level assessment offices in Georgia. They found that there are substantial economies of scale. They used both the number of parcels and the value of parcels as alternate measures of volume, which yielded similar results, concluding that property assessment exhibits increasing return of scales. The estimated elasticity of expenditure to volume is 0.323 if based on the

[8] D. Rowley, MAAO, Michigan Assessor Association Past President, personal communication, May 1, 2018

number of parcels and 0.243 if based on property value. They estimated that consolidating all assessment offices with outputs below the median volume would reduce the total property assessment expenditure for these districts by over 20 percent. Their research, though enlightening, was limited by two factors: First, the available data set is small; there is complete information on only 138 assessment offices for a single year. Second, the research does not consider a possible quadratic relationship between assessment expenditure and size.

Another informative section of literature focuses on the privatization of public goods and services. Over 100 independent studies compare the expenditures of in-house government agencies versus the private sector for providing public goods and services. The typical findings range from expenditure reductions of 20 percent to 50 percent resulting from privatization. Deacon (1979) compared in-house versus intergovernmental production of all services and found intergovernmental contracting reduced costs by 14 percent. David (1987) surveyed local administrators to obtain comparisons of publicly provided versus and privately contracted services, reporting expenditure savings in 98 percent of contracting efforts, with a weighted average expenditure saving of 19 percent. Ahlbrandt (1973, 1974) and Hike (1986) obtained similar results on expenditure reductions from privatization for the provision of fire protection. Schlesing, Dorwart, and Pulice (1986) also found savings from privatizing health services; Deacon (1979) and Steven (1984) also found savings from private contracting for highways.

Turning more specifically to property assessment, Stocker (1973) analyzed in-house property tax assessors and private contractors in Ohio, concluding that private assessments were more accurate and 50 percent less expensive. There are arguments

against the privatization of certain public goods and services concerning the quality of services. However, other empirical research on property assessment has found no such impact. For example, Mikesell (1987) analyzed the data from the state of Indiana, finding no support for the argument that private provision produces a technically inferior job relative to publicly provided assessment. Finally, Stocker (1973) found that private contractors provided more accurate assessment results relative to in-house assessors.

Our research will contribute to the current literature in four ways: First, it provides a more comprehensive analysis of how local governments can minimize property assessment expenditures. It attempts to build a system of best practices for property assessment by analyzing the effects of assessment size, assessor incentives, and other factors not thoroughly evaluated in literature such as assessor training levels and government type. Second, this research utilizes an intensive data set – panel data that includes 1310 local government (townships and cities) assessment offices in the State of Michigan over three years. Third, this research also considers the possible quadratic relationship between size and expenditure, which adds value to the current literature on economies of scale in property assessment. Fourth, the Michigan property assessment data allows a three-way comparison of in-house assessors, private contractors assessors from county equalization departments. In summary, my evaluations add value to the current literature on the privatization of property assessment.

2.3 Model Specification

This research seeks to determine the pattern of property assessment expenditures in the State of Michigan, and the relationship between property assessment expenditures

and various potential factors. Property assessment expenditure per parcel is modeled as being affected by six local government characteristics.

The first characteristic this research considers is the total number of property parcels in each jurisdiction as an indicator of the assessing unit size. I test the hypothesis that assessment expenditure per parcel is positively or negatively related to the number of property parcels. The result will help identify whether property assessment exhibits decreasing, constant, or increasing return to scale. Also, this research tests the potential nonlinear (quadratic) relationship between assessing unit size and assessment expenditure per parcel. In the case of Michigan property assessment, this analysis helps answer practical questions: Will consolidation of assessing offices reduce per parcel assessment expenditure? How big of an effect will such consolidation have on reducing property assessment expenditures? My assessment provides answers that have important policy implications for the consolidation of assessing offices.

Oftentimes, multiple local governments (townships and cities) hire the same private contractor or county equalization director for assessment service. It might make this analysis less intuitive because the assessor seems to be conducting the assessment on a larger scale as he/she secures multiple contracts from several assessing offices. However, it is important to note that private contractors do not determine the contract price unilaterally. Instead, the pricing of a contract is a negotiation process, and a contractor might be paid with a different rate per parcel or per hour by different townships and cities. In this sense, the research also helps test whether larger local government units have a larger or smaller power in negotiating with private contractors.

This difference in negotiation power can also be seen as economies of scale of assessment to assessing offices.

Some might argue that it is more appropriate to see assessors as units of assessing activities when testing the economies of scale. However, note that assessing offices, not assessors, are the organizers of property assessment activities. The reasons are: 1) assessing offices have complete discretion in choosing private contractors who propose different services and prices; and 2) assessor salaries or private contracts only count a portion of total assessment expenditures. A significant part of expenditures goes to staff salaries, benefits, tribunal expenditure, and so on. Hence, assessing offices are the most appropriate units of assessment for testing the economies of scale. Furthermore, using assessing offices as units of assessment makes this research consistent with Sjoquist and Walker (1999), who used assessing offices of each county in Georgia to test the economies of scale of property assessment.

The research then looks at average State Equalized Value (SEV) as the second potential factor affecting assessment expenditure per parcel. SEV is assessed property value based on 50 percent of true cash value, which is the same as the market value, i.e., what the property worth on the open market. Sjoquist and Walker (1999) consider the value of parcels as an alternative measure of assessing size in their analysis of economies of scale of property assessment. However, such analysis is less relevant in Michigan because private contractors in Michigan typically charge local governments based on parcel numbers and hours worked in offices, not parcel value.[9] Yet, average SEV is still expected to be an important factor in determining assessment expenditure because of the

[9] D. Rowley, MAAO, Michigan Assessor Association Past President, personal communication, May 1, 2018

potential larger tribunal and other legal expenditures associated with higher valued properties. In addition, the potential difference in legal expenditure might result in the assessor behaving differently when assessing more expensive properties. An error made on expensive properties might bring either a larger loss to government revenue or a larger legal expenditure fighting assessment challenges. Thus, it is worthwhile to test the relationship between property value and assessment expenditure, controlling the total parcel number, to see whether more expensive properties require more care or incur larger expenditures.

The third potential factor for assessment expenditure per parcel tested is the assessor type: whether the assessor is an in-house assessor, private contractor, or county equalization director. As the previous literature on privatization indicated, it is reasonable to expect assessors of different types to perform differently. The current trend of replacing in-house assessors with private contractors was originated from local governments' pursuit of cutting staff and expenditures. Different local government units choose different methods during this privatization trend. Some governments sign contracts with private assessing firms or with individuals with differing assessing capabilities. Some local governments request their county equalization departments to help with assessment, whereas others retain in-house assessors. This research analyzes whether the replacement of in-house assessors reduced the outlays.

The fourth potential characteristic affecting assessment expenditure per parcel is the required assessor certification level, as a measurement of the quality of assessors. Assessors' quality may affect assessment expenditure in different directions. On the one hand, assessors with better education and training charge higher salaries or contract

prices. On the other hand, assessing staff with better education and stronger skills might assess more efficiently and reduce expenditures. Assuming all assessors attempt to minimize assessment expenditures without sacrificing basic assessment quality requirements, analyzing the relationship between assessment expenditure per parcel and assessor certification level has critical policy implications. A negative or insignificant relationship implies that requiring a higher assessor certification level does not incur extra expenditure or even help reduce expenditure, and thus is highly recommended. A positive relationship means that it should be given a second thought when requiring a local government to have higher-level certified assessors.

The fifth potential factor considered in this evaluation is the government type: township or city. There might be a difference in expenditures between townships and cities due to different governmental structures. This research tests whether township and city governments behave differently in property assessment administration. There might be valuable lessons to be drawn from the potential differences.

The last characteristic potentially affects assessment per parcel is the property composition (agriculture, residential, commercial, and industrial parcel value in percent of total property value). It is helpful to test the hypothesis that the assessors perform assessments differently when facing different types of property that may require different skills and techniques. This analysis will help to explain the behavior of assessors facing different property classifications.

In this study, let the expenditure function for the *i*th local government in the *t*th year be represented by the following specification:

$$C_{i,t} = \beta_0 + \beta_1 {P_{i,t}}^2 + \beta_2 P_{i,t} + \beta_3 SEV_{i,t} + \beta_4 Emp_i + \beta_5 Cer_{i,t} + \beta_6 City_i + \beta_7 Com_{i,t} + \beta_8 SEV_{i,t-1} + \beta_9 Year_t + c_i + u_{i,t}$$

where $C_{i,t}$ is the log of per parcel assessment expenditure in ith township or city in the tth year; $P_{i,t}$ is the log of total parcel number in ith township or city in the tth year (the square term will be centered in the estimation); $SEV_{i,t}$ is the log of average SEV in ith township or city in the tth year; Emp_i are the dummy variables representing assessor employment type in ith township or city; $Cer_{i,t}$ are the dummy variables representing required assessor certification level in ith township or city in the tth year; $City_i$ is the dummy variable indicating whether ith government is a township or a city; $Com_{i,t}$ is the vector of different types of parcels in percent of total parcel value in ith township or city in the tth year; $SEV_{i,t-1}$ is the log of average SEV in ith township or city in the (t-1)th year (lagged SEV is added as a control because the required certification levels are decided based on prior year's SEV); $Year_t$ represents a vector of time dummies added to control for the impact of inflation on assessment expenditure; c_i is the unobserved time-invariant individual effect; $u_{i,t}$ is the error term.

Since $P_{i,t}$ and $SEV_{i,t}$ are in log terms, their coefficients will be elasticities. β_1 and β_2 represent the elasticity of assessment expenditure to parcel number together; β_3 is the elasticity of assessment expenditure to average SEV. The coefficient of dummy variables will be the impact of the corresponding factors on expenditure per parcel in percentage terms. β_8 and β_9 will not be interpreted because lag SEV and year dummies are added as control variables in the model.

2.4 Data

Michigan has 83 counties, within which there are 1607 townships and cities. This research utilizes a balanced panel data of 1310 local government units (including 1090 townships and 220 cities) from 2015 to 2017 to estimate the specified model. Summary statistics are provided in Table 2.2 in Appendix E.

I obtained "total assessment expenditure" from the item "assessing equalization" in the Annual Financial Report (F-65) for each township and city in the State of Michigan. The F-65 form is submitted by primary government units (county, township, city, village) every year within six months of the end of the fiscal year. In F-65, the item "assessing equalization" records the sum of 1) the activities for the assessor, 2) the property description department, 3) the board of review, and 4) activity for the equalization department. Unfortunately, assessment expenditures for each detailed item are not available. Assessing equalization is reported with five expense types: 1) general funds, 2) all other government funds, 3) enterprise funds, 4) component units, and 5) total. For most government units, assessing equalization expenditures is fully covered by general funds. The number used in this research is the total expenditure of assessing equalization (expense type five).

Michigan Department of Treasury provides parcel numbers annually for the state, each county, and all local government units (township and city) in the L-4023 Forms. For each government unit, detailed parcel numbers for categorical properties are also reported: Agricultural Real property, Commercial Real property, Industrial Real property, Residential Real property, Timber-Cutover Real property, Developmental Real property, Agricultural Personal property, Commercial Personal property, Industrial Personal

property, Residential Personal property, Utility Personal property. From Table 2.2, we see a significant variance in size across government units, ranging from 65 to 66403 in 2017, for example. Over the years, the average parcel number slightly reduced from 3165 in 2015 to 3157 in 2017.

By dividing total assessment expenditures by total property parcel counts, I obtained assessment expenditure per parcel for each county and each local government unit (township and city) from tax years 2015 through 2017. As shown in Table 2.2, expenditure per parcel ranges from $0.17 to $151 in 2017, for example. Over the years, the average expenditure per parcel increased slightly from $15.91 in 2015 to $16.88 in 2017.

By dividing the value of agriculture, residential, commercial, and industrial parcels by the total property parcel value, I obtained parcel composition for each county and each local government unit (township and city) for tax years 2015 through 2017. The percentage of agriculture, residential, commercial, and industrial classifications in 2017 are 10.17, 70.05, 9.32, and 4.68, respectively. The composition within each property classification in Michigan is stable over time, as shown in Table 2.2, with similar means, min, and max over 2015 through 2017.

Michigan Department of Treasury also reports SEV (assessed property value based on 50 percent of market value) annually for the whole state, each county, and each local government unit (township and city) in the L-4023 Forms. By dividing total SEV by the total numbers of parcels, I obtained the average SEV for each county and each local government unit (township and city) from the tax year 2015 through 2017. Average of average SEV rises from $69,519 in 2015 to $74,801 in 2017.

Based on Certification Level Guidelines approved by the State Tax Commission at each year's meeting, the State Tax Commission publishes the required certification levels standard for counties and townships and cities based on their previous year SEV annually for tax years 2015 through 2017. Three certification level dummies: MCAO, MAAO, and MMAO are created based on the standards. As shown in Table 2.2, most (84-85 percent) of local governments are only required to have MCAO holders as assessors. Only a small portion (3-4 percent) of local governments are required to have MMAO holders as assessors. For example, in 2017, 85.11 percent (or 1115 out of 1310) local governments are required to have an assessor holding MCAO or higher-level certification. 11.60 percent (or 152 out of 1310) local governments are required to have an assessor holding MAAO or higher-level certification. 3.28 percent (or 43 out of 1310) local governments are required to have an assessor holding MMAO certification.

Each Michigan county equalization department publishes the name of its equalization director, and each township/city publishes the name of the township/city assessor and the company he/she belongs to (if applicable). For those governments with no or underdeveloped official websites, I contacted their equalization departments via phone calls and emails to obtain the assessor name list. With the assessor name list, I created the assessor employment type dummy of each township and city using the following method: if a township or city assessor is the county director or specified as "county equalization department," I deem that the assessor employment type is "county equalization assessor" for this government unit; if a township or city assessor is an employee of a private, professional property assessment company, I deem that this township or city uses a "private contractor" as its assessor; if a township or city assessor

is an individual whose name appears in other government unit(s), I deem that this township or city uses a "private contractor" as assessor; I deem a township or city using "in-house assessor" if it hires a unique assessor who is not a county equalization director. Except in rare cases where individual private contractor assessors only have one contract from one local government unit, this method should provide a good approximate of assessor employment type for local government units. Using this approximation, the assessor employment type dummies are time-invariant. As calculated with the dataset, 4.35 percent (or 57 out of 1310) townships and cities have county directors performing their property assessments. 73.13 percent (or 958 out of 1310) townships and cities have private contractors performing property assessments. 22.52 percent (or 295 out of 1310) townships and cities have in-house assessors performing property assessments.
There are 1090 townships and 220 cities in the dataset as stated above, and a dummy variable "city" is created to indicate whether a local government unit is a city or not. This dummy variable is time-invariant because the government type does not change over time under normal circumstances.

All of the data mentioned above were transformed into log terms except parcel classification, required certification level dummies, assessor employment type dummies, city dummy, and year dummies. Thus, most of the coefficients in the results represent elasticities. Detailed analysis will be given in the next section.

2.5 Results and Discussion

The specification model is estimated using three methods: Random Effects (RE), Fixed Effects (FE), and correlated Random Effects (CRE). The results are shown in Table 2.3 in Appendix E.

In the CRE result column of Table 2.3, we see the coefficients of time-averages of independent variables are mostly significantly different from zero. Also, an F-test yields a P-value of 0.000, which indicates a correlation between the independent variables and the unobserved time-invariant individual effect. Thus, the random effects estimate is inappropriate. This is confirmed with an overall Hausman Test, which rejects the hypothesis that the difference in coefficients is not significant with a P-value of 0.000. Thus, I draw conclusions based on the CRE/FE results.

First, the results indicate a quadratic relationship between assessment expenditure and the number of parcels. Since the coefficient on the square term is negative, and the coefficient on the level term is positive, the quadratic has a parabolic shape. The turning point is when log of parcel count = 5.88/(2*0.43) = 6.83, or parcel count = 925. The parabola slopes down after the turning point, which accounts for 84 percent of all data points. In other words, assessment expenditure per parcel is negatively related to property parcel counts in local government units for 84 percent of the data. Therefore, property assessment generally exhibits an increasing return of scale.

The quadratic relationship implies that the parcel number has an increasing effect on assessment expenditure per parcel—the elasticity of assessment expenditure to parcel number becomes higher when the parcel number becomes bigger. For example, for a local unit with 1700 parcels (or log of parcel number = 7.45, the local unit with medium size in the dataset), the elasticity is 5.88-2*0.43*7.45 = -0.53, which means each one percent increase in parcel number will reduce per parcel assessment expenditure by 0.53 percent. For a local unit with 1100 parcels (or log of parcel number = 7, the local unit at the first quartile of size in the dataset), the elasticity is 5.88-2*0.43*7= -0.14, so each one

percent increase in parcel number will reduce per parcel assessment expenditure by 0.14 percent. For a local unit with 3000 parcels (or log of parcel number = 8, the local unit at the third quartile of size in the dataset), the elasticity is 5.88-2*0.43*8= -1, so each one percent increase in the number of parcels will reduce per parcel assessment expenditure by 1 percent. This research is consistent with Sjoquist and Walker's finding that property assessment exhibits an increasing return of scale. However, unlike Sjoquist and Walker, who found a constant elasticity of total expenditure to the number of parcels (0.323), this research reveals an increasing effect of parcel number on assessment expenditures as the parcel numbers grow, and the elasticity is 0.53 for the local unit with the medium parcel number.

Thus, assessment becomes more efficient when an assessing office deals with a larger number of parcels, and this impact becomes more substantial when the parcel number becomes bigger. Therefore, combining two townships with similar parcel numbers could help reduce the assessment expenditure and is thus recommended if the primary goal is to reduce costs.

The property tax assessment process in Michigan is highly decentralized. Each township or city completes its own assessment and maintains an assessment office, which is a potential redundancy. Intuitively, merging assessing offices into adjacent offices could save a large amount of staff salary, contract expenditure, overhead expenditure, and other expenditures. This is an important argument for the consolidation of local assessment units—the expenditures could be reduced through consolidating assessing offices of townships or cities to form bigger assessing districts.

Second, this research found a statistically significant positive relationship between assessment expenditure per parcel and average SEV. The elasticity of assessment expenditure per parcel to average SEV is 0.54, which implies a 0.54 percent increase in per parcel assessment expenditure associated with each one percent increase in average assessed value. In addition, considering the value of parcels as an alternate measure of size as did Sjoquist and Walker (1999), a better possible explanation is a potential larger tribunal and other legal expenditure associated with more expensive properties. Or, assessors behave differently when facing expensive properties, as properties with higher values need to be handled with more care than other properties, for an error on their assessments could mean either a bigger loss on government revenue or a larger potential legal expenditure.

Third, one of the most interesting findings is that assessment expenditure per parcel is not statistically significantly related to the assessor type. In other words, privatization through replacing in-house assessors with private contractors or county equalization director fails to help local government units to reduce property assessment expenditure, although expenditure cutting is the exact intention of this privatization. This result could contradict our intuition and previous literature on privatization. Some possible explanations of such phenomenon include, but are not limited to 1) although privatization of assessment is prevailing in Michigan, there are still a considerable number of assessment offices hiring in-house assessors, which makes them benchmarks on how much an assessment office can/should spend for those who privatize; 2) some professional assessing firms might have a big negotiation power in the market and thus charge a higher price; 3) assessors salary and assessment contracts only expenditure a

part of the assessment total expenditure, and those who save by hiring a private contractor might be more generous on other aspects, such as administrative staff or regular office activities. Additional research will be needed to determine the reason for the failure of Michigan privatization on property assessments.

Fourth, the results show no statistically significant relationship between assessment expenditure per parcel and assessors certification level required by townships or cities, which implies that requiring high assessor certification levels does not incur additional expenditure. This could be due to the higher efficiency of better-trained assessors, who may save more assessing expenditure, thus offsetting their higher salaries. Hence, requiring high assessor certification levels is recommended.

Fifth, the results show a statistically significant positive relationship between assessment expenditure per parcel and government type. The coefficient of the "city" dummy is 0.16, which implies that city governments spend approximately 16 percent more per parcel than townships do. Township governments are much more expenditure efficient than city governments when it comes to property assessment.

Finally, the composition of parcel classification matters. Assessors seem to deal with different properties differently, and such differences result in significant differences in assessment expenditures.

2.6 Conclusion

This research has some important findings, including the quadratic relationship between the number of parcels and assessment expenditure, the positive relationship between average assessed value and assessment expenditure. For a local unit with 1700 parcels (the local unit with medium size in our dataset), each one percent increase in the

number of parcels will reduce assessment expenditure per parcel by 0.53 percent. Each one percent increase of average assessed value is associated with a 0.54 percent decrease of assessment expenditure per parcel. Interestingly, privatization, or hiring private assessors or county assessors as alternatives to in-house assessors, fails to reduce assessment expenditure as intended. Requiring higher-level certified assessors does not significantly increase assessment expenditures. City governments spend 24 percent more per parcel than do township governments.

Several policy implications stem from this research. First, my analysis suggests merging small assessing districts to reduce expenditures because assessment is an activity with economies of scale. Second, privatization is not an effective way to reduce assessment expenditure. However, it is too soon to conclude the effectiveness of privatization before comparing the assessment performance of different types of assessors. This is one of the limitations of this research because it does not consider the possible differences in assessment quality, such as fairness and precision. It will be helpful to compare both the expenditure analysis and assessment quality analysis, which leads to my third chapter, where I analyze the assessment performance of different types of assessors.

Another drawback of this research is the short time span of data. A panel data of three years contains limited information; it will be helpful to extend this analysis with a longer series in future research.

APPENDICES

APPENDIX A

Evolvement of Michigan Property Tax Statutes

The authority of the Michigan government to levy property taxes is contained in Article 9 of the Constitution of the State of Michigan. Section 3 of Article 9 states that "The legislature shall provide for the uniform general ad valorem taxation of real and tangible personal property not exempt by law except for taxes levied for school operating purposes. The legislature shall provide for the determination of true cash value of such property; the proportion of true cash value at which such property shall be uniformly assessed, which shall not, after January 1, 1966, exceed 50 percent; and for a system of equalization of assessments…" Article 9 were amended by the Headlee Constitutional Tax Limitation Amendment in 1978, to prohibit states from "requiring any new or expanded activities by local governments without full state financing" (Section 25), to prohibit local units from "levying any tax not authorized by law or charter when this section is ratified" or "increasing the rate of an existing tax above that rate authorized by law or charter when this section is ratified, without the approval of a majority of the qualified electors of that unit of Local Government voting…", to limit local government tax revenue growth by demanding reduction of maximum authorized tax rates to "yield the same gross revenue from existing property, adjusted for changes in the General Price Level, as could have been collected at the existing authorized rate on the prior assessed value" (Section 31).

In 1994, the voters in Michigan approved the Michigan education finance amendment, known as Proposal A, as a means to amend the Constitution. Proposal A replaced most school property tax with an increase in sales tax to restrain the increasing reliance on property taxes for K-12 funding. One primary influence to property assessment is that growth on each individual parcel's taxable value is capped to the rate of

inflation or five percent, whichever is lesser. When a property is sold, its taxable value gets uncapped and reset to the State Equalized Value (SEV) and then recapped, subjecting the growth limitation until it sells again.[10]

10 Assessed Value (AV) is 50 percent of the usual selling price or true cash value of property; State Equalized Value (SEV) is the assessed value as finalized by the county and state equalization process. In most municipalities the SEV and AV are the same; Taxable Value (TV) is the lesser of State Equalized Value or Capped Value; Capped Value (CV) is the prior year's Taxable Value minus losses increased by the consumer price index or five percent whichever is less, plus additions.

APPENDIX B

Three-Step Michigan Property Assessment Process

Step One: The local assessor (township assessor or city assessor) determines the assessed value of a property based on the property's condition on December 31 of the previous year by determining the market price of the property. This process produces the taxable value (TV).

To be more specific, local assessors 1) list and inventory all properties located within the assessment jurisdiction; 2) equitably evaluate every item of taxable property; 3) correctly calculate the taxable value of each taxable property by identifying the taxability and the owner, describing the location and physical condition of the property, and determining the assessed value, capped value and taxable value; and 4) prepare an assessment roll with all taxable property listed in an orderly fashion by parcel id or legal description.

According to State Tax Commission guidelines, all local units (cities and townships) are expected to physically inspect a minimum of 20 percent of their parcels in any given assessment year. The expectation is that the physical data on the property record card is no more than five years old. Sometimes a complete re-evaluation or reassessment is needed (i.e., 100 percent of the parcels).

Step Two: The board of commissioners in each county equalization department equalizes, or applies an adjustment factor, to ensure that property owners in all cities, townships, villages, or school districts in the county pay their fair share of that unit’s taxes. Equalization serves to bring the total valuation across assessing units as close to the 50 percent level as possible.

As the General Property Tax Act 206 of 1893 states, “The county board of commissioners of a county shall establish and maintain a department to survey

assessments and assist the board of commissioners in the matter of equalization of assessments, and may employ in that department technical and clerical personnel which in its judgment are considered necessary. The personnel of the department shall be under the direct supervision and control of a director of the tax or equalization department who may designate an employee of the department as his or her deputy. The director of the county tax or equalization department shall be appointed by the county board of commissioners. The county board of commissioners, through the department, may furnish assistance to local assessing officers in the performance of duties imposed upon those officers by this act, including the development and maintenance of accurate property descriptions, the discovery, listing, and valuation of properties for tax purposes, and the development and use of uniform valuation standards and techniques for the assessment of property." (211.34)

The main purpose of this step is to make sure that all the local government units in the county are assessing fairly and equitably at the constitutionally required level of 50 percent. This is accomplished by appraisers in county equalization departments who conduct appraisals and studies of all the seven classes of property (Agricultural, Commercial, Industrial, Residential, Developmental, Timber Cutover, and Personal property). Some county equalization departments also perform complete assessments and appraisals of every parcel in one or more local government units when requested by the unit(s).

Step Three: The State Tax Commission applies an adjustment factor to the county assessments to bring the total valuation across counties as close to the 50 percent level as possible. This process produces the property's state equalized value or SEV.

More specifically, the commission convenes to receive recommended state equalized valuation for each county; hears the equalization director of each county or its duly authorized representative who desires to address the commission; prepares a statement showing detailed assessment valuation of each property assessed/appraised by each level of government units, by county in an aggregate amount and by county for personal property and each classification of real property; hold a formal hearing, upon conclusion of which the commission adopts, by roll call vote, the final state equalized valuation report.

APPENDIX C

Assessing Eligibilities and Training Requirements of Assessors with Different Certifications

Michigan Certified Assessing Technician (MCAT) is a limited certification that provides basic education in assessment administration. MCAT can be achieved by attending a two and half-day course and passing the STC MCAT exam with a score of 75 percent or higher.

Michigan Certified Assessing Officer (MCAO) is a certification which provides individual with eligibility to act as the assessor of record for a local unit and sign an assessment roll with a SEV as specified in the STC Certification Level Requirements. MCAO certification can be obtained by completing one of two paths: STC six-month program or Self-Study, and pass the STC MCAO exam with a score of 75 percent or higher.

Michigan Advanced Assessing Officer (MAAO) is a certification that provides eligibility to act as the assessor of record for a local unit and sign the assessment roll with a SEV as specified in the STC Certification Level Requirements, which is a broader range than granted for MCAO certification holders. MCAO certification can be obtained by completing one of two paths: STC 1-year online/lecture hybrid program or course through an approved organization and passing an exam at the conclusion of each course with a 75 percent or higher score.

Michigan Master Assessing Officer (MMAO) is a certification that provides eligibility to act as the assessor of record for a local unit and sign the assessment roll with a SEV as specified in the STC Certification Level Requirements, which is a broader range than granted for MAAO certification holders. To obtain MMAO certification, MAAO certified assessors must have two years of assessment administration experience

after obtaining MAAO certification, complete three MMAO required courses, and pass both the Case Study and the Oral Examination with 75 percent or higher.

APPENDIX D

Functions of Local Assessing Offices

Besides step one of the Michigan property assessment process, functions of local assessing offices also include: 1) the administration of the Principal Residence Exemption, processing of Property Transfer Affidavits, processing of tax exemption applications, and processing of property splits and/or combinations; 2) the processing of divisions of land, maintaining digital mapping (GIS) of property lines and the write up of legal descriptions, establishing special assessment districts and apportioning the special assessment within that special assessment district; 3) defending assessed and taxable values before the Michigan Tax Tribunal and assisting other departments and divisions within the city with valuation, real estate, and property; 4) assisting residents with questions regarding property assessments.

APPENDIX E

Tables

Table 2.1 Assessment Cycle and Other Requirements of States in U.S.

State	Revaluation Cycle	Assessing Level
Alabama	No fixed schedule	county
Alaska	No fixed schedule, properties are revalued on locally determined cycles not to exceed 6 years.	borough and municipal
Arizona	Not to exceed 3 years For property classified as class 2, 3, or 4 property. Agricultural property an inspection is required every 4 years.	county
Arkansas	Each county must reappraise all real property every 3 or 5 years,	county
California	Most real property is revalued upon a change in ownership or upon completion of new construction. State assessed and personal property are assessed annually.	county
Colorado	Every 2 years	county
Connecticut	Assessors must revalue property at least once every 5 years. Inspections are required once during every 10 assessment years.	cities and towns
Delaware	No fixed schedule	county/local(city, own, municipality)
District of Columbia	Every year	the District
Florida	Every year	county
Georgia	Every year	county
Hawaii	Every year	county
Idaho	Property must be revaluated at least once every 5 years.	county
Illinois	Property other than farmland must be viewed, inspected, and revalued once every 4 years. Farmland is reassessed each year.	counties and townships
Indiana	Every 5 years	counties and townships
Iowa	Every 2 years	county or city
Kansas	Every year	county/appraisal district
Kentucky	Every year	counties, school districts, and special districts
Louisiana	Real property - no more than 4 years. Personal property - every year.	parish
Maine	At least once every 10 years.	municipality/multi-municipal area
Maryland	Every 3 years	state
Massachusetts	Each city and town must value property each year. The Department of Revenue reviews local assessing practices every 3 years.	cities and towns

Source: Lincoln Institute of Land Policy

Table 2.1 (cont'd)

State	Revaluation Cycle	Assessing Level
Michigan	Every year	townships, villages, and cities, and counties
Minnesota	Every 5 years	county
Mississippi	Every year	county
Missouri	Every 2 years	counties and the City of St. Louis.
Montana	Every 6 years	Department of Revenue
Nebraska	Every 6 years	county
Nevada	Every 5 years	counties and the City of Carson City
New Hampshire	At least once every 5 years, the general court may order more frequent revaluations.	municipalities/ cooperative assessment districts
New Jersey	Every year	municipal and county
New Mexico	Every year	county
New York	No fixed schedule. At least once every 4 years.	counties, cities, and towns
North Carolina	At least once every 8 years, but may elect to revalue more frequently.	county
North Dakota	Every year	city and township
Ohio	At least once every 6 years.	county
Oklahoma	Every year	county
Oregon	Every year	county
Pennsylvania	Every 4 years	county/city
Rhode Island	Every city or town must conduct a revaluation within 9 years of the date of the prior revaluation and must conduct an update of real property every 3 years from the date of the last revaluation.	cities and towns
South Carolina	Every 5 years	county
South Dakota	Every year	county
Tennessee	6-year, 5-year or 4-year inspection cycle	county
Texas	At least once every three years.	county/ multiple county appraisal district/ home-rule city
Utah	Every year	county
Vermont	Every year	municipality and town
Virginia	Every 2 years in cities, every 4 years in counties, every 4 years in towns.	counties, cities, and towns
Washington	Every year	county
West Virginia	Every year	county
Wisconsin	At least once every 5 years	any subdivision of territory
Wyoming	Every year	county

Source: Lincoln Institute of Land Policy

Table 2.2 Summary of Statistics

Variables	Observations	Mean (Count) 1/	Std. Dev.	Min	Max
Assessment Expenditure per Parcel (in Dollars)					
2015	1310	15.91	9.79	0.02	185.23
2016	1310	16.31	8.32	0.13	72.56
2017	1310	16.88	9.54	0.17	151.34
Parcel Number					
2015	1310	3165	5275	66	67165
2016	1310	3158	5249	66	66245
2017	1310	3157	5246	65	66403
Agriculture Valuation (in percent of total)					
2015	1310	10.25	13.58	0	74.32
2016	1310	10.25	13.52	0	71.22
2017	1310	10.17	13.38	0	70.93
Residential Valuation (in percent of total)					
2015	1310	69.36	18.41	3.48	98.64
2016	1310	69.86	18.09	3.67	98.6
2017	1310	70.05	18.09	3.61	98.59
Commercial Valuation (in percent of total)					
2015	1310	9.28	10.43	0	63.97
2016	1310	9.35	10.61	0	63.6
2017	1310	9.32	10.67	0	64.24
Industrial Valuation (in percent of total)					
2015	1310	5.7	10.79	0	82.58
2016	1310	4.83	9.86	0	82.54
2017	1310	4.68	9.76	0	83.06
Average SEV (in Dollars)					
2015	1310	69519.19	43317.47	9472.67	693161
2016	1310	71987.13	45271.16	9805.33	695846
2017	1310	74801.25	47654.21	10565.92	747799
MCAO					
2015	1310	0.84 (1103)	0.36	0	1
2016	1310	0.84 (1105)	0.36	0	1
2017	1310	0.85 (1115)	0.37	0	1
MAAO					
2015	1310	0.12 (161)	0.33	0	1
2016	1310	0.12 (155)	0.32	0	1
2017	1310	0.12 (152)	0.32	0	1
MMAO					
2015	1310	0.04 (46)	0.18	0	1
2016	1310	0.04 (50)	0.19	0	1
2017	1310	0.03 (43)	0.18	0	1
In-House Assessor 2/	1310	0.23 (295)	0.42	0	1
Private Assessor 2/	1310	0.73 (958)	0.44	0	1
County Equalization Assessor 2/	1310	0.44 (57)	0.20	0	1
City 2/	1310	0.17 (220)	0.37	0	1

1/ For dummy variables, figures in brackets are counts of "1"s.
2/ For time-invariant variables, all statistics are for a single year.

Table 2.3 Coefficients of Potential Determinants of Assessment Expenditure

Per Parcel Expenditure (log)	**RE**	**FE**	**CRE**
Parcel Number (log) Square	.0041 (.0113)	-.4311 (.2326)*	-.4311 (.2326)*
Time-average 3/			.4196 (.2328)
Parcel Number (log)	-.2421 (.2200)	5.8818 (3.6848)	5.8818 (3.6848)
Time-average			-5.682 (3.710)
Average SEV (log)	.0985 (.1176)	.5412(.2016)**	.5412(.2016)**
Time-average			-.2604 (.4944)
Agriculture Valuation (in percent of total)	-.0042 (.0023)*	.0005(.0068)	.0005(.0068)
Time-average			-.0056 (.0071)
Residential Valuation (in percent of total)	.0012 (.0020)	.0128(.0051)**	.0128(.0051)**
Time-average			-.0126 (.0049)
Commercial Valuation (in percent of total)	-.0100 (.0032)**	.0119(.0096)	.0119(.0096)
Time-average			-.0035 (.0099)
Industrial Valuation (in percent of total)	.0018 (.0025)	.0079 (.0045)*	.0079 (.0045)*
Time-average			-.0078(.0052)
SEV Last Year (log)	.1107 (.1202)	.0709 (.0915)	.0709 (.0915)
Time-average			-.1780 (.4573)
Assessor Employment Type (Dummies) 2/			
Private Contractor	-.0438 (.3701)		-.0434 (.0370)
County Equalization Director	-.0879 (.0831)		-.0840 (.0832)
Certification Level (Dummies)			
MAAO	.0836 (.0502)*	.0094 (.0275)	.0094 (.0275)
Time-average			.1533 (.0815)
MMAO	.2473 (.0903)**	-.0416 (.0695)	-.0416 (.0695)
Time-average			.5131 (.1531)
City (Dummy) 2/	.1583 (.0676)**		.1606 (.0681)**
Year (Dummy)			
2016	.0405 (.0147)**	.0280 (.0150)*	.0280 (.0150)*
2017	.0708 (.0154)**	.0415 (.0198)**	.0415 (.0198)**
Observation	3,930	3,930	3,930
R-Square			
within	0.0166	0.0257	0.0257
between	0.1819	0.0141	0.1845
overall	0.1392	0.0096	0.1434

1/ Figures in brackets are robust standard errors, * indicates significance level of 0.10, ** indicates significance level of 0.05.
2/ Assessor Employment Type Dummies and City Dummy are dropped out from FE because they are time invariant in the dataset.
3/ Time-averages coefficenst in CRE can be seen as average partial effects.

CHAPTER 3:

An Analysis of Public vs. Private Contracting Performance in Michigan Property Tax Assessment

3.1 Introduction

Privatization of services traditionally provided by government agencies is a process of transferring the management of public services from government agencies to the private sector. The rationale for such transfers includes cost savings, introducing market competition, a lack of in-house expertise, a desire to improve service quality, etc. In recent years, privatization has been increasingly used as a means for national, state, and local governments to fulfill their public service obligations. The most common services outsourced in Michigan include attorney/legal services, engineering, solid waste and recycling, and property assessment and inspections.[11]

Michigan property assessment is currently conducted by a mix of three types of assessors: in-house assessors, private assessors, and county government assessors. Traditionally, local township and city assessing offices are more inclined to hire their own local assessors as long-term government employees, with an implicit preference towards an assessor who is a part of the community. To make cuts to address budget shortfalls, many local assessing offices increasingly contracted assessment services to for-profit companies or stand-alone private contractors to replace the previously kept in-house local assessors.[12] Several assessing offices may hire the same contractor to share the assessment expenditure and achieve economies of scale. Those assessing offices

[11] Leonard Gilroy (2014), "University of Michigan Survey Finds High Use, Satisfaction with Local Government Privatization", https://reason.org/commentary/michigan-local-privatization-survey/

[12] D. Rowley, MAAO, Michigan Assessor Association Past President, personal communication, May 1, 2018

without in-house assessors or private contractors can request the county equalization department to perform assessments. Currently, hiring private contractors is most common. About 70 percent (or 985 out of 1,400) townships and cities hire private contractors, 4 percent (or 57 out of 1,400) townships and cities seek help from county assessors, and 26 percent (or 358 out of 1,400) townships and cities have in-house assessors[13].

Privatization of government services, including property assessment, has led to a long-lasting and heated discussion in the U.S. and worldwide. The focus has been on comparing the advantages and disadvantages of private contractors relative to the in-house provision to determine whether the private sector can provide higher quality services at a lower expenditure. In other words, do private contractors perform better than government employees? Should we privatize or stay with government service providers? However, this might not need to be an "either-or" question. The assumption that one type of assessor arrangement is always superior to another might be misguided. Is it possible that each arrangement performs better under some conditions, and neither is always superior or inferior to the other? Perhaps both in-house assessors and private contractors have their comparative advantages in different types of communities; a more optimal balance may require matching the service arrangement to the most appropriate communities.

In this chapter, I measure the performance of property assessment using detailed data from most local governments in Michigan. I explore the potential determinants of assessment performance, such as the size of the community and average property value. I

[13] Calculated from data collected in 2017.

will answer the following questions: Does increased assessment expenditure help to improve assessment outcomes? Under what conditions does property assessment achieve economies of scale? Does the composition of property parcels affect assessment performance?

This research also aims to identify the comparative advantage of contractor assessors, in-house assessors, and county assessors by analyzing how the determinants of performance impact the three types of assessors differently. This evaluation will provide insight into how different types of assessment arrangements can be optimally allocated. For example, if community size affects private assessors negatively, but affects in-house assessors positively, then assessment performance can be improved by hiring in-house assessors in larger communities.

I also compare the optimal distribution of assessor types with the current distribution to analyze whether there is a misallocation of assessors in the state. In other words, are private contractors and in-house assessors providing services in those communities where they have a comparative advantage? For example, if private contractors perform better in larger communities, but tend to be used in smaller communities, then there may be a misallocation of assessors.

The remainder of this chapter is organized as follows. Section 2 provides a review of the current Michigan property assessment process. In section 3, I summarize the relevant literature. I discuss the econometric specification in Section 4 and the data in Section 5. I present the current distribution of the three types of assessors in Section 6 and then discuss the empirical results in Section 7.

3.2 Background

3.2.1 Michigan Property Assessment Process

Michigan property assessment is a three-step process: 1) The local assessor (township assessor or city assessor) determines the assessed value of each property based on market values. The local assessor also calculates taxable values (TV), which is the tax base; 2) The board of commissioners in each county equalization department equalizes, or applies an adjustment factor, to ensure that property taxes are paid in a fair and equitable manner across all cities, townships, villages, and school districts; 3) the State Tax Commission (STC) applies an adjustment factor to county assessments to bring the total valuation across counties as close to the 50 percent[14] level as possible, and calculates a state equalized value (SEV) for each property, which is equal to 50% of the market value.

Compared to other states in the U.S., Michigan property assessment is highly decentralized, with local property assessment conducted at the township, city, and village levels. Michigan has 83 counties, within which there are more than 1,700 townships and cities. Each township and city is required by state statute to maintain its own assessing office and to conduct independent property assessment. Michigan is among the ten states in the U.S. that require local (city, township, or municipal level) assessment. In contrast, most states conduct assessments at the county level, and some states even conduct assessments at the state level (See Figure 3.1 in Appendix B). Moreover, Michigan requires annual reassessment, the most frequent required assessment cycle among U.S. states. (see Figure 3.2 in Appendix B for more details).

[14] Michigan assesses property value at 50 percent of true market value. For example, the property tax base of a house that worth $1 million should be $500,000, and the tax bill should be tax rate times $500,000.

3.2.2 Michigan Property Assessment Performance Overview

There are two key dimensions when it comes to property assessment quality (or performance): **level** and **uniformity** (IAAO, 1990). Assessment level measures the overall ratio at which properties are evaluated in relation to true market value, while uniformity measures the degree to which properties are equally and fairly appraised in relation to their true market value. A generally preferred measure of overall assessment level in an assessing district is the **median sales ratio** (assessed value/sale price) [15] of each parcel sold in a particular year in that district. The closer the median sales ratio is to 1, the higher the assessment quality is in an assessing district, as the assessed value of each property in a perfect assessment should be precisely the same as the true market value. Uniformity is typically measured by the **coefficient of dispersion (COD)[16]**, which reflects the average percentage deviation of the ratios from the median ratio. For example, a COD of 10 indicates that individual sales ratios within a district vary from the median sales ratio by plus or minus 10 percent on average. A smaller COD means a higher quality assessment, as the sales ratio for each property in a fair assessment should be close to the median sales ratio. According to the International Association of Assessing Officers (IAAO), good assessments should have a COD of less than 30 (IAAO, 1990). The ideal assessment would have a median sales ratio of 1 and a COD of 0, implying that the assessed value is equal to the market price for each parcel.

According to these guidelines, property assessment performance in Michigan is generally unsatisfactory in terms of both level and uniformity. Figure 3.3 in Appendix B

[15] Michigan median sales ratio is calculated as 2 times assessed value/sale price of each parcel, as Michigan assesses property value at 50 percent of true market value.
[16] The calculation of COD will be discussed in later sections.

shows the distribution of the median sales ratio of Michigan local assessing districts (townships and cities) in 2016,[17] which ranges from 0.02 to 4, with an average of 0.94. Only 39% of assessing districts have a median sales ratio falling between 0.9 and 1. The wide range of median SR shows a high variation in assessment quality across Michigan. While many assessing units perform well in terms of level, some over- or under-estimate significantly. Figure 3.4 in Appendix B shows the distribution of COD in Michigan in 2016.[18] Only 16% of Michigan assessing districts achieved the 30 IAAO criteria. Most assessing districts have a COD much higher than 30, and some have a COD exceeding 100. Figure 3.5 in Appendix B shows the average median sales ratio and COD of Michigan local assessing districts from 2008 to 2016. The average COD is relatively stable over time, ranging from 75 to about 90. The average median sales ratio declined from 1.5 in 2009 to around 0.9 in 2016, indicating an apparent systematic overestimation in Michigan during the financial crisis.

In summary, the primary challenges in Michigan property assessment include (i) lack of uniformity in assessment as indicated by high COD; (ii) high variation of assessment throughout Michigan as evidenced by a wide range of median sales ratio; (iii) a tendency of overestimation in the wake of the financial crisis; and (iv) potential over-spending caused by high decentralization of assessment.

3.2.3 Michigan Assessors Overview

As mentioned in an earlier section, local assessors in Michigan can be classified into three categories: in-house assessors, private assessors, and county government

[17] Only assessing units with more than 30 correctly recorded arm's-length, open-market transfers are included in the distribution.
[18] Only assessing units with more than 30 correctly recorded arm's-length, open-market transfers are included in the distribution. Assessing units with COD bigger than 300 are not shown in the graph.

assessors. In-house assessors are usually long-term government employees who only work for one specific local assessing office. Private assessors can be either certified individual assessors or employees of private assessing companies. Most private assessors have appointments with more than one local assessing office. The contract terms are usually negotiated between local assessing offices and assessors, and are usually between one to five years. County assessors typically also serve as the director of the county equalization department.[19]

It might be possible for the three types of assessors to behave differently due to different incentives. Thus, it is worthwhile to examine whether the performance of each type of assessor responds differently to various determinants of assessment performance. For example, private contractor performance could be more sensitive to community size, as they might think it is important to secure contracts with larger jurisdictions. To address this question, I examine the responsiveness of the three assessor types to community characteristics.

In this research, I will analyze potential factors affecting Michigan property assessment performance with given assessment expenditures, including assessing district size, average property value, effective tax rate, property composition (the value of agriculture, commercial, residential parcels as in percentage of total parcels) and the number of transactions. I also test whether these factors have different impacts on in-house assessors, private assessors, and county assessors. I then consider whether there is a misallocation of assessors by comparing the current distribution and a more optimal distribution indicated by the analysis.

[19] I conclude this base on the namelist of local assessors collected for this research.

3.3 Literature Review

There is extensive existing literature comparing the quality and cost/efficiency of public and private delivery of public services, the results of which are mixed. Hilke (1993) compiled over 100 independent studies comparing the cost/efficiency of in-house government agencies versus private, professional providers in various areas of public goods and services, including airline operation and airplane maintenance, property tax assessments, banks, electric utilities, fire protection, debt services, and so on. Most studies show cost reduction resulting from privatization in his compilation, and the typical reductions range from 20 percent to 50 percent. Some studies show little difference in efficiency/cost between in-house and contract provision of services, or even higher cost for private service providers. The empirical results comparing the service quality of private and public service providers are also mixed. Mikesell (1987) analyzed the data of private and local assessors in Indiana and found that better quality assessment is likely to emerge from private appraisal firms working under contracts as opposed to elected assessors. Stocker (1973) compared in-house property assessors and private contractors in Ohio and found that private assessments are more accurate. Lowery (1982) analyzed Michigan private and in-house assessors and found that contracting leads to substantially lower levels of assessment.

With inconsistent empirical findings, some research supports the argument that both public and private sectors may have certain relative strengths, and neither sector is inherently better or worse when it comes to delivering public services. Bendick (1989), Osborne and Gaebler (1992) conclude that private contractors tend to perform better on straightforward or specialized services such as processing payments and computer

systems design, but worse on complex, long-range, and subjective services such as ensuring equity, continuity, and stability of services, social cohesion, etc.

However, this does not explain the inconsistency in empirical results in a specific area of public service. For example, as mentioned above, Mikesell (1987), Stocker (1973), and Lowery (1982) found opposite results, even though they all analyzed the same area of public service: property assessments. Another example is a case study conducted by Hatry (1989) comparing matched pairs of public and privately administered prisons, which found mixed results for the cost reduction of private services provision.

A potential explanation for such inconsistency is that both public and private sectors may have certain relative strengths even in the same area of public services, and neither sector is always superior or inferior. This research tests the hypothesis that private assessors, in-house assessors, and county assessors in Michigan have different comparative advantages, using the panel data from 2008 through 2016 for most Michigan property parcels (over 5 million parcels) over 1000 local governments.

This research follows the framework advocated by Mehta & Giertz (1996), who proposed innovative methods for calculating technical efficiency of property assessment within the stochastic frontier framework. Their methodology incorporates both output (COD) and input (assessment expenditure per parcel) of property assessments to compare and rank assessing district efficiency. They found that the factors that played a role in determining efficiency include the number of parcels, tax rate, parcel composition, and legal structures of each county. They suggest a possible optimal district size in property tax administration, which advocates further examining the policy recommendation to consolidate assessing districts.

The present research includes several technical improvements to Mehta & Giertz (1996). First, instead of using COD as the sole measurement of property assessment output as Mehta & Giertz did, I take both assessment level and assessment uniformity into consideration. Specifically, I create a new performance measure, combining COD, the measurement of assessment uniformity, and median sales ratio, the measurement of assessment level. The inclusion of assessment level measurement is particularly relevant in Michigan, as property assessment practices are more diverse than in other states. Michigan not only contains jurisdictions where governments systematically underestimate property values to avoid sudden tax increases and/or aversion, even appeals from taxpayers[20], but also contains jurisdictions such as Detroit where the government systematically overestimates real property value (Hodge, McMillen, Sands and Skidmore, 2017). Furthermore, while Mehta & Giertz used a single-year cross-section data of 88 counties in Illinois, I use panel data from 2008 to 2016 for over 1000 local governments in Michigan. The substantial improvement in both the volume and quality of data increases the reliability of this research. To exploit this extensive panel data set, I use the Stochastic Frontier Model developed by Schmidt & Sickles (1984), which is essentially the same model used by Mehta & Giertz (Stochastic Frontier Model by Schmidt & Lovell (1979)) but adapted for panel data.

The Stochastic Frontier Econometric model was initially developed by Aigner, Lovell, and Schmidt (1977) and van den Broeck (1977). Its purpose was to practically distinguish inefficiencies due to structural problems such as failing to utilize "best practice" technology or other factors which cause companies/organizations to produce

[20] Any citizen in Michigan who are not satisfied by the property assessment decision made by the local Board of Review can file an appeal of the decision with the Michigan Tax Tribunal by filing a petition.

below their maximum attainable output, and those due to random disturbances such as bad luck or systematic errors. The model was then extended by Battese and Corra (1977), Battese and Coelli (1988), Lee and Tyler (1978), Pitt and Lee (1981), Androw et al. (1982), Kalirajan and Flinn (1983), Bagi and Huang (1983), Schmidt and Sickles (1984), and Waldman (1984), etc. to allow adaption for various data complications. It is now one of the dominant models used in empirical industrial production studies and has been used to study public production too.

3.4 Model Specification

The Stochastic Frontier Framework models the production frontier to be the set of technical efficient producing institutes, which produce the maximum feasible outputs with given inputs. The actual production is bounded within the production frontier, indicating that the actual output is always smaller than or equal to the maximum feasible outputs with given inputs.

The Stochastic Frontier Econometric Model structures the output frontier as a function of inputs, controls, and a symmetric error v_i as $N(0, \sigma_v^2)$:

$$MY_{it} = \alpha + \sum \beta_j X_{ijt} + v_{it}; \;\; v_{it} \sim N(0, \sigma_v^2) \qquad (1)$$

where X_{ijt} is the jth input or control variable of unit i at time t; MY_{it} is the maximum feasible output given the inputs and controls X_{ijt}; β_j is the coefficient of each input and control variable; and v_{it} is the symmetric error term.

The model structures the gap between actual output and maximum feasible output as a one-sided error $u_i \leq 0$, which comes from the concept that actual output is always smaller than or equal to maximum feasible output. The actual output function is the output frontier plus the one-sided error:

$$Y_{it} = \alpha + \sum \beta_j X_{ijt} + v_{it} + u_i; \quad u_i \leq 0, \quad E[u_i] = u < 0 \qquad (2)$$

where Y_{it} is the actual output of unit i at time t, and u_i is the one-sided error term. Formula (1) and (2) clearly show that the actual output of unit i is always within the frontier function as the error term $u_i \leq 0$.

There are two error terms in the output function: the symmetric error, and the one-sided error. This compound error comes from the economic logic that the production process is subject to two different random disturbances: the one-sided error reflecting the deviation from the best output due to technical or economic inefficiencies, and under the unit's control. The symmetric error reflects that the frontier is stochastic due to random factors such as luck, climate, topography, and can be favorable or unfavorable.

My research will focus on β_j, not the u_i, as I am more interested in learning about the factors that affect assessment output rather than how far away a specific unit is from the frontier.

In the context of property assessment, the output is the quality (or performance) of assessments. As mentioned above, there are primarily two dimensions for property assessment quality: level and uniformity (IAAO, 1990). Assessment level measures the degree to which goals or certain legal requirements are met, while uniformity measures the degree to which properties are appraised in relation to true market value. A generally preferred measure of overall appraisal level in an assessing district is the median sales ratio (assessed value/sale price of each parcel transacted in that year) in that district. Uniformity is usually measured by the coefficient of dispersion (COD), which reflects the average percentage deviation of the ratios from the median ratio:

$$COD_{it} = 100 \frac{\sum_{h \in i} |SR_{ht} - SR_{median,it}|}{n_{it} SR_{median,it}} \qquad (3)$$

where COD_{it} is the COD of assessing district i in year t, SR_{ht} is the sales ratio of parcel h (belonging to district i and transacted in year t) in year t, $SR_{median,it}$ is the median sales ratio of district i in year t, and n_{it} is the number of parcels transacted in district i in year t. Both median sales and COD are annual and based on the parcels sold in the relevant year. The closer the median sales ratio is to 1, and the closer COD is to 0, the higher the assessment quality is in one assessing district. The ideal assessment would have a median sales ratio of 1 and COD of 0, implying assessed value equals the market price for each parcel.

Because a one-dimension measurement to evaluate assessment quality is needed for the evaluation, I create a measurement "**Performance Score**" to combine both level and uniformity. With this measurement, it is easier to compare and rank the assessment quality of each Michigan local assessing district. The created measurement Performance score is calculated as:

$$P_{it} = \frac{100 \sum_{h \in i} |SR_{ht} - 1|}{n_{it}} \qquad (4)$$

where P_{it} is the performance score of assessing district i in year t. This performance measure is very similar to COD, only replacing the median sales ratio with the ideal sales ratio—1. By analogy, performance measures the average percentage deviation of the ratios from the ideal sales ratio of 1. For example, a performance score of 10 indicates that individual sales ratios within the assessing district vary from 1 (ideal sales ratio) by plus or minus 10 percent on average. A lower performance score indicates a better assessment.

I then use the calculated performance score as the output measurement (left-side variable) in the stochastic frontier framework. I use assessment expenditure per parcel or

assessment expenditure as a percent of total property tax collected as the assessment input of each assessing district. Since a lower performance score means a better assessment, the production frontier is the set of technical efficient producing institutes that generate the minimum feasible performance score with given inputs and controls. The actual performance function is always beyond the production frontier, indicating that the actual performance score is always larger than or equal to the optimal performance score with given inputs.

To specify the performance frontier as a function of assessment inputs and controls, we have:

$$MP_{it} = \alpha + \beta_1 C_{it} + \beta_2 Con_{it} + v_{it};\ v_{it} \sim N(0, \sigma_v^2) \quad (5)$$

I specify the actual performance function as the performance frontier plus a positive disturbance, reflecting the concept that the actual performance score is always larger than or equal to the optimal performance score with everything else equal.

$$P_{it} = \alpha + \beta_1 C_{it} + \beta_2 Con_{it} + v_{it} + u_i;\ \ u_i \geq 0,\ \ E[u_i] = u > 0 \quad (6)$$

where C_{it} is assessment expenditure of assessing district i in year t; Con_{it} represents the control for the difficulty (or the workload) of the assessment of assessing district i in year t; v_{it} is the symmetric error term; and u_i is the positive error term. My research will focus on estimation of the β's, not the u_i. In other words, in this analysis I am more interested in learning about what affects assessment output than how far away a specific unit is from the frontier.

In the property assessment literature, assessment expenditure is usually measured by either assessment expenditure per parcel or assessment expenditure as a percentage of tax revenue. The two measurements both have advantages and disadvantages.

Expenditure as a percentage of tax revenue is highly dependent on the property tax rate, which is left to the discretion of each local government and ranges from 9.3 mil to 96.6 mil in Michigan.[21] The expenditure per parcel does not capture differences in the workload of assessing different properties. After controlling the average property value and tax rate, both approaches are good reflections of the assessment input of individual townships and cities. This research uses expenditure per parcel as the input measure in the **core analysis**, and also reports a **robust analysis** with expenditure as a percentage of tax revenue as the alternative input measure to confirm the results.

Control variables include the number of parcels (in log), average assessed property value (in log), parcel composition (agriculture, residential, and commercial parcels in percent of total parcels), effective property tax rate (in %), number of transactions (in log), and time dummies. The number of parcels measures the size of an assessing district and is expected to affect the assessment workload. Average assessed property value measures how wealthy an assessing district is, and is expected to affect tax assessment performance as well—the effort involved in assessing a $100 million worth parcel is expected to be greater than that of a $100,000 worth parcel. Parcel classification is expected to affect assessment performance as the difficulty in assessment may vary from one parcel classification to another. The effective tax rate is expected to affect assessment performance as a higher tax rate might boost taxpayer awareness. The number of transactions is expected to impact the assessment performance because recent sales can reference similar properties in an assessment. I included time dummy variables because tax performance might be affected by the financial crisis in 2008, as the government

[21] 2016 data in the dataset.

might over- or under-estimate property values to differing degrees over the period of analysis.

It is essential to point out that u_i in equation (6) is homogeneous over time to assess any given district, reflecting the assumption that each assessing district has the same deviation from best performance due to technical inefficiencies over time. This assumption is necessary to differentiate between the symmetric error term and the one-sided error term. It also has economic justifications: the factors contributing to technical inefficiencies, such as insufficiently trained personnel and inadequate management system, are usually stable over time.

To test the hypothesis that the three types of assessors respond differently to changes in district size, average value, etc., I estimate the following model. This model is similar to equations (5) and (6), with additional terms interacting with each control with assessor type dummies.

The performance frontier is:

$$MP_{it} = \alpha+\beta_1 Factor_{it}+\beta_2 Factor_{it} * 1[Type_i = P]+\beta_3 Factor_{it} * 1[Type_i = C] + v_{it};$$

$$v_{it} \sim N(0,\ \sigma_v^2) \qquad (7)$$

And actual performance is:

$$P_{it} = \alpha+\beta_1 Factor_{it}+\beta_2 Factor_{it} * 1[Type_i = P]+\beta_3 Factor_{it} * 1[Type_i = C] + v_{it} +$$

$$u_i;\ \ u_i \geq 0,\ \ \ E[u_i] = u > 0 \qquad (8)$$

where 1[•] is the indicator function, which equals 1 if the statement in the bracket is true, and equals to 0 if not. $1[Type_i = P] = 1$ if assessing district i has a private assessor, $1[Type_i = C] = 1$ if assessing district i has a county assessor. Factors include assessment expenditure per parcel and all the controls previously discussed: number of

parcels (in log), average assessed property value (in log), parcel composition, effective property tax rate (in %), and number of transactions (in log). Time dummies are included but are not interacted with assessor-type dummies to simplify the model.

3.5 Data

I calculate the output measurements – performance score, COD, and the median sales ratio – from individual parcel tax records and current sales data obtained from CoreLogic[22]. I include only parcels transacted in the current year in the calculation. For example, 1,854 out of 43,181 parcels in Lansing were involved in transactions in 2016 (after trimming out non-arm's-length transactions, errors, and outliers). I calculate the 1,854 sales ratios and use them to measure performance, COD, and median sales ratio for Lansing in 2016. To ensure all sales ratios included in the calculation are correctly recorded arm's-length, open-market transfer, I eliminated all individual transactions with transaction types other than "resale" and "new construction." Eliminated transaction types include non-arm's-length transactions, construction loan/financing, and seller carrybacks. Those transactions are not standard open-market transactions, and their sales prices are not proper reflections of their market values. I also eliminated all individual transactions with sales prices less than $1,000 or sales ratios greater than 20 as they are most likely errors or non-arm's-length transactions. Since Michigan assesses property values at 50 percent of market value, I calculate the sales ratios as two times the assessed value divided by market value.

Figure 3.6 in Appendix B shows that the new measurement performance score successfully combines information from both level and uniformity. From 2008 to 2015,

[22] CoreLogic, Inc. provides financial, property and consumer information, analytics and business intelligence. The data used in this research are the tax roll records they maintain.

when the COD is relatively stable, the change of performance score coincides with the average median sales ratio. From 2015 to 2016, performance score picks up the increasing trend of average COD.

In this research, assessment expenditure is measured by either assessment expenditure per parcel or assessment expenditure as a percentage of tax revenue. Assessment expenditure per parcel is obtained by dividing total assessment expenditures by total property parcel counts, and assessment expenditure as a percentage of tax revenue is self-explanatory. I obtain total assessment expenditures of each county, township, and city from the item "assessing equalization" in the Annual Financial Report (F-65). Parcel numbers of the whole state, each county, and each assessing unit (township and city) are published by the Michigan Department of Treasury in L-4023 forms annually. Total tax revenues of each county, township and city are obtained from the Ad Valorem Property Tax Report published by the Department of Treasury annually, reflecting the sum of county taxes, township/city taxes, school taxes, and authority taxes if applicable. Figure 3.7 in Appendix B shows that the average expenditure as a percent of tax revenue increases throughout the years, but the expenditure per parcel is relatively stable, with some fluctuations in 2013.

Following the literature, I measure the size of assessing districts by the log of total parcel numbers. I measure property compositions of each assessing unit by the percentage of total parcel valuation in the agriculture, commercial, and residential property classes.

I determine the type of assessor in each township and city using the following method. Each Michigan county equalization department publishes the name of its

equalization director, and each township/city publishes the name of the township/city assessor and the company he/she belongs to (if applicable). For those governments with no or underdeveloped official websites, I contacted their equalization departments via phone calls and emails to obtain the assessor name list. I then created the assessor employment type dummy variable from this name list. If a township or city assessor is the county director or specified as "county equalization department," I deem that the assessor employment type is "county assessor." If a township or city assessor is an employee of a private, professional property assessment company, I determine that this township or city uses a "private contractor." If two or more township or city hires the same person who is not county equalization director, then I determine that they also use a "private contractor." A township or city uses an "in-house assessor" if it hires a unique assessor but not a county equalization director. Except in rare cases where individual private contractor assessors have only one contract from one local government unit, this method should provide a good approximate of assessor employment type.

Only assessing units (townships and cities) with more than 30 correctly recorded arm's-length, open-market transfers are included in my data, because calculating the median, COD, performance from individual sales ratio is not statistically meaningful for a sample smaller than 30. Such trimming might create bias because the number of transactions is highly correlated with the total parcel number in an assessing unit, and I may be excluding the smaller assessing units. However, it is necessary to eliminate the unrepresentative observations to assure meaningful analysis. If an assessing unit has more than 30 of such transfers in some years but not in other years, only the observations in the years with more than 30 transfers are kept. For example, if Lansing has 31 property

transactions in 2016 and 29 transactions in 2015, then only the 2016 record would be included in the dataset. This trimming method creates an unbalanced panel, but it helps to prevent excessive or unnecessary trimming.

I provide a detailed summary of the statistics in Table 3.1 in Appendix A. We can see that the dataset is unbalanced. Out of the 1,607 observations, there are 762 for 2016, but only 326 are for 2008. This is due to my trimming method, as an assessing district might have more than 30 transactions in one year, but not in others. From "COD," it is clear that some of the townships and cities have very large COD, as the max reaches more than 1,000 in some years. To ensure that the analysis is not affected by those extreme observations, all observations with COD larger than 500 are considered outliers. I estimate the specifications with all data, as well as after eliminating the outliers. It is also apparent in "Number of Parcels" that the smallest assessing district contains 166 parcels (in 2008), but it is not the smallest district in Michigan because the smallest one (which only contains 55 parcels) is eliminated from the dataset as it does not have a sufficient number of transactions. There is also a trend in the "number of transactions"—the property transactions are less frequent during financial crisis years (2008-2012) and become more frequent after the economy begins to recover. Total effective tax rates are stable throughout the years, reflecting the relatively stable tax environment.

3.6 Distribution of Private vs. In-house vs. County Assessors

As mentioned earlier, hiring private contractors is the current trend: 70 percent (985 of 1,400) of townships and cities hire private contractors, 4 percent (57 of 1,400) of

townships and cities seek help from county assessors, and 26 percent (or 358 out of 1,400) of townships and cities keep in-house assessors[23].

To learn more about where the three types of assessors are allocated in Michigan, I estimate the following multinomial probit model, in which the probability of a local assessing district having a private or in-house or county assessor is a function of parcel number and average assessed property value in that district.

Let the outcomes be numbered $j = 1$ (in-house assessor), 2 (private assessor), and 3 (county assessor). For assessing district i, the model assumes a latent (unobserved) utility or score for each outcome :

$$U_{ij} = x_i\beta_j + \varepsilon_{ij} \quad (9)$$

Here x_i = $[parcels_i, AvgVal_i]$, a row vector of explanatory variables for district i; β_j= vector of coefficients for outcome j; and the ε_{ij} are independently and identically distributed as N(0,1). The probability that outcome k is chosen is the probability that U_{ik} is the largest of U_{i1}, U_{i2} and U_{i3}. It is therefore a multivariate normal probability. Since the differences of the utilities depend only on the differences of the β_j, they are not all identified, and we use the normalization that β_1 = 0. Thus β_2 and β_3 influence the effects of the explanatory variables on the probabilities of outcomes 2 and 3, respectively. The calculations were done in Stata using the command *mprobit.* The discussion above is a summary of the Stata documentation. For more theoretical detail, see Cameron and Trivedi (2005, 516-519), Greene(2012, 770-771), or Wooldridge (2012, 648-649).

[23] Calculated from data collected in 2017.

These parameters are estimated by maximum likelihood with 2017 data[24], and the result is shown in Table 3.2 in Appendix A.[25] The coefficients are shown in the first column, and the average partial effects (APE) are shown in the third column.

The results indicate that private contractors are more concentrated in smaller and inexpensive assessing districts, and county assessors are concentrated in larger and expensive assessing districts. To be specific, a one percent increase in district size reduces the probability of hiring a private contractor by 0.11 on average. A one percent increase in average property value reduces the probability of hiring a private contractor by 0.07. A one percent increase in district size will increase the probability of using a county assessor by 0.02. A one percent increase in average property value will increase the probability of using a county assessor by 0.04. All the relationships are statistically significant at the 0.05 level.

The rationale behind such distribution of assessors seems straightforward. Smaller assessing districts usually have a smaller budget on property assessments and higher fixed expenditures per parcel. They have a greater incentive to contract out for assessment services as a method of expenditure-saving. The same argument also holds for assessing districts with less average property value because they might collect less revenue.

However, such a distribution might not be an optimum allocation of the three types of assessors, as they might not be assessing the districts they are relatively better at assessing. This issue will be discussed in greater detail in the following section.

[24] The data used for multinomial probit model estimation does not eliminate observations with transactions less than 30, or COD greater than 500. All observations will non-missing values are included.
[25] The Probit analysis uses 2016 data and does not exclude the observations with transactions less than 30.

3.7 Results and Discussion

3.7.1 Overall Analysis

I estimate equation (6) using fixed effects and present the results in Table 3.3 in Appendix A. The first two columns show the results of the core analysis with assessment expenditure per parcel as the input measurement and without eliminating the outliers. The first column shows coefficients, and the second column shows the standard errors. The third and fourth columns show the results from the robust analysis with assessment expenditure in percent of property tax collected as the input measurement. Following this are the results from the core and robust analysis with outliers eliminated.

All four analyses point to the same consistent results: (i) average assessed property value and the number of parcels is the most important factors of performance; (ii) assessment quality tends to be better in larger communities and communities with higher average property value; (iii) parcel composition and tax rate also matter. The results are consistent with Mehta & Giertz's findings.

The overall analysis does not find a statistically significant relationship between assessment expenditure and performance score, implying that assessment quality is insensitive to expenditure changes in general. This result contradicts the intuitive speculation that more input on property assessment will bring better output. It seems that the assessors in Michigan are not taking advantage when the assessment expenditure increases.

The performance score is negatively related to the number of parcels. Since performance score is smaller for higher quality assessment, this result implies that assessment quality tends to be higher in bigger assessing districts with everything else

equal. A one percent increase in parcel number brings down the performance scores by 0.223 percent, on average. This result is consistent with Mehta & Giertz's finding that property assessment is an activity with an efficiency of scale. This finding suggests that Michigan's decentralized property assessment scheme is not the best approach, considering the strong economies of scale nature of assessing equalization activities[26]. Decentralization increases expenditures by requiring more assessing offices and assessors and may substantially decrease assessment quality.

There is a statistically significant negative relationship between average parcel value and assessment performance score, and the relationship is strong in terms of magnitude. A one percent increase in average property value is associated with a 0.311 percent decrease in performance scores on average. A possible explanation is that assessments for properties with high assessed value are completed with greater care, and such care affects assessment quality.

Parcel classification also affects assessment performance. Michigan groups its properties into different classifications: agricultural, commercial, industrial, residential, developmental, and timber cutover. This research studies the three main classes: agricultural, commercial, and residential. The performance scores are statistically significantly lower when the properties are more concentrated in commercial and residential classes. The result implies that commercial and residential parcels are easier for assessors to assess than other kinds of parcels. A one percent increase of commercial or residential parcels as a percent of total parcels is approximately associated with a 0.009 or 0.006 percent reduction in assessment performance score, respectively. A

[26] Yunni Deng. Determinants of Property Assessment Expenditures in the State of Michigan. (Working Paper)

possible explanation is that assessors might be more experienced in handling these two classes of properties, rather than agricultural, industrial, developmental, and timber cutover properties.

The result also indicates a positive relationship between the overall property tax rate and assessment performance. The higher the tax rate is, the lower the performance score is, holding other factors constant. A 1‰ increase in the effective tax rate will lead to a 0.08‰ (0.008 percent) deduction in assessment performance scores, on average. This confirms the conjecture that a higher tax rate improves assessment performance, perhaps by boosting taxpayer awareness in assessing districts.

Surprisingly, the result indicates a slight negative relationship between transaction frequency and assessment performance. Intuitively, current property transactions can provide assessors with more information on the property market, and thus enhance assessment quality. However, the evaluation suggests that Michigan assessors did not take full advantage of the information provided by real property sales.

3.7.2 An Analysis for Assessor Types

Given that the three types of assessors may behave differently, it is helpful to analyze how assessor performance responds to the factors based on assessor type. I thus estimate equation (8) using fixed effects and present the result in Table 3.4 in Appendix A. Again, both core analysis and robust analysis are done with and without eliminating outliers.

The key results from the analysis are: (i) larger parcel counts, higher average property value, and higher effective property tax rates enhance assessment qualities for all three types of assessors; (ii) in-house assessors, private contract assessors, and county

assessors respond very differently to changes in assessment expenditures, average property values, assessing district sizes, and tax rates; (iii) private contractors perform relatively better in communities with more parcels; (iv) county assessors perform relatively worse in communities with high average property value.

County assessors appear to be more expenditure-sensitive than private or in-house assessors. The performance scores of both private and in-house assessors are slightly positively related to either assessment expenditure per parcel or assessment expenditure in percent of property tax collected, implying that increases in assessment expenditure would not improve assessment quality. In contrast, there is a statistically significant negative relationship between assessment expenditure per parcel and performance scores for county assessors. A one percent increase in assessment expenditure per parcel translates into an average (0.197 –0.034 =) 0.163 percent reduction in assessment performance scores.

The number of parcels is negatively related to performance scores for all three types of assessors, but the relationship is stronger in magnitude for private contractors than for in-house assessors and county assessors. A one percent increase in parcel number reduces performance scores by 0.139 percent on average for in-house and county assessors. This number is (0.139 + 0.112 =) 0.251 percent for private contractors. This result indicates that the private contractors are most effective in dealing with communities with a large number of parcels and should be allocated in such communities. From this research, the reasons for the private contractor comparative advantage in larger communities is unclear. I speculate that private contractors might emphasize contracts with larger assessing districts and thus conduct the assessments more

carefully to ensure the renewal of their contracts when the existing contracts end. However, such speculation should be formally tested in further research. This result also indicates a misallocation of private contractors in Michigan: private contractors are best in assessing larger districts, but they are more concentrated in smaller assessing districts. The policy implications followed by this result are clear—merging small assessing districts to form large assessing districts would improve performance, and large assessing districts should consider hiring private contractors.

Average property value affects property assessment performances differently for the three kinds of assessors as well. Average property values are also negatively related to performance scores for all three types of assessors, but the relationship is weaker in magnitude for county contractors than for in-house assessors and private contractors. According to the core analysis without eliminating outliers, a one percent increase in average property value reduces performance scores by 0.286 percent on average for in-house and private assessors. This number is (0.286 – 0.138 =) 0.148 for county assessors. Although county contractors are least effective in assessing communities with higher value properties, they are most concentrated in such communities. The policy suggestion is that assessing districts with high average property values should consider hiring private contractors or in-house assessors instead of county assessors.

A higher effective tax rate improves all three types of assessors' assessment quality, and the impact is stronger in terms of magnitude for county assessors. According to the core analysis without eliminating outliers, a one mil increase in total effective tax rate reduces performance scores by 0.1 mils (or 0.01 percent) on average for in-house and private assessors. This number is (0.1 + 0.19 =) 0.29 mil for county assessors.

It seems that parcel composition affects the three types of assessors almost to the same degree. The number of transactions affects private contractors and county assessors more than in-house assessors. Again, the reasons for such similarities and differences are not the scope of this research and need to be explored in the future.

3.7.3 Scenario Forecasts

To more clearly demonstrate how misallocation of assessors affects overall property assessment performance, I provide linear forecasts for average performance score under the following four scenarios: (i) each assessing district remains status quo; (ii) if all private contractors are replaced by in-house contractors; (iii) if all in-house assessors are replaced by private contractors; (iv) if the assessors are optimally (according to this research) allocated based on community size: private contractors assess communities containing more than 50,000 parcels, and in-house assessors assess the rest of the communities. I present the result in the first part of Table 3.5 in Appendix A.

I provide forecasts for average performance scores assuming every assessing unit performs without technical inefficiency (lies on the performance frontier). It is interesting that changing to all private contractors makes things worse, whereas changing to all in-house makes things better. The average performance score would be 29.03 if all private contractors are replaced by in-house contractors, and 30.20 if all in-house assessors are replaced by private contractors.

The average performance score would be 28.94 if assessors were allocated optimally, which indicates the highest quality assessment among the four scenarios. Compared to the current situation, “optimal allocation” improves performance by approximately 2.3 percent. The simulation result serves as further evidence of

comparative advantages among different types of assessors since neither scenario (ii) or (iii) is the optimal allocation.

As this research suggested, consolidating smaller assessing units into larger ones would affect the performances since all three types of assessors performs better in larger communities. In order to estimate how consolidation would affect overall performances, I provide the linear forecasts for average performance scores under the previous four scenarios, but assuming smaller assessing units are consolidated into one large assessing district. I do that by limiting the observations to assessing units with more than 5,000 parcels (larger than median size communities), as this will be a good approximation to the scenario in which all small assessing units are consolidated into one large one. I present the result in the second part of Table 3.5 in Appendix A.

The performance would be significantly improved once small assessing districts are consolidated. Table 3.5 shows that the overall performance score comes down to 21.48 even if we keep the assessors' types unchanged, which accounts for a 27.5 percent improvement compared to the current situation. The performance score would further decrease to 20.17 if we were to allocate assessors optimally.

Overall, consolidating small communities and moving to the “optimal” scenario improves performance by 32 percent compared to the current situation, and the improvement is statistically significant considering the standard deviation.

3.8 Conclusion

In summary, the key results of this research are: (i) average assessed property value and the number of parcels are the most important factors for performance; (ii) assessment quality tends to be better in larger communities and communities with higher

average property value for all types of assessors; (iii) in-house assessors, private contract assessors, and county assessors respond very differently to changes in assessment expenditures, average property values, and assessing district sizes; (iv) there is a misallocation of Michigan assessors: private contractors have a comparative advantage in assessing communities with more parcels, but are actually more heavily employed in communities with fewer parcels; county assessors have a comparative advantage in assessing communities with lower average property value, but are actually not used as much in such communities; (iv) consolidating small communities and moving to the "optimal" scenario improves performance by 32 percent as compared to the current situation.

The policy implications drawn from these findings are consistent with those of Chapter 2. First, my analyses suggest merging small assessing districts and form larger assessing areas. This consolidation would improve assessment performance as all types of assessors tend to perform better in larger communities and reduce assessment expenditure since assessment is an activity with economies of scale. Second, I recommend allocating assessors based on their comparative advantages. Specifically, private contractors should be hired in communities containing more than 50,000 parcels, and in-house assessors should be hired in the rest of the communities. Such reallocation would enhance assessment performance without increasing assessment expenditure because hiring different types of assessors does not affect assessment expenditure, as shown in Chapter 2.

With all the important policy implications offered, I acknowledge some limitations to this analysis. As discussed in the data section, eliminating all communities

with fewer than 30 parcel sales may introduce selection bias. Moreover, due to data limitations, there are some potential factors of assessment performance not included in this research, such as assessors' certification level and the degree of local economic development in each assessing district. Furthermore, the reasons for assessors' comparative advantages are not within this analysis's scope and require further research. Finally, the jurisdictions might have reasons for not taking optimal assessing regimes as discussed in this chapter. For example, they might be foregoing assessment performance for more control to the assessors to deliberately over- or under-estimates properties. It would be interesting to extend this research with a focus on government assessing objectives.

Going forward, one possibility is to extend this research with a more comprehensive analysis. One possibility is to calculate the technical efficiency of each Michigan local government and rank them based on their efficiency. The econometric methodology used in this research – the Stochastic Frontier Model — could also be used to calculate technical efficiencies for each government by combining both assessment expenditure and performance. Such an analysis would offer a more comprehensive view of Michigan property assessment instead of focusing on either input or output aspects.

APPENDICES

APPENDIX A

Tables

Table 3.1 Summary of Statistics

		Performance				COD				Median Sales Ratio			
Year	Obs.	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
2016	762	89.0	92.6	16.7	844	91.1	97.9	14.4	1653	0.94	0.29	0.03	3.94
2015	747	77.7	72.8	14.1	761	75.1	51.8	10.4	283	0.96	0.32	0.19	5.14
2014	691	81.6	90.8	18.0	1159	77.0	55.1	12.6	393	0.98	0.55	0.09	10.17
2013	660	89.9	92.7	15.5	1220	83.2	77.4	13.4	894	1.05	0.57	0.08	10.89
2012	631	103.5	103.4	16.1	993	83.0	77.4	16.1	1542	1.19	0.64	0.04	9.20
2011	541	113.4	105.8	18.8	986	80.8	58.5	16.9	698	1.29	0.62	0.11	7.03
2010	496	112.7	103.3	19.3	1133	76.0	50.2	17.7	378	1.34	0.77	0.20	9.48
2009	434	138.9	129.0	20.8	1234	78.6	56.6	17.3	456	1.54	0.92	0.22	10.68
2008	326	124.0	138.2	18.2	880	88.6	234.2	11.9	3850	1.42	0.86	0.00	7.84
		Expenditure per Parcel				**Expenditure (% of Tax Revenue)**				**Number of Parcels**			
		Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
2016		17.5	9.1	0.1	73.6	1.05	0.56	0.01	6.91	4599	6700	683	66245
2015		17.1	11.7	0.0	185.2	1.03	0.55	0.00	4.32	4701	6619	710	67165
2014		16.5	9.5	0.1	87.5	1.01	0.52	0.00	3.67	4962	6904	717	67395
2013		20.8	35.1	0.1	389.2	1.01	0.52	0.00	4.12	4900	6955	129	67421
2012		16.6	10.4	0.1	126.6	1.05	0.60	0.00	5.64	5273	7200	717	67459
2011		16.7	9.9	0.1	84.8	1.02	0.58	0.01	5.05	5892	7778	776	67581
2010		17.8	11.9	0.2	123.7	1.02	0.57	0.01	4.68	6116	7890	726	68107
2009		17.9	11.0	0.2	90.3	0.95	0.58	0.01	5.60	6712	8322	651	68165
2008		19.1	12.1	0.2	113.3	0.93	0.70	0.01	8.76	7775	9234	166	68075
		Number of Transactions				**Total Tax Rate (‰)**				**Average Parcel Assessed Value**			
		Mean	Std. Dev.	Min 1/	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
2016		183	322	30	4196	31.6	9.9	16.0	96.6	78207	46025	18458	695846
2015		165	283	30	3401	30.9	9.2	15.9	74.8	73268	36285	9473	335233
2014		153	251	30	2748	30.6	9.2	15.9	82.2	70912	40980	10441	660082
2013		146	243	30	2549	30.2	9.1	15.6	81.7	86757	121451	9847	1035049
2012		138	238	30	2838	30.3	9.2	16.3	85.6	67175	31843	9703	283632
2011		128	195	30	1667	30.2	9.0	11.1	78.1	70487	32186	9544	298398
2010		131	204	30	1802	30.3	8.8	15.7	77.5	74550	33527	15775	306417
2009		135	210	30	1887	30.0	8.8	15.5	73.2	84025	39282	18998	453901
2008		139	193	30	1661	31.0	9.0	15.3	69.2	92576	42496	19402	357048

1/ Townships and cities with number of sales less than 30 are eliminated from the dataset.

Table 3.2 Factors of Assessor Performance

	Coefficients	Std. Err.	APE (dy/dx)	Delta-method Std. Err.
In-House Assessors (dummy)				
Number of Parcels (log)	omitted 1/		0.10**	0.01
Average Assessed Value (log)	omitted 1/		0.03	0.02
Private Contractors (dummy)				
Number of Parcels (log)	-0.48**	0.06	-0.11**	0.01
Average Assessed Value (log)	-0.21**	0.10	-0.07**	0.02
County Assessors (dummy)				
Number of Parcels (log)	0.07	0.08	0.02**	0.01
Average Assessed Value (log)	0.38**	0.15	0.04**	0.01

Note: * indicates statistically significance with 0.1 level, ** indicates statistically significance with 0.05 level. The regression is based on 2017 data, as the type information is collected in 2017.
1/ Inhouse assessors is the base type, and thus the coefficients are omitted.

Table 3.3 Coefficients of Determinants of Assessment Performance

	Core Analysis		Robust Analysis		Core Analysis (w/o outliers) 1/		Robust Analysis (w/o outliers) 1/	
Performance Score (log)	Coefficients	Std. Err.	Coefficients	Std. Err.	Coefficients	Std. Err.	Coefficients	Std. Err.
Assessment Expenditure per Parcel (log)	0.011	0.011			0.011	0.011		
Assessment Expenditure (in percent of property tax collected)			0.010	0.011			0.010	0.011
Average Assessed Value (log)	-0.311**	0.031	-0.301**	0.031	-0.306**	0.031	-0.296**	0.031
Number of Parcels (log)	-0.223**	0.028	-0.224**	0.028	-0.225**	0.028	-0.226**	0.028
Agriculture Parcels (in percent of Total Parcels)	0.001	0.003	0.000	0.003	0.000	0.003	0.000	0.003
Commercial Parcels (in percent of Total Parcels)	-0.009**	0.002	-0.009**	0.002	-0.009**	0.002	-0.009**	0.002
Residential Parcels (in percent of Total Parcels)	-0.006**	0.002	-0.006**	0.002	-0.006**	0.002	-0.006**	0.002
Total Effective Tax Rate (‰)	-0.008**	0.002	-0.007**	0.002	-0.007**	0.002	-0.007**	0.002
Number of Transactions (log)	0.090**	0.024	0.090**	0.024	0.094**	0.024	0.094**	0.023
Year Dummies	X		X		X		X	
Number of Observations	5288		5288		5274		5274	
Number of Cross Sections	959		959		958		958	

Note: * indicates statistically significance with 0.1 level, ** indicates statistically significance with 0.05 level. Assessing districts with number of transactions less than 30 are eliminated.

1/ observations with COD>500 are deemed as outliers.

Table 3.4 Coefficients of Performance Factors for Different Types of Assessors

	Core Analysis		Robust Analysis		Core Analysis (w/o outliers) 1/		Robust Analysis (w/o outliers) 1/	
Performance Score (log)	Coefficients	Std. Err.	Coefficients	Std. Err.	Coefficients	Std. Err.	Coefficients	Std. Err.
Assessment Expenditure per Parcel (log)	0.034*	0.018			0.034*	0.018		
Assessment Expenditure (to property tax collected)			0.038**	0.018			0.038**	0.018
Average Assessed Value (log)	-0.286**	0.036	-0.265**	0.035	-0.283**	0.036	-0.262**	0.035
Number of Parcels (log)	-0.139**	0.037	-0.148**	0.037	-0.135**	0.037	-0.144**	0.036
Agriculture Parcels (in percent of Total Parcels)	-0.006	0.005	-0.005	0.005	0.006	0.005	-0.005	0.005
Commercial Parcels (in percent of Total Parcels)	-0.010**	0.004	-0.011**	0.003	-0.010**	0.003	-0.011**	0.003
Residential Parcels (in percent of Total Parcels)	-0.009**	0.002	-0.010**	0.002	-0.009**	0.002	-0.010**	0.002
Total Effective Tax Rate (‰)	-0.010**	0.004	-0.009**	0.004	-0.009**	0.004	-0.009**	0.004
Number of Transactions (log)	-0.001	0.031	0.004	0.031	0.005	0.031	0.009	0.031
Interactive Terms 2/								
Interactive with County Assessor (dummy)								
Assessment Expenditure per Parcel	-0.197*	0.114			-0.196*	0.114		
Assessment Expenditure (to property tax collected)			-0.139	0.108			-0.136	0.108
Average Assessed Value	0.138*	0.074	0.028	0.053	0.136*	0.073	0.027	0.052
Number of Parcels	-0.088	0.069	-0.036	0.068	-0.091	0.069	-0.038	0.067
Agriculture Parcels	-0.006	0.011	0.001	0.011	-0.006	0.011	0.000	0.011
Commercial Parcels	-0.004	0.009	-0.002	0.009	-0.003	0.009	-0.002	0.009
Residential Parcels	-0.003	0.006	0.000	0.005	-0.003	0.006	0.001	0.005
Total Effective Tax Rate	-0.019**	0.007	-0.021**	0.007	-0.019**	0.007	-0.020**	0.007
Number of Transactions	0.180**	0.058	0.163**	0.058	0.179**	0.058	0.162**	0.058
Interactive with Contract Assessor (dummy)								
Assessment Expenditure per Parcel	-0.032	0.023			-0.031	0.023		
Assessment Expenditure (to property tax collected)			-0.041*	0.023			-0.040*	0.023
Average Assessed Value	-0.023	0.031	-0.041	0.029	-0.017	0.031	-0.035	0.029
Number of Parcels	-0.112**	0.041	-0.102**	0.041	-0.120**	0.041	-0.110**	0.041
Agriculture Parcels	0.003	0.005	-0.001	0.005	-0.003	0.005	-0.002	0.005
Commercial Parcels	0.005	0.005	0.006	0.005	0.005	0.005	0.006	0.005
Residential Parcels	0.007**	0.003	0.007**	0.003	0.007**	0.003	0.008**	0.003
Total Effective Tax Rate	0.005	0.004	0.005	0.004	0.005	0.004	0.004	0.004
Number of Transactions	0.124**	0.033	0.119**	0.033	0.121**	0.033	0.117**	0.032
Year Dummies	X		X		X		X	
Number of Observations	5288		5288		5274		5274	
Number of Cross Sections	959		959		958		958	

Note: * indicates statistically significance with 0.1 level, ** indicates statistically significance with 0.05 level. Assessing districts with number of transactions less than 30 are eliminated.

1/ observations with COD>500 are deemed as outliers.

2/ controls in the interactive terms are of the same unit with the controls themselves, such as in logs, in percent.

Table 3.5 Scenario Analysis

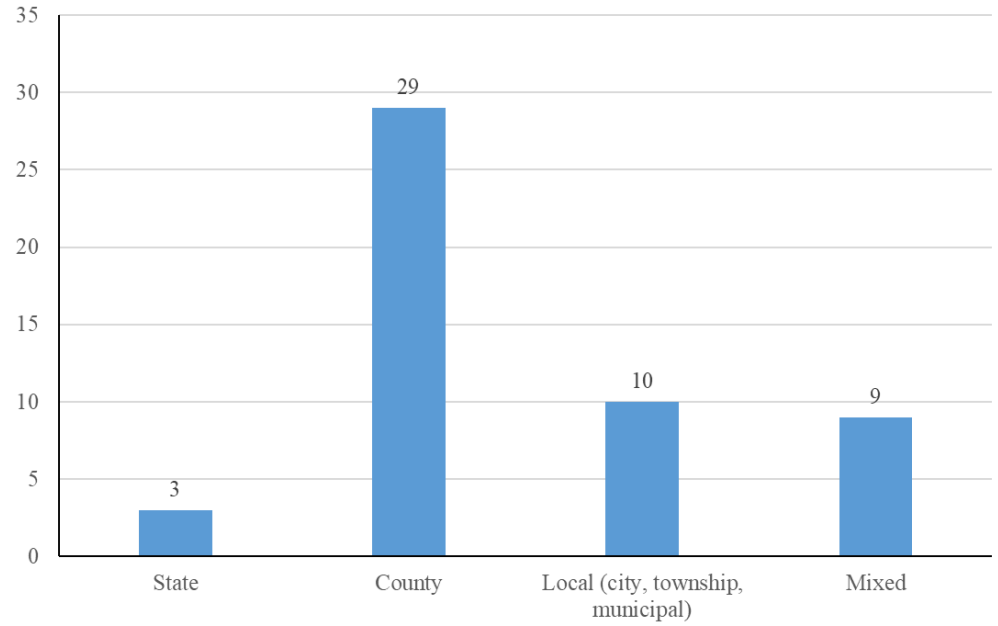
	Observations	Performance Score (Mean)	Performance Score (Std. Dev.)
For All Assessing Units			
Senario 1 (Original)	762	29.62	7.11
Senario 2 (In-House)	762	29.03	8.45
Senario 3 (Contractor)	762	30.20	6.51
Senario 4 (Optimal)	762	28.94	8.25
For Assessing Units with More than 5000 Parcels			
Senario 1 (Original)	159	21.48	5.02
Senario 2 (In-House)	159	20.17	4.76
Senario 3 (Contractor)	159	23.08	4.57
Senario 4 (Optimal)	159	20.17	3.34

Note: Forecast is based on the assumption that every assessing units are performing without technical inefficiency. Forecast is based on 2016 data, and observations are limited to communities with more than 30 transactions.

APPENDIX B

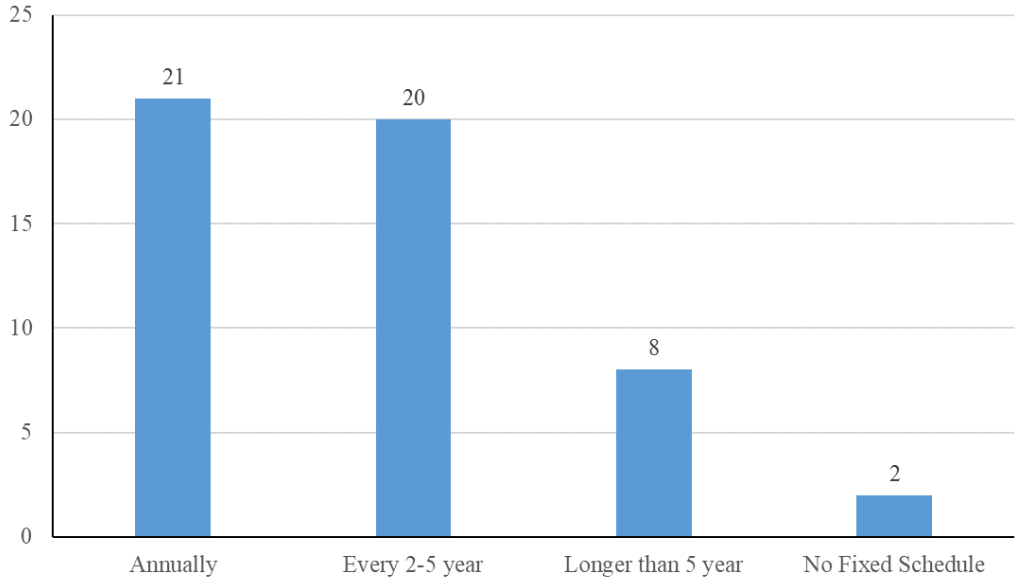
Figures

Figure 3.1 Number of States by Assessment Level



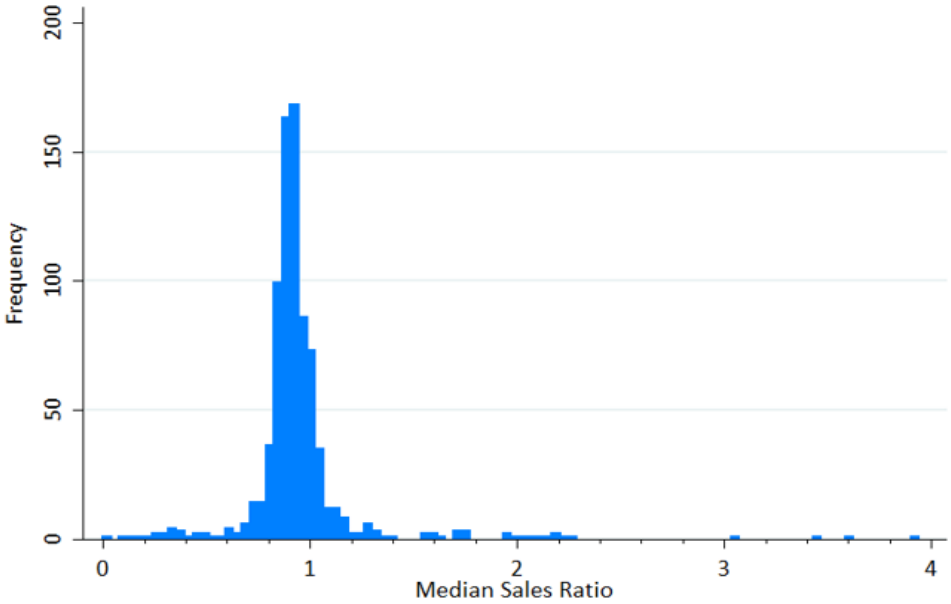
Source: Lincoln Institute of Land Policy

Figure 3.2 Number of States by Assessment Frequency



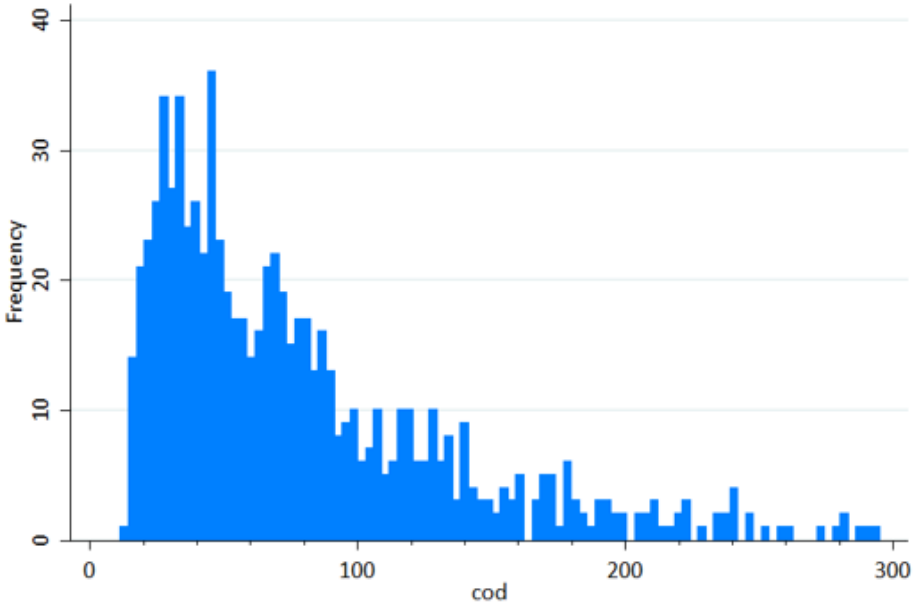
Source: Lincoln Institute of Land Policy

Figure 3.3 Frequency Distribution of Michigan Median Sales Ratio, 2016



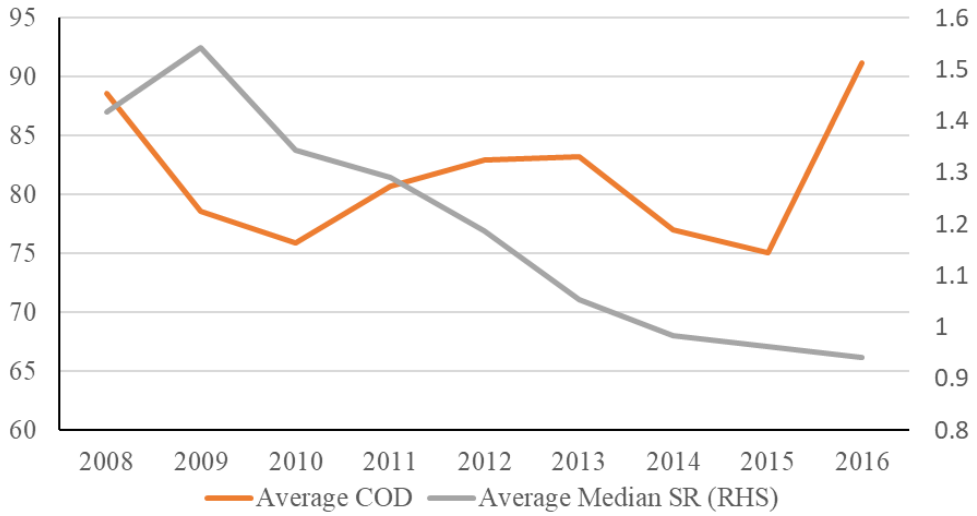
Source: Calculated
Note: Assessing units with transactions account less than 30 are eliminated.

Figure 3.4 Frequency Distribution of Michigan COD, 2016



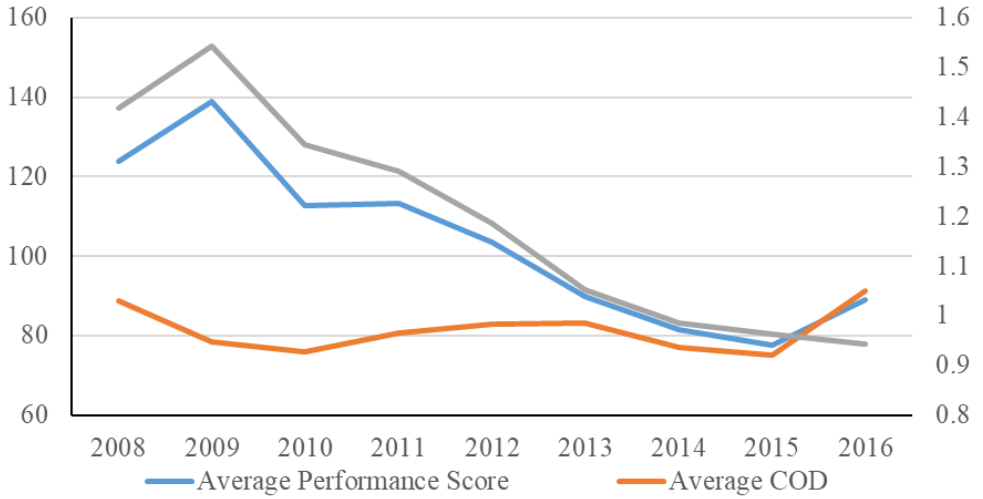
Source: Calculated
Note: Units with transactions account less than 30 are trimmed, COD bigger than 300 are not shown.

Figure 3.5 Michigan Assessment COD and Average Median Sales Ratio, 2008-2016



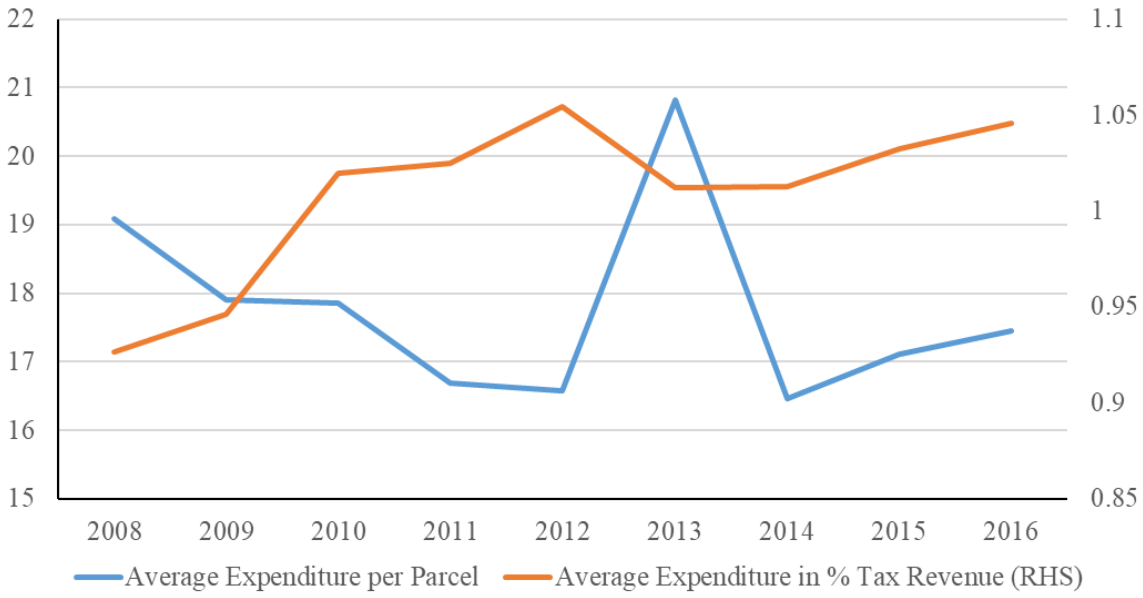
Source: Calculated.
Note: Units with transactions account less than 30 are eliminated.

Figure 3.6 Michigan Assessment Performance, 2008-2016



Source: Calculated.
Note: Units with transactions account less than 30 are eliminated.

Figure 3.7 Michigan Assessment Expenditure, 2008-2016



Source: Calculated.
Note: Units with transactions account less than 30 are eliminated.

CHAPTER 4:

A Dynamic Analysis of the Impacts of Changes in Housing Values on Property Tax Assessment During and After the 2008 Financial Crisis

4.1 Introduction

The property tax is a primary revenue source for state and local governments. In 2017, state and local property tax revenue accounted for 31.8 percent of total states and local general tax revenue, ranging from 17.3 percent in Alabama to 66.6 percent in Massachusetts, and in Michigan, the figure is 33.7 percent.[27] However, there is a concern that property tax revenue could experience rapid changes if housing price fluctuations were to be entirely passed through to property tax collection. This concern was especially heightened when housing prices declined dramatically during the 2008 Global Financial Crisis.

Changes in house prices are typically not immediately reflected in the property assessment and tax collection.[28] This phenomenon has captured many researchers' interest; how do property assessments respond to large cyclic upturns and downturns, especially real estate fluctuations? Many studies have examined the relationship between property price fluctuations and property tax revenues since the 2008 Global Financial Crisis. Most of this research found that the housing price fluctuations are not fully reflected in property tax revenue. In a relatively early study, using census data at both national and local levels from the 1980s to 2008, Lutz (2008) found that it takes about

[27] State & Local Government Finance Data Query System. http://www.taxpolicycenter.org/statistics/property-taxes-percentage-state-and-local-taxes. The Urban Institute-Brookings Institution Tax Policy Center. Data from U.S. Census Bureau, Annual Survey of State and Local Government Finances, Volume 4, and Census of Governments (1977-2017). 2017 data.
[28] Mikesell, and Liu, "Property Tax Stability: A Tax System Model of Base and Revenue Dynamics Through the Great Recession and Beyond", Public Finance and Management, Volume 13, Number 4, pp. 310-334, 2013

three years for house price changes to affect tax revenues; and the elasticity of property tax revenue to house prices reaches 0.4 over that period, Chernick, Langley, and Reschovsky (2011) forecast the impact of the recession and the housing crisis on central city revenues and expenditures between 2009 and 2013, using data from nation's largest central cities from 1997 to 2008. They estimate that property tax collection in these cities is 3.8% lower three years following a 10% reduction in the housing price index. Using local level housing data from Zillow® matched to property tax data from 1998 to 2012, Goodman (2018) also found that decreases in property values have an elasticity between 0.3 and 0.4; and that it takes three years for changes in values to be fully reflected in property tax revenues.

As the economic situation improves following a downturn, governments are relieved from immediate fiscal pressures. Thus, in recent years fewer researchers have focused on the relationship between housing prices and property assessments. The most recent published research in this area is Goodman (2017), which includes data for 2012, the starting point of housing market reversal after the dramatic decline. One contribution of the present work is that I extend the period of analysis to more fully explore the longer-run post-recession property assessment patterns.

Another line of related research has focused on the quality and timing of property assessment during periods of significant property price fluctuations. Such studies include Paglin and Fogarty (1972), Cheng (1974), IAAO (1978), Kochin and Parks (1982), Bell (1984), Sunderman et al. (1990), Clapp (1990), Hodge, et al. (2017), among others. The general findings in this line of research indicate that assessment ratios decline with the property sale price, which is a violation of the principle of vertical equity. Of most direct

relevance to the present study is Hodge, et al. (2017), who examine assessment quality in the wake of the financial crisis. They found that officials in the City of Detroit, who were facing imminent bankruptcy, did not reduce property assessments in response to dramatic real estate price reductions.

The present research aims to analyze the medium-term impact of the Global Financial Crisis's on property assessment by examining how local officials changed assessments during and following the crisis. To examine this issue, I construct and compare a Hedonic Housing Price Index (HPI) and a State Equalized Value (SEV) index for 120 Michigan assessing units in the five-county region surrounding Detroit (Macomb, Monroe, Oakland, Washtenaw, and Wayne counties), using individual parcel-level data on housing sales and local government property assessment in Michigan from 2008 through 2016. This analysis offers a multi-government evaluation of how housing price declines and then increases were reflected in assessed values, how long it took for such changes to be implemented, and the potential asymmetry in responses to price declines and increases. My examination also enables the differential behavior across different types of local units: do assessment patterns in struggling places such as Detroit behave differently than places that have a more robust economic base?

My analysis also demonstrates variability across local governments in property assessment practices; townships and cities can either significantly over-estimate or under-estimate assessments as indicated by the wide range of median sales ratios.[29] My analysis offers an evaluation of the different assessment practices across over- and under-estimating local governments. Do local governments that overestimate assessments pass

[29] Yunni Deng, "An Analysis of Public vs. Private Contracting Performance in Michigan Property Tax Assessment", working paper, 2021

through housing price declines more quickly to assessed values than an underestimating local government and vice versa? This chapter provides descriptive and anecdotal analyses in an attempt to explain the differences in governmental assessment objectives. To do this, I compare the HPI and the SEV indices for several local governments with high and low median sales ratios.[30]

This research also contributes to the literature by building an HPI at a much less aggregated level. All the above-cited studies use house price indices aggregated to a larger scale, such as county-, metropolitan-, or state-levels, which is much more aggregated than the level of property assessment and tax collection. Hence, a housing price index that is calculated at a more aggregated level does not always map well with local-level property tax assessments.

The remainder of this chapter is organized as follows. Section 2 provides a review of the current Michigan property assessment processes and guidelines. I discuss the construction of the indices in Section 3 and the data in Section 4. I present and discuss the empirical results in Section 5 and conclude in Section 6.

4.2 Institutional Details

4.2.1 Michigan Property Assessment and Tax Collection Process

In Michigan, property assessment is carried out annually in each local assessing district (townships, cities, and villages), with county equalization and state government oversight.

[30] Sales ratio is assessed value/sale price. Median sales ratio in one assessing district is the median sales ratio of each parcel sold in a particular year in that district, which is a widely used measurement of assessment precision.

The process of Michigan property assessment contains three steps: i) the local assessor (township, city, or village assessor) determines the **assessed value** (AV) of property, which is 50 percent of what the assessor determines to be the market price. The local assessors evaluate the market price of a property based on its condition on December 31 of the previous year, including: the advantages and disadvantages of location; quality of soil; zoning; existing use; present economic income of structures; present economic income of land if the land is being farmed or used for the production of income; quantity and value of standing timber; water power and privileges, etc.; ii) The board of commissioners in each county equalization department equalizes to ensure that property owners in all local assessing districts in the county pay their fair share of that unit's taxes; 3) the State Tax Commission (STC) applies an adjustment factor to the county assessments to bring the total valuation across counties as close to the 50 percent level as possible. This process produces the property's **state equalized value** (SEV).[31]

4.2.2 Michigan Property Tax and Assessment Cap

Michigan has two different limitations on how much property tax revenue can grow each year.

The first limit is on property tax growth for each local government taxing unit (cities, villages, counties, and townships). According to the Headlee Amendment, an amendment to the Constitution enacted in 1978, if the total assessed value of a local tax unit's all existing properties, not including new properties, grows faster than the inflation rate, the maximum property tax rate must be rolled back. So property taxes on existing

[31] Michigan Legislature, Michigan Taxpayer's Guide, February 2017.

properties will not increase by more than inflation unless the local unit asks the voters for an override of the automatic rollback.

The second limit is on the annual growth in the assessed value of each parcel of property. In 1994, voters approved Michigan Education Finance Amendment, known as Proposal A, which restrained Michigan's increasing reliance on property taxes for K-12 funding. Proposal A introduced the term "**taxable value** (TV)," and since then, each parcel has three values, a capped value, an assessed value (SEV), and a taxable value.[32] Proposal A capped the taxable value to be the 1994 assessed value. Since 1994 the annual increase of the taxable value for each parcel of property may not exceed five percent or the rate of inflation, whichever is less. Unless a property is sold, its TV gets uncapped and reset to the SEV and then recapped, subjecting the growth limitation until it sells again.

To elaborate, the relationship of the three values, assessed value (AV) is 50 percent of its determined true cash value; state equalized value (SEV) is the assessed value as finalized by the county and state equalization process. In most municipalities, the SEV and AV are the same; taxable value (TV) is the lesser of SEV or capped value; capped value (CV) is the prior year's TV minus losses increased by the consumer price index or five percent, whichever is less, plus additions. It is worth noting that TV is the tax base of property tax, i.e., what is used to calculate property taxes, even though SEV is the final result of the assessment and equalization process.

In this research, I use assessed value (or state equalized value) as the measurement of property assessed value, because it is not capped and not affected by

[32] State Tax Commission, Guide to Basic Assessing, May 2018.

Proposal A, and only related to the assessor-determined true market value of the properties.

4.3 Indices Construction

4.3.1 Hedonic Price Index

In this section, I describe how I construct a Hedonic Housing Price Index for the 120 Michigan assessing units in the five-county region surrounding Detroit (Macomb, Monroe, Oakland, Washtenaw, and Wayne counties), using the parcel-level data on sale prices and the quality and characteristic attributes of the residential parcels sold. Hedonic pricing is a method that takes into account the inherent characteristics of the products. It is often used to calculate price indices for heterogeneous goods, because traditional measures of changes in the average price of such goods reflect not only changes in the price level but also changes in the quality-mix of goods transacted. The hedonic pricing index approach, on the other hand, helps to eliminate price differences that arise from changes in characteristics or quality of goods and focus on the pricing trend. The hedonic pricing method is advantageous when calculating the price index of the property market, where the price of a specific parcel is affected significantly by its own characteristics, such as square feet, appearance, age of structures, and condition, as well as characteristics of the surrounding environment, such as the distance to the nearest highway, crime rates, school districts, the pollution level, etc.

The hedonic pricing method uses a regression model to estimate the influence that each characteristic has on the price of a good, and interprets the resulting estimated coefficients on the characteristic variables to be the marginal price of a particular characteristic. The estimated marginal prices of various characteristics are then used to

extract the price difference arising from the overall pricing trend from the compound price changes.

The methods of constructing a hedonic price index can be divided into two groups: direct and indirect. Direct methods can be further divided into the Time Dummy Variable method and the Characteristic method. I use the Time Dummy Variable (TD) method in this paper for the following reasons: i) Among all hedonic pricing methods, TD is most relevant to the property market because properties are sold less frequently than other products and have their unique characteristics, structural or locational[33]; ii) TD method is relatively easy to apply to panel datasets, as it only requires the inclusion of time dummy variables into the data set, and does not require matching of properties.

The starting point is to construct a hedonic regression for all the property transactions in the five-county area from 2008 to 2016, as the TD method suggests pooling together transactions of different assessing districts to analyze the marginal prices of housing characteristics. This chapter uses a log-linear functional form of the hedonic regression. I have the prices of an individual property on the left-hand side (LHS) as the dependent variable and their characteristics on the right-hand side (RHS) as the explanatory variables. The hedonic regressions are estimated for the base year 2008 (t=0) and each successive year until 2016 (t=1, 2, …, 7). The log-linear functional form for period t is given by:

$$lnP_{it} = \gamma_0 + \sum_{t=1}^{T} D_{it}\gamma_t + \sum_{k=1}^{K} \delta_k lnX_{ikt} + \varepsilon_{it} \quad (1)$$

P_{it} is the selling price of property i in period t. γ_0 is the intercept term that captures the time effect of the base period. D_{it} is a vector of dummy variables that take

[33] William Chow (2011), "Hedonic Price Index: An Illustration with Residential Property Prices"

on the value of 1 if the transaction takes place in period *t*, and 0 otherwise, γ_t is a vector of 7 constants. Thus, the time effect of period t is represented by $\gamma_0 + \gamma_t$. X_{ikt} is a vector of K price-determining characteristics for property *i* in period *t*. δ_k are the coefficients from the hedonic equation, and can be interpreted as the marginal price of the *k*-th characteristic. ε_{it} is the error term.

The price-determining characteristics in the hedonic housing price function usually include property attributes, such as building size, building age, physical condition, location influence (positive or negative aspects associated with the parcel's location such as waterfront, airport, etc.). Considering the data constraints, I used the following attributes in this analysis: land area (square feet), number of bathrooms, garage area (square feet), the month of the transaction, and five-digit zip code. I would like to include other variables, such as building size, the total number of rooms, and building age, but data limitations prevent the inclusion of these factors. However, based on the regression results presented later, the variables included in my analysis explain a large proportion of price variation. I offer a more detailed discussion regarding variables selection and the hedonic regression results in later sections.

One assumption of the TD hedonic method is that the coefficients δ_k of the hedonic regression are constant over all time periods: $\delta_k^0 = \delta_k^t = \delta_k$ for all *t*. This restriction assumes that the prices for each price-determining characteristic remain unchanged throughout the sample period, and among the whole state. This assumption is unlikely to hold precisely but has its advantages for i) making the model much more straightforward; and ii) making estimation of equation (1) possible even with a limited number of transactions each year in each assessing unit. Although in this particular

analysis, the assessing units with less than 30 transactions are eliminated in the final analysis for their small sample sizes.

Equation (1) illustrated the regression model:

$$ln\hat{P}_{it} = \hat{\gamma}_0 + \sum_{t=1}^{T} D_{it}\hat{\gamma}_t + \sum_{k=1}^{K} \hat{\delta}_k lnX_{ikt} \quad (2)$$

where $\hat{P}_{it}$, $\hat{\gamma}_0$, $\hat{\gamma}_t$, and $\hat{\delta}_k$ are the estimator of P_{it}, γ_0, γ_t, and δ_k.

I then evaluate the TD hedonic price index for each assessing district based on its average characteristics and the estimated parameters in equation (2). The computation is shown in equation (3), and details of the index construction process can be found in de Haan (2004):

$$P_t^h = \frac{\prod_{i\epsilon h_t}(P_{it})^{1/n_t}}{\prod_{i\epsilon h_0}(P_{i0})^{1/n_0}} exp\left[\sum_{k=1}^{K} \widehat{\delta_k}(\overline{X_{k0}} - \overline{X_{kt}})\right] = \exp(\hat{\gamma}_t), \text{ where } \overline{X_{kt}} = \sum_{i\epsilon h_t} \frac{X_{ikt}}{n_t} \quad (3)$$

where P_t^h is the estimator of the quality-adjusted price index for assessing district *h* in period *t*, $i\epsilon h_t$ means parcel *i* is in assessing district *h* transacted in period *t*, P_{it} is the selling price of property i in period t, n_t is the number of parcels sold in district *h* in period *t*. Thus, $\prod_{i\epsilon h_t}(P_{it})^{1/n_t}$ is the geometric average of selling prices within district h in period t. $\widehat{\delta_k}$ is the estimator of δ_k, which is the price effect of the *k*-th characteristic. $\overline{X_{kt}} = \sum_{i\epsilon h_t} \frac{X_{ikt}}{n_t}$ is the average of the jth characteristic in period t, and thus $\sum_{k=1}^{K} \widehat{\delta_k}(\overline{X_{k0}} - \overline{X_{kt}})$ reflects the housing price changes due to the average changes of all characteristics from period 0 to period t. According to de Haan (2004), $\frac{\prod_{i\epsilon h_t}(P_{it})^{1/n_t}}{\prod_{i\epsilon h_0}(P_{i0})^{1/n_0}} exp\left[\sum_{k=1}^{K} \widehat{\delta_k}(\overline{X_{k0}} - \overline{X_{kt}})\right]$ approximately equals to $\exp(\hat{\gamma}_t)$, which makes the interpretation very intuitive, as $\hat{\gamma}_t$ is the estimator of γ_t—the difference between the time effect of period t ($\gamma_0 + \gamma_t$) and that of period 0 (γ_0). The price index can therefore be readily derived from the estimated

coefficients of the time dummy variable $\hat{\gamma}_t$. The price index is 100*exp($\hat{\gamma}_t$) for each period t=1,..,T, with respect to base period t=0, which equals 100.

4.3.2 SEV index

I also create the SEV index, which reflects the fluctuation of average property assessed value and is comparable to the HPI index constructed in section 3.1.

Similar to the HPI index, the SEV index is 100 for the base period t=0, which is 2008. And for each period within t=1,..,T, the SEV index is calculated as dividing the SEV per parcel in period t by the SEV per parcel in the base period, or

$$S_t^h = 100 \frac{SEV_t^h / Parcel_t^h}{SEV_0^h / Parcel_0^h} \quad (4)$$

S_t^h is the calculated SEV index for assessing district *h* in period *t*. SEV_t^h is the total assessed value, or state equalized value for assessing district *h* in period *t*, SEV_0^h is the total SEV for assessing district *h* in the base period 2008. $Parcel_t^h$ is the total number of parcels in assessing district *h* in period *t*, $Parcel_0^h$ is the total number of parcels in assessing district *h* in the base period 2008.

4.3.3 Median Sales Ratio

The median sales ratio is a widely used measurement of assessment precision, or assessment level in this profession (IAAO, 1990). It measures the degree to which goals or specific legal requirements are met. The median sales ratio in assessing district *h* in period *t* is the median assessed value over the sale price ratio of each parcel transacted in district *h* in period *t*.

The median sales ratio is annual and is based on the parcels sold in a given year. The closer the median sales ratio is to 1, the higher the assessment quality is in the assessing district. The ideal assessment would have a median sales ratio of 1, implying

that the properties in the district are neither systematically over-assessed nor under-assessed. Please note that this only provides a general measure of assessment quality, other methods such as those used in Hodge, et al (2017) are beyond the scope of the present analysis.

4.4 Data

4.4.1 Data used to calculate Hedonic HPI

I calculated the Hedonic Housing Price Index with the base year of 2008; in the 120 Michigan assessing units in the five-county region surrounding Detroit (Macomb, Monroe, Oakland, Washtenaw, and Wayne counties). The selection of this five-county region is consistent with Skidmore, Reese, and Kang (2012) in their analysis of tax competition effects of Michigan property tax, and is adopted for this research for two reasons: 1) This five-county region is the most densely populated area in Michigan and covers many of the most populated cities in the state, including Detroit, Ann Arbor, Sterling Heights, and Warren; This dense concentration of people and property parcels gives us confidence that we can estimate an HPI for each local government jurisdictions; 2) this region includes Detroit, the city that witnessed one of the most drastic housing price changes during the 2008 financial crisis.

The dataset used in the calculation of the Housing Price Index is individual parcel data for all single-family residential units obtained from CoreLogic, LLC., which covers nearly all the property parcel information in the five-county region. For each single-family residential parcel, there are records on the latest transaction information, including sale price, and sale date, location information, including county, and local government belong to, address, census track, and zip code, and over 50 property attributes, including

building size, land size, number of rooms, number of bathrooms, building age, building condition, number of stories, number of furnaces, etc. Out of the many property attributes, I include the following in my analysis: land area (square feet), number of bathrooms, garage area (square feet), the month of the transaction, and five-digit zip code. The inclusion of these variables is based on the need to balance the data quality/availability and the number of observations included in my regression. I would prefer to add building size, the total number of rooms, and building age, but adding them would require omitting many observations because of low-quality and/or data unavailability. Robustness analyses using smaller samples with these additional variables suggest that inclusion of these other control variables may be unnecessary given the purpose of this paper because the number of bathrooms is closely related to building size and the total number of rooms, to some degree. Thus, the reduced variable specification, though potentially misspecified, generates relatively high explanatory power. Recall that the goal is to generate an HPI and not necessarily focus on coefficient estimates of specific property characteristics. The specification used in my analysis generates an R-square of about 0.5 depending on the local unit for the hedonic regressions, thus accounting for a large portion of price variability over time for each local unit.

Out of over 1,900,000 parcels in the five-county region, around 316,000 parcels are used in the analysis. The selection of properties is based on the following criteria: 1) the land usage of the property is "single house family" since it is most appropriate to construct a housing pricing index; 2) the property has a recorded sales transactions between 2008 and 2016; 3) there are no missing values or errors in the variables specified included the specification; 4) the transaction type is either "resale" or "sale of new

construction" (in order to eliminate of transactions where the sale price does not reflect true market value, such as refinancing); 5) the property with sales price larger than $1,000, and sales ratio, which is assessed value divided by sales price, smaller than 20 (to eliminate non-arm's length transactions). [34]

The number of observations used in the hedonic regression and the number of total parcels of each county and assessing unit are shown in Table 4.1 in the Appendix. The table shows the parcels used in the hedonic regression are around 10 to 20 percent of the total parcels in the majority of assessing units. However, some regressions used a considerably smaller proportion of total parcels. For example, Ray township in Macomb county has 2267 parcels, but only 52 parcels, or 2.3 percent of total parcels, are included in the regression. The reason for the low number of observations is due to the low data quality of these local governments. More specifically, a large proportion of the parcel level data in these governments are missing one or more attributes. Those governments using more than 10 percent of total parcels generally have high-quality data. In such governments, most parcels trimmed out are for the property type and lack of sales between 2008 to 2016, not for missing data.

4.4.2 Data used to calculate SEV index

I calculated a SEV per parcel index with the base year of 2008 for each of the 120 assessing districts and the five counties, in order to make a comparison with the HPI index constructed. The data used is an assessing district-level dataset obtained from the Michigan Department of Treasury. In its annual L-4023 form, the Department of Treasury publishes the total assessed value of all properties and the number of total

[34] Consistent with the criteria used in Chapter 3.

parcels of the state, each county, and assessing district. As mentioned in the previous section, the assessed value is 50 percent of its determined true cash value, which equals SEV in most municipalities. I calculate the SEV per parcel from 2008 to 2016 for each county and local government by dividing the total assessed value by the number of parcels.

The SEV index measures fluctuations in the assessed value for all parcels in an assessing district, not just for the single house family with a transaction from 2008 to 2016. Thus, the calculation involves all single house parcels in an assessing district, as opposed to the calculation of HPI, where only single-family residential properties sold between 2008 and 2016 are involved.

4.4.3 Data used to calculate Median Sales Ratio

I calculate the median sales ratio using individual parcel tax records and current sales data obtained from CoreLogic. The calculation of median sales ratio involves only parcels sold in the calculated year after trimming out non-arm's-length transactions, errors, and outliers. To ensure all sales ratios included in the calculation are correctly recorded arm's-length, open-market transfer, I eliminated all individual transactions with transaction types other than "resale" and "new construction." Eliminated transaction types include non-arm's-length transactions, construction loan/financing, and seller carrybacks. Those transactions are not standard open-market transactions, and their sales prices are not proper reflections of their market values. I also eliminated all individual transactions with sales prices less than $1,000 or sales ratios greater than 20 to eliminate errors or non-arm's-length transactions. Since Michigan assesses property values at 50 percent of

market value, I calculate the sales ratios; as two times the assessed value divided by market value.

4.5 Results and Discussion

4.5.1 Time Dummies Hedonic Regressions

The results of 124-time dummies hedonic regressions are shown in Table 4.1 in the Appendix, including 119 regressions for local governments, and five regressions for the counties. The table shows the coefficients and standard errors of each year dummy, and each of the hedonic attributes of houses used in the regression, including the log of land area, the log of the garage area, and the number of bathrooms. The coefficient of the sale year 2008 is not reported because 2008 is set to be the base year. The five-digit zip code dummies and sale month dummies are included in the regressions, but the coefficients are not shown for space reasons.

Again, the parcels used in the hedonic regression are around 10 to 20 percent of total parcels in the majority of assessing units. However, some regressions only used a much smaller proportion, and thus the quality of the regression may be lower because: 1) the number of observations is smaller, which makes the regression less likely to generate reasonable-size effects with reasonable power; 2) the sample may be unrepresentative because of selection bias. For example, in Monroe county, only Monroe township has satisfactory data, and thus the regression of Monroe county only reflects Monroe township.

The average R-square for all regressions is 0.49, which offers a strong level of the explanatory power of the hedonic model. Note that the average R-square of the five-county regressions – 0.64 – is considerably higher than the average R-square. And if we

only count the three counties where the parcels used account for higher than 10 percent of total parcels (Macomb, Oakland, and Wayne), the average R-square becomes 0.72, which is even higher. One possible explanation for the results is that the sample in the county regressions are more varied, and a larger part of this variation can be explained by differences of attributes, including location differences.

4.5.2 Comparison of Indices

Table 4.2 in the Appendix presents the housing price index, SEV index, and the median sales ratio for 108 local governments and the five counties. Indices for a few townships (including Lenox, Ray, New Haven, and eight other townships) are not shown because the hedonic regressions for these districts used less than 100 observations or 10 percent of total parcels, and thus less likely to generate a meaningful HPI.

The left side of the following panel figure (Figure 4.1) shows the indices of three counties with high-quality data (Macomb, Oakland, and Wayne). The right side shows the city and township averages and two typical townships. In most districts, the housing price index went down dramatically in 2009, and remained nearly unchanged until 2011, and started to increase in 2012. Housing prices recovered to 2008 levels around 2013 or 2014 in most districts, and the rising trend continued through 2016. In 2008, SEV per parcel went down, but not as much as housing prices, which helped with tax revenue stabilization during the immediate crisis, though assessment delays also mean that property owners are paying too high a tax. However, SEV per parcel continued to fall until 2012 or 2013, to a level even lower than the lowest HPI level. Interestingly, eight years past the financial crisis, assessed values are still far from their initial 2008 levels, though housing prices recovered to 2008 levels around 2013 or 2014.

Figure 4.1 Indices Comparison of Representative Counties and Cities

This result is consistent with the literature that there is about a three-year lag from the housing price decline to tax assessment but challenges the literature that the elasticity of tax revenue to housing prices is far less than one. Although the property tax revenue is relatively stable in the short run, the problem is only delayed and not mitigated in the longer term. Assessed property values decreased more slowly than housing prices did in 2009, but fell to an even deeper level than housing prices when we look further out in

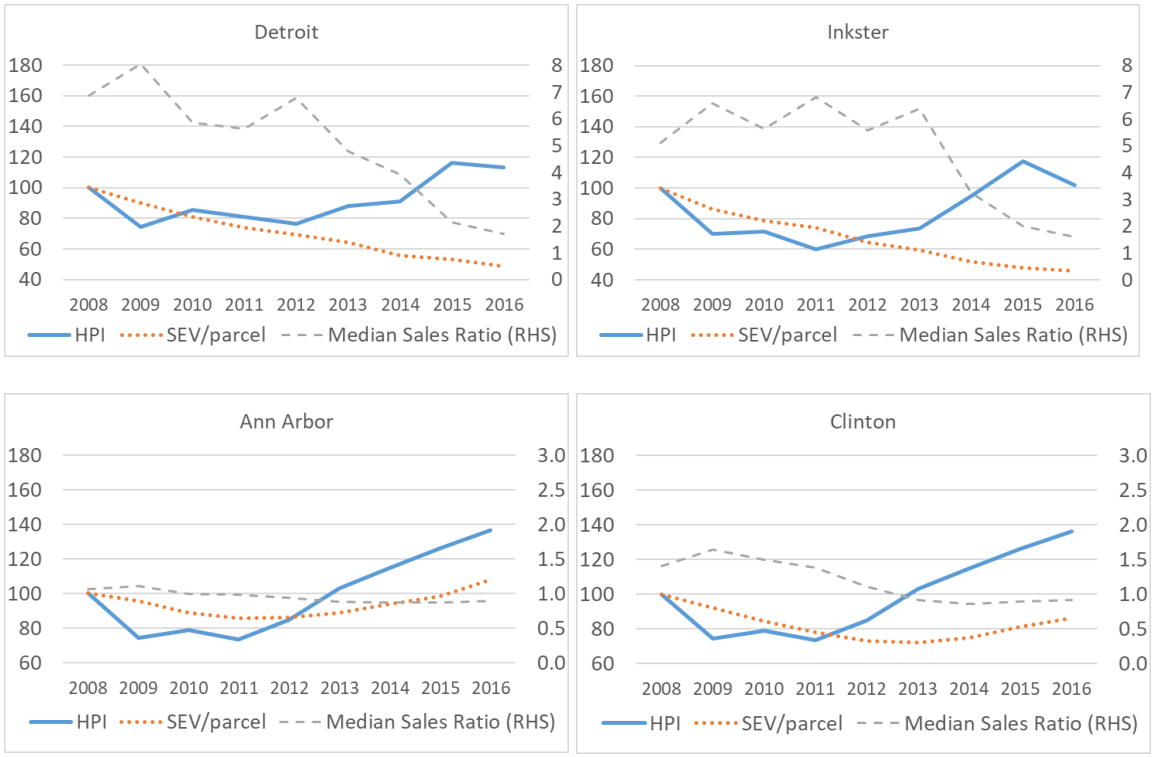
time. In fact, the problem becomes more severe because generally the lowest level of SEV per parcel is even lower than that of housing prices.

4.5.3 Different behavior of over-estimating governments

Anecdotally, the behavior of over-estimating governments is very different from other governments. In the 108 local governments reported in Table 4.2 in Appendix, the average initial median sales ratio in 2008 was 1.83, which indicates a systematic overestimation in general. However, there are a few local governments that over-estimate to a much higher degree, including Detroit, Inkster, River Rouge, Ecorse, Highland Park, and Pontiac, with an initial median sales ratio of 6.9, 5.1, 7.8, 6.7, 6.3, and 6.1, respectively. While the SEV index in most other local governments started to pick up around 2013 or 2014, these six cities never turned around, and where SEV continues to fall until 2016. The median sales ratio also continues to fall during the entire period in the six over-estimating governments. This finding is opposite to the other governments, which had SEV's that stabilized or even started to increase around 2014.

In the following panel figure (Figure 4.2), I compared the housing price and assessment behavior of two large over-estimating cities, Detroit and Inkster, with two other large cities, Ann Arbor, Clinton. It is clear that the SEV index decreases from 2008 to 2016 in both Detroit and Inkster, and the decrease is quite sharp, without any signs of stopping. On the other hand, the SEV index reached its lowest point in 2012 or 2013 in Ann Arbor and Clinton, which is similar to most other cities. This pattern demonstrates that assessments during and following the crisis served as a self-correcting scheme, as over-estimating governments took the housing price declines as an opportunity to correct its over-assessment condition.

Figure 4.2 Comparison of Overestimating and Other Cities



The crisis served to help correct the variation of assessment precision as well. From Table 4.2 in the Appendix, we see that the range of median sales ratio is wide in 2008, from 0[35] to 7.8, but is considerably narrowed in 2016, from 0.2 to 3.9, with over 90 percent of local units falling between 0.8 and 1. Previously before the crisis, Michigan failed to assess properties across local governments equally: some places are way overestimated than others. As financially stressful governments likely to overestimate properties, this inequality can cause the state and local tax burden to be regressive, meaning that people in financially unhealthy cities such as Detroit (usually lower-income households) are paying a higher share of taxes.[36] After the crisis, this inequality is

[35] York city in Washtenaw county.

[36] According to "How Lower-Income Americans Get Cheated on Property Taxes" from the New York Times, more expensive properties are undervalued, while less expensive properties are overvalued, resulting that most state and local governments collect a larger share of the income of lower-income households than of upper-income households. New York Times. (2021). "How Lower-Income Americans Get Cheated on

significantly alleviated, meaning that people across different local governments and different financial backgrounds are now treated more equally than before.

4.6 Conclusion

My findings are generally consistent with the literature that there is about a three-year lag between the housing price changes and changes in property assessments for tax purposes. However, my research also suggests that the earlier showing that the elasticity of property assessment (and thus property tax revenue) to housing prices is far less than one may not apply to Michigan. Assessed property value decreased more slowly than housing prices fell immediately after the crisis, but ultimately fell to an even deeper level than housing prices when we consider a longer time horizon. In other words, the decline in housing prices passes through completely to assessed values, and the elasticity might be greater than one, given enough time.

Before the crisis, a number of Michigan communities tended to overestimate property values to support property tax revenue streams. I find that assessment adjustments to market declines in these overestimating places lagged in other fiscally healthier cities. On a positive note, my evaluation also shows that local authorities in these struggling communities used the financial crisis period as an opportunity to realign assessments more closely to actual market conditions as per legal requirements. While the SEV index in most local governments began to once again grow in the wake of the crisis by 2013 or 2014, SEVs in struggling local governments such as Detroit continued to fall through 2016.

Property Taxes". 04/03. Accessed at: https://www.nytimes.com/2021/04/03/opinion/sunday/property-taxes-housing-assessment-inequality.html

Given that SEV per parcel for most districts has not risen to their 2008 levels, it seems that the impact of the 2008 financial crisis on property assessment had not concluded until about 2016. Going forward, it would be interesting to extend this research with more recent data to examine whether the median sales ratios remained closely aligned with legal requirements.

To further explore the impact of housing price changes on property assessment, it would be interesting to calculate each assessing district's elasticity of assessed value regarding housing price changes in a relatively long term. The next step is to compare different districts, to see whether some districts have higher elasticity than other districts, and find out the reasons for potential variations. Who are the districts responding mostly to housing price changes, and is there any geographic clustering of such districts? Why are they responding more drastically than others, is such response associated with the social and economic characteristics of the districts? Answering these questions would offer a more comprehensive view of Michigan property assessment and thus shed some light on how to improve property assessments in general.

APPENDIX

Table 4.1 Results of Time Dummies Hedonic Regressions

Government	2009	2010	2011	2012	2013	2014	2015	2016	lgLand	lgGarage	BATH	5-digit Zip	Sale Month	Parcels Used 1/	Total Parcels	Parcels Used (%)	R^2
Macomb																	
ARMADA TOW	-0.042	-0.121	-0.261	-0.248	0.033	0.136	0.172	0.177	0.104	-0.029	0.359	X	X	268	2586	10.4%	0.44
	(0.157)	(0.150)	(0.157)*	(0.153)	(0.142)	(0.145)	(0.150)	(0.137)	(0.033)***	(0.015)*	(0.033)***						
ARMADA VIL	-0.330	-0.527	-0.579	-0.271	-0.019	-0.218	0.288	0.205	-0.071	-0.004	0.230	X	X	159	*669*	23.8%	0.50
	(0.181)*	(0.168)***	(0.196)***	(0.172)	(0.189)	(0.184)	(0.159)*	(0.177)	(0.090)	(0.014)	(0.051)***						
BRUCE TOWN	-0.149	0.006	0.004	-0.219	-0.025	0.266	0.359	0.487	0.016	0.066	0.212	X	X	451	4433	10.2%	0.41
	(0.141)	(0.136)	(0.134)	(0.119)*	(0.121)	(0.116)**	(0.116)***	(0.116)***	(0.022)	(0.009)***	(0.024)***						
CENTER LIN	-0.383	-0.342	-0.407	-0.256	0.007	0.176	0.350	0.496	0.292	0.062	0.273	X	X	749	3110	24.1%	0.43
	(0.076)***	(0.080)***	(0.080)***	(0.077)***	(0.075)	(0.075)**	(0.078)***	(0.073)***	(0.055)***	(0.010)***	(0.028)***						
CHESTERFIE	-0.269	-0.153	-0.177	-0.060	0.102	0.190	0.254	0.302	0.008	0.019	0.290	X	X	2047	18314	11.2%	0.48
	(0.034)***	(0.034)***	(0.032)***	(0.033)*	(0.030)***	(0.031)***	(0.030)***	(0.029)***	(0.012)	(0.003)***	(0.009)***						
CLINTON TO	-0.295	-0.236	-0.307	-0.163	0.029	0.138	0.232	0.310	0.229	0.059	0.310	X	X	5446	35838	15.2%	0.63
	(0.028)***	(0.029)***	(0.029)***	(0.027)***	(0.027)	(0.026)***	(0.026)***	(0.025)***	(0.013)***	(0.003)***	(0.007)***						
EASTPOINTE	-0.450	-0.361	-0.375	-0.319	-0.051	0.393	0.371	0.376	0.289	-0.003	0.168	X	X	4569	14652	31.2%	0.27
	(0.042)***	(0.043)***	(0.043)***	(0.044)***	(0.043)	(0.043)***	(0.042)***	(0.041)***	(0.033)***	(0.003)	(0.017)***						
FRASER	-0.289	-0.309	-0.376	-0.268	-0.096	0.026	0.146	0.234	0.032	-0.004	0.338	X	X	1026	6303	16.3%	0.44
	(0.068)***	(0.064)***	(0.063)***	(0.063)***	(0.061)	(0.060)	(0.059)**	(0.058)***	(0.028)	(0.008)	(0.016)***						
HARRISON T	-0.263	-0.175	-0.200	-0.153	0.051	0.163	0.291	0.318	0.055	0.039	0.424	X	X	1613	11972	13.5%	0.45
	(0.066)***	(0.065)***	(0.063)***	(0.062)**	(0.059)	(0.059)***	(0.059)***	(0.057)***	(0.023)**	(0.006)***	(0.015)***						
LENOX TOWN	-0.784	-0.237	-0.954	-0.553	-0.579	-0.312	-0.085	-0.114	0.126	0.000	0.119	X	X	53	3717	1.4%	0.58
	(0.453)*	(0.483)	(0.379)**	(0.360)	(0.437)	(0.392)	(0.369)	(0.348)	(0.086)	(0.025)	(0.124)						
MACOMB TOW	-0.148	-0.109	-0.148	-0.038	0.101	0.161	0.209	0.257	-0.025	0.007	0.329	X	X	3694	30753	12.0%	0.55
	(0.016)***	(0.016)***	(0.016)***	(0.015)**	(0.015)***	(0.015)***	(0.014)***	(0.014)***	(0.009)***	(0.002)***	(0.006)***						
MOUNT CLEM	-0.581	-0.410	-0.414	-0.215	0.040	0.328	0.483	0.589	0.564	0.054	0.063	X	X	921	6872	13.4%	0.38
	(0.093)***	(0.098)***	(0.103)***	(0.113)*	(0.104)	(0.100)***	(0.100)***	(0.092)***	(0.058)***	(0.008)***	(0.027)**						
NEW BALTIM	-0.202	-0.149	-0.127	-0.070	0.051	0.209	0.237	0.311	0.054	-0.002	0.344	X	X	1118	4835	23.1%	0.41
	(0.063)***	(0.065)**	(0.061)**	(0.060)	(0.059)	(0.059)***	(0.057)***	(0.056)***	(0.024)**	(0.004)	(0.015)***						
NEW HAVEN	-0.519	-1.038	-0.507	-1.148	0.513	0.549	0.214	0.167	-0.245	-0.059	0.684	X	X	37	*1681*	2.2%	0.79
	(0.681)	(0.633)	(0.583)	(0.704)	(0.578)	(0.527)	(0.463)	(0.684)	(0.673)	(0.052)	(0.300)**						
RAY TOWNSH	-0.770	-0.748	-0.883	-0.120	-0.144	-0.081	-0.321	0.049	0.240	0.022	0.460	X	X	52	2267	2.3%	0.70
	(0.493)	(0.416)*	(0.358)**	(0.373)	(0.348)	(0.354)	(0.377)	(0.376)	(0.064)***	(0.025)	(0.110)***						
ROMEO VILL	-0.027	-0.160	0.024	0.056	0.345	0.360	0.534	0.632	0.239	0.052	0.220	X	X	305	*1613*	18.9%	0.54
	(0.191)	(0.198)	(0.189)	(0.185)	(0.184)*	(0.182)**	(0.180)***	(0.179)***	(0.047)***	(0.009)***	(0.029)***						

Note: Numbers in the brackets are standard errors, * indicates statistical significance of 0.1 level, ** indicates statistical 1/ 1/ significance of 0.05 level, *** indicates statistical significance of 0.01 level.
1/ Numbers in Italic comes are calculated from CoreLogic, other numbers are from Michigan Department of Treasury.

Table 4.1 (Cont'd)

Government	2009	2010	2011	2012	2013	2014	2015	2016	lgLand	lgGarage	BATH	5-digit Zip	Sale Month	Parcels Used 1/	Total Parcels	Parcels Used (%)	R^2
ROSEVILLE	-0.394	-0.413	-0.384	-0.306	-0.088	0.219	0.331	0.404	0.099	0.037	0.275	X	X	4845	20049	24.2%	0.33
	(0.037)***	(0.039)***	(0.039)***	(0.039)***	(0.037)**	(0.037)***	(0.037)***	(0.036)***	(0.021)***	(0.003)***	(0.013)***						
SAINT CLAI	-0.304	-0.352	-0.372	-0.226	-0.038	0.105	0.223	0.292	0.257	0.036	0.214	X	X	6545	28773	22.7%	0.35
	(0.030)***	(0.029)***	(0.029)***	(0.028)***	(0.027)	(0.027)***	(0.026)***	(0.026)***	(0.016)***	(0.003)***	(0.009)***						
SHELBY TOW	-0.176	-0.193	-0.227	-0.102	0.075	0.160	0.187	0.257	-0.037	0.044	0.363	X	X	3880	30422	12.8%	0.68
	(0.026)***	(0.025)***	(0.025)***	(0.024)***	(0.023)***	(0.023)***	(0.022)***	(0.022)***	(0.007)***	(0.003)***	(0.006)***						
STERLING H	-0.219	-0.227	-0.269	-0.162	0.028	0.141	0.188	0.258	0.022	-0.006	0.275	X	X	5210	46885	11.1%	0.52
	(0.017)***	(0.017)***	(0.016)***	(0.016)***	(0.015)*	(0.015)***	(0.015)***	(0.015)***	(0.012)*	(0.001)***	(0.005)***						
UTICA	-0.152	-0.242	-0.693	-0.156	0.152	0.234	0.249	0.327	0.062	0.020	0.211	X	X	260	2063	12.6%	0.37
	(0.179)	(0.183)	(0.173)***	(0.161)	(0.167)	(0.167)	(0.163)	(0.157)**	(0.085)	(0.011)*	(0.045)***						
WARREN	-0.327	-0.268	-0.112	-0.109	0.155	0.362	0.584	0.535	0.374	0.056	0.103	X	X	13316	59291	22.5%	0.48
	(0.028)***	(0.028)***	(0.028)***	(0.028)***	(0.027)***	(0.027)***	(0.026)***	(0.026)***	(0.017)***	(0.003)***	(0.011)***						
WASHINGTON	-0.159	-0.210	-0.210	-0.115	0.009	0.156	0.279	0.275	0.015	0.011	0.310	X	X	1563	11364	13.8%	0.43
	(0.061)**	(0.062)***	(0.061)***	(0.057)**	(0.056)	(0.056)***	(0.055)***	(0.055)***	(0.014)	(0.003)***	(0.010)***						
Monroe																	
MONROE	-0.278	-0.358	-0.302	-0.274	-0.142	-0.022	0.076	0.256	0.316	0.079	0.228	X	X	1765	8720	20.2%	0.45
	(0.070)***	(0.075)***	(0.070)***	(0.072)***	(0.066)**	(0.065)	(0.064)	(0.062)***	(0.036)***	(0.006)***	(0.020)***						
Oakland																	
ADDISON TO	-0.135	-0.209	-0.118	-0.153	0.048	0.056	0.287	0.335	0.030	0.013	0.275	X	X	489	3237	15.1%	0.35
	(0.137)	(0.133)	(0.125)	(0.120)	(0.119)	(0.124)	(0.117)**	(0.119)***	(0.022)	(0.012)	(0.027)***						
AUBURN HIL	-0.501	-0.364	-0.377	-0.277	-0.011	0.156	0.300	0.394	0.068	0.049	0.465	X	X	1035	8233	12.6%	0.56
	(0.081)***	(0.079)***	(0.075)***	(0.078)***	(0.075)	(0.074)**	(0.073)***	(0.071)***	(0.023)***	(0.008)***	(0.017)***						
BERKLEY	-0.220	-0.259	-0.374	-0.142	0.073	0.210	0.262	0.346	0.148	0.032	0.273	X	X	2230	7748	28.8%	0.52
	(0.042)***	(0.042)***	(0.041)***	(0.038)***	(0.036)**	(0.035)***	(0.035)***	(0.034)***	(0.030)***	(0.003)***	(0.009)***						
BEVERLY HI	-0.208	-0.229	-0.143	0.002	0.154	0.221	0.310	0.355	0.091	0.083	0.236	X	X	1184	*4188*	28.3%	0.57
	(0.053)***	(0.049)***	(0.048)***	(0.046)	(0.046)***	(0.046)***	(0.045)***	(0.044)***	(0.018)***	(0.011)***	(0.011)***						
BINGHAM FA	-0.695	-0.606	-0.554	-0.303	-0.287	-0.076	-0.205	0.007	-0.081	0.159	0.194	X	X	70	*552*	12.7%	0.64
	(0.389)*	(0.438)	(0.454)	(0.400)	(0.435)	(0.388)	(0.410)	(0.388)	(0.108)	(0.320)	(0.061)***						
BIRMINGHAM	-0.152	-0.101	-0.040	0.062	0.268	0.342	0.391	0.457	0.200	0.059	0.247	X	X	2517	11310	22.3%	0.55
	(0.053)***	(0.051)*	(0.050)	(0.048)	(0.049)***	(0.048)***	(0.047)***	(0.047)***	(0.022)***	(0.007)***	(0.006)***						
BLOOMFIELD	-0.118	-0.047	0.011	0.029	0.209	0.325	0.333	0.399	0.196	0.074	0.252	X	X	4212	19644	21.4%	0.51
	(0.039)***	(0.037)	(0.036)	(0.035)	(0.035)***	(0.035)***	(0.035)***	(0.035)***	(0.014)***	(0.012)***	(0.005)***						

Note: Numbers in the brackets are standard errors, * indicates statistical significance of 0.1 level, ** indicates statistical 1/ 1/ significance of 0.05 level, *** indicates statistical significance of 0.01 level.
1/ Numbers in Italic comes are calculated from CoreLogic, other numbers are from Michigan Department of Treasury.

Table 4.1 (Cont'd)

Government	2009	2010	2011	2012	2013	2014	2015	2016	lgLand	lgGarage	BATH	5-digit Zip	Sale Month	Parcels Used 1/	Total Parcels	Parcels Used (%)	R^2
BRANDON TO	-0.174	-0.132	-0.055	-0.028	0.168	0.252	0.359	0.412	0.005	0.042	0.378	X	X	1147	6404	17.9%	0.46
	(0.068)**	(0.065)**	(0.063)	(0.062)	(0.062)***	(0.062)***	(0.060)***	(0.059)***	(0.007)	(0.006)***	(0.019)***						
CLARKSTON	-0.196	-0.200	-0.185	0.132	0.009	0.323	0.328	0.627	0.054	0.033	0.275	X	X	94	542	17.3%	0.54
	(0.323)	(0.308)	(0.293)	(0.274)	(0.281)	(0.281)	(0.272)	(0.280)**	(0.090)	(0.027)	(0.059)***						
CLAWSON	-0.387	-0.243	-0.310	-0.106	0.099	0.239	0.304	0.354	0.004	0.030	0.238	X	X	1386	5889	23.5%	0.51
	(0.049)***	(0.048)***	(0.045)***	(0.043)**	(0.043)**	(0.041)***	(0.040)***	(0.040)***	(0.026)	(0.004)***	(0.012)***						
COMMERCE T	-0.446	-0.309	-0.404	-0.257	-0.058	0.006	0.104	0.207	0.105	0.045	0.382	X	X	2482	18638	13.3%	0.57
	(0.047)***	(0.047)***	(0.046)***	(0.046)***	(0.043)	(0.043)	(0.042)**	(0.042)***	(0.015)***	(0.005)***	(0.009)***						
FARMINGTON	-0.231	-0.144	-0.171	-0.099	0.088	0.214	0.258	0.327	0.086	0.074	0.310	X	X	6304	30906	20.4%	0.64
	(0.022)***	(0.022)***	(0.022)***	(0.021)***	(0.020)***	(0.020)***	(0.020)***	(0.019)***	(0.008)***	(0.003)***	(0.005)***						
FERNDALE	-0.334	-0.365	-0.346	-0.062	0.343	0.531	0.656	0.787	0.381	0.036	0.374	X	X	3165	11078	28.6%	0.53
	(0.053)***	(0.052)***	(0.051)***	(0.050)	(0.047)***	(0.046)***	(0.045)***	(0.044)***	(0.037)***	(0.003)***	(0.015)***						
FRANKLIN V	-0.389	-0.232	0.037	-0.034	0.028	0.254	0.199	0.308	0.181	-0.050	0.214	X	X	302	*1313*	23.0%	0.42
	(0.163)**	(0.152)	(0.159)	(0.151)	(0.146)	(0.146)*	(0.148)	(0.152)**	(0.057)***	(0.041)	(0.022)***						
GROVELAND	-0.205	-0.475	-0.180	-0.148	0.046	0.198	0.184	0.273	0.116	0.060	0.296	X	X	444	2614	17.0%	0.51
	(0.109)*	(0.111)***	(0.110)	(0.108)	(0.102)	(0.101)*	(0.099)*	(0.100)***	(0.022)***	(0.013)***	(0.024)***						
HAZEL PARK	-0.343	-0.338	-0.408	-0.142	0.008	0.449	0.576	0.765	0.221	0.035	0.423	X	X	2022	8372	24.2%	0.37
	(0.058)***	(0.056)***	(0.063)***	(0.063)**	(0.061)	(0.063)***	(0.063)***	(0.059)***	(0.057)***	(0.005)***	(0.026)***						
HIGHLAND T	-0.371	-0.320	-0.316	-0.229	-0.009	0.073	0.196	0.269	0.053	0.052	0.338	X	X	1494	8361	17.9%	0.48
	(0.066)***	(0.067)***	(0.063)***	(0.062)***	(0.061)	(0.060)	(0.058)***	(0.059)***	(0.011)***	(0.006)***	(0.014)***						
HOLLY TOWN	-0.367	-0.344	-0.288	-0.179	-0.103	0.009	0.072	0.250	0.172	0.050	0.283	X	X	358	5578	6.4%	0.49
	(0.144)**	(0.138)**	(0.146)*	(0.143)	(0.135)	(0.130)	(0.133)	(0.131)*	(0.024)***	(0.012)***	(0.031)***						
HOLLY VILL	-0.474	-0.373	-0.290	-0.301	-0.030	0.255	0.235	0.374	0.080	0.038	0.286	X	X	487	*2165*	22.5%	0.47
	(0.100)***	(0.108)***	(0.103)***	(0.099)***	(0.093)	(0.095)***	(0.093)**	(0.095)***	(0.031)**	(0.007)***	(0.030)***						
HUNTINGTON	-0.130	-0.126	-0.041	-0.024	0.174	0.282	0.324	0.361	0.187	0.031	0.167	X	X	680	2647	25.7%	0.47
	(0.071)*	(0.064)*	(0.064)	(0.060)	(0.060)***	(0.061)***	(0.058)***	(0.058)***	(0.038)***	(0.007)***	(0.013)***						
INDEPENDEN	-0.287	-0.277	-0.236	-0.105	0.061	0.173	0.236	0.321	0.084	0.045	0.331	X	X	2501	14176	17.6%	0.62
	(0.043)***	(0.040)***	(0.040)***	(0.038)***	(0.037)	(0.037)***	(0.036)***	(0.036)***	(0.009)***	(0.006)***	(0.007)***						
KEEGO HARB	-0.490	-0.587	-0.729	-0.100	-0.087	0.126	0.334	0.451	0.191	0.045	0.533	X	X	234	1651	14.2%	0.71
	(0.187)***	(0.200)***	(0.189)***	(0.188)	(0.184)	(0.200)	(0.172)*	(0.171)***	(0.084)**	(0.013)***	(0.042)***						
LAKE ORION	-0.563	-0.621	-0.415	-0.360	-0.092	0.059	0.037	0.133	-0.116	0.046	0.399	X	X	302	*1477*	20.4%	0.57
	(0.162)***	(0.163)***	(0.153)***	(0.151)**	(0.148)	(0.142)	(0.138)	(0.138)	(0.052)**	(0.011)***	(0.031)***						
LATHRUP VI	-0.250	-0.079	-0.155	0.006	0.219	0.396	0.399	0.563	0.195	0.018	0.130	X	X	478	2151	22.2%	0.54
	(0.069)***	(0.076)	(0.076)**	(0.074)	(0.075)***	(0.073)***	(0.074)***	(0.072)***	(0.047)***	(0.067)	(0.023)***						

Note: Numbers in the brackets are standard errors, * indicates statistical significance of 0.1 level, ** indicates statistical 1/ 1/ significance of 0.05 level, *** indicates statistical significance of 0.01 level.
1/ Numbers in Italic comes are calculated from CoreLogic, other numbers are from Michigan Department of Treasury.

Table 4.1 (Cont'd)

Government	2009	2010	2011	2012	2013	2014	2015	2016	lgLand	lgGarage	BATH	5-digit Zip	Sale Month	Parcels Used 1/	Total Parcels	Parcels Used (%)	R^2
LEONARD VI	-0.383	-0.430	-0.510	-1.049	0.793	0.005	0.600	0.437	-0.151	0.032	0.599	X	X	37	*233*	15.9%	0.81
	(0.857)	(0.879)	(1.469)	(1.065)	(0.663)	(0.786)	(0.815)	(0.996)	(0.195)	(0.062)	(0.178)***						
LYON TOWNS	-0.225	-0.351	-0.264	-0.084	0.003	0.102	0.159	0.284	0.030	0.024	0.289	X	X	945	8439	11.2%	0.41
	(0.078)***	(0.073)***	(0.073)***	(0.069)	(0.066)	(0.067)	(0.065)**	(0.065)***	(0.015)*	(0.013)*	(0.016)***						
MADISON HE	-0.388	-0.352	-0.392	-0.249	0.086	0.236	0.406	0.469	0.329	0.032	0.359	X	X	2841	13190	21.5%	0.52
	(0.042)***	(0.041)***	(0.042)***	(0.040)***	(0.039)**	(0.039)***	(0.038)***	(0.037)***	(0.033)***	(0.003)***	(0.013)***						
MILFORD TO	-0.135	-0.302	-0.031	-0.100	0.001	0.190	0.232	0.292	0.100	0.038	0.247	X	X	657	7485	8.8%	0.42
	(0.105)	(0.096)***	(0.093)	(0.095)	(0.087)	(0.090)**	(0.086)***	(0.085)***	(0.023)***	(0.014)***	(0.018)***						
MILFORD VI	-0.343	-0.242	-0.447	-0.303	-0.136	0.049	0.132	0.210	0.151	0.036	0.268	X	X	474	*2783*	17.0%	0.59
	(0.086)***	(0.084)***	(0.090)***	(0.089)***	(0.081)*	(0.080)	(0.080)	(0.078)***	(0.029)***	(0.008)***	(0.019)***						
NORTHVILLE	-0.160	-0.060	0.056	0.075	0.311	0.373	0.394	0.378	0.190	0.034	0.219	X	X	279	*13657*	2.0%	0.59
	(0.095)*	(0.091)	(0.094)	(0.089)	(0.081)***	(0.082)***	(0.079)***	(0.082)***	(0.047)***	(0.019)*	(0.022)***						
OAK PARK	-0.283	-0.147	-0.188	-0.085	0.210	0.417	0.581	0.751	0.111	0.037	0.303	X	X	2812	12078	23.3%	0.46
	(0.039)***	(0.039)***	(0.041)***	(0.042)**	(0.040)***	(0.040)***	(0.038)***	(0.037)***	(0.042)***	(0.003)***	(0.013)***						
OAKLAND TO	-0.327	-0.253	-0.204	-0.293	-0.100	0.108	0.138	0.156	0.005	0.094	0.244	X	X	1410	7560	18.7%	0.46
	(0.070)***	(0.067)***	(0.063)***	(0.060)***	(0.058)*	(0.059)*	(0.059)**	(0.058)***	(0.013)	(0.014)***	(0.009)***						
ORCHARD LA	-0.481	0.043	0.000	-0.308	0.040	0.010	-0.183	-0.045	0.286	0.065	0.157	X	X	183	1135	16.1%	0.42
	(0.262)*	(0.259)	(0.244)	(0.243)	(0.242)	(0.265)	(0.231)	(0.226)	(0.088)***	(0.043)	(0.034)***						
ORION TOWN	-0.309	-0.301	-0.232	-0.121	0.079	0.149	0.241	0.275	-0.003	0.051	0.357	X	X	2479	15814	15.7%	0.54
	(0.050)***	(0.048)***	(0.047)***	(0.046)***	(0.044)*	(0.044)***	(0.043)***	(0.043)***	(0.011)	(0.005)***	(0.009)***						
ORTONVILLE	-0.328	-0.084	-0.242	-0.197	0.049	0.235	0.259	0.262	0.157	0.057	0.285	X	X	108	*620*	17.4%	0.54
	(0.232)	(0.221)	(0.212)	(0.259)	(0.219)	(0.217)	(0.226)	(0.199)	(0.086)*	(0.018)***	(0.079)***						
OXFORD TOW	-0.242	-0.299	-0.221	-0.188	-0.003	0.155	0.126	0.299	0.043	0.030	0.356	X	X	1258	8550	14.7%	0.52
	(0.065)***	(0.062)***	(0.063)***	(0.061)***	(0.059)	(0.057)***	(0.057)**	(0.056)***	(0.012)***	(0.009)***	(0.012)***						
OXFORD VIL	-0.068	-0.336	-0.300	-0.074	0.149	0.296	0.386	0.365	0.042	0.049	0.392	X	X	353	*1420*	24.9%	0.63
	(0.135)	(0.128)***	(0.125)**	(0.123)	(0.119)	(0.119)**	(0.115)***	(0.114)***	(0.063)	(0.012)***	(0.024)***						
PLEASANT R	-0.213	-0.024	0.031	-0.041	0.179	0.324	0.364	0.489	0.434	0.055	0.195	X	X	364	1355	26.9%	0.64
	(0.105)**	(0.095)	(0.097)	(0.091)	(0.090)**	(0.088)***	(0.083)***	(0.084)***	(0.051)***	(0.011)***	(0.020)***						
PONTIAC	-0.327	-0.321	-0.183	-0.009	0.084	0.247	0.667	0.865	0.164	0.059	0.483	X	X	4275	26874	15.9%	0.35
	(0.048)***	(0.050)***	(0.057)***	(0.060)	(0.053)	(0.054)***	(0.058)***	(0.055)***	(0.028)***	(0.004)***	(0.021)***						
ROCHESTER	-0.166	-0.142	-0.137	-0.025	0.131	0.226	0.319	0.363	-0.061	0.060	0.311	X	X	6222	27464	22.7%	0.56
	(0.026)***	(0.024)***	(0.024)***	(0.024)	(0.023)***	(0.023)***	(0.022)***	(0.022)***	(0.009)***	(0.004)***	(0.004)***						
ROSE TOWNS	-0.059	-0.120	-0.205	-0.057	0.066	0.327	0.302	0.458	0.128	0.011	0.260	X	X	532	3327	16.0%	0.43
	(0.116)	(0.105)	(0.105)*	(0.102)	(0.100)	(0.098)***	(0.099)***	(0.099)***	(0.019)***	(0.010)	(0.028)***						

Note: Numbers in the brackets are standard errors, * indicates statistical significance of 0.1 level, ** indicates statistical 1/ 1/ significance of 0.05 level, *** indicates statistical significance of 0.01 level.
1/ Numbers in Italic comes are calculated from CoreLogic, other numbers are from Michigan Department of Treasury.

Table 4.1 (Cont'd)

Government	2009	2010	2011	2012	2013	2014	2015	2016	lgLand	lgGarage	BATH	5-digit Zip	Sale Month	Parcels Used 1/	Total Parcels	Parcels Used (%)	R^2
ROYAL OAK	-0.213	-0.186	-0.201	-0.018	0.180	0.301	0.398	0.482	0.238	0.031	0.256	X	X	7068	27857	25.4%	0.57
	(0.027)***	(0.027)***	(0.027)***	(0.025)	(0.024)***	(0.023)***	(0.023)***	(0.023)***	(0.015)***	(0.002)***	(0.006)***						
SOUTH LYON	-0.157	-0.131	-0.238	-0.075	0.066	0.160	0.246	0.276	-0.009	0.039	0.303	X	X	508	4213	12.1%	0.53
	(0.073)**	(0.077)*	(0.077)***	(0.076)	(0.073)	(0.071)**	(0.071)***	(0.070)***	(0.036)	(0.008)***	(0.018)***						
SOUTHFIELD	-0.290	-0.132	-0.102	-0.011	0.275	0.465	0.607	0.756	0.126	0.045	0.396	X	X	5426	30661	17.7%	0.57
	(0.026)***	(0.027)***	(0.028)***	(0.028)	(0.027)***	(0.028)***	(0.027)***	(0.027)***	(0.012)***	(0.003)***	(0.007)***						
SPRINGFIEL	-0.165	-0.134	-0.315	-0.145	0.066	0.245	0.405	0.422	0.041	0.071	0.308	X	X	981	5871	16.7%	0.57
	(0.069)**	(0.071)*	(0.073)***	(0.067)**	(0.068)	(0.068)***	(0.066)***	(0.065)***	(0.014)***	(0.009)***	(0.015)***						
SYLVAN LAK	-0.357	-0.299	-0.275	-0.114	0.016	0.198	0.269	0.472	0.336	0.020	0.298	X	X	263	1069	24.6%	0.53
	(0.168)**	(0.154)*	(0.139)**	(0.139)	(0.131)	(0.132)	(0.132)**	(0.126)***	(0.090)***	(0.014)	(0.032)***						
TROY	-0.211	-0.184	-0.201	-0.062	0.075	0.189	0.250	0.313	-0.023	0.055	0.300	X	X	5922	37307	15.9%	0.63
	(0.022)***	(0.021)***	(0.021)***	(0.020)***	(0.020)***	(0.020)***	(0.019)***	(0.019)***	(0.009)**	(0.004)***	(0.005)***						
WALLED LAK	-0.321	-0.334	-0.355	-0.196	0.156	0.337	0.288	0.481	0.017	0.041	0.377	X	X	310	3501	8.9%	0.60
	(0.122)***	(0.109)***	(0.115)***	(0.115)*	(0.107)	(0.115)***	(0.110)**	(0.101)***	(0.046)	(0.011)***	(0.034)***						
WATERFORD	-0.322	-0.293	-0.317	-0.143	0.088	0.258	0.371	0.441	0.108	0.052	0.394	X	X	6538	32806	19.9%	0.52
	(0.030)***	(0.030)***	(0.030)***	(0.029)***	(0.028)***	(0.028)***	(0.027)***	(0.027)***	(0.010)***	(0.003)***	(0.007)***						
WEST BLOOM	-0.193	-0.165	-0.153	-0.038	0.150	0.232	0.289	0.358	0.080	0.050	0.312	X	X	5156	26691	19.3%	0.55
	(0.028)***	(0.027)***	(0.027)***	(0.026)	(0.025)***	(0.026)***	(0.025)***	(0.025)***	(0.011)***	(0.005)***	(0.005)***						
WHITE LAKE	-0.438	-0.223	-0.349	-0.189	0.022	0.187	0.282	0.345	0.044	0.045	0.360	X	X	2315	12591	18.4%	0.53
	(0.054)***	(0.053)***	(0.052)***	(0.051)***	(0.050)	(0.048)***	(0.048)***	(0.047)***	(0.013)***	(0.005)***	(0.012)***						
WIXOM	-0.146	-0.223	-0.212	-0.162	-0.029	0.111	0.184	0.238	0.006	0.091	0.317	X	X	734	5220	14.1%	0.61
	(0.060)**	(0.058)***	(0.057)***	(0.057)***	(0.055)	(0.054)**	(0.053)***	(0.054)***	(0.021)	(0.012)***	(0.013)***						
WOLVERINE	-0.425	-0.339	-0.332	-0.350	-0.107	-0.009	0.124	0.175	0.267	0.048	0.392	X	X	461	*1903*	24.2%	0.53
	(0.119)***	(0.122)***	(0.119)***	(0.117)***	(0.109)	(0.111)	(0.109)	(0.108)	(0.052)***	(0.011)***	(0.027)***						
Washtenaw																	
ANN ARBOR	-0.067	-0.006	-0.010	0.049	0.161	0.242	0.296	0.377	0.081	0.004	0.273	X	X	5542	35246	15.7%	0.51
	(0.027)**	(0.027)	(0.026)	(0.024)**	(0.024)***	(0.024)***	(0.023)***	(0.023)***	(0.009)***	(0.002)**	(0.005)***						
SALEM TOWN	0.072	-0.020	0.105	0.081	0.245	0.314	0.459	0.475	0.168	0.060	0.230	X	X	369	3469	10.6%	0.59
	(0.115)	(0.112)	(0.110)	(0.109)	(0.101)**	(0.103)***	(0.100)***	(0.103)***	(0.028)***	(0.010)***	(0.019)***						
YORK TOWNS	-0.046	-0.117	-0.210	-0.141	-0.011	0.141	0.225	0.262	0.091	0.053	0.359	X	X	472	3169	14.9%	0.58
	(0.113)	(0.107)	(0.100)**	(0.098)	(0.092)	(0.093)	(0.096)**	(0.093)***	(0.027)***	(0.010)***	(0.022)***						
YPSILANTI	-0.062	-0.074	-0.120	0.118	0.388	0.501	0.689	0.804	0.211	0.059	0.280	X	X	956	5326	17.9%	0.34
	(0.110)	(0.117)	(0.116)	(0.112)	(0.108)***	(0.104)***	(0.101)***	(0.099)***	(0.062)***	(0.008)***	(0.033)***						

Note: Numbers in the brackets are standard errors, * indicates statistical significance of 0.1 level, ** indicates statistical 1/ 1/ significance of 0.05 level, *** indicates statistical significance of 0.01 level.
1/ Numbers in Italic comes are calculated from CoreLogic, other numbers are from Michigan Department of Treasury.

Table 4.1 (Cont'd)

Government	2009	2010	2011	2012	2013	2014	2015	2016	lgLand	lgGarage	BATH	5-digit Zip	Sale Month	Parcels Used 1/	Total Parcels	Parcels Used (%)	R^2
Wayne																	
ALLEN PARK	-0.393	-0.431	-0.477	-0.383	-0.243	-0.083	0.018	0.090	0.391	0.046	0.172	X	X	3130	13624	23.0%	0.38
	(0.035)***	(0.034)***	(0.034)***	(0.033)***	(0.031)***	(0.031)***	(0.031)	(0.030)***	(0.023)***	(0.004)***	(0.012)***						
BELLEVILLE	-0.255	-0.274	-0.408	-0.260	-0.046	0.138	0.361	0.438	-0.049	0.049	0.298	X	X	298	1635	18.2%	0.49
	(0.147)*	(0.136)**	(0.139)***	(0.130)**	(0.135)	(0.126)	(0.124)***	(0.129)***	(0.060)	(0.012)***	(0.032)***						
BROWNSTOWN	-0.188	-0.163	-0.228	-0.126	-0.039	0.089	0.240	0.307	-0.003	0.040	0.455	X	X	2009	13360	15.0%	0.44
	(0.055)***	(0.054)***	(0.055)***	(0.052)**	(0.052)	(0.053)*	(0.051)***	(0.053)***	(0.015)	(0.005)***	(0.013)***						
CANTON TWP	-0.131	-0.124	-0.137	-0.085	0.043	0.134	0.163	0.224	0.134	-0.014	0.319	X	X	5750	31869	18.0%	0.56
	(0.019)***	(0.018)***	(0.018)***	(0.017)***	(0.017)**	(0.017)***	(0.016)***	(0.016)***	(0.007)***	(0.001)***	(0.004)***						
DEARBORN	-0.318	-0.357	-0.402	-0.258	0.012	0.158	0.211	0.322	0.622	0.001	0.260	X	X	8728	37371	23.4%	0.50
	(0.024)***	(0.023)***	(0.024)***	(0.024)***	(0.024)	(0.024)***	(0.023)***	(0.023)***	(0.018)***	(0.002)	(0.007)***						
DEARBORN H	-0.393	-0.426	-0.485	-0.348	-0.083	0.198	0.271	0.395	0.366	-0.004	0.380	X	X	7066	25464	27.7%	0.62
	(0.027)***	(0.027)***	(0.028)***	(0.027)***	(0.027)***	(0.027)***	(0.027)***	(0.026)***	(0.017)***	(0.001)**	(0.007)***						
DETROIT	-0.296	-0.159	-0.212	-0.267	-0.126	-0.096	0.151	0.124	0.615	0.027	0.396	X	X	53148	358835	14.8%	0.34
	(0.018)***	(0.019)***	(0.019)***	(0.017)***	(0.017)***	(0.017)***	(0.018)***	(0.019)***	(0.017)***	(0.001)***	(0.007)***						
ECORSE	-0.318	-0.235	-0.261	-0.400	-0.334	-0.056	-0.263	0.413	0.220	-0.008	0.202	X	X	757	4497	16.8%	0.28
	(0.133)**	(0.129)*	(0.139)*	(0.144)***	(0.129)**	(0.134)	(0.132)**	(0.140)***	(0.073)***	(0.079)	(0.052)***						
FLAT ROCK	-0.200	-0.211	-0.187	-0.155	0.045	0.209	0.265	0.293	0.059	0.000	0.537	X	X	843	3512	24.0%	0.52
	(0.084)**	(0.082)**	(0.084)**	(0.083)*	(0.080)	(0.079)***	(0.078)***	(0.078)***	(0.020)***	(0)***	(0.020)***						
GARDEN CIT	-0.467	-0.343	-0.468	-0.365	-0.138	0.068	0.164	0.267	0.089	0.005	0.272	X	X	3252	12491	26.0%	0.31
	(0.037)***	(0.038)***	(0.039)***	(0.037)***	(0.037)***	(0.038)*	(0.036)***	(0.036)***	(0.023)***	(0.003)*	(0.017)***						
GIBRALTAR	-0.146	-0.294	-0.454	0.147	0.058	-0.017	0.110	0.228	0.113	0.041	0.375	X	X	414	2244	18.4%	0.38
	(0.151)	(0.134)**	(0.137)***	(0.141)	(0.134)	(0.129)	(0.134)	(0.127)*	(0.048)**	(0.012)***	(0.039)***						
GROSS ILE	-0.160	-0.137	-0.119	-0.140	-0.008	0.073	0.152	0.230	0.328	-0.016	0.295	X	X	1121	6567	17.1%	0.50
	(0.076)**	(0.072)*	(0.071)*	(0.069)**	(0.068)	(0.066)	(0.067)**	(0.067)***	(0.023)***	(0.074)	(0.014)***						
GROSSE POI	-0.299	-0.283	-0.344	-0.247	-0.026	0.101	0.148	0.205	0.497	-0.012	0.222	X	X	5538	*19063*	29.1%	0.64
	(0.030)***	(0.028)***	(0.028)***	(0.027)***	(0.026)	(0.026)***	(0.025)***	(0.025)***	(0.012)***	(0.001)***	(0.005)***						
HAMTRAMCK	-0.441	-0.018	-0.505	0.296	-0.139	0.963	0.805	1.257	0.073	0.000	-0.195	X	X	116	7353	1.6%	0.36
	(0.469)	(0.431)	(0.413)	(0.419)	(0.463)	(0.424)**	(0.437)*	(0.486)**	(0.240)	(0)***	(0.137)						
HARPER WOO	-0.539	-0.389	-0.459	-0.104	-0.064	0.126	0.292	0.382	0.275	-0.024	0.318	X	X	2046	6374	32.1%	0.34
	(0.062)***	(0.064)***	(0.063)***	(0.065)	(0.066)	(0.063)**	(0.063)***	(0.063)***	(0.033)***	(0.004)***	(0.023)***						

Note: Numbers in the brackets are standard errors, * indicates statistical significance of 0.1 level, ** indicates statistical 1/ 1/ significance of 0.05 level, *** indicates statistical significance of 0.01 level.
1/ Numbers in Italic comes are calculated from CoreLogic, other numbers are from Michigan Department of Treasury.

Table 4.1 (Cont'd)

Government	2009	2010	2011	2012	2013	2014	2015	2016	lgLand	lgGarage	BATH	5-digit Zip	Sale Month	Parcels Used 1/	Total Parcels	Parcels Used (%)	R^2
HIGHLAND P	0.074	-0.025	-0.045	0.062	0.422	-0.204	0.200	0.225	0.281	0.000	0.341	X	X	590	4812	12.3%	0.24
	(0.189)	(0.219)	(0.197)	(0.184)	(0.167)**	(0.166)	(0.164)	(0.193)	(0.154)*	(0)***	(0.058)***						
HURON TWP	-0.582	-0.405	-0.421	-0.409	-0.260	-0.034	-0.033	0.054	0.061	-0.060	0.404	X	X	1096	6931	15.8%	0.36
	(0.083)***	(0.082)***	(0.085)***	(0.080)***	(0.079)***	(0.081)	(0.077)	(0.076)	(0.009)***	(0.061)	(0.020)***						
INKSTER	-0.360	-0.332	-0.512	-0.379	-0.305	-0.053	0.159	0.020	0.163	0.018	0.434	X	X	2607	10543	24.7%	0.33
	(0.073)***	(0.079)***	(0.076)***	(0.076)***	(0.073)***	(0.072)	(0.072)**	(0.075)	(0.045)***	(0.006)***	(0.036)***						
LINCOLN PA	-0.324	-0.181	-0.304	-0.198	0.020	0.218	0.655	0.600	0.324	0.002	0.111	X	X	4400	16114	27.3%	0.26
	(0.042)***	(0.044)***	(0.046)***	(0.046)***	(0.044)	(0.045)***	(0.045)***	(0.044)***	(0.032)***	(0.003)	(0.021)***						
LIVONIA	-0.208	-0.238	-0.249	-0.184	0.050	0.157	0.230	0.295	0.053	0.064	0.348	X	X	9234	44138	20.9%	0.52
	(0.021)***	(0.021)***	(0.020)***	(0.019)***	(0.018)***	(0.018)***	(0.018)***	(0.018)***	(0.007)***	(0.002)***	(0.005)***						
MELVINDALE	-0.303	-0.199	-0.285	-0.146	-0.017	0.319	0.484	0.671	0.547	0.000	0.198	X	X	977	5061	19.3%	0.29
	(0.080)***	(0.084)**	(0.086)***	(0.087)*	(0.085)	(0.087)***	(0.087)***	(0.088)***	(0.066)***	(0)***	(0.049)***						
NORTHVILLE	-0.169	-0.214	-0.153	-0.033	0.147	0.193	0.316	0.272	0.188	0.001	0.237	X	X	2459	11137	22.1%	0.58
	(0.040)***	(0.038)***	(0.038)***	(0.036)	(0.035)***	(0.036)***	(0.036)***	(0.036)***	(0.010)***	(0.002)	(0.007)***						
PLYMOUTH	0.037	-0.080	0.019	0.187	0.314	0.443	0.458	0.551	0.303	0.016	0.117	X	X	864	4976	17.4%	0.29
	(0.080)	(0.078)	(0.077)	(0.075)**	(0.070)***	(0.071)***	(0.069)***	(0.068)***	(0.045)***	(0.006)**	(0.019)***						
PLYMOUTH T	-0.117	-0.094	-0.075	-0.002	0.125	0.175	0.230	0.284	0.196	-0.001	0.345	X	X	2097	11889	17.6%	0.69
	(0.032)***	(0.033)***	(0.032)**	(0.030)	(0.029)***	(0.029)***	(0.028)***	(0.028)***	(0.012)***	(0.002)	(0.007)***						
REDFORD TW	-0.331	-0.333	-0.501	-0.399	-0.113	0.104	0.221	0.346	0.234	0.029	0.251	X	X	6611	23222	28.5%	0.36
	(0.028)***	(0.029)***	(0.029)***	(0.028)***	(0.028)***	(0.029)***	(0.028)***	(0.028)***	(0.016)***	(0.002)***	(0.012)***						
RIVER ROUG	-0.530	-0.403	-0.348	-0.358	-0.151	-0.257	-0.071	-0.034	0.155	0.000	0.177	X	X	614	3555	17.3%	0.26
	(0.147)***	(0.176)**	(0.180)*	(0.156)**	(0.151)	(0.132)*	(0.140)	(0.155)	(0.086)*	(0)***	(0.044)***						
RIVERVIEW	-0.341	-0.331	-0.444	-0.299	-0.130	-0.080	0.068	0.147	0.334	0.000	0.412	X	X	982	4417	22.2%	0.60
	(0.068)***	(0.068)***	(0.065)***	(0.065)***	(0.064)**	(0.062)	(0.061)	(0.060)**	(0.024)***	(0)***	(0.016)***						
ROCKWOOD	-0.375	-0.351	-0.379	-0.088	-0.021	0.128	0.226	0.312	0.024	0.000	0.533	X	X	281	1382	20.3%	0.58
	(0.155)**	(0.141)**	(0.140)***	(0.132)	(0.136)	(0.135)	(0.143)	(0.129)**	(0.043)	(0)***	(0.037)***						
ROMULUS	-0.451	-0.229	-0.254	-0.290	0.010	0.245	0.369	0.561	0.103	0.020	0.510	X	X	2003	10971	18.3%	0.43
	(0.058)***	(0.064)***	(0.064)***	(0.063)***	(0.063)	(0.064)***	(0.063)***	(0.064)***	(0.018)***	(0.005)***	(0.017)***						
SOUTHGATE	-0.178	-0.237	-0.308	-0.223	0.082	0.164	0.277	0.335	0.213	-0.030	0.384	X	X	2802	12347	22.7%	0.37
	(0.046)***	(0.046)***	(0.045)***	(0.043)***	(0.042)*	(0.043)***	(0.043)***	(0.042)***	(0.024)***	(0.086)	(0.014)***						
SUMPTER TW	-0.484	-0.268	-0.257	-0.179	-0.061	0.062	0.194	0.487	0.117	0.003	0.348	X	X	792	4273	18.5%	0.32
	(0.107)***	(0.109)**	(0.109)**	(0.105)*	(0.105)	(0.107)	(0.110)*	(0.109)***	(0.022)***	(0.013)	(0.028)***						
TAYLOR	-0.554	-0.401	-0.424	-0.312	-0.095	0.121	0.356	0.447	0.133	0.022	0.530	X	X	5325	25675	20.7%	0.36
	(0.039)***	(0.040)***	(0.040)***	(0.039)***	(0.039)**	(0.039)***	(0.040)***	(0.038)***	(0.016)***	(0.006)***	(0.015)***						

Note: Numbers in the brackets are standard errors, * indicates statistical significance of 0.1 level, ** indicates statistical 1/ 1/ significance of 0.05 level, *** indicates statistical significance of 0.01 level.
1/ Numbers in Italic comes are calculated from CoreLogic, other numbers are from Michigan Department of Treasury.

Table 4.1 (Cont'd)

Government	2009	2010	2011	2012	2013	2014	2015	2016	lgLand	lgGarage	BATH	5-digit Zip	Sale Month	Parcels Used 1/	Total Parcels	Parcels Used (%)	R^2
TRENTON	-0.417	-0.372	-0.471	-0.290	-0.052	0.003	0.117	0.186	0.477	0.000	0.267	X	X	1499	8417	17.8%	0.41
	(0.063)***	(0.061)***	(0.061)***	(0.058)***	(0.057)	(0.056)	(0.054)**	(0.055)***	(0.037)***	(0)***	(0.018)***						
VAN BUREN	-0.264	-0.241	-0.285	-0.206	-0.079	0.027	0.199	0.270	0.080	-0.003	0.443	X	X	2147	10725	20.0%	0.49
	(0.044)***	(0.044)***	(0.047)***	(0.044)***	(0.045)*	(0.045)	(0.045)***	(0.043)***	(0.012)***	(0.003)	(0.010)***						
WAYNE	-0.417	-0.577	-0.556	-0.527	-0.202	0.118	0.294	0.449	0.224	0.051	0.333	X	X	1611	6763	23.8%	0.43
	(0.062)***	(0.065)***	(0.065)***	(0.064)***	(0.063)***	(0.067)*	(0.064)***	(0.063)***	(0.034)***	(0.006)***	(0.023)***						
WESTLAND	-0.325	-0.255	-0.332	-0.270	0.009	0.188	0.310	0.428	0.049	0.071	0.318	X	X	6460	29904	21.6%	0.40
	(0.034)***	(0.035)***	(0.035)***	(0.034)***	(0.033)	(0.033)***	(0.032)***	(0.032)***	(0.015)***	(0.003)***	(0.010)***						
WOODHAVEN	-0.232	-0.203	-0.443	-0.203	-0.124	0.069	0.134	0.220	-0.113	0.001	0.364	X	X	859	4962	17.3%	0.48
	(0.059)***	(0.060)***	(0.061)***	(0.061)***	(0.059)**	(0.057)	(0.056)**	(0.056)***	(0.024)***	(0.004)	(0.016)***						
WYANDOTTE	-0.587	-0.442	-0.490	-0.260	-0.176	0.077	0.219	0.285	0.314	0.014	0.298	X	X	1394	11940	11.7%	0.32
	(0.065)***	(0.068)***	(0.070)***	(0.070)***	(0.066)***	(0.069)	(0.068)***	(0.063)***	(0.047)***	(0.005)**	(0.024)***						
Macomb	-0.310	-0.267	-0.245	-0.154	0.052	0.230	0.340	0.371	0.133	0.029	0.268	X	X	58249	349381	16.7%	0.63
	(0.010)***	(0.010)***	(0.010)***	(0.010)***	(0.010)***	(0.010)***	(0.009)***	(0.009)***	(0.004)***	(0.001)***	(0.003)***						
Monroe	-0.278	-0.358	-0.302	-0.274	-0.142	-0.022	0.076	0.256	0.316	0.079	0.228	X	X	1765	75053	2.4%	0.45
	(0.070)***	(0.075)***	(0.070)***	(0.072)***	(0.066)**	(0.065)	(0.064)	(0.062)***	(0.036)***	(0.006)***	(0.020)***						
Oakland	-0.271	-0.212	-0.196	-0.071	0.128	0.263	0.359	0.448	0.075	0.049	0.322	X	X	96557	533512	18.1%	0.75
	(0.007)***	(0.007)***	(0.007)***	(0.007)***	(0.007)***	(0.007)***	(0.007)***	(0.006)***	(0.002)***	(0.000)***	(0.001)***						
Washtenaw	-0.071	-0.020	-0.022	0.056	0.187	0.280	0.356	0.443	0.097	0.017	0.278	X	X	7339	136419	5.4%	0.60
	(0.027)**	(0.028)	(0.026)	(0.025)**	(0.024)***	(0.024)***	(0.024)***	(0.024)***	(0.008)***	(0.002)***	(0.005)***						
Wayne	-0.319	-0.264	-0.330	-0.295	-0.111	-0.007	0.174	0.240	0.212	0.016	0.379	X	X	151920	829939	18.3%	0.76
	(0.008)***	(0.009)***	(0.009)***	(0.008)***	(0.008)***	(0.008)	(0.008)***	(0.008)***	(0.004)***	(0.000)***	(0.002)***						

Note: Numbers in the brackets are standard errors, * indicates statistical significance of 0.1 level, ** indicates statistical 1/ 1/ significance of 0.05 level, *** indicates statistical significance of 0.01 level.
1/ Numbers in Italic comes are calculated from CoreLogic, other numbers are from Michigan Department of Treasury.

Table 4.2 Comparison between HPI and SEV index (base year = 2008)

	HPI									SEV per Parcel									Median Sales Ratio								
Government	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
MACOMB																											
ARMADA	100	95.9	88.6	77.1	78.0	103.4	114.6	118.8	119.3	100	92.5	82.3	73.1	71.3	77.4	99.4	108.1	111.5	1.4	1.2	1.3	1.0	0.9	0.9	0.8	0.9	0.9
ARMADA VIL	100	71.9	59.1	56.0	76.3	98.1	80.4	133.3	122.8																		
BRUCE	100	86.2	100.6	100.4	80.3	97.5	130.5	143.3	162.8	100	110.2	92.0	71.1	69.5	70.4	75.1	85.2	85.7	1.3	1.4	1.1	1.1	1.1	0.9	0.7	0.8	0.9
CENTER LINE	100	68.2	71.0	66.6	77.4	100.7	119.2	141.9	164.3	100	91.1	79.5	70.2	64.9	58.0	59.6	63.5	63.7	2.2	2.9	2.3	2.2	1.5	1.1	0.9	0.8	0.9
CHESTERFIELD	100	76.4	85.8	83.8	94.2	110.7	120.9	129.0	135.3	100	89.7	84.8	75.5	71.1	71.9	74.6	82.6	88.2	1.3	1.5	1.3	1.2	1.0	0.9	0.8	0.9	0.9
CLINTON	100	74.5	79.0	73.6	84.9	102.9	114.8	126.1	136.4	100	92.2	84.5	78.0	72.9	72.2	74.8	81.0	86.3	1.4	1.6	1.5	1.4	1.1	0.9	0.9	0.9	0.9
EASTPOINTE	100	63.7	69.7	68.7	72.7	95.0	148.1	144.9	145.7	100	86.0	68.1	61.3	52.4	48.3	47.9	50.5	56.6	2.2	3.1	2.3	2.1	1.6	1.1	0.8	0.8	0.8
FRASER	100	74.9	73.4	68.7	76.5	90.8	102.6	115.8	126.4	100	89.5	84.9	72.6	67.3	65.5	68.1	75.4	75.9	1.2	1.5	1.5	1.4	1.2	0.9	0.9	0.9	0.9
HARRISON	100	76.9	84.0	81.8	85.8	105.3	117.7	133.8	137.5	100	88.3	81.9	75.8	72.9	70.6	67.2	73.5	79.1	1.5	1.5	1.4	1.4	1.2	0.9	0.8	0.9	0.9
MACOMB	100	86.2	89.7	86.3	96.3	110.6	117.5	123.2	129.3	100	91.3	80.7	76.2	74.6	78.1	82.7	90.2	96.8	1.2	1.3	1.0	1.1	0.9	0.9	0.8	0.9	0.9
MT. CLEMENS	100	55.9	66.4	66.1	80.7	104.1	138.9	162.1	180.2	100	92.7	79.8	71.5	64.7	65.7	62.5	67.2	67.6	2.3	3.7	2.6	2.3	1.7	1.3	1.0	0.9	0.9
N BALTIMORE	100	81.7	86.2	88.0	93.2	105.2	123.3	126.7	136.5	100	91.2	76.1	76.0	71.5	73.2	76.7	84.6	89.9	1.4	1.3	1.1	1.1	0.9	0.8	0.8	0.8	0.9
ROMEO VILL	100	97.4	85.2	102.4	105.8	141.1	143.4	170.6	188.1																		
ROSEVILLE	100	67.4	66.1	68.1	73.6	91.6	124.5	139.3	149.8	100	90.7	78.0	68.3	60.4	57.0	57.3	60.9	63.8	2.0	2.8	2.3	2.0	1.5	1.1	0.9	0.8	0.8
ST. CLAIR S	100	73.8	70.4	69.0	79.8	96.2	111.1	125.0	133.9	100	91.3	76.8	68.3	62.1	59.2	61.4	68.7	76.1	1.3	1.7	1.5	1.4	1.1	0.9	0.8	0.8	0.8
SHELBY	100	83.9	82.4	79.7	90.3	107.8	117.3	120.6	129.3	100	93.7	77.8	71.8	69.1	71.3	74.4	82.6	88.5	1.2	1.3	1.1	1.1	1.0	0.8	0.8	0.9	0.9
STERLING H	100	80.3	79.7	76.4	85.1	102.9	115.1	120.7	129.5	100	93.7	82.2	75.6	70.4	71.2	74.9	83.3	86.1	1.3	1.4	1.2	1.2	1.0	0.8	0.8	0.9	0.9
UTICA	100	85.9	78.5	50.0	85.5	116.4	126.4	128.2	138.7	100	92.9	83.9	78.9	71.0	68.9	67.6	72.4	79.3	1.5	2.0	1.2	1.5	1.3	0.9	0.8	0.8	0.9
WARREN	100	72.1	76.5	89.4	89.7	116.8	143.6	179.3	170.7	100	91.5	79.3	68.0	63.8	61.8	64.9	72.5	71.9	1.9	2.2	1.8	1.6	1.3	1.0	0.8	0.8	0.9
WASHINGTON	100	85.3	81.0	81.0	89.2	100.9	116.8	132.2	131.6	100	89.1	73.8	74.2	67.1	71.7	74.7	80.6	87.4	1.3	1.2	1.1	1.1	0.9	0.9	0.8	0.9	0.9
MONROE																											
MONROE	100	75.8	69.9	73.9	76.0	86.8	97.8	107.9	129.2	100	93.5	92.3	90.6	89.5	89.5	91.8	98.1	98.7	1.0	1.4	2.2	1.8	1.6	1.1	0.7	1.5	0.9
OAKLAND																											
ADDISON	100	87.4	81.2	88.9	85.8	104.9	105.7	133.2	139.8	100	87.8	74.5	68.9	66.6	67.1	75.8	87.4	87.4	1.4	1.5	1.2	1.1	1.0	0.8	0.9	0.9	1.0
AUBURN HILLS	100	60.6	69.5	68.6	75.8	98.9	116.9	135.0	148.4	100	95.3	82.2	74.6	68.5	66.5	66.4	70.2	70.5	1.6	2.2	1.4	1.3	1.2	0.8	0.8	0.8	0.9
BERKLEY	100	80.3	77.2	68.8	86.8	107.6	123.4	129.9	141.4	100	90.5	80.0	73.5	70.5	72.5	80.0	90.4	96.9	1.2	1.3	1.2	1.3	1.0	0.8	0.8	0.9	0.9
BEVERLY HI	100	81.2	79.5	86.7	100.2	116.6	124.8	136.3	142.6																		
BIRMINGHAM	100	85.9	90.4	96.1	106.4	130.7	140.8	147.9	158.0	100	87.8	77.7	70.8	70.8	74.5	81.7	93.6	103.0	1.4	1.5	1.1	1.0	0.9	0.8	0.8	0.9	0.9

Table 4.2 (Cont'd)

	HPI									SEV per Parcel									Median Sales Ratio								
Government	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
BLOOMFIELD	100	88.9	95.4	101.1	103.0	123.2	138.4	139.5	149.1	100	92.1	78.4	73.1	73.6	76.9	84.6	94.4	101.9	1.4	1.5	1.2	1.0	0.9	0.8	0.8	0.9	1.0
BRANDON	100	84.0	87.6	94.6	97.2	118.3	128.6	143.3	151.0	100	90.3	75.2	69.5	69.3	71.8	77.7	89.6	97.2	1.4	1.7	1.2	1.1	1.0	0.9	0.8	0.9	0.9
CLAWSON	100	67.9	78.4	73.4	89.9	110.4	127.0	135.6	142.4	100	90.3	76.1	68.8	64.3	65.2	71.0	80.2	86.9	1.3	1.5	1.2	1.1	0.9	0.8	0.8	0.8	0.8
COMMERCE	100	64.0	73.4	66.7	77.4	94.3	100.6	111.0	123.0	100	87.7	75.4	71.2	70.0	71.1	77.0	86.3	92.0	1.2	1.4	1.1	1.0	0.9	0.8	0.8	0.9	0.9
FARMINGTON H	100	79.4	86.6	84.3	90.6	109.2	123.8	129.4	138.7	100	90.6	77.8	70.7	66.8	66.0	69.8	76.1	80.3	1.4	1.5	1.2	1.1	1.0	0.8	0.8	0.9	0.9
FERNDALE	100	71.6	69.4	70.7	94.0	140.9	170.0	192.8	219.7	100	91.6	79.0	69.2	62.9	59.7	63.3	71.4	80.1	1.9	2.2	2.2	2.0	1.2	0.8	0.7	0.7	0.7
FRANKLIN V	100	67.8	79.3	103.8	96.6	102.8	128.9	122.0	136.0																		
GROVELAND	100	81.5	62.2	83.6	86.3	104.7	121.9	120.2	131.3	100	85.5	67.1	60.3	61.1	64.5	68.7	77.8	83.9	1.2	1.4	1.3	1.0	1.0	0.8	0.8	0.8	0.9
HAZEL PARK	100	71.0	71.3	66.5	86.7	100.8	156.7	177.9	214.9	100	81.7	64.5	51.8	43.5	38.3	38.3	40.0	43.5	4.1	4.8	3.6	2.9	1.7	1.2	0.8	0.7	0.7
HIGHLAND	100	69.0	72.6	72.9	79.5	99.1	107.6	121.6	130.8	100	87.0	75.5	69.1	67.8	68.5	73.3	81.2	88.0	1.3	1.4	1.2	1.0	0.9	0.8	0.8	0.8	0.8
HOLLY VILL	100	62.2	68.8	74.9	74.0	97.0	129.0	126.5	145.4																		
HUNTINGTON W	100	87.8	88.2	96.0	97.6	119.0	132.6	138.3	143.4	100	92.8	80.2	73.4	72.8	76.1	84.9	97.9	107.2	1.3	1.3	1.1	1.0	0.9	0.8	0.8	0.9	0.9
INDEPENDENCE	100	75.0	75.8	78.9	90.0	106.3	118.9	126.6	137.8	100	91.9	79.0	71.8	70.6	71.7	79.5	87.6	94.5	1.3	1.5	1.2	1.0	0.9	0.8	0.8	0.9	0.9
KEEGO HARBOR	100	61.2	55.6	48.3	90.5	91.6	113.4	139.7	156.9	100	86.7	73.8	64.0	59.7	60.8	63.9	71.4	79.4	1.8	2.0	1.6	1.9	1.0	0.8	0.7	0.8	0.9
LAKE ORION	100	57.0	53.7	66.0	69.7	91.2	106.1	103.8	114.2																		
LATHRUP VILLAC	100	77.9	92.4	85.7	100.6	124.5	148.6	149.0	175.6	100	81.4	64.3	61.5	57.2	55.5	58.8	67.0	74.7	2.0	1.8	1.2	1.3	1.0	0.8	0.7	0.8	0.8
LYON	100	79.9	70.4	76.8	92.0	100.3	110.8	117.2	132.8	100	93.5	78.5	73.2	73.3	75.2	81.7	91.0	96.4	1.2	1.2	1.0	0.9	0.8	0.7	0.7	0.8	0.7
MADISON HEIGH	100	67.8	70.3	67.5	77.9	109.0	126.6	150.1	159.9	100	93.9	78.1	67.7	61.7	57.7	58.8	63.7	67.5	1.8	2.5	1.9	1.6	1.3	0.8	0.8	0.8	0.8
MILFORD VI	100	70.9	78.5	64.0	73.8	87.2	105.0	114.1	123.4																		
NORTHVILLE	100	85.2	94.2	105.7	107.8	136.5	145.2	148.3	145.9																		
OAK PARK	100	75.3	86.3	82.8	91.9	123.4	151.8	178.9	211.9	100	90.4	71.7	59.7	52.9	49.0	48.8	52.8	57.1	2.7	3.3	2.4	1.8	1.3	0.9	0.8	0.7	0.7
OAKLAND TOWN	100	72.1	77.6	81.6	74.6	90.5	111.4	114.8	116.9	100	89.6	76.9	74.9	75.4	78.8	86.2	98.6	105.4	1.1	1.2	0.9	0.9	0.8	0.7	0.7	0.8	0.9
ORCHARD LAKE '	100	61.8	104.3	100.0	73.5	104.0	101.0	83.3	95.6	100	91.6	78.1	76.2	75.4	75.1	82.6	94.8	103.2	1.4	1.4	1.1	1.1	1.1	0.7	0.7	1.0	0.9
ORION	100	73.4	74.0	79.3	88.6	108.2	116.1	127.3	131.7	100	89.3	74.4	67.4	66.5	68.7	74.1	81.9	87.9	1.3	1.4	1.2	1.1	0.9	0.8	0.8	0.8	0.9
ORTONVILLE	100	72.1	91.9	78.5	82.1	105.1	126.5	129.5	130.0																		
OXFORD TOWN	100	78.5	74.1	80.2	82.9	99.7	116.8	113.4	134.9	100	87.8	76.0	72.4	70.7	72.6	80.0	90.2	94.2	1.3	1.2	1.1	1.0	0.9	0.8	0.8	0.9	0.9
OXFORD VIL	100	93.4	71.5	74.1	92.8	116.1	134.4	147.0	144.1																		
PLEASANT R	100	80.8	97.6	103.1	96.0	119.6	138.3	144.0	163.1	100	94.0	79.6	80.8	79.5	84.7	93.4	102.0	111.8	1.1	1.4	1.0	1.0	1.0	0.9	0.8	0.9	0.9
PONTIAC	100	72.1	72.5	83.3	99.1	108.7	128.0	194.8	237.6	100	86.0	69.0	50.7	43.5	37.2	36.9	38.6	39.5	6.1	6.4	5.2	3.5	2.1	1.6	1.5	1.0	0.9
ROCHESTER	100	84.7	86.7	87.2	97.6	114.0	125.4	137.6	143.8	100	93.3	81.9	75.5	74.0	76.9	82.0	89.7	95.0									

Table 4.2 (Cont'd)

	HPI									SEV per Parcel									Median Sales Ratio								
Government	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
ROSE	100	94.2	88.7	81.5	94.5	106.8	138.7	135.3	158.0	100	93.4	72.1	67.5	66.4	67.4	72.1	84.0	91.1	1.5	1.5	0.7	1.3	0.9	0.9	0.8	0.9	0.9
ROYAL OAK	100	80.8	83.0	81.8	98.2	119.7	135.1	148.9	161.9	100	94.9	83.8	79.4	77.4	78.8	84.6	90.9	96.1	1.3	1.5	1.3	1.2	1.0	0.8	0.8	0.9	0.8
SOUTH LYON	100	85.4	87.7	78.8	92.8	106.8	117.3	127.9	131.8	100	87.3	77.0	71.9	70.9	71.3	76.3	85.9	91.9	1.2	1.2	1.2	1.0	0.9	0.8	0.8	0.9	0.9
SOUTHFIELD	100	74.8	87.6	90.3	98.9	131.7	159.2	183.6	212.9	100	92.8	77.8	66.3	60.9	58.5	58.1	61.8	66.9									
SPRINGFIELD	100	84.8	87.4	73.0	86.5	106.8	127.8	149.9	152.4	100	89.4	77.8	72.9	73.1	74.5	80.4	91.3	99.2	1.2	1.5	1.2	1.1	1.0	0.9	0.9	0.9	1.0
SYLVAN LAKE	100	70.0	74.1	75.9	89.3	101.6	121.9	130.9	160.4	100	88.7	75.3	63.9	62.6	62.8	70.1	81.0	87.8	1.1	1.5	1.2	1.2	1.0	0.7	0.8	0.8	0.9
TROY	100	81.0	83.2	81.8	94.0	107.8	120.8	128.4	136.7	100	92.0	80.9	72.7	71.8	72.1	76.3	82.8	86.3	1.2	1.3	1.1	1.0	0.9	0.8	0.8	0.9	0.9
WATERFORD	100	72.4	74.6	72.8	86.7	109.2	129.4	144.9	155.4	100	92.4	75.0	65.2	62.9	63.1	65.7	72.7	79.8	1.5	1.8	1.4	1.3	1.1	0.8	0.7	0.8	0.8
WEST BLOOM	100	82.4	84.8	85.8	96.3	116.2	126.1	133.5	143.0	100	90.3	76.1	70.2	68.7	68.8	74.1	81.8	87.9	1.4	1.5	1.3	1.1	1.0	0.8	0.8	0.9	0.9
WHITE LAKE	100	64.5	80.0	70.5	82.8	102.2	120.6	132.5	141.2	100	90.2	73.2	67.8	65.5	66.7	72.8	81.9	90.7	1.4	1.7	1.2	1.1	0.9	0.8	0.8	0.9	0.9
WIXOM	100	86.4	80.0	80.9	85.0	97.1	111.8	120.2	126.9	100	95.5	83.0	76.0	69.7	70.6	72.1	78.0	79.8	1.1	1.2	1.1	1.1	0.9	0.8	0.8	0.9	0.9
WOLVERINE	100	65.4	71.2	71.8	70.5	89.8	99.1	113.2	119.1																		
WASHTENAW																											
ANN ARBOR	100	93.5	99.4	99.0	105.0	117.5	127.4	134.4	145.8	100	95.8	88.8	85.5	86.3	89.0	93.7	98.6	107.9	1.1	1.1	1.0	1.0	0.9	0.9	0.9	0.9	0.9
SALEM	100	107.5	98.0	111.1	108.4	127.8	137.0	158.2	160.7	100	92.2	80.0	79.9	82.7	86.4	87.3	89.1	98.2	0.4	0.2	0.4	0.3	0.5	0.0	0.3	0.2	0.2
YORK	100	95.5	88.9	81.1	86.8	98.9	115.2	125.2	130.0	100	80.4	81.4	81.1	79.0	83.9	89.2	94.4	99.0	0.0	0.0	0.2	0.3	0.1	0.0	0.3	0.3	0.3
YPSILANTI	100	94.0	92.9	88.7	112.5	147.4	165.1	199.2	223.6	100	85.2	73.0	68.4	62.3	63.1	65.5	69.4	75.6									
WAYNE																											
ALLEN PARK	100	67.5	65.0	62.0	68.2	78.4	92.0	101.8	109.4	100	91.5	77.4	70.9	62.9	63.4	65.9	67.8	67.9	1.3	1.6	1.5	1.4	1.1	0.9	0.9	0.8	0.8
BELLEVILLE	100	77.5	76.0	66.5	77.1	95.5	114.8	143.5	155.0	100	95.2	86.2	75.7	69.6	68.4	68.7	71.3	73.9	1.6	1.7	1.5	1.5	1.2	0.9	1.0	0.8	0.8
BROWNSTOWN	100	82.9	85.0	79.6	88.2	96.2	109.3	127.2	136.0	100	89.4	81.6	75.7	74.1	75.0	77.6	82.4	85.3	1.4	1.4	1.2	1.1	1.0	0.9	0.9	0.9	0.9
CANTON	100	87.7	88.3	87.2	91.8	104.4	114.4	117.7	125.2	100	91.0	81.9	78.3	76.2	77.7	80.3	87.1	94.9	1.2	1.2	1.1	1.1	1.0	0.9	0.8	0.9	0.9
DEARBORN	100	72.8	70.0	66.9	77.3	101.2	117.1	123.5	138.0	100	90.6	82.0	73.0	68.2	67.8	69.1	73.1	71.8	1.6	2.0	1.9	1.7	1.3	1.0	0.9	0.9	0.9
DEARBORN H	100	67.5	65.3	61.6	70.6	92.1	122.0	131.1	148.4	100	84.3	70.3	63.2	59.3	60.6	62.1	67.7	72.0	1.8	2.2	1.8	1.7	1.3	1.0	0.9	0.9	0.9
DETROIT	100	74.4	85.3	80.9	76.6	88.1	90.9	116.3	113.2	100	90.1	81.1	73.8	69.2	64.4	55.9	53.1	48.5	6.9	8.1	5.8	5.6	6.8	4.8	3.9	2.1	1.7
ECORSE	100	72.7	79.1	77.0	67.0	71.6	94.5	76.8	151.1	100	97.5	88.6	81.0	73.0	71.6	66.9	56.9	40.7	6.7	9.4	7.8	7.0	8.1	10.9	6.0	4.6	2.1
FLAT ROCK	100	81.8	81.0	83.0	85.6	104.6	123.2	130.3	134.0	100	96.3	88.5	82.4	80.0	78.2	73.1	75.3	73.9	1.4	1.5	1.3	1.2	1.2	1.0	0.9	0.9	0.9
GARDEN CITY	100	62.7	70.9	62.6	69.4	87.1	107.0	117.8	130.6	100	87.8	75.0	65.8	57.3	55.0	55.7	61.3	65.4	1.7	2.5	1.9	1.9	1.4	1.1	0.9	0.9	0.9
GIBRALTAR	100	86.4	74.6	63.5	115.9	105.9	98.3	111.6	125.6	100	88.4	84.2	76.5	71.4	73.2	76.3	77.8	80.0	1.4	1.6	1.5	1.6	1.0	1.2	1.0	0.9	0.9

Table 4.2 (Cont'd)

	HPI									SEV per Parcel									Median Sales Ratio								
Government	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
GROSSE ILE	100	85.2	87.2	88.8	86.9	99.2	107.5	116.5	125.9	100	84.9	77.4	71.9	69.3	69.9	71.9	74.4	78.0	1.5	1.4	1.2	1.2	1.1	1.0	0.9	0.9	0.9
ROCHESTER H	100	74.1	75.3	70.9	78.1	97.4	110.7	116.0	122.8	100	92.2	80.1	74.6	74.3	75.9	82.6	90.6	97.0	1.2	1.3	1.1	1.0	0.9	0.8	0.8	0.9	0.9
HARPER WOODS	100	58.3	67.8	63.2	90.2	93.8	113.4	133.9	146.5	100	83.5	69.9	62.2	55.5	49.1	47.5	49.0	49.5	2.7	3.7	2.4	2.4	1.5	1.1	0.9	0.8	0.8
HIGHLAND P	100	107.7	97.6	95.6	106.4	152.6	81.5	122.2	125.2	100	97.3	87.4	80.5	74.0	71.3	69.8	61.8	78.6	6.3	10.7	9.5	6.0	5.5	3.2	10.2	4.4	3.9
HURON	100	55.9	66.7	65.6	66.4	77.1	96.7	96.8	105.6	100	95.3	82.6	73.7	71.2	72.4	72.8	81.3	85.0	1.3	1.6	1.1	1.2	1.1	1.0	0.8	0.9	0.9
INKSTER	100	69.8	71.7	59.9	68.4	73.7	94.9	117.3	102.0	100	86.3	78.5	74.2	64.6	59.3	51.8	47.6	45.6	5.1	6.6	5.6	6.8	5.6	6.4	3.2	2.0	1.6
LINCOLN PARK	100	72.3	83.4	73.8	82.0	102.0	124.3	192.5	182.2	100	91.9	77.8	68.4	60.8	56.5	54.6	54.2	56.4	2.7	3.6	3.0	2.9	2.1	1.6	1.1	0.9	0.8
LIVONIA	100	81.3	78.8	78.0	83.2	105.2	117.0	125.9	134.4	100	93.1	79.4	73.3	69.3	68.8	71.7	77.2	81.3	1.3	1.4	1.2	1.2	1.0	0.9	0.8	0.9	0.9
MELVINDALE	100	73.9	82.0	75.2	86.4	98.3	137.5	162.3	195.7	100	89.5	78.3	71.7	64.0	65.4	66.2	66.9	70.0	3.3	3.8	2.5	2.1	1.6	1.3	1.0	0.9	0.8
PLYMOUTH	100	103.8	92.3	102.0	120.6	136.8	155.8	158.1	173.5	100	93.7	86.9	84.9	83.6	85.4	92.1	99.6	108.1	1.2	1.2	1.2	1.1	0.9	0.8	0.8	0.8	0.9
PLYMOUTH T	100	88.9	91.0	92.7	99.8	113.3	119.1	125.9	132.9	100	93.5	84.3	78.9	77.2	77.2	81.2	86.4	88.0	1.2	1.3	1.1	0.0	0.9	0.9	0.9	0.9	0.9
REDFORD	100	71.8	71.7	60.6	67.1	89.3	111.0	124.7	141.3	100	85.8	70.9	62.3	54.4	49.9	50.5	53.5	55.9	2.1	2.7	2.1	2.1	1.6	1.1	0.9	0.8	0.8
RIVER ROUGE	100	58.9	66.8	70.6	69.9	86.0	77.3	93.1	96.7	100	95.0	89.6	86.7	85.2	86.7	84.5	76.7	63.3	7.8	9.6	8.2	7.0	7.9	8.3	8.9	5.0	3.6
RIVERVIEW	100	71.1	71.8	64.1	74.2	87.8	92.3	107.0	115.9	100	91.8	82.8	76.1	75.9	66.2	68.1	78.4	78.2	1.3	1.5	1.4	1.4	1.2	1.0	0.9	1.0	0.9
ROCKWOOD	100	68.7	70.4	68.5	91.5	97.9	113.6	125.4	136.6	100	93.6	77.7	71.3	64.0	64.5	66.1	73.0	73.5	1.3	2.0	1.5	1.5	1.1	0.9	0.9	1.0	0.9
ROMULUS	100	63.7	79.5	77.5	74.8	101.0	127.8	144.7	175.3	100	90.2	233.6	67.0	57.5	62.1	60.4	62.0	67.9	2.0	2.1	2.0	1.8	1.8	1.1	1.0	1.0	0.8
SOUTHGATE	100	83.7	78.9	73.5	80.0	108.6	117.9	131.9	139.8	100	88.5	77.7	67.7	62.1	61.1	64.6	66.5	68.8	1.7	1.7	1.6	1.5	1.2	1.0	1.0	0.9	0.9
SUMPTER	100	61.7	76.5	77.3	83.6	94.1	106.4	121.4	162.8	100	90.2	87.2	79.2	70.5	73.0	75.4	78.8	82.7	1.6	2.3	1.7	1.7	1.2	1.3	1.0	1.1	0.9
TAYLOR	100	57.5	67.0	65.4	73.2	90.9	112.8	142.8	156.4	100	91.3	79.3	72.3	65.4	63.7	62.7	64.4	66.9	2.0	3.2	2.0	2.2	2.2	1.3	1.0	0.9	0.9
TRENTON	100	65.9	68.9	62.4	74.8	94.9	100.3	112.4	120.5	100	92.0	86.1	80.5	71.1	72.2	72.8	77.3	77.3	1.3	1.5	1.4	1.5	1.2	1.0	0.9	0.9	0.9
VAN BUREN	100	76.8	78.6	75.2	81.4	92.4	102.7	122.0	131.0	100	90.9	76.3	73.1	69.1	70.3	70.7	74.8	76.8	1.5	1.4	1.3	1.3	1.4	0.9	0.9	0.9	0.9
WAYNE	100	65.9	56.2	57.3	59.0	81.7	112.5	134.1	156.7	100	86.4	73.3	57.6	54.1	52.6	50.3	52.1	53.4	2.1	3.4	3.2	2.7	2.3	1.5	1.0	0.9	0.8
WESTLAND	100	72.2	77.5	71.7	76.3	101.0	120.7	136.4	153.4	100	88.3	76.5	69.8	64.1	60.9	61.4	66.8	72.4	1.7	2.0	1.6	1.6	1.3	1.0	0.9	0.9	0.9
WOODHAVEN	100	79.3	81.6	64.2	81.6	88.3	107.1	114.3	124.6	100	94.3	86.7	80.9	74.9	76.6	75.3	78.8	79.0	1.3	1.5	1.4	1.4	1.0	1.0	0.9	0.9	0.9
WYANDOTTE	100	55.6	64.3	61.3	77.1	83.9	108.0	124.4	133.0	100	89.0	76.2	69.4	65.0	63.9	64.5	68.4	73.0	1.6	2.4	1.8	1.7	1.4	1.1	0.9	0.9	0.9
Average	**100**	**76.4**	**78.8**	**77.6**	**86**	**104**	**120**	**133**	**145**	**100**	**90.8**	**80.5**	**72.1**	**68.2**	**68.2**	**70.9**	**76.5**	**80.6**	**1.83**	**2.22**	**1.83**	**1.67**	**1.45**	**1.22**	**1.13**	**1.01**	**0.95**
Macomb	100	73.3	76.6	78.3	85.7	105.3	125.8	140.5	145.0	100	91.9	80.4	72.8	68.5	68.7	71.4	78.8	83.0									
Monroe	100	75.8	69.9	73.9	76.0	86.8	97.8	107.9	129.2	100	91.3	85.0	82.1	79.9	79.3	81.2	85.4	88.5									
Oakland	100	76.2	80.9	82.2	93.1	113.6	130.1	143.2	156.5	100	91.3	78.0	70.9	68.7	69.4	74.2	81.8	87.4									
Washtenaw	100	93.2	98.0	97.8	105.8	120.6	132.3	142.8	155.7	100	93.3	86.7	82.5	80.6	82.4	86.5	92.1	98.6									
Wayne	100	72.7	76.8	71.9	74.5	89.5	99.3	119.0	127.1	100	90.3	81.0	73.5	69.1	67.5	66.8	69.2	69.9									

CHAPTER 5:

Conclusion

In this dissertation, I examine and analyze several aspects of Michigan property assessment practice. In the first essay, I estimated a Michigan property assessment expenditure function using data for most Michigan local governments. Assessment is more efficient when an assessing office is working with a larger number of properties. For a local unit with 1700 parcels (the average size local unit in my dataset), each one percent increase in parcel numbers will reduce assessment expenditure per parcel by 0.53 percent. Each one percent increase in average property assessed value is associated with a 0.54 percent increase of assessment expenditure per parcel. My analysis suggests that hiring private assessors instead of "in-house" assessors does not necessarily result in expenditure reduction.

In the second essay, I evaluate the performance of three types of property assessors: "in-house" assessors, private assessors, and county assessors, to test the hypothesis that neither the public nor the private sector is inherently superior to the other in the case of Michigan tax assessment. I also attempt to determine assessor type respective comparative advantages, identify a more optimal allocation of assessors, and compare a more optimal allocation to the existing arrangement to determine the degree of misallocation. Results show: (i) Neither private nor public assessors is always superior nor inferior to the other, and they both have relative strengths within different types of communities; (ii) they both tend to perform better in larger communities and communities with higher average property values; and (iii) there appears to be a

misallocation of assessors in Michigan. Private contractors perform better in communities with more parcels but tend to be employed in communities with fewer parcels. Based on the results, I recommend merging smaller assessing districts in Michigan to form larger assessing areas, and then allocate different types of assessors to move toward a more optimal arrangement. Scenario forecasts suggest that following my recommendation could improve assessment performance by 32 percent as compared to the current situation.

In the last essay, I offer dynamic analysis of Michigan property assessments and connect assessment practices with housing price fluctuations by constructing and comparing a Hedonic Housing Price Index (HPI) and a State Equalized Value (SEV) index for 120 Michigan assessing units in the five-county region surrounding Detroit. My findings are generally consistent with the literature that there is about a three-year lag between housing price changes and changes in property assessments for tax purposes. However, I also find that before the crisis struggling communities tended to over-estimate assessments to support property tax revenue streams. Assessment adjustments to market declines in these places also lagged in other fiscally healthier cities. On a positive note, the evaluation shows that local authorities in these struggling communities used the financial crisis period to align assessments more closely to actual market conditions as per legal requirements. While the SEV index in most local governments began to once again grow in the wake of the crisis in 2013 or 2014, SEVs in struggling local governments such as Detroit continued to fall through 2016.

Several policy implications stem from this dissertation. First, my analysis suggests merging small assessing districts to form larger assessing areas to help reduce

expenditures and improve productivity. I base this conclusion on the following: (i) as shown in the first essay, assessment expenditure per parcel is smaller in bigger communities, and the impact of size becomes more substantial the larger is the community; and (ii) the second essay indicates, all types of assessors tend to perform better in larger communities. I also recommend that assessor types be reallocated in a way that improves productivity. Specifically, improvements can be achieved by using private contractors in communities containing more than 50,000 parcels and using in-house assessors in the rest of the communities. The reasons for this suggested allocation are: (i) as the first essay indicates, hiring different types of assessors does not affect assessment expenditure; and (ii) as the second essay indicates, a reallocation of assessors could potentially significantly enhance assessment performance. However, the jurisdictions might have reasons for not taking optimal assessing regimes, as discussed in this paper. For example, they might be foregoing assessment performance for more control to the assessors, to deliberately over- or under-states properties. It would be interesting to extend this research with focuses on government assessing objectives.

Looking forward, I will continue to pursue research on Michigan property assessment. One possibility venue for further study is to explore the overestimation of property value in Michigan. With the calculated median sales ratio of each local government, it would be interesting to offer a dynamic overview of what types of local governments over- or under-assess property. In particular, I plan to map the geolocation of local governments with their median sales ratio, explore potential clustering of over-estimating governments, as well as identify trends in assessment over time. I also plan to

analyze what types of governments are more likely to over- or under-state properties. This proposed additional analysis will be an extension of this dissertation.

Another possibility is to rank Michigan local governments by their technical efficiency in property assessment. An innovative methodology – Stochastic Frontier Model – was used in this dissertation to measure the influences of various determinants of assessment performance. It would be valuable to extend this analysis with the same methodology to calculate technical efficiencies for each government. This research will combine both the expenditure and performance components of assessment, and offer a more comprehensive view of Michigan property assessment.

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