The Effect of Land Value Ratio on Property Tax Protests and the Effects of Protests on Assessment Uniformity

Elizabeth Plummer

Lincoln Institute of Land Policy
Working Paper

Lincoln Reference Number: WP10EP1

Abstract

This study examines the association of a property's land value ratio with the probability and outcome of an owner protesting the property's assessed value, and the resulting effects of property tax protests on the uniformity of assessed property values. Land value ratio is defined as a property's assessed land value divided by total assessed market value. The study includes all single-family residential properties in Harris County Appraisal District for the period 2006, 2007, and 2008. Harris County is an urban county located in the southeast part of Texas. The county covers approximately 1,778-square miles, and currently has about 4.0 million residents.

This study addresses three questions:

1. Is a property's land value ratio associated with the likelihood that a property owner will protest the property's assessed market value?

2. If a protest is filed, is a property's land value ratio associated with the percentage decrease in the property's assessed market value that the owner realizes through the appeals process?

3. Is the assessment uniformity of total property value affected by adjustments made in the appeals process? More specifically, is the assessment uniformity of land value and improvement value affected by adjustments made in the appeals process?

About the Author

Elizabeth Plummer is an Associate Professor of Accounting at the Neeley School of Business, Texas Christian University, in Fort Worth, Texas. Her current research focuses on property and land value taxation issues, as well as the recent changes made to the financial reporting requirements of state and local governments. She has published several papers which focus on the distributional effects of the property tax and the land value tax. She currently teaches federal income tax courses in the graduate and undergraduate programs in the Neeley School. Prior to entering academics, she worked in the tax department at Price Waterhouse (now PricewaterhouseCoopers).

Elizabeth Plummer, Ph.D., CPA
Department of Accounting
Neeley School of Business
Texas Christian University
TCU Box 298530
Fort Worth, TX 76129
Phone: 817-257-5104
Fax: 817-257-7227
E-mail: c.e.plummer@tcu.edu

Table of Contents

List of Tables

The Effect of Land Value Ratio on Property Tax Protests and the Effects of Protests on Assessment Uniformity

Introduction

This project examines the association of a property's land value ratio with the probability and outcome of an owner protesting the property's assessed value, and the resulting effects of property tax protests on the uniformity of assessed property values. I define land value ratio as a property's assessed land value divided by total assessed market value. Specifically, this project addresses three questions:

1. Is a property's land value ratio associated with the likelihood that a property owner will protest the property's assessed market value?

2. If a protest is filed, is a property's land value ratio associated with the percentage decrease in the property's assessed market value that the owner realizes through the appeals process?

3. Is the assessment uniformity of total property value affected by adjustments made in the appeals process? More specifically, is the assessment uniformity of land value and improvement value affected by adjustments made in the appeals process?

This project provides several important contributions to the study of land value taxation, and property taxation in general. First, this study increases our understanding of the role that land values play in the current property tax system and consequently, we can better understand the benefits and challenges of a land value tax (LVT) system. In a LVT system, land would be the only asset with an assessed tax value. By understanding how land value ratios are associated with protests and appeals adjustments, we can better predict the administrative issues surrounding a LVT system. Focusing on a property's land value component is also consistent with the work of Bostic, Longhofer, and Redfearn (2007) and Clapp and Salavei (2010). Bostic et al. (2007) demonstrate that changes in overall property value depend critically on how much of a property's value is represented by land value, a proportion they call "land leverage." (I refer to this as the "land value ratio.") Bostic et al. argue that considering a property's land leverage can help improve our analysis of real estate markets and policies. This project directly applies their suggestion in its analysis.

Second, this study significantly expands on the work of Weber and McMillen (2010) by examining the factors that affect the probability that a residential property owner protests their assessed value for tax purposes. Weber and McMillen estimate two models: an appeals model, which estimates the probability that a property owner files an appeal; and a success model, which estimates the probability that the appeal is successful. My analysis differs from Weber and McMillen (2010) in several important ways. Weber and McMillen do not examine how a property's land value ratio is related to the probability of protest or appeals success. Their primary concern is with the effect that neighborhood sales activity has on a property owner's likelihood of protesting and likelihood of success. Another important distinction of this project is that the measure of appeals success used by Weber and McMillen is an indicator variable (1=reduction in value indicating success, 0=no reduction in value). In contrast, the data used for this project allows me to measure the exact dollar amount of the decrease in assessed property value resulting from the appeals process. In addition, the data allows me to examine whether the format of the appeals hearing (formal or informal) affects the reduction in property value realized upon appeal. This was not examined by Weber and McMillen.

Third, with the exception of Firoozi et al. (2006) whose sample included 252 homes over a two-year period, this will be the first study to examine how the appeals process affects assessment uniformity. An important part of the property tax system is an owner's ability to appeal his property's assessed value (Shavell 1995 and 2006). However, there is little evidence on the changes that result from the appeals process. If adjustments made through the appeals process decrease assessment uniformity, then this suggests that the appeals process as currently implemented reduces the horizontal equity of the property tax system. Evidence on equity effects is important to academicians, policymakers, and taxpayers when evaluating the property tax system.

Summary of Results

This study's sample includes all single-family residential properties in Harris County Appraisal District (HCAD) for the period 2006, 2007, and 2008. Harris County is an urban county located in the southeast part of Texas. The county covers approximately 1,778-square miles, and contains 34 different cities and 23 different school districts. Harris County currently has almost 4.0 million residents, making it the third most populous county in the U.S. Most of those residents live in Houston, the county's largest city. Harris County's population grew by 14.3% over the period 2000 to 2008. This study's results related to the three questions above can be summarized as follows:

Question 1: I use a probit model to explain an owner's likelihood of protesting the property's assessed market value. The probit model correctly classifies between 86.7% to 90.7% of the observations, indicating the model does a good job of explaining the likelihood an owner protests. The results for land value ratio (LVR) are not consistent across years. The LVR coefficient is significantly positive in 2006, significantly negative in 2007, and positive but only marginally significant in 2008. These results suggest that LVR is not systematically associated with the likelihood that a property owner will protest their property's assessed value.

Endogeneity: It is possible that the reduction in market value obtained through an appeals hearing is endogenous. Endogeneity could arise because property owners choose whether or not they will protest their property values. Properties of owners who choose to protest may have systematically different characteristics than properties of owners who do not choose to protest. If these characteristics are related to market value but are omitted from the models used to test question 2 and question 3, then the results could be biased. To help control for the possibility that a property owner's choice to protest is endogenous, I use the maximum likelihood estimation (MLE) approach to Heckman's two-stage estimation process (Heckman 1979). In the first stage, I estimate the probit equation that models a property owner's decision to appeal the initial assessed property value (i.e., the equation used in 1 above). In the second stage, I use the predicted probabilities from the probit model to construct the inverse Mills ratio (λ_{it}), which is then included as an additional explanatory variable in the equations used to address question 2 and question 3.

Question 2: To provide evidence on question 2, the sample includes only those properties that were protested and had an appeals hearing. The dependent variable is the percentage decrease in a property's market value resulting from the appeals hearing. The model's independent variables include factors that are likely to affect the magnitude of the appeals adjustment. Results suggest that, if an owner files a protest, the percentage appeals adjustment decreases as a property's land value ratio increases. In other words, properties with higher land value ratios receive a smaller percentage reduction in assessed market value than properties with lower land value ratios.

Results also suggest that the magnitude of the appeals adjustment differs depending on the format of the appeals hearing (formal/informal, agent/no agent). All else equal, results suggest that:

- the appeals adjustments of owners who represent themselves are about 1% greater if they settle their protest through a formal hearing rather than an informal hearing,
- the appeals adjustments of owners whose protest is settled through an informal hearing are between 0.6% and 2.3% lower if owners use an agent compared with representing themselves, and
- the appeals adjustments of owners whose protest is settled through a formal hearing are between 2.6% and 3.4% lower if owners use an agent compared with representing themselves.

Question 3 (uniformity of total value): To provide evidence on question 3, I use the full sample of single-family residential properties (i.e., both protest and non-protest properties). I use a hedonic pricing model to explain the assessed market value of all properties before the appeals adjustment, and the value after the appeals adjustment (if any). Results suggest that, after controlling for other determinants of market value, assessed market values for protest properties are greater than values for non-protest properties. This is true both before and after the appeals process is completed. This suggests that the appeals process increased assessment uniformity by decreasing the market values of protest properties. However, those adjustments were not sufficient.

I also examine whether there is a difference in the assessed market values for protest properties that obtained a decrease in assessed value (*Adjustment* properties) versus protest properties that obtained no decrease in value (*NoAdjustment* properties). Evidence suggests that the initially assessed market values for *Adjustment* properties are systematically greater than for *NoAdjustment* properties. Results for the final values—*after* any adjustments—are mixed. For 2006, the final assessed market values for *Adjustment* properties are greater than the values for *NoAdjustment* properties. In contrast, for 2007 and 2008, the final assessed market values for *Adjustment* properties are less than the values for *NoAdjustment* properties.

Question 3 (uniformity of land and improvement values): I also test the effect of the appeals process on the assessment uniformity of land and improvements separately. The data does not provide separate values for land and improvements as they are valued before the appeals hearing. I can therefore only examine assessment uniformity after the appeals process. Overall, results suggest that there is a lack of assessment uniformity for both land values and improvement values, even after any value adjustments made through the appeals process. For *Adjustment* properties, the final assessed values of improvements are significantly less than for non-protest properties for 2006 and 2007, but are significantly greater in 2008. Assessed land values are greater for *Adjustment* properties than for non-protest properties in 2006 and 2008, but not significantly different in 2007. For *NoAdjustment* properties, the final assessed values of improvements are greater than for non-protest properties in all years. Assessed land values are greater for *NoAdjustment* properties than for non-protest properties in 2006 and 2008, but significantly less in 2007.

For *Improvements*, results suggest that the final assessed value for improvements is systematically less for *Adjustment* properties than for *NoAdjustment* properties. The exact opposite is true for land values. Results suggest that the final assessed market value for land is systematically greater for *Adjustment* properties than for *NoAdjustment* properties. I do not have access to the initially assessed values for land and improvements separately (i.e., before the appeals hearings), so I cannot comment on the relative changes that were made to each component through the appeals hearing. However, for the *Adjustment* properties, the results are consistent with a relatively larger adjustment being made to improvement values than to land values.

The remainder of this paper is organized as follows. Section 2 reviews prior research and develops the hypotheses. Section 3 describes the methodology, while Section 4 describes the data and sample, including descriptive statistics. Section 5 provides results for the association of land value ratio with the likelihood that an owner protests and, assuming the owner protests, with the decrease in assessed market value obtained in the appeals process. Section 6 provides results for examining the effect of appeals on assessment uniformity. The final section provides implications for future research.

Background and Hypotheses

Background

As prescribed by Texas state law, HCAD determines the market value of all taxable property in Harris County as of January 1. Property owners generally receive notices of their property's assessed market values in March or April. If a property owner believes the assessed value is too high, the individual generally has about 30 days to file a protest. HCAD will then schedule a date for a formal meeting with the Appraisal Review Board. Prior to this formal hearing, however, the owner has an opportunity to have a preliminary informal meeting with an appraiser.[1] The purpose of the preliminary meeting is to review and, if possible, settle the protest in an informal setting. If the protest is not resolved at the informal hearing, then the property

[1] The owner or his representative meets with an HCAD appraiser who can settle the protest at this preliminary informal meeting. If the protest is settled, the owner is not required to attend the formal hearing with the Appraisal Review Board. An informal meeting is not required by law.

owner will proceed to a formal hearing with the Appraisal Review Board (ARB).[2] Formal hearings are conducted by a panel of three ARB members. The HCAD appraiser and the taxpayer (or his representative) each present evidence to support their valuations. The ARB panel then confers to reach a decision. The panel's decision must be approved by the entire ARB before it becomes final.

Owners can represent themselves in any property tax matter. Alternatively, owners can appoint a representative—commonly known as an agent—to represent them. With limited exceptions, agents who represent property owners for a fee must be state-licensed. Property owners can authorize agents to present them in one or more areas, including filing protests, presenting an appeals case before the ARB, and negotiating value disputes.

The studies most relevant to this current study are Weber and McMillen (2010) and Firoozi, Hollas, Rutherford, and Thomson (2006). Weber and McMillen (2010) is the only paper of which I am aware that examines characteristics that are associated with a residential property owner's decision to appeal the property's assessed value, and the owner's probability of obtaining a value reduction through the appeals process. Weber and McMillen's (2010) sample consists of property tax appeals made in Chicago in 2000 and 2003, pertaining to residential parcels with six or fewer units. The authors use a sequential probit model to examine the probability that property owners appeal their assessments, and within this group of owners who appeal, the probability that owners are successful in obtaining a value reduction. Their final sample consists of approximately 393,000 properties for 2000, of which about 36,000 (9.2%) were protested, and approximately 368,000 for 2003, of which almost 49,000 (13.3%) were protested. The authors find that the probability of an owner filing a protest is greater for properties in areas (census tracts) with higher property values, a greater proportion of homeowners, and a larger number of other owners also protesting; and the probability is smaller for areas with higher median income, larger percentages of non-white residents, and a greater number of properties sold within the past three years. They also find that the probability of protest is greater for larger homes, but smaller for properties with higher assessed values and for properties that have sold recently.

Weber and McMillen (2010) also examine the probability that a property owner who appeals is successful in obtaining a value reduction. Their data only allows them to examine the likelihood of success, and not the magnitude of the value reduction. The authors find that success is more likely for older properties, and for properties in areas with higher median income and higher assessed property values. They find that success is less likely for larger properties, and for properties in areas with a larger number of properties that have recently sold and a larger number of other owners also protesting. They also find that success is less likely when an owner uses an attorney, rather than representing himself.[3] Weber and McMillen (2010) do not provide evidence on the effects of the appeals process on assessment uniformity.

[2] The Appraisal Review Board is not bound by any discussions or settlement offers made between the owner and the appraiser at the informal meeting.
[3] Weber and McMillen (2010) examine other factors, but results for those factors are either inconsistent across years or are only marginally significant.

To my knowledge, the only prior study that examines how the appeals process affects assessment uniformity is Firoozi et al. (2006). They examine whether owners who protest to the Appraisal Review Board have lower tax valuations. Their sample includes 503 property observations over a two-year period (2000 and 2001), or about 252 single-family residential properties each year. Their data do not allow them to observe the property value before the appeals adjustments (if any), only the value afterwards, so they cannot determine whether an appraised value was actually reduced through appeal. They examine the tax values of protested and non-protested properties, and find no difference between values assigned by the appraiser's office and values determined through the Appraisal Review Board. They interpret this as evidence that the appeals process results in assessment uniformity, and does not result in unjustified low valuations for owners who protest. However, they do find evidence that state-licensed property tax consultants who appeal to the Appraisal Review Board have approximately 6.2% lower assessed values compared with owners who do not protest.

Hypotheses

This current project examines the association of a property's land value ratio on the probability and outcome of an owner protesting the property's assessed value, and the resulting effects of property tax protests on the uniformity of assessed property values. I define land value ratio as a property's assessed land value divided by total assessed property value. Specifically, this project addresses three questions:

1. Is a property's land value ratio associated with the likelihood that a property owner will protest the property's assessed market value?

2. If a protest is filed, is a property's land value ratio associated with the percentage decrease in the property's assessed market value that the owner realizes through the appeals process?

3. Is the assessment uniformity of total property value affected by adjustments made in the appeals process? More specifically, is the assessment uniformity of land value and improvement value affected by adjustments made in the appeals process?

The first question examines whether a property's land value ratio is associated with the likelihood that a property owner will protest a property's assessed market value. On one hand, property owners with a low land value ratio may be *more* likely to protest their property's assessed market value. A property's total value is composed of two separate components: the value of the improvements and the value of the land. Improvement values are affected by a myriad of factors, and owners can argue that the assessed value of improvements should be adjusted downward for numerous variables that the appraiser has failed to consider (e.g., construction quality, condition, style). In contrast, relative to improvements, land is less variable and more uniform across properties. Except for size and value per square foot, there are generally fewer features on which an owner can base an appeal. This suggests that property owners with a low land value ratio, and thus a higher percentage of value attributable to improvements, will be more likely to protest their property's assessed market value than owners with high land value ratios. On the other hand, Goolsby (1997) provides evidence that residential properties with a larger land value ratio are overassessed by appraisal districts. Specifically, Goolsby examines 8,268 residential properties from three counties in Washington State. He models assessment ratio (i.e., assessed value divided by sales price) as a function of the property's land value ratio and other variables, and finds that the coefficient on land value ratio is significantly positive in estimations for all three counties. If land value ratio is positively associated with overassessment, then this suggests that property owners with a low (high) land value ratio will be less (more) likely to protest their property's market value. Because of the conflicting predictions, there is no ex ante basis for a prediction, and H1 is stated in the null form:

H1: A property's land value ratio is not associated with the likelihood that a property owner will protest the property's assessed market value.

For properties where owners protest the assessed value, the second question examines whether a property's land value ratio is associated with the percentage decrease in assessed value realized through the appeals process. As discussed above, properties with a lower land value ratio, and a higher percentage of value attributable to improvements, have more potential arguments for requesting a downward adjustment in property value. This suggests that, among properties with protested values, properties with low land value ratios are likely to receive a larger percentage decrease in assessed market value than properties with high land value ratios. However, Goolsby's (1997) evidence suggests that properties with a larger land value ratio are more likely to be overassessed. This suggests that properties with high land value ratios may receive a larger percentage decrease through the appeals process, if the appraiser or ARB panel recognizes and corrects the overassessment. Because of the conflicting predictions, the H2 is also stated in the null form:

H2: Among properties with protested values, a property's land value ratio is not associated with the percentage reduction in assessed market value.

The third question examines whether assessment uniformity is improved by adjustments made in the appeals process. Assessment uniformity is important because it directly relates to the property tax system's equity. An appeals process provides taxpayers with an opportunity to challenge inappropriate valuations, and also helps guard against arbitrary value changes that decrease uniformity (Malme 1991). An appeals process also increases incentives for appraisers to improve the quality of their initial valuations, so that there are fewer protests and fewer value adjustments made in the appeals process (Shavell 1995 and 2006; Weber and McMillen 2010). Improvements in assessment quality help increase property tax equity.

The appeals process allows for a possible reduction in assessed market value for properties that are protested. If protested properties are overvalued by appraisers, relative to non-protested properties, and if the appeals process appropriately reduces the values of protested properties, then this could increase assessment uniformity. This leads to H3:

H3: Assessed values determined through the appeals process exhibit greater uniformity than assessed values determined before the appeals process.

It is not a foregone conclusion that the appeals process will improve assessment uniformity. If the appeals process results in value reductions that are too large or are not justified, then assessment uniformity may not increase—and could possibly decrease.

Methodology

H1: Property Tax Protest

To test H1, I estimate the following probit model separately for each year using all single-family residential properties in the appraisal district:

$$Protest_{it} = \alpha_0 + \alpha_1 LVR_{it-1} + \phi' Y_{it} + \varepsilon_{it} \qquad (1)$$

Protest is an indicator variable equal to 1 if the owner protests the property valuation, and equal to zero otherwise. LVR_{it-1} is property i's land value ratio for year t-1, defined as the property's market value of land divided by its total market value. If $\alpha_1 > 0$ ($\alpha_1 < 0$), this suggests that owners are more likely (less likely) to file a protest as their property's land value ratio increases.[4]

Y_i is a vector of variables which are likely to affect the likelihood that a property owner protests his property valuation. These explanatory variables include:

$Log\_InitialMKTV_{it}$	=	log of initial market value for property i (i.e., this is market value before the appeals adjustment, if any).
$\%\Delta MKTV_{it}$	=	% change in property i' assessed market value from year t-1 to year t, before the current-year's appeal adjustment (if any). This is computed as $InitialMKTV_{it}$ minus $FinalMKTV_{it-1}$, divided by $FinalMKTV_{it-1}$, where *FinalMKTV* is assessed market value after the appeals adjustment (if any).
$PY\_Protest_{it}$	=	1 if value for property i was protested in prior year, and 0 otherwise.
$PY\_Success_{it}$	=	1 if value for property i was protested in prior year and owner obtained a lower value due to the appeal, and 0 otherwise.
Log_age_{it}	=	log of property i's age, where age is measured in years.
No_age_{it}	=	1 if there is no age available for property i, and 0 otherwise.
$RecentSale_{it}$	=	1 if property i has sold in past 3 years, and 0 otherwise.
$Homeowner_{it}$`	=	1 if the property has a homestead exemption, and 0 otherwise.
$Over65_{it}$	=	1 if the property has an over-65 exemption, and 0 otherwise.
$Disability_{it}$	=	1 if the property has a disabled exemption, and 0 otherwise.
$OtherExemption_{it}$	=	1 if the property has another type of exemption, and 0 otherwise.
CAP_{it}	=	1 if property i is a capped property, and 0 otherwise.
$\%Protest_{ijt}$	=	% of single-family properties in neighborhood j for which a current-year protest has been filed. Property i is located in neighborhood j.

[4] I measure LVR at year t-1 because the only measure I have of year t land values for successfully protested properties are assessed land values *after* any adjustments made though the appeals process.

%Homeowners$_{ijt}$	=	% of owner-occupied properties in property i's neighborhood j.
%RecentSale$_{ijt}$	=	% of properties in neighborhood j that have sold in past 3 years.
Log_stdTBldgArea$_{ijt}$	=	log of the standard deviation of single-family residential building size in neighborhood j, where size is measured in square feet.
HigherInitialMKTV$_{it}$	=	1 if *InitialMKTV$_{it}$* for property i is above the median *InitialMKTV$_{it}$* for neighborhood j.
Higher%ΔMKTV$_{it}$	=	1 if *%ΔMKTV$_{it}$* for property i is above the median *%ΔMKTV$_{it}$* for neighborhood j.

As an owner's tax liability increases, the owner has more incentive to appeal (Bowman and Mikesell 1978; Bowman and Butcher 1986). I therefore expect *Log_InitialMKTV* to be positively related to *Protest*. *%ΔMKTV* measures the annual increase in a property's assessed market value. Evidence suggests that rapidly changing market values make it more difficult to estimate such values (Bowman and Mikesell 1978; Bowman and Butcher 1986). Property owners may also interpret any large increase in assessed market value to assessment error, rather than a justified increase in market value (Weber and McMillen 2010). I therefore expect *%ΔMKTV* to be positively related to *Protest*. I also include indicator variables if a property's value was protested in the prior year (*PY_Protest*), and if the owner obtained a lower value due to the protest (*PY_Success*). The characteristics of these properties or their owners may indicate an increased likelihood of protest, and I therefore expect both *PY_Protest* and *PY_Sucess* to be positively related to *Protest*.

Older properties may be more difficult to value than newer ones (Bowman and Mikesell 1978; Bowman and Butcher 1986), so I expect *Log_age* to be positively related to *Protest*. Each year, a little less than 3% of properties do not have an age variable coded in the database. Rather than delete these properties from analysis, I include an indicator variable (*No_age*) to signify properties with no age information. Simple analysis of the data suggests that these properties are likely to be older properties, so I expect *No_age* to be positively related to *Protest*. *RecentSale* is an indicator variable equal to one if a property has sold in the past 3 years. Because sales value is a relatively good indication of current market value, it is more difficult for property owners to dispute the assessed value (Weber and McMillen 2010). I therefore expect *RecentSale* to be negatively related to *Protest*.[5]

I include indicator variables if a property owner claims an exemption. Exemptions remove part of the property's market value from taxation. Exemptions for residential property are only available if a homeowner uses the property as their personal residence, and possible exemptions include the general homestead, over-65, disabled, and disabled veterans. If a home qualifies for an over-65 or disabled exemption, state law also provides that the property owner's school district taxes can never exceed the level imposed on the property the year the homeowner turns 65 years old or becomes disabled. School taxes can go below this ceiling, but they can never

[5] Texas is a nondisclosure state, which means that sales prices are not required to be submitted to the appraisal district or the county office, and are not otherwise made available to the public. However, appraisal districts can purchase MLS data, which provides list (asking) prices. Although HCAD may not be able to determine a property's exact sales price, HCAD will know the date when the ownership changed, as well as the general list prices for neighborhood homes, and perhaps the list price for the property itself.

exceed it. Because the exemptions and related ceilings reduce a property owner's tax liability, I expect all exemption variables (*Homeowner, Over65, Disability, and OtherExemption*) to be negatively related to *Protest*.

State law also provides homeowners with a tax relief measure referred to as the "10% cap." The 10% cap specifies that a homestead's assessed tax value cannot be increased by more than 10% per year times the number of years since the last appraisal. In other words, the property's market value will be set at the current market value, but the value used for determining tax liability will be set at the capped amount.[6] I therefore include the indicator variable *CAP*, which is equal to one if a property's market value exceeds its tax value (i.e., the property is a capped property). The 10% cap reduces a property owner's tax liability and makes market value less relevant, and I expect *CAP* to be negatively related to *Protest.*

I also include four neighborhood characteristic variables. *%Protest* is the percentage of single-family properties in the neighborhood for which a current-year protest has been filed. Property owners are likely to be influenced by their neighbor's decision to protest. There is also likely to be more information disseminated about the appeals process when there are more protests (Weber and McMillen 2010). This suggests that *%Protest* will be positively related to *Protest*. *%Homeowners* is the percentage of owner-occupied properties in the neighborhood. I include *%Homeowners* to help control for neighborhood characteristics, but do not make a prediction on its relation with *Protest*. *%RecentSale* is the percentage of properties in the neighborhood that have sold in the past 3 years. Weber and McMillen (2010) argue that greater sales activity in a neighborhood leads to more information about market prices, and can thus improve the quality of assessments. As assessment quality increases, owners are less likely to protest. I therefore expect *%RecentSale* to be negatively related to *Protest*. *Log_stdTBldgArea* proxies for the variability in neighborhood houses. I do not make a prediction on the sign of its coefficient. On one hand, increased variability of neighborhood properties may decrease assessment quality because of the lack of the similar property types. Lower assessment quality could motivate owners to protest. On the other hand, the lack of comparable properties may also decrease a property owner's knowledge of their own property value and make them less likely to protest. Finally, I expect *HigherInitialMKTV* and *Higher%ΔMKTV* to be positively related to *Protest*. Properties with market value, and changes in assessed market value, in the top half of their neighborhood are more likely to protest. These owners face more significant tax liabilities and are more likely to see the property's value change as unfair and/or unjustified.

Controlling for Endogeneity in Tests of H2 and H3

It is possible that the reduction in market value obtained through an appeals hearing is endogenous. Endogeneity could arise because property owners choose whether or not they will protest their property values. Properties of owners who choose to protest may have systematically different characteristics than properties of owners who do not choose to protest. If these characteristics are related to market value but are omitted from the models used to test H2 and H3, then the results could be biased. This could result in incorrectly attributing

[6] For example, the January 1 market value of a capped residence might be $200,000. However, if that home is appraised at $175,000 on January 1 of the prior year, the current year's capped value would be $192,500 ($175,000 times 1.10).

differences in final market values to the fact that there was an appeals hearing, rather than to the inherently different characteristics of protested properties.

To help control for the possibility that a property owner's choice to protest is endogenous, I use the MLE approach to Heckman's two-stage estimation process (Heckman 1979**).**[7] In the first stage, I estimate the probit equation that models a property owner's decision to appeal the initial assessed property value (equation 1 above). In the second stage, I use the predicted probabilities from the probit model to construct the inverse Mills ratio (λ_{it}), which is then included as an additional explanatory variable in the equations used to test H2 and H3. This procedure specifically addresses the issue of selection bias regarding a property owner's choice to protest, and should help alleviate the problem of falsely associating differences in property values with an appeals hearing. MLE is used in the second stage, because Maddala (1983 and 1991) argues that MLE is superior to ordinary least squares (OLS).[8]

H2: Percentage Reduction in Assessed Value

To test H2, I estimate the following model separately for each year using all single-family residential properties for which an informal or formal appeals hearing was completed:

$$\%\Delta MKTV\_hearing_{it} = \beta_0 + \beta_1 LVR_{it-1} + \beta_2 Formal_{it} + \beta_3 Agent_{it} + \beta_4 Formal_{it} * Agent_{it} + \delta' Z_{it} + \lambda_{it} + \varepsilon_i \quad (2)$$

where

$\%\Delta MKTV\_hearing_{it}$	=	percentage decrease in property i' market value resulting from the appeals hearing. This is computed as the assessed market value before the hearing ($InitialMKTV_{it}$) minus the assessed market value after the hearing ($FinalMKTV_{it}$), divided by $InitialMKTV_{it}$. Therefore, all decreases are coded as positive values.
$Formal_{it}$	=	1 if the protest is settled through a formal appeals hearing, and 0 if settled through an informal appeals hearing. A formal hearing is one which is heard by the Appraisal Review Board.
$Agent_{it}$	=	1 if the appeals hearing is handled by an agent or representative, and 0 if handled by the owner.

LVR_{it-1} is defined as above. Larger values of *%ΔMKTV_hearing* indicate larger percentage decreases in market value obtained through the appeals hearing. I refer to these percentage decreases as "appeals adjustments." If $\beta_1>0$ ($\beta_1<0$), this suggests that, if an owner files a protest, the percentage appeals adjustment increases (decreases) as a property's land value ratio

[7] Studies using Heckman's two-stage MLE procedure to help control for self-selection problems include Rutherford et al. (2005) and Plummer and Pavur (2009).

[8] It is frequently argued that the first-stage selection model (probit model) must contain at least one variable which is not included in the second-stage model. However, Maddala (1983) and Wooldridge (2002) note that it is not technically necessary for the selection model to contain additional variables. Regardless, this study's probit model contains more than one variable that is not included in the second-stage models.

increases. In other words, properties with high land value ratios receive a larger (smaller) percentage reduction in assessed market value than properties with low land value ratios.

I include *Formal* and *Agent* to examine whether the format of the appeals hearing affects the reduction in assessed market value. If $\beta_2>0$ ($\beta_2<0$), then this suggests that protests settled through a formal ARB hearing result in a larger (smaller) appeals adjustment than protests settled through an informal hearing. Similarly, if $\beta_3>0$ ($\beta_3<0$), then this suggests that an appeals hearing handled by an agent results in a larger (smaller) appeals adjustment than appeals hearings handled by the property owner alone. I include the interaction term *Formal*Agent* to allow for the possibility that the effect of using an agent varies with the formality of the appeals hearing.

Z_{it} is a vector of variables which are likely to affect the magnitude of the appeals adjustment. These explanatory variables include:

$Log\_InitialMKTV_{it}$	=	} where all these variables are defined as above.
$\%\Delta MKTV_{it}$	=	
Log_age_{it}	=	
No_age_{it}	=	
$RecentSale_{it}$	=	
$Homeowner_{it}$`	=	
$Over65_{it}$	=	
$Disability_{it}$	=	
$OtherExemption_{it}$	=	
CAP_{it}	=	
$\%Protest_{ijt}$	=	
$\%Homeowners_{ijt}$	=	
$\%RecentSale_{ijt}$	=	
$HigherInitialMKTV_{it}$	=	
$Higher\%\Delta MKTV_{it}$	=	
$\%\Delta MKTV\_hearing_{it-1}$	=	% decrease in property i' market value resulting from the appeals hearing from prior year (t-1).
$Good\ quality_{it}$	=	1 if property condition is classified as good, and 0 otherwise.
$Above\ average\ quality_{it}$	=	1 if property condition is classified as above average, and 0 otherwise.
$Average\ quality_{it}$	=	1 if property condition is classified as average, and 0 otherwise.
$Fair\ quality_{it}$	=	1 if property condition is classified as fair, and 0 otherwise.
$Poor\ quality_{it}$	=	1 if property condition is classified poor, and 0 otherwise.
λ_{it}	=	selectivity term (inverse Mills ratio) for property i in year t, computed from the probit model (equation 1 above).

I include *Log_InitialMKTV* to examine whether appeals adjustments are associated with property market value, but do not make a prediction on the sign of its coefficient.[9] If rapidly changing market values make it more difficult to estimate property values, and if the appeals process helps correct for this, then *%ΔMKTV* will be positively related to *%ΔMKTV_hearing*. Similarly, if older properties are more difficult to value than new ones, and if the appeals process helps correct for this, then *Log_age* and *No_age* will be positively related to *%ΔMKTV_hearing*. This would also be consistent with Weber and McMillen (2010) who find that owners of older properties are more likely to obtain an appeals adjustment than owners of newer properties.

If a property has sold within the past 3 years, the sales price provides information about current market values. This makes it less likely that an owner will obtain an appeals adjustment. Weber and McMillen (2010) find some evidence that recently sold properties are less likely to obtain an appeals adjustment. I therefore expect *RecentSale* to be negatively related to *%ΔMKTV_hearing*. I include the exemption variables (*Homeowner*, *Over65*, *Disability*, *OtherExemption*) and the *CAP* variable to examine whether appeals adjustments are associated with these characteristics, but do not make a prediction on the sign of their coefficients.

As more protests are filed in a neighborhood, there is more information about the appeals process and property values. The richer information environment makes it more likely that the appeals process will correct the values of overvalued properties. Alternatively, appraisers may just find it more difficult to refuse to make value adjustments as the number of protests, and the corresponding workload, increases. Either condition suggests that *%Protest* will be positively related to *Protest*. I include *%Homeowners*, but do not make a prediction on the sign of its coefficient. Weber and McMillen (2010) argue that greater sales activity in a neighborhood improves the quality of assessments. As assessment quality increases, property owners are less likely to obtain an appeals adjustment. Weber and McMillen find some evidence that the probability of obtaining an appeals adjustment decreases as the number of sales in a property's same census tract increases. I therefore expect *%RecentSale* to be negatively related to *%ΔMKTV_hearing*.

I do not make a prediction on the sign of *HigherInitialMKTV*'s coefficient, but I expect *Higher%ΔMKTV* to be positively related to *%ΔMKTV_hearing*. Properties with above average changes in market value are likely to be among the most difficult for appraisers to value, and the appeals process can help adjust for possible overvaluations. I also include $\%\Delta MKTV\_hearing_{it-1}$, which is the value adjustment obtained in the property's prior-year appeals hearing (if any). This helps control for the characteristics of these properties or their owners. I do not make a prediction on the sign of its coefficient. On one hand, these properties may be systematically overvalued each year, and the owners justifiably pursue and obtain an appropriate appeals adjustment. Alternatively, these owners could be "squeaky wheels" who continually appeal and obtain an appeals adjustment. Either case suggests that $\%\Delta MKTV\_hearing_{it-1}$ will be positively related to $\%\Delta MKTV\_hearing_{it}$.

---

[9] Weber and McMillen (2010) examine the relation between the probability of obtaining an appeals adjustment and the property's assessed value, and between the probability of obtaining an appeals adjustment and the median home value in the property's census tract. The coefficient signs are all negative, but none are statistically significant at the 10% level.

I include indicator variables to help control for differences in quality across properties. Quality ranges from excellent to poor. In equation (2) above, excellent is the default condition, and indicator variables are included for good, above average, average, fair, and poor. Finally, λ_{it} is the inverse Mills ratio that helps control for selection bias. A value of λ_{it} is computed for each property-year observation using the probit model discussed above.

H3: Effect of Appeals Process on Assessment Uniformity

To test H3, I estimate the following models separately for each year using all single-family residential properties in the appraisal district. As discussed above, I estimate the models using the Heckman MLE two-stage procedure:

$$Log\_InitialMKTV_{it} = \theta_0 + \theta' X_{it} + \theta_1 Adjustment_{it} + \theta_2 NoAdjustment_{it} + \theta_3 \lambda_{it} + \alpha_{ijt} + \varepsilon_{it} \quad (3a)$$

$$Log\_FinalMKTV_{it} = \theta_0 + \theta' X_{it} + \theta_1 Adjustment_{it} + \theta_2 NoAdjustment_{it} + \theta_3 \lambda_{it} + \alpha_{ijt} + \varepsilon_{it} \quad (3b)$$

where

$Log\_InitialMKTV_{it}$	=	log of total assessed market value for property i, before appeals adjustment (if any).
$Log\_FinalMKTV_{it}$	=	log of total assessed market value for property i, after appeals adjustment (if any).
X_{it}	=	vector of property characteristics for property i.
$Adjustment_{it}$	=	1 if the property's value was lowered through the appeals process, and 0 otherwise.
$NoAdjustment_{it}$	=	1 if the property's value was not lowered through the appeals process, and 0 otherwise.
λ_{it}	=	selectivity term (inverse Mills ratio) for property i in year t, computed from the probit model (equation 1 above).
α_{ijt}	=	dummy variable equal to 1 if property i is in neighborhood j, and equal to 0 otherwise.

$Log\_InitialMKTV_{it}$ and $Log\_FinalMKTV_{it}$ will be equal for properties that were not protested, and for protested properties that did not receive a value reduction through the appeals process (i.e., *NoAdjustment* properties). If $\theta_1 > 0$ in equation (3a), then this suggests that the initial assessed market value of properties that were protested and received a value reduction is systematically greater than the initial assessed value of non-protest properties. Further, if θ_1 is not significantly different from zero in equation (3b), then this suggests that the appeals process corrected for these overvaluations and improved assessment uniformity. If instead, $\theta_1 > 0$ in equation (3b), then this suggests that the appeals adjustments were too small (or too large if $\theta_1 < 0$ in equation (3b)). The θ_2 coefficient values in equations (3a) and (3b) will be similar since *Log_InitialMKTV* and *Log_FinalMKTV* are the same for *NoAdjustment* properties. If $\theta_2 > 0$, this suggests that the assessed market values of properties that were protested but received no value reduction are systematically higher than non-protest properties (or systematically lower if $\theta_2<0$).

Similar to other hedonic pricing models, X_{it} is a vector of attributes describing property i. These variables are based on prior research and include:

LVR_{it-1}	=	where these variables are defined as above.
Log_age_{it}	=	
No_age_{it}	=	
Good quality$_{it}$	=	
Above average quality$_{it}$	=	
Average quality$_{it}$	=	
Fair quality$_{it}$	=	
Poor quality$_{it}$	=	
Log of building size square feet$_{it}$	=	log of the size of property i's improvements, measured in square feet.
Log of land size square feet$_{it}$	=	log of the size of property i's land, measured in square feet. Total square feet of the land.
# of bedrooms$_{it}$	=	total number of bedrooms.
# of baths$_{it}$	=	total number of bathrooms.
Total # of rooms$_{it}$	=	total number of rooms.
# of stories$_{it}$	=	number of stories.
Pool$_{it}$	=	1 if property i has a swimming pool, and 0 otherwise.
NoHVAC$_{it}$	=	1 if the house does not have an air conditioning and heating system, and 0 otherwise.

Clapp and Salavaei (2010) argue that a property's assessed land value provides information that is not provided by a property's lot size (e.g., location, option value related to property redevelopment). Consistent with prior research, I expect LVR_{it-1} to be positively associated with a property's market value (Goolsby 1997; Bostic, Longhofer, and Redfearn 2007; Clapp and Salavei 2010). Market value should decrease as quality decreases, and I expect negative coefficients for all quality variables.

Consistent with prior research, I expect market value to be negatively associated with age, number of stories, and the lack of an air conditioning and heating system (Sirmans, Macpherson, and Zietz 2005).[10] Also consistent with prior research, I expect market value to be positively associated with building size, land size, number of bathrooms and total rooms, and the existence

[10] Sirmans et al. (2005) provide a review of recent hedonic pricing models in the real estate literature. They examine approximately 125 studies, and summarize and discuss the property characteristics included in the studies' hedonic models. Also see Basu and Thibodeau (1998); Clapp and Salavei (2010); Conway, Li, Wolch, Kahle, and Jerrett (2010); Firoozi, Hollas, Rutherford, and Thomson (2006); Goolsby (1997); Haag, Rutherford, and Thomson (2000); Rogers (2010); Smith (2008); and Zietz, Zietz, and Sirmans (2008).

of a pool. Because of inconsistent results across prior studies, I do not make a prediction for the sign on the coefficient for number of bedrooms (Sirmans et al. 2005).[11]

I also include neighborhood indicator variables (α_{ijt}) to help control for neighborhood characteristics that are otherwise omitted from the model (e.g., location and neighborhood amenities). Depending on the year, there are 349 or 351 different neighborhoods. Finally, λ_{it} is the inverse Mills ratio that helps control for selection bias.[12]

Data and Sample

Harris County Appraisal District Data

The sample includes all single-family residential properties in Harris County Appraisal District (HCAD) from the period 2006 through 2008. Harris County is an urban county located in the southeast part of Texas. The county covers approximately 1,778-square miles, and contains 34 different cities and 23 different school districts. Harris County currently has almost 4.0 million residents, making it the third most populous county in the U.S. Most of those residents live in Houston, the county's largest city. Harris County's population grew by 14.3% over the period 2000 to 2008.

The study uses data from the HCAD Real Property Database and from the HCAD Protest and Hearing files (http://pdata.hcad.org/download). The HCAD real property data contains parcel-level information for all real properties in HCAD, including residential, business, agricultural, and vacant land. The HCAD protest and hearing files contains information on which properties filed protests, whether the owner represented themselves or used an agent, whether the protest was settled through a formal or informal hearing, and the property's total assessed market value before and after the appeals hearing. The value information on the hearing files is not provided separately for land and improvements.

Sample

Table 1 provides information on the sample selection process. For each year, I begin with all real properties in the HCAD database, and then delete all properties that are not classified as single-family residential properties. I also delete all properties that are not in Harris County, properties that are classified as low income housing or as having a total exemption, and properties for which the market value of land or improvements is zero. The final sample consists of between 832,628 to 891,032 single-family residential properties in each of the three years.

---

[11] In a review of 40 studies, Sirmans et al. (2005) find that 21 studies find a positive result for number of bedrooms, and 19 studies find a negative or insignificant result.

[12] Currently, the variable *Log_InitialMKTV* is an independent variable in the probit model, and also the dependent variable in equation (3a). This could cause estimation problems for equation (3a) and possibly (3b). Therefore, in sensitivity analysis, I redefine the probit model used for equation (3a) and (3b) purposes. In this redefined probit model, I replace the independent variable *Log_InitialMKTV* with the variable *Log_Prior_FinalMKTV_PSF*, which is equal to the log of: the property's final assessed market value for the prior year, divided by the square feet of the home's structure. In the results section, I estimate equation (3a) and (3b) using the inverse Mills ratio computed from this modified probit model and present the results in a footnote. The results are essentially identical to those presented in the paper.

The bottom of Table 1 provides information on the number of properties for which a protest was filed and an appeals hearing actually occurred. I refer to these properties as "protested properties." The percentage of protested single-family residential properties was 12% in 2006, but increased sharply to 18.4% in 2007 and 18.3% in 2008. At least two factors likely contributed to this increase in protested properties. First, the average growth in assessed property values was higher for 2007 than 2006. For the sample properties, the mean (median) average growth in assessed property values was 9.0% (4.7%) for 2007, compared with 5.6% (0.1%) for 2006. It is also important to consider the economic conditions during 2007. U.S. sales of existing homes fell 8.4% in March 2007—the largest one-month drop in 18 years (Isidore 2007). Recall that owners generally receive their property value notices sometime in March or April, so their increased 2007 property valuations would contrast sharply with the market headlines.[13]

The second factor that likely contributed to the increase in protests is an expansion of HCAD's electronic protest filing system. HCAD adopted *iFile* in 2004, which allows property owners to file their protests online. In addition to *iFile*, HCAD also encourages tax agents with large inventories of properties to file protests electronically on compact disc (CD). Both these programs were expanded and made more visible in 2007.[14, 15]

For each year, there are a substantial number of properties for which an owner files a protest, but the owner either withdraws the protest or never follows through with an informal or formal hearing (for example, does not show up at the scheduled hearing time). I do not classify these properties as protested properties because merely filing a protest is essentially costless. A protest can be filed by completing a simple form and mailing it to HCAD, or filling out the form on the HCAD website. The protest form is included in the owner's valuation notice, along with instructions on how to file using the HCAD website. Either method takes less than 30 minutes and requires no significant effort by the property owner. For the period 2006 through 2008, Table 2 shows that about 15% to 18% of property owners who filed a protest took no further action.

---

[13] For Houston, existing-home sales were 16.7% lower in September 2007 compared with September 2006, and 8.6% lower in October 2007 compared with October 2006. New home sales were 41% lower in September 2007 compared with the year before (Federal Reserve Bank of Dallas 2007).

[14] In July 2007, HCAD introduced *iSettle* as a pilot program. HCAD developed this online settlement process to help expedite the appeals process and reduce costs. The *iSettle* program is only available for non-agent-represented residential property. A property owner files their protest online using *iFile*, and if the account is eligible for an *iSettle* offer, HCAD provides the owner with a settlement offer electronically. The owner has 10 days to accept or reject the offer. If the owner rejects the offer or does not respond, the system automatically schedules a formal hearing with the ARB. HCAD states that most neighborhoods are eligible for *iSettle*, but a few neighborhoods are not because of market complexities in those neighborhoods. The *iSettle* system will only make an electronic settlement offer if the value calculated by the system falls within certain parameters. For my Table 2 protest samples, 7.0% of protests were settled using *iSettle* in 2007 (n=11,156), and 20.2% were settled using *iSettle* in 2008 (n=32,964).

[15] Beginning January 1, 2010, Texas appraisal districts in counties with a population of 500,000 or more must provide for electronic filing of a protest for excessive appraisal or unequal appraisal on residential homesteaded properties. Electronic filing of protests is not required for property owners using tax agents. Appraisal districts that have a website and are in counties with a population of more than 250,000, but less than 500,000, must implement electronic filing by January 1, 2011, and counties with a population of 250,000 or less must implement electronic filing by January 1, 2013.

Formal/Informal and Agent/Owner Representation

Table 3 provides the percentage of hearings for each year that are formal versus informal, and with owner versus agent representation. Panel A shows that most protests are settled through an informal hearing rather than a formal hearing with the 3-member ARB panel. For each year, over 67% of protests were settled through an informal hearing. Panel B shows that agents are used a majority of the time (between 51.5% to 54%).

To provide a better understanding of when agents are used, Table 1 also provides a breakdown of owner versus agent representation for informal hearings (Panel C) and for formal hearings (Panel D). For informal hearings, agents are used a little over half the time in 2006 and 2007, and slightly less than half the time in 2008. For formal hearings, agents are again used a little more than half the time in 2006 and 2007, but there is a significant increase in 2008, when agents were used in 67.0% of the formal hearings.

Decrease in Market Value from Appeals Hearings

Table 4 provides information on the decrease in market value that results from appeals hearings. There were 421,014 hearings over the 3-year period. Panel A shows that 88.6% of the property owners obtained some decrease in assessed market value. The mean decrease in market value was 7.7%, and the median decrease was 5.9%. Panel A also shows that the average decrease has fallen slightly over this period. For example, the mean decrease was 8.9% in 2006, 7.9% in 2007, and 6.8% in 2009.

Panels B and C show how the decreases in market value vary depending on the hearing's formality and use of an agent. Panel B shows that, on average, property owners fare slightly better in informal hearings than formal hearings. For all years combined, 91.4% of property owners in informal hearings obtained a decrease in market value, while only 82.9% of property owners in formal hearings received a decrease. The mean decrease in market value is 7.7% for both informal and formal hearings, while the median decrease is slightly larger for informal hearings than for formal hearings (6.1% and 5.5%, respectively).

Panel C shows that property owners fare better, on average, when an agent is not used. When owners represent themselves, 92.3% of property owners obtained a decrease in assessed market value. The mean decrease was 9.2%, and the median decrease was 7.2%. When agents were used, 85.4% of property owners obtained a decrease in assessed value, and the mean and median decrease was 6.4% and 4.8%, respectively.

Descriptive Statistics

Table 5 provides descriptive statistics for the equation (1) variables for 2006, 2007, and 2008 (Panels A, B, and C, respectively). The first three columns of each panel present results for protested properties (*Protest*=1), and the next three columns present results for properties whose values were not protested (*Protest*=0). The last column provides z-statistics from the Wilcoxon rank-sum test, which is a non-parametric test for assessing whether the two groups are significantly different on the corresponding variable.

For all years, the Table 5 results suggest that the protest and non-protest properties are significantly different on every variable. However, it should be noted that because of the large sample size, small differences can be statistically significant but perhaps not economically meaningful. I will therefore discuss the more economically important differences here. Results suggest that protest properties are more expensive, have a greater change in market value, and have a higher land value ratio. Using 2007 as an example, the mean property value was $259,666 for protest properties and $146,507 for non-protest properties. The median property values were $171,265 and $116,300, respectively. Importantly, protest properties had experienced a mean and median one-year increase in assessed value (*%ΔMKTV*) of 15.4% and 9.7%, while non-protest properties had experienced a mean and median increase in assessed value of only 7.5% and 3.6%.

Table 5 results also suggest that protest properties are more likely to have a prior-year protest and a decrease in assessed market value resulting from the prior-year appeals hearing. Again using 2007 as an example, 52.1% of properties with protested values in 2007 also had their values protested in the prior year, and 40% of properties with protested values in 2007 had a value reduction obtained through an appeals hearing in the prior year. In contrast, only 6.5% of non-protest properties in 2007 had their values protested in the prior year, and only 3.7% had obtained a value reduction through an appeals hearing in the prior year. Table 5 also shows that protest properties are more likely than non-protest properties to have assessed market values above their neighborhood's median value (*HigherInitialMKTV*), and to have a one-year increase in assessed market value above their neighborhood's median increase (*Higher%ΔMKTV*).

Table 6 reports average Spearman correlation coefficients for the variables in equation (1) for 2006, 2007, and 2008 (Panels A, B, and C, respectively). Because of the large sample size, correlations greater than |0.01| are significant at 0.001. To help highlight the more meaningful correlations in the table, I bold those correlations with values greater than |0.40|. *Protest* is positively correlated with *PY_Protest* and *PY_Success* for all years (values ranging from 0.44 to 0.50). The only correlation greater than |0.40| for *LandValueRatio* is its correlation with *Log_Age*. *LandValueRatio* is positively correlated with *Log_Age* for each year, with correlation values of 0.43 to 0.46.

Results for H1 and H2

Results for Probit Selection Model

Table 7 presents results from estimating the probit model (equation 1) separately for each year. Table 7 shows that the probit model correctly classifies 90.7% of the observations for 2006, 86.7% for 2007, and 86.9% for 2008. The coefficient estimates for *LVR* are not consistent across years. The coefficient is significantly positive in 2006 (α_1=0.2347, p<0.001), significantly negative in 2007 (α_1=-0.0821, p<0.001), and positive but only marginally significant in 2008 (α_1=0.0353, p=0.012). These results suggest that land value ratio is not systematically associated with the likelihood that a property owner will protest their property's assessed value.

With the exception of *Homeowner* and *%RecentSale*, results for all control variables are consistent across years and in the predicted directions. The coefficients on *Log_InitialMKTV* and *%ΔMKTV* are significantly positive (all p-values<0.001, except one p-value=0.007), indicating that more expensive properties and properties with larger increases in recent market value are more likely to be protested. The coefficients on *PY_Protest* and *PY_Success* are significantly positive (p<0.001), suggesting that owners are more likely to protest if the property's value was protested in the prior year and if there was a value reduction obtained because of that protest. The coefficients on *Log_Age* and *No_Age* are significantly positive (p<0.001). This suggests that owners are more likely to protest assessed value as a property becomes older. The coefficient on *RecentSale* is significantly negative (p<0.001), suggesting that owners are less likely to protest if the property was purchased in the past 3 years.

With two exceptions, the coefficients on all exemption variables (*Homeowner, Over65, Disability*, *OtherExemption*) are significantly negative for all years (p<0.001). The coefficient on *CAP* is also significantly negative (p<0.001). These results are consistent with owners being less likely to protest when the property's assessed market value is less relevant to determining property tax liability.

The coefficient on *%Protest* is significantly positive for each year (p<0.001). This suggests that property owners are more likely to protest when there is more protest activity in their neighborhood. The coefficient on *%Homeowners* is significantly negative for each year (p<0.001), suggesting that property owners are less likely to protest when they are in neighborhoods with a greater proportion of homeowners. Consistent with Weber and McMillen (2010), the coefficient on *%RecentSale* is significantly negative for 2006 (p=0.007), but the coefficient is not significantly different from zero for 2007 or 2008. This provides only limited evidence that more sales activity in the neighborhood decreases the likelihood that a property owner will protest their property value.

The coefficient on *Log_stdTBldgArea* is significantly negative in each year (p<0.001). The probability that a property's value is protested is smaller when there is more variation in the size of neighborhood properties. As expected, the coefficients on *HigherInitialMKTV* and *Higher%ΔMKTV* are significantly positive for each year (p<0.001). Owners of properties that are in the upper half of the neighborhood in terms of market value and recent growth in market value are more likely to protest their assessed valuations.

Results for *%ΔMKTV_hearing*

Table 8 presents MLE regression results for equation (2), which examines the effect of *LVR* and other variables on the amount of decrease in market value obtained through the appeals hearing. I present pseudo-R^2 values, since I use MLE and not OLS (Nagelkerke 1991). Pseudo-R^2 values range from 24.2% to 31.0%. The coefficient on *LVR* is significantly negative in each year (p<0.001). This suggests that, if an owner files a protest, the percentage appeals adjustment decreases as a property's land value ratio increases.

For all years, the *Formal* coefficient is significantly positive (p<0.001), with values between 0.0072 and 0.0133. This suggests that, all else equal, the appeals adjustments of owners who represent themselves are about 1% greater if they settle their protest through a formal hearing rather than an informal hearing. The *Agent* coefficient measures the incremental effect of using an agent in an informal hearing compared with an owner representing himself in an informal hearing. The *Agent* coefficient is significantly negative for all years ($p<0.001$), with values between -0.0065 and -0.0233. This suggests that the appeals adjustments of owners whose protest is settled through an informal hearing are between 0.6% and 2.3% lower if owners use an agent compared with representing themselves.

The sum of the coefficients *Agent+Formal*Agent* measures the incremental effect of using an agent in a formal hearing compared with an owner representing himself in a formal hearing. The last line of Table 8 presents the sum of the coefficient *Agent+Formal*Agent*, and the t-statistic for the test of whether the sum is significantly different from zero. The sum of *Agent+Formal*Agent* is significantly negative for all years ($p<0.001$), with coefficient values between -0.0256 and -0.0338. This suggests that the appeals adjustments of owners whose protest is settled through a formal hearing are between 2.6% and 3.4% lower if owners use an agent compared with representing themselves.

The coefficients on *Log_InitialMKTV* and *%ΔMKTV* are significantly positive for all years ($p<0.001$). The coefficients on *Log_Age* and *No_Age* are also significantly positive for all years ($p<0.001$). This suggests that percentage appeals adjustments are larger for more expensive homes, for homes with a greater increase in assessed value over the prior year, and for older homes. The coefficient on *RecentSale* is significantly negative for 2006 and 2007 ($p<0.001$), but negative and only marginally significant for 2008 ($p=0.074$). This suggests that appeals adjustments are smaller for properties that have been purchased recently.

Results for the exemption variables are mixed, with coefficients that are not significantly different from zero or only marginally significant. There is some evidence, however, that appeals adjustments are smaller for owners with a homestead exemption (*Homeowner*). The coefficient on *CAP* is negative and significant for all years ($p <0.001$), suggesting that appeals adjustments are smaller when a property's market value exceeds the value used to determine its tax liability.

The *%Protest* coefficient is significantly positive for all years ($p<0.001$), while the *%Homeowners* coefficient is significantly negative for all years ($p<0.001$). This suggests that appeals adjustments are larger when properties are in neighborhoods with greater protest activity, and adjustments are smaller when properties are in neighborhoods with a greater percentage of homeowners. Consistent with Weber and McMillen's (2010) prediction, the *%RecentSale* coefficient is significantly negative for all years. This suggests that appeals adjustments are smaller when properties are in neighborhoods with a greater percentage of sales activity in the past 3 years. The coefficients on *HigherInitialMKTV* and *Higher%ΔMKTV* are positive for all years and significant at $p<0.001$, except one instance when $p=0.014$. This suggests that appeals adjustments are greater when properties are in the upper half of their neighborhood in terms of market value and recent growth in market value.

The coefficient on $\%\Delta MKTV\_hearing_{it-1}$ is significantly positive for all years ($p<0.001$), suggesting that appeals adjustments are positively related to the value adjustment obtained in the property's prior-year appeals hearing (if any). The coefficients on the quality variables are somewhat mixed, although there appears to be consistent evidence that appeals adjustments are larger for the lowest quality properties (i.e., *Fair quality* and *Poor quality*). Lastly, the significant coefficient on the inverse Mill's ratio (λ_{it}) for each year indicates the importance of controlling for possible self-selection bias.

Results for Assessment Uniformity (H3)

Uniformity of Total Assessed Market Values

Table 9 presents MLE results for equations (3a) and (3b), which examine the effect of the appeals process on the assessment uniformity of total assessed market values. Pseudo-R^2 values range from 88.8% to 89.7%. The coefficients on *Adjustment* and *NoAdjustment* are significantly positive in all estimations (all p-values<0.001). This suggests that, after controlling for other determinants of market value, assessed market values for protest properties are greater than values for non-protest properties. This is true both before and after the appeals process is completed. This suggests that the appeals process increased assessment uniformity by decreasing the market values of *Adjustment* properties. However, those adjustments were insufficient, as evidenced by the significantly positive coefficient for *Adjustment* in the *Log_FinalMKTV* equations. Similarly, the coefficient for *NoAdjustment* is also significantly positive in the *Log_FinalMKTV* equations. These properties received no value reduction in the appeals process, even though the evdience suggests their valuations are too high.

The last line of Table 9 presents the t-statistic for the test of differences between the coefficients of *Adjustment* and *NoAdjustment*. For all years for the *Log_InitialMKTV* equations, the *Adjustment* coefficient is significantly greater than the *NoAdjustment* coefficient. This suggests that the initially assessed market values for *Adjustment* properties are systematically greater than for *NoAdjustment* properties. The results for the *Log_FinalMKTV* equations are mixed. For 2006, the *Adjustment* coefficient is greater than the *NoAdjustment* coefficient. This suggests that, on average, the final assessed market values for *Adjustment* properties are greater than the values for *NoAdjustment* properties. In contrast, the *Adjustment* coefficient is significantly smaller than the *NoAdjustment* coefficient for 2007 and 2008. This suggests that, on average, the final assessed market values for *Adjustment* properties are less than the values for *NoAdjustment* properties.

The coefficient *LVR* is significantly positive (p<0.001) for each estimation. This suggests that land value ratio increases as property value increases. Results for each of the remaining control variables are consistent across all estimations and consistent with prior research. Results suggest that older homes have lower property values, and that larger homes have higher property values. Results also suggest that property values are greater for homes with larger lots, more bathrooms, homes with more total rooms, and homes with a pool. In contrast, property values are less for homes that have more bedrooms, are more than one story, and have no HVAC system.

For all estimations, the coefficients on the quality variables monotonically decrease as the indicator variable moves from *Good quality* to *Poor quality*, and all coefficients are significantly negative (p<0.001). Lastly, the coefficient on the inverse Mill's ratio (λ_{it}) is significantly negative in every estimation ($p<0.001$). This indicates the importance of controlling for self-selection bias and suggests that protest properties, compared to non-protest properties, have unmeasured characteristics that are negatively related to property value.[16][17]

Uniformity of Improvement and Land Values

I also test the effect of the appeals process on the assessment uniformity of land and improvements separately. The only values for land and improvement separately are the final values (i.e., *after* the appeals adjustment, if any). The data does not provide separate values for land and improvements as they are valued before the appeals hearing. Therefore, I can only examine assessment uniformity after the appeals process. I estimate the following models separately for each year using all single-family residential properties in the appraisal district. As before, I estimate the models using the Heckman MLE two-stage procedure:

$$Log\_IMPRV_{it} = \theta_0 + \theta' X_{it} + \theta_1 Adjustment_{it} + \theta_2 NoAdjustment_{it} + \theta_3 \lambda_{it} + \alpha_{ijt} + \varepsilon_{it} \quad (4)$$

$$Log\_LV_{it} = \theta_0 + \theta' X_{it} + \theta_1 Adjustment_{it} + \theta_2 NoAdjustment_{it} + \theta_3 \lambda_{it} + \alpha_{ijt} + \varepsilon_{it} \quad (5)$$

where

Log_IMPRV_{it}	=	log of assessed market value for improvements for property i, after any appeals adjustments.
Log_LV_{it}	=	log of assessed market value for land for property i, after any appeals adjustments.

and the other variables are as defined earlier.

Table 10 presents MLE results for equations 4 and 5, which separately examine the effect of the appeals process on the assessment uniformity of improvement and land values. (For ease of presentation, I do not include results for all the control variables, but these results are available

[16] As an alternate method of controlling for endogeneity, I also estimate the Table 9 results using an instrumental variables (IV) technique similar to that used by Dye et al. (2005) and Boarnet and Bogart (1996). This approach uses the probit model (equation 1) to generate a predicted value for a property's value being protested. The predicted value is then included in equations (3a) and (3b), and the inverse mills ratio is not included in the equation. I use MLE to estimate these IV equations and find results nearly identical to those using the Heckman MLE approach. Vella and Verbeck (1999) discuss the similarity between the instrumental variables approach and the Heckman two-stage procedure for estimating the impact of endogenous treatment effects.

[17] As discussed in a footnote at the end of Section 3, I redefine the probit model used for equation (3a) and (3b) purposes. Specifically, I replace the independent variable *Log_InitialMKTV* with the variable *Log_Prior_FinalMKTV_PSF*. The results are similar to those reported in the paper, but the coefficient estimates are smaller. The redefined probit model correctly estimates 90.6% observations for 2006, 86.7% observations for 2007, and 86.7% observations for 2008. The coefficients for *Adjustment* and *NoAdjustment* in equation (3a) are 0.1830 and 0.0438 for 2006, 0.1296 and 0.0791 for 2007, and 0.1498 and 0.0932 for 2008. The coefficients for *Adjustment* and *NoAdjustment* in equation (3b) are 0.0625 and 0.0408 for 2006, 0.0226 and 0.0532 for 2007, and 0.0683 and 0.0947 for 2008.

upon request.) Pseudo-R^2 values range from 74.0% to 90.0%. Results for the *Adjustment* and *NoAdjustment* properties differ, so I will discuss them separately. For the *Improvements* model, the *Adjustment* coefficient is significantly negative in 2006 and 2007, but is significantly positive in 2008. This suggests that, for *Adjustment* properties, the final assessed values of improvements for 2006 and 2007 are significantly less than for non-protest properties. For 2008, *Adjustment* properties have significantly greater improvement values relative to non-protest properties. For the *Land* model, the *Adjustment* coefficient is significantly positive in 2006 and 2008, but is not significantly different from zero in 2007. This suggests that assessed land values are greater for *Adjustment* properties than for non-protest properties in 2006 and 2008, but not significantly different in 2007.

For the *Improvements* model, the *NoAdjustment* coefficient is significantly positive for all years. This suggests that, after controlling for other determinants of market value, assessed improvement values are greater for *NoAdjustment* properties than for non-protest properties. For the *Land* model, the *NoAdjustment* coefficient is significantly positive in 2006 and 2008, but is significantly negative in 2007. This suggests that land values are greater for *NoAdjustment* properties than for non-protest properties in 2006 and 2008, but significantly less in 2007. Overall, the results suggest that there is a lack of assessment uniformity for both land values and improvement values, even after any value adjustments made through the appeals process.

The last line of Table 10 presents the t-statistic for the test of differences between the coefficients of *Adjustment* and *NoAdjustment*. For the *Improvements* equation for all years, the *Adjustment* coefficient is significantly less than the *NoAdjustment* coefficient. This suggests that the final assessed market value for improvements is systematically less for *Adjustment* properties than for *NoAdjustment* properties. The exact opposite is true for land values. For the *Land* equation for all years, the *Adjustment* coefficient is significantly greater than the *NoAdjustment* coefficient. This suggests that the final assessed market value for land is systematically greater for *Adjustment* properties than for *NoAdjustment* properties. I do not have access to the initial assessed values for land and improvements separately (i.e., before the appeals hearings), so I cannot comment on the relative changes that were made to each component through the appeals hearing. However, for the *Adjustment* properties, the results are consistent with a relatively larger adjustment being made to improvement values than to land values.

Implications for future research

This study uses parcel-level single-family residential property data for Harris County for the 3-year period 2006 through 2008. A significant contribution would be to extend the analysis to commercial and industrial properties. One could examine the factors that determine likelihood of protest, the factors that are associated with the size of the appeals adjustment, and the assessment uniformity across such properties.

I chose to examine Harris County properties because of the availability of detailed data regarding protests and the appeals process. By focusing on this homogeneous sample, I increase the internal validity of the study but decrease the generalizability of its results. A significant contribution would be to extend this analysis to other appraisal districts, including more rural areas and areas in other states.

In future work, I will extend the *%ΔMKTV* analysis by estimating a second probit model, where the dependent variable is an owner's choice to use an agent or not.[18] I will construct an inverse Mills ratio from this second probit model, and will then include both IMR's in equation (2) (i.e., this new IMR and the IMR based on the protest probit model). This extension will accomplish two objectives. First, it will help determine what factors affect the probability that an owner chooses an agent. Second, it will help control for possible endogeneity problems in equation (2), given that an owner's choice to use an agent may be endogenous. Equation (2) in the current paper helps control for endogeneity related to an owner's choice to protest, but not for endogeneity related to an owner's choice to use an agent.

[18] I thank David C. Lincoln and Jeremy Groves for initiating this extension.

References

Basu, Sabyasachi, and Thomas G. Thibodeau. 1998. "Analysis of Spatial Autocorrelation in House Prices." *Journal of Real Estate, Finance, and Economics* 17 (1): 61-85.

Boarnet, M. G., and W. T. Bogart. 1996. "Enterprise zones and employment: Evidence from New Jersey." *Journal of Urban Economics* 40: 198-215.

Bostic, Raphael W., Stanley D. Longhofer, and Christian L. Redfearn. 2007. "Land Leverage: Decomposing Home Price Dynamics." *Real Estate Economics* 35 (2): 183-208.

Bowman, John H., and William A. Butcher. 1986. "Institutional Remedies and the Uniform Assessment of Property: An Update and Extension." *National Tax Journal* 39: 157-169.

Bowman, John H., and John L. Mikesell. 1978. "Uniform Assessment of Property: Returns from Institutional Remedies." *National Tax Journal* 31: 137-152.

Clapp, John M., and Katsiaryna Salavei. 2010. "Hedonic pricing with redevelopment options: A new approach to estimating depreciation effects." *Journal of Urban Economics* 67: 362-377.

Conway, Delores, Christina Q. Li, Jennifer Wolch, Christopher Kahle, and Michael Jerrett. 2010. "A Spatial Autocorrelation Approach for Examining the Effects of Urban Greenspace on Residential Property Values." *Journal of Real Estate, Finance, and Economics* 41: 150-169.

Dye, Richard, Therese McGuire, and Daniel P. McMillen. 2005. "Are property tax limitations more binding over time?" *National Tax Journal* 58: 215-225.

Federal Reserve Bank of Dallas. 2007. "Houston Economic Update." Accessed on October 7, 2010, at http://www.dallasfed.org/research/update-hou/2007/0708.cfm.

Firoozi, Fathali, Daniel R. Hollas, Ronald C. Rutherford, and Thomas A. Thomson. 2006. "Property Assessments and Information Asymmetry in Residential Real Estate." *Journal of Real Estate Research* 28 (3): 275-291.

Goolsby, William C. 1997. "Assessment Error in the Valuation of Owner-Occupied Housing." *Journal of Real Estate Research* 13 (1): 33-45.

Haag, Jerry T., Ronald C. Rutherford, and Thomas A. Thomson. 2000. "Real Estate Agent Remarks: Help or Hype?" *Journal of Real Estate Research* 20 (1/2): 205-215.

Heckman, J. 1979. Sample selection bias as a specification error. *Econometrica* 47: 153-161.

Isidore, Chris. 2007. "Home sales: Worst drop in 18 years." *CNNMoney.com* (April 24, 2007).

Longhofer, Stanley D., and Christian L. Redfearn. 2009. "Estimating Land Values using Residential Sales Data." Cambridge, MA: Lincoln Institute of Land Policy working paper.

Maddala, G. S. 1983. *Limited Dependent and Qualitative Variables in Econometrics*. Cambridge, U.K.: Cambridge University Press.

Maddala, G. S. 1991. A perspective on the use of limited dependent variable models in accounting. *The Accounting Review* 66 (October): 788-807.

Malme, Jane. 1991. "Policies and Practices that Promote Assessment Equity: Case Studies of Alternative Models." Cambridge, MA: Lincoln Institute of Land Policy working paper.

McMillen, Daniel P., and Christian L. Redfearn. 2010. "Estimation and Hypothesis Testing for Nonparametric Hedonic House Price Functions." *Journal of Regional Science* 20 (10): 1-22.

Nagelkerke, N. J. D. 1991. "Miscellanea: A note on a general definition of the coefficient of determination." *Biometrika* 78: 691-692.

Peterson, Steven, and Albert B. Flanagan. 2009. "Neural Network Hedonic Pricing Models in Mass Real Estate Appraisal." *Journal of Real Estate Research* 31 (2): 147-164.

Plummer, E., and R. J. Pavur. 2009. "The Effects of Rate Limits on Property Tax Revenues and School Expenditures: Evidence from Texas." *Journal of the American Taxation Association* 31 (2): 81-107.

Rogers, William H. 2010. "The Housing Price Impact of Covenant Restrictions and Other Subdivision Characteristics." *Journal of Real Estate, Finance, and Economics* 40: 203-220.

Rutherford, R. C., T. M. Springer, and A. Yavas. 2005. "Conflicts between principals and agents: Evidence from residential brokerage." *Journal of Financial Economics* 76: 627-665.

Shavell, Steven. 2010. "On the Design of the Appeals Process: The Optimal Use of Discretionary Review versus Direct Appeal." *The Journal of Legal Studies* 39: 63-107 (January).

Shavell, Steven. 2006. "The Appeals Process and Adjudicator Incentives." *The Journal of Legal Studies* 35: 1 (January).

Shavell, Steven. 1995. "The Appeals Process as a Means of Error Correction." *The Journal of Legal Studies* 24: 379 (June).

Sirmans, G. Stacy, David A. Macpherson, and Emily N. Zietz. 2005. The composition of hedonic pricing models. *Journal of Real Estate Literature* 13 (1): 3-46.

Smith, Brent C. 2008. “Intrajurisdictional Segmentation of Property Tax Burdens: Neighborhood Inequities Across an Urban Sphere.” *Journal of Real Estate Research* 30 (2): 207-223.

Vella, F., and M. Verbeek. 1999. “Estimating and interpreting models with endogenous treatment effects.” *Journal of Business & Economics Statistics* (4): 473-478.

Weber, Rachel N., and Daniel P. McMillen. 2010. “Ask and Ye Shall Receive? Predicting the Successful Appeal of Property Tax Assessments.” *Public Finance Review* 38(1): 74-101.

Woodridge, J. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: The MIT Press.

Youngman, Joan. 1994. *Legal Issues in Property Valuation and Taxation: Cases and Materials.* Chicago: The International Association of Assessing Officers.

Zietz, Joachim, Emily Norman Zietz, and G. Stacy Sirmans. 2008. “Determinants of House Prices: A Quantile Regression Approach.” *Journal of Real Estate, Finance, and Economics* 37: 317-333.

Appendix 1: Variable Definitions

Probit Model Variables (equation 1):		
$Protest_{it}$	=	1 if there was a protest and hearing, and 0 otherwise.
$Log\_InitialMKTV_{it}$	=	log of initial market value for property i (i.e., this is market value before the appeals adjustment, if any).
$\%\Delta MKTV_{it}$	=	% change in property i' assessed market value from year t-1 to year t, before the current-year's appeal adjustment (if any). This is computed as $InitialMKTV_{it}$ minus $FinalMKTV_{it-1}$, divided by $FinalMKTV_{it-1}$, where *FinalMKTV* is the assessed market value after appeals adjustment (if any).
LVR_{it-1}	=	market value of land divided by total market value, for property i for year t-1.
$PY\_Protest_{it}$	=	1 if value for property i was protested in prior year, and 0 otherwise.
$PY\_Success_{it}$	=	1 if value for property i was protested in prior year and owner obtained a lower value due to the appeal, and 0 otherwise.
Log_age_{it}	=	log of property i's age, where age is measured in years.
No_age_{it}	=	1 if there is no age available for property i, and 0 otherwise.
$RecentSale_{it}$	=	1 if property i has sold in past 3 years, and 0 otherwise.
$Homeowner_{it}$`	=	1 if the property has a homestead exemption, and 0 otherwise.
$Over65_{it}$	=	1 if the property has an over-65 exemption, and 0 otherwise.
$Disability_{it}$	=	1 if the property has a disabled exemption, and 0 otherwise.
$OtherExemption_{it}$	=	1 if the property has another type of exemption, and 0 otherwise.
CAP_{it}	=	1 if property i is a capped property, and 0 otherwise.
$\%Protest_{ijt}$	=	% of single-family properties in neighborhood j for which a current-year protest has been filed. Property i is located in neighborhood j.
$\%Homeowners_{ijt}$	=	% of owner-occupied properties in property i's neighborhood j.
$\%RecentSale_{ijt}$	=	% of properties in neighborhood j that have sold in past 3 years.
$Log\_std\ TBldgArea_{ijt}$	=	log of the standard deviation of single-family residential building size in neighborhood j, where size is measured in square feet.
$Higher\ InitialMKTV_{it}$	=	1 if $InitialMKTV_{it}$ for property i is above the median $InitialMKTV_{it}$ for neighborhood j.
$Higher\ GrowthMKTV_{it}$	=	1 if $\%\Delta MKTV_{it}$ for property i is above the median $\%\Delta MKTV_{it}$ for neighborhood j.

Additional variables for *%ΔMKTV_hearing* model (equation 2):		
$\%\Delta MKTV\_hearing_{it}$	=	% decrease in property i' market value resulting from the appeals hearing. This is computed as the assessed market value before the hearing ($InitialMKTV_{it}$), minus the assessed market value after the hearing ($FinalMKTV_{it}$), divided by $InitialMKTV_{it}$. Therefore, all decreases are coded as positive values.
$Formal_{it}$	=	1 if the protest is settled through a formal appeals hearing, and 0 if settled through an informal appeals hearing. A formal hearing is one which is heard by the Appraisal Review Board.

Additional variables for *%ΔMKTV_hearing* model (equation 2), continued:		
$Agent_{it}$	=	1 if the appeals hearing is handled by an agent or representative, and 0 if handled by the owner.
$\%\Delta MKTV\_hearing_{it-1}$	=	% decrease in property i' market value resulting from the appeals hearing from prior year (t-1).
$Good\ quality_{it}$	=	1 if property condition is classified as good, and 0 otherwise.
$Above\ average\ quality_{it}$	=	1 if property condition is classified as above average, and 0 otherwise.
$Average\ quality_{it}$	=	1 if property condition is classified as average, and 0 otherwise.
$Fair\ quality_{it}$	=	1 if property condition is classified as fair, and 0 otherwise.
$Poor\ quality_{it}$	=	1 if property condition is classified poor, and 0 otherwise.
λ_{it}	=	selectivity term (inverse Mills ratio) for property i in year t, computed from the probit model.

Additional variables for *Log_InitialMKTV* and *Log_FinalMKTV* models (equations 3a and 3b):		
$Log\_InitialMKTV_{it}$	=	log of total assessed market value for property i, before appeals adjustment (if any).
$Log\_FinalMKTV_{it}$	=	log of total assessed market value for property i, after appeals adjustment (if any).
Log_IMPRV_{it}	=	log of assessed market value for improvements for property i, after appeals adjustment (if any).
Log_LV_{it}	=	log of assessed market value for land for property i, after appeals adjustment (if any).
$Adjustment_{it}$	=	1 if the property's value was lowered through the appeals process, and 0 otherwise.
$NoAdjustment_{it}$	=	1 if the property's value was not lowered through the appeals process, and 0 otherwise.
$Log\ of\ building\ size\ square\ feet_{it}$	=	log of the size of property i's improvements, measured in square feet.
$Log\ of\ land\ size\ square\ feet_{it}$	=	log of the size of property i's land, measured in square feet.
$\#\ of\ bedrooms_{it}$	=	Total number of bedrooms.
$\#\ of\ baths_{it}$	=	Total number of bathrooms.
$Total\ \#\ of\ rooms_{it}$	=	Total number of rooms.
$\#\ of\ stories_{it}$	=	Number of stories.
$Pool_{it}$	=	1 if property I has a swimming pool, and 0 otherwise.
$No\ HVAC_{it}$	=	1 if the house does not have an air conditioning and heating system, and 0 otherwise.

Table 1
Sample Selection: Residential Single-Family Properties in Harris County Appraisal District

	2006		**2007**		**2008**	
All real properties on HCAD database	1,273,009		1,317,084		1,348,678	
Less properties that are not single-family residential properties (not coded as A1)	(409,075)		(424,532)		(435,493)	
Single-family residential properties	863,934		892,552		913,185	
Less properties not in Harris County, or properties classified as low income housing, or have an exemption code of TOT or ABT	(68)		(96)		(134)	
Less properties for which the market value of land or improvements is zero for year t or year t-1	(31,238)		(31,016)		(22,019)	
Final sample of single-family residential properties	832,628		861,440		891,032	
Properties protested with hearing	99,521	*12.0%*	158,492	*18.4%*	163,001	*18.3%*
Properties not protested or without hearing	733,107	*88.0%*	702,948	*81.6%*	728,031	*81.7%*

Table 2
Sample Selection: Residential Single-Family Properties which
Protested and Appealed Property Value

	2006		2007		2008	
# of properties for which owner filed a protest	121,875	*100%*	194,139	*100%*	193,140	*100%*
# of properties for which owner or agent did not appear for hearing ("no shows")	(22,354)	*(18.3%)*	(35.647)	*(18.4%)*	(30,139)	*(15.6%)*
# of properties for which owner filed a protest and had a hearing	99,521	*81.7%*	158,492	*81.6%*	163,001	*84.4%*

Table 3
Percentage of hearings by classification (informal/formal, agent/no agent)

	2006	**2007**	**2008**
Panel A: Percentage of all hearings that are:			
Informal	72.6%	67.6%	67.0%
Formal	27.4%	32.5%	33.0%
	100%	100%	100%
Panel B: Percentage of all hearings with:			
No agent (owner represents self)	46.7%	48.5%	46.0%
Agent representation	53.3%	51.5%	54.0%
	100%	100%	100%
Panel C: Percentage of informal hearings with:			
No agent (owner represents self)	47.5%	48.4%	52.3%
Agent representation	52.5%	51.6%	47.7%
	100%	100%	100%
Panel D: Percentage of formal hearings with:			
No agent (owner represents self)	44.5%	48.7%	33.0%
Agent representation	55.5%	51.3%	67.0%
	100%	100%	100%

Table 4
Percentage Decrease in Assessed Market Value
(Mean, median, and % of properties that obtained reduction)

	2006	2007	2008	All years
Total number of hearings	99,521	158,492	163,001	421,014
Panel A: All hearings				
Mean	8.9%	7.9%	6.8%	7.7%
Median	6.8%	6.0%	5.3%	5.9%
%age of properties receiving decrease	*85.4%*	*90.1%*	*89.2%*	*88.6%*
Panel B: Informal versus Formal Hearings				
Informal hearings only:				
Mean	8.7%	7.9%	7.0%	7.7%
Median	6.7%	6.2%	5.7%	6.1%
%age of properties receiving decrease	*87.0%*	*92.8%*	*92.6%*	*91.4%*
Formal hearings only:				
Mean	9.3%	7.9%	6.4%	7.7%
Median	6.9%	5.8%	4.3%	5.5%
%age of properties receiving decrease	*81.2%*	*84.4%*	*82.4%*	*82.9%*
Panel C: Agent versus No agent				
Hearings with no agent:				
Mean	11.1%	9.2%	8.1%	9.2%
Median	8.8%	7.1%	6.4%	7.2%
%age of properties receiving decrease	*90.6%*	*91.3%*	*94.4%*	*92.3%*
Hearings with agent:				
Mean	7.0%	6.7%	5.7%	6.4%
Median	5.1%	5.1%	4.4%	4.8%
%age of properties receiving decrease	*81.0%*	*88.9%*	*84.8%*	*85.4%*

Table 5: Panel A

Descriptive Statistics for 2006 (n=832,628)

	Protest=1 properties (n=99,521)			Protest=0 properties (n=733,107)			z-statistic for differences across groups
	Mean	Median	St. Dev.	Mean	Median	St. Dev	
$InitialMKTV_{it}$	\$285,567	\$185,152	\$374,577	\$138,941	\$111,759	\$138,241	219.67***
$\%\Delta MKTV_{it}$	0.1355	0.0714	0.2744	0.0456	0	0.3243	198.38***
LVR_{it-1}	0.3164	0.2239	0.2222	0.2182	0.1681	0.1452	141.54***
CAP_{it}	0.1155	0	0.3196	0.1521	0	0.3591	-30.54***
$RecentSale_{it}$	0.3620	0	0.4806	0.3839	0	0.4863	-13.34***
$PY\_Protest_{it}$	0.5417	1.00	0.4983	0.0666	0	0.2494	427.59***
$PY\_Success_{it}$	0.4297	0	0.4950	0.0432	0	0.2033	400.96***
Age_{it}	31.45	28.00	22.09	32.15	29.00	20.14	-20.11***
No_Age_{it}	0.0326	0	0.1776	0.0266	0	0.1608	10.97***
$Homeowners_{it}$`	0.7577	1.00	0.4285	0.7931	1.00	0.4051	-25.66***
$Over65_{it}$	0.1198	0	0.3248	0.1752	0	0.3801	-43.74***
$Disability_{it}$	0.0192	0	0.1371	0.0326	0	0.1776	-22.95***
$OtherExemption_{it}$	0.0003	0	0.0177	0.0006	0	0.0240	-3.37***
$\%Protest_{ijt}$	0.2092	0.1471	0.1345	0.1417	0.1215	0.0751	169.77***
$\%Homeowners_{ijt}$	0.7966	0.8082	0.0825	0.7735	0.7952	0.0842	85.93***
$\%RecentSale_{ijt}$	0.4025	0.3743	0.1119	0.3982	0.3756	0.1132	10.16***
$Std\_TBldgArea_{ijt}$	822.85	754.03	343.39	729.06	704.07	251.71	79.33***
$HigherInitialMKTV_{it}$	0.6433	1.00	0.4790	0.4747	0	0.4994	99.85***
$Higher\%\Delta MKTV_{it}$	0.6000	1.00	0.4899	0.3620	0	0.4806	144.45***

*, **, *** indicate significance at 10%, 5%, and 1% respectively, using a two-tailed test. The last column provides z-statistics from the Wilcoxon rank-sum test, which is a nonparametric test for assessing whether the two groups are significantly different on the corresponding variable. Variable definitions are in Appendix 1.

Table 5: Panel B
Descriptive Statistics for 2007 (n=861,440)

	Protest=1 properties (n=158,492)			Protest=0 properties (n=702,948)			z-statistic for differences across groups
	Mean	**Median**	**St. Dev.**	**Mean**	**Median**	**St. Dev**	
$InitialMKTV_{it}$	\$259,666	\$171,265	\$337,955	\$146,507	\$116,300	\$152,994	234.91***
$\%\Delta MKTV_{it}$	0.1540	0.0968	0.2690	0.0752	0.0358	0.1945	233.13***
LVR_{it-1}	0.2926	0.1955	0.2168	0.2246	0.1709	0.1527	108.59***
CAP_{it}	0.1597	0	0.3664	0.1799	0	0.3841	-19.05***
$RecentSale_{it}$	0.3526	0	0.4778	0.3893	0	0.4876	-27.11***
$PY\_Protest_{it}$	0.5210	1.00	0.4996	0.0651	0	0.2468	460.42***
$PY\_Success_{it}$	0.4006	0	0.49002	0.0374	0	0.1897	427.56***
Age_{it}	30.06	27.00	21.53	32.33	30.00	20.63	-45.06***
No_Age_{it}	0.0297	0	0.1697	0.0263	0	0.1600	7.53***
$Homeowners_{it}$`	0.7750	1.00	0.4176	0.7819	1.00	0.4129	-6.06***
$Over65_{it}$	0.1164	0	0.3207	0.1787	0	0.3831	-60.05***
$Disability_{it}$	0.0199	0	0.1396	0.0344	0	0.1822	-29.75***
$OtherExemption_{it}$	0.0002	0	0.0133	0.0007	0	0.0258	-7.32***
$\%Protest_{ijt}$	0.2672	0.2179	0.1170	0.2159	0.2023	0.0791	169.93***
$\%Homeowners_{ijt}$	0.7882	0.8002	0.0809	0.7652	0.7877	0.0832	102.83***
$\%RecentSale_{ijt}$	0.4056	0.3756	0.1141	0.3976	0.3696	0.1140	27.13***
$Std\_TBldgArea_{ijt}$	801.02	739.05	318.73	735.14	701.30	254.96	69.12***
$HigherInitialMKTV_{it}$	0.6258	1.00	0.4839	0.4656	0	0.4988	115.22***
$Higher\%\Delta MKTV_{it}$	0.6835	1.00	0.4651	0.4379	0	0.4961	176.68***

*, **, *** indicate significance at 10%, 5%, and 1% respectively, using a two-tailed test. The last column provides z-statistics from the Wilcoxon rank-sum test, which is a nonparametric test for assessing whether the two groups are significantly different on the corresponding variable. Variable definitions are in Appendix 1.

Table 5: Panel C

Descriptive Statistics for 2008 (n=891,032)

	Protest=1 properties (n=163,001)			Protest=0 properties (n=728,031)			z-statistic for differences across groups
	Mean	**Median**	**St. Dev.**	**Mean**	**Median**	**St. Dev**	
$InitialMKTV_{it}$	$293,792	$187,871	$394,189	$148,675	$116,832	$161,433	297.97***
$\%\Delta MKTV_{it}$	0.1145	0.0692	0.7442	0.0373	0	0.3141	281.55***
LVR_{it-1}	0.3054	0.2054	0.2343	0.2330	0.1795	0.1580	108.00***
CAP_{it}	0.1676	0	0.2249	0.1362	0	0.3430	32.78***
$RecentSale_{it}$	0.3547	0	0.3735	0.3747	0	0.4840	-15.07***
$PY\_Protest_{it}$	0.6664	1.00	0.4784	0.1280	0	0.3341	469.46***
$PY\_Success_{it}$	0.5594	1.00	0.4715	0.0835	0	0.2767	461.71***
Age_{it}	28.87	26.00	21.69	32.39	30.00	21.52	-62.60***
No_Age_{it}	0.0273	0	0.1630	0.0275	0	0.1634	-0.30
$Homeowners_{it}$`	0.7937	1.00	0.4047	0.7715	1.00	0.4199	19.40***
$Over65_{it}$	0.1298	0	0.3360	0.1757	0	0.3806	-44.94***
$Disability_{it}$	0.0197	0	0.1390	0.0349	0	0.1835	-31.40***
$OtherExemption_{it}$	0.0002	0	0.0136	0.0007	0	0.0261	-7.48***
$\%Protest_{ijt}$	0.2730	0.2223	0.1352	0.2043	0.1893	0.0908	206.53***
$\%Homeowners_{ijt}$	0.7931	0.8040	0.0785	0.7637	0.7831	0.0830	135.16***
$\%RecentSale_{ijt}$	0.3924	0.3550	0.1126	0.3803	0.3528	0.1101	39.68***
$Std\_TBldgArea_{ijt}$	819.45	754.31	324.44	740.99	700.37	256.97	86.10***
$HigherInitialMKTV_{it}$	0.6695	1.00	0.4704	0.4571	0	0.4982	155.01***
$Higher\%\Delta MKTV_{it}$	0.6543	1.00	0.4756	0.3667	0	0.4820	212.64***

*, **, *** indicate significance at 10%, 5%, and 1% respectively, using a two-tailed test. The last column provides z-statistics from the Wilcoxon rank-sum test, which is a nonparametric test for assessing whether the two groups are significantly different on the corresponding variable. Variable definitions are in Appendix 1.

Table 6: Panel A
2006 Spearman Correlation Coefficients (n=832,628)

	Variable	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
a	*Protest*$_{it}$																			
b	*Log_InitialMKTV*$_{it}$	0.24																		
c	*%ΔMKTV*$_{it}$	0.22	0.04																	
d	*LVR*$_{it-1}$	0.16	0.08	0.27																
e	*CAP*$_{it}$	-0.03	-0.05	0.34	0.15															
f	*RecentSale*$_{it}$	-0.01	0.13	-0.02	-0.05	-0.16														
g	*PY_Protest*$_{it}$	**0.47**	0.20	0.13	0.16	0.01	0.01													
h	*PY_Success*$_{it}$	**0.44**	0.19	0.14	0.16	0.01	-0.00	**0.84**												
i	*Log_Age*$_{it}$	-0.02	**-0.42**	0.20	**0.43**	0.25	-0.25	-0.03	-0.03											
j	*No_Age*$_{it}$	0.01	-0.04	-0.00	0.02	-0.01	0.02	0.02	0.02	-0.28										
k	*Homeowners*$_{it}$`	-0.03	0.25	-0.04	-0.09	0.21	-0.14	-0.04	-0.03	-0.13	-0.06									
l	*Over65*$_{it}$	-0.05	-0.02	0.04	0.10	0.20	-0.18	-0.04	-0.04	0.18	0.01	0.23								
m	*Disability*$_{it}$	-0.03	-0.05	0.00	-0.02	0.06	-0.04	-0.02	-0.02	0.03	-0.01	0.08	-0.02							
n	*OtherExemption*$_{it}$	-0.00	-0.02	0.00	0.01	-0.00	0.00	-0.00	-0.00	0.02	-0.00	-0.03	-0.01	-0.00						
o	*%Protest*$_{it}$	0.19	**0.50**	0.13	0.21	-0.00	0.05	0.16	0.15	-0.12	0.05	0.10	-0.00	-0.03	-0.01					
p	*%Homeowners*$_{it}$	0.09	**0.50**	-0.06	-0.08	-0.19	0.04	0.08	0.08	-0.29	-0.05	0.19	-0.02	-0.03	-0.02	**0.48**				
q	*%RecentSale*$_{it}$	0.01	0.30	-0.12	-0.21	-0.17	0.19	0.01	0.01	**-0.51**	0.07	0.09	-0.12	-0.03	-0.01	0.22	0.22			
r	*Log_std_TBldgArea*$_{it}$	0.09	0.17	0.02	0.02	0.02	0.03	0.08	0.07	-0.12	0.04	0.02	-0.02	-0.01	0.00	**0.46**	0.12	0.18		
s	*HigherInitialMKTV*$_{it}$	0.11	**0.56**	0.03	-0.06	0.05	0.07	0.07	0.06	-0.24	-0.05	0.16	0.01	-0.01	-0.01	0.00	0.00	-0.00	-0.00	
t	*Higher%ΔMKTV*$_{it}$	0.16	0.00	**0.86**	0.16	0.26	-0.01	0.07	0.09	0.14	-0.00	-0.03	0.03	0.00	0.00	0.06	-0.03	-0.06	0.03	0.02

Correlations ≥ |0.01| are significant at 0.001. Correlations greater than |0.40| are in bold. Variable definitions are in Appendix 1.

Table 6: Panel B
2007 Spearman Correlation Coefficients (n=861,440)

	Variable	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
a	$Protest_{it}$																			
b	$Log\_InitialMKTV_{it}$	0.25																		
c	$\%\Delta MKTV_{it}$	0.25	0.06																	
d	LVR_{it-1}	0.12	0.08	0.21																
e	CAP_{it}	-0.02	0.02	0.38	0.17															
f	$RecentSale_{it}$	-0.03	0.12	-0.03	-0.04	-0.16														
g	$PY\_Protest_{it}$	**0.50**	0.24	0.23	0.17	0.07	0.00													
h	$PY\_Success_{it}$	**0.46**	0.22	0.25	0.18	0.07	-0.01	**0.82**												
i	Log_Age_{it}	-0.05	**-0.40**	0.16	**0.43**	0.22	-0.26	-0.03	-0.02											
j	No_Age_{it}	0.01	-0.04	-0.03	0.02	-0.03	0.02	0.01	0.01	-0.28										
k	$Homeowners_{it}$`	-0.01	0.24	-0.05	-0.08	0.24	-0.16	-0.02	-0.01	-0.11	-0.06									
l	$Over65_{it}$	-0.06	-0.01	0.02	0.10	0.20	-0.18	-0.05	-0.03	0.17	0.01	0.23								
m	$Disability_{it}$	-0.03	-0.05	-0.00	-0.02	0.05	-0.04	-0.02	-0.02	0.03	-0.01	0.09	-0.02							
n	$OtherExemption_{it}$	0.01	-0.03	0.00	0.01	-0.00	-0.00	-0.00	-0.00	0.02	-0.00	-0.03	-0.01	-0.00						
o	$\%Protest_{it}$	0.18	**0.56**	0.07	0.18	-0.01	0.05	0.17	0.16	-0.16	0.05	0.12	-0.01	-0.04	-0.01					
p	$\%Homeowners_{it}$	0.11	**0.48**	-0.08	-0.07	-0.14	0.04	0.09	0.09	-0.27	-0.04	0.18	-0.02	-0.03	-0.02	**0.61**				
q	$\%RecentSale_{it}$	0.03	0.29	-0.12	-0.18	-0.18	0.19	0.02	0.01	**-0.51**	0.06	0.08	-0.12	-0.03	-0.01	0.24	0.19			
r	$Log\_std\_TBldgArea_{it}$	0.07	0.17	0.03	0.03	0.04	0.02	0.08	0.08	-0.11	0.03	0.02	-0.01	-0.01	0.00	0.38	0.14	0.17		
s	$HigherInitialMKTV_{it}$	0.12	**0.57**	0.04	-0.06	0.07	0.07	0.11	0.10	-0.24	-0.05	0.15	0.01	-0.01	-0.02	0.00	0.00	-0.00	-0.0	
t	$Higher\%\Delta MKTV_{it}$	0.19	0.03	**0.77**	0.06	0.24	-0.02	0.16	0.19	0.05	-0.01	-0.03	-0.01	-0.00	-0.00	0.00	-0.00	-0.02	0.00	0.03

Correlations $\geq$ |0.01| are significant at 0.001. Correlations greater than |0.40| are in bold. Variable definitions are in Appendix 1.

Table 6: Panel C

2008 Spearman Correlation Coefficients (n=891,032)

	Variable	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
a	$Protest_{it}$																			
b	$Log\_InitialMKTV_{it}$	0.32																		
c	$\%\Delta MKTV_{it}$	0.30	0.31																	
d	LVR_{it-1}	0.11	0.06	0.31																
e	CAP_{it}	0.03	0.11	0.32	0.25															
f	$RecentSale_{it}$	-0.02	0.12	-0.02	-0.06	-0.15														
g	$PY\_Protest_{it}$	**0.50**	0.23	0.25	0.12	0.08	-0.02													
h	$PY\_Success_{it}$	**0.49**	0.21	0.28	0.13	0.09	-0.04	**0.84**												
i	Log_Age_{it}	-0.07	-0.39	0.11	**0.46**	0.21	-0.28	-0.06	-0.04											
j	No_Age_{it}	-0.00	-0.03	-0.01	0.02	-0.02	0.02	0.01	0.00	-0.28										
k	$Homeowners_{it}$`	0.02	0.23	0.02	-0.08	0.22	-0.17	-0.00	-0.00	-0.10	-0.06									
l	$Over65_{it}$	-0.05	-0.00	0.03	0.10	0.19	-0.18	-0.06	-0.05	0.17	0.00	0.24								
m	$Disability_{it}$	-0.03	-0.05	-0.02	-0.02	0.04	-0.04	-0.03	-0.03	0.04	-0.01	0.09	-0.02							
n	$OtherExemption_{it}$	-0.01	-0.03	-0.00	0.01	-0.00	-0.00	-0.01	-0.01	0.02	-0.00	-0.03	-0.01	-0.00						
o	$\%Protest_{it}$	0.22	**0.60**	0.23	0.16	0.04	0.06	0.17	0.16	-0.18	0.03	0.13	-0.01	-0.04	-0.02					
p	$\%Homeowners_{it}$	0.14	**0.48**	0.06	-0.08	-0.10	0.04	0.11	0.10	-0.27	-0.04	0.18	-0.01	-0.03	-0.02	**0.70**				
q	$\%RecentSale_{it}$	0.04	0.28	-0.04	-0.22	-0.15	0.20	0.04	0.03	**-0.50**	0.04	0.07	-0.12	-0.03	-0.02	0.28	0.20			
r	$Log\_std\_TBldgArea_{it}$	0.09	0.19	0.08	0.03	0.09	0.01	0.07	0.07	-0.10	0.03	0.03	-0.01	-0.01	0.00	**0.41**	0.19	0.17		
s	$HigherInitialMKTV_{it}$	0.16	**0.57**	0.16	-0.08	0.09	0.07	0.10	0.09	-0.23	-0.04	0.14	0.01	-0.01	-0.02	0.00	0.00	-0.00	-0.00	
t	$Higher\%\Delta MKTV_{it}$	0.23	0.19	**0.81**	0.14	0.20	-0.01	0.19	0.22	0.04	-0.02	0.02	0.01	-0.01	-0.00	0.09	0.05	0.02	0.05	0.16

Correlations ≥ |0.01| are significant at 0.001. Correlations greater than |0.40| are in bold. Variable definitions are in Appendix 1.

Table 7
Probit Model Results

		2006			2007			2008		
Independent Variables	**Predicted Sign**	**Estimated Coefficient**	**χ^2 value**	**p-value**	**Estimated Coefficient**	**χ^2 value**	**p-value**	**Estimated Coefficient**	**χ^2 value**	**p-value**
$Intercept_{it}$		-6.447	8,033.2	<0.001	-5.3768	6,900.4	<0.001	-6.9239	10,457.1	<0.001
LVR_{it-1}	?	0.2347	199.09	<0.001	-0.0821	31.42	<0.001	0.0353	6.26	0.012
$Log\_InitialMKTV_{it}$	+	0.4596	6,107.2	<0.001	0.3636	4,722.9	<0.001	0.4726	8,025.5	<0.001
$\%\Delta MKTV_{it}$	+	0.0505	168.13	<0.001	0.1623	416.75	<0.001	0.0121	7.41	0.007
$PY\_Protest_{it}$	+	1.1786	20,272.20	<0.001	1.1727	28,420.8	<0.001	0.9243	20,373.6	<0.001
$PY\_Success_{it}$	+	0.3269	1,234.95	<0.001	0.3861	2,252.29	<0.001	0.5485	6,154.45	<0.001
Log_Age_{it}	+	0.0254	64.97	<0.001	0.0443	263.58	<0.001	0.0242	82.59	<0.001
No_Age_{it}	+	0.1566	97.88	<0.001	0.1740	156.86	<0.001	0.0830	35.90	<0.001
$RecentSale_{it}$	-	-0.1809	1,467.06	<0.001	-0.2253	3,029.76	<0.001	-0.1148	757.99	<0.001
$Homeowner_{it}$`	-	-0.1453	634.42	<0.001	0.0090	3.24	0.072	-0.0575	132.16	<0.001
$Over65_{it}$	-	-0.2215	1,107.99	<0.001	-0.2693	2,265.75	<0.001	-0.1664	879.29	<0.001
$Disability_{it}$	-	-0.0749	29.27	<0.001	-0.1577	184.32	<0.001	-0.1247	111.46	<0.001
$OtherExemption_{it}$	-	-0.1712	2.49	0.114	-0.5548	23.77	<0.001	-0.4237	12.65	<0.001

CAP_{it}	-	-0.5991	6,481.15	<0.001	-0.6042	10,697.0	<0.001	-0.4786	6,009.06	<0.001
$\%Protest_{ijt}$	+	0.9131	741.95	<0.001	1.2057	1,428.30	<0.001	1.0122	1,196.48	<0.001
$\%Homeowners_{ijt}$	?	-0.5918	316.59	<0.001	-0.4322	206.98	<0.001	-0.2454	62.02	<0.001
$\%RecentSale_{ijt}$	-	-0.0594	7.41	0.007	0.0369	3.94	0.047	-0.0053	0.08	0.783
$Log\_std\ TBldgArea_{ijt}$	?	-0.0490	52.68	<0.001	-0.0559	95.62	<0.001	-0.0487	67.20	<0.001
$Higher\ InitialMKTV_{it}$	+	0.1053	327.00	<0.001	0.1238	629.85	<0.001	0.1779	1,247.48	<0.001
$Higher\ \%\Delta MKTV_{it}$	+	0.5463	14,927.0	<0.001	0.4851	14,671.4	<0.001	0.4169	11,318.2	<0.001
Number of observations		832,628			861,440			891,032		
Percentage of cases correctly classified		90.7%			86.7%			86.9%		
Log-likelihood for full selection model		-213,272.71			-298,654.88			-291,628.03		

This table presents results from estimating equation (1). Variable definitions are in Appendix 1.

Table 8

MLE Regression Results for $\%\Delta MKTV\_hearing_{it}$

		2006			2007			2008		
Independent Variables	**Predicted Sign**	**Estimated Coefficient**	**t-statistic**	**p-value**	**Estimated Coefficient**	**t-statistic**	**p-value**	**Estimated Coefficient**	**t-statistic**	**p-value**
$Intercept_{it}$		-0.0799	-7.84	<0.001	0.0582	7.46	<0.001	0.0050	0.70	0.486
LVR_{it-1}	?	-0.0313	-17.90	<0.001	-0.0299	-23.40	<0.001	-0.0210	-18.62	<0.001
$Formal_{it}$	?	0.0126	15.19	<0.001	0.0072	13.33	<0.001	0.0133	24.84	<0.001
$Agent_{it}$	?	-0.0233	-38.87	<0.001	-0.0122	-28.00	<0.001	-0.0065	-16.64	<0.001
$Formal_{it}*Agent_{it}$	?	-0.0105	-9.49	<0.001	-0.0134	-18.04	<0.001	-0.0265	-39.05	<0.001
$Log\_InitialMKTV_{it}$	?	0.0174	22.69	<0.001	0.0078	13.47	<0.001	0.0090	17.59	<0.001
$\%\Delta MKTV_{it}$	+	0.1069	101.54	<0.001	0.0938	123.46	<0.001	0.0674	85.21	<0.001
Log_age_{it}	+	0.0070	18.91	<0.001	0.0091	34.24	<0.001	0.0072	31.87	<0.001
No_age_{it}	+	0.0377	14.31	<0.001	0.0346	16.59	<0.001	0.0198	11.29	<0.001
$RecentSale_{it}$	-	-0.0060	-10.69	<0.001	-0.0035	-8.65	<0.001	-0.0006	-1.78	0.074
$Homeowner_{it}$	?	-0.0060	-8.25	<0.001	0.0001	0.24	0.813	-0.0083	-18.58	<0.001
$Over65_{it}$	?	0.0005	0.70	0.485	0.0020	3.61	<0.001	0.0001	0.16	0.874
$Disability_{it}$	?	0.0069	3.84	<0.001	0.0056	4.53	<0.001	0.0024	2.22	0.026
$OtherExemp_{it}$	?	0.0478	3.41	<0.001	0.0023	0.17	0.862	0.0368	3.31	<0.001
CAP_{it}	?	-0.0490	-57.02	<0.001	-0.0418	-75.45	<0.001	-0.0342	-69.82	<0.001
$\%Protest_{ijt}$	+	0.0421	14.17	<0.001	0.0385	15.31	<0.001	0.0309	15.36	<0.001
$\%Homeowners_{ijt}$	?	-0.1494	-38.36	<0.001	-0.1521	-52.34	<0.001	-0.1175	-44.60	<0.001
$\%RecentSale_{ijt}$	-	-0.0374	-14.85	<0.001	-0.0279	-15.71	<0.001	-0.0175	-11.23	<0.001
$Higher\ InitialMKTV_{it}$	?	0.0048	6.79	<0.001	0.0012	2.47	0.014	0.0019	4.37	<0.001
$Higher\%\Delta MKTV_{it}$	+	0.0302	49.90	<0.001	0.0151	33.37	<0.001	0.0128	33.23	<0.001
$\%\Delta MKTV\_hearing_{it-1}$	+	0.2213	54.65	<0.001	0.2063	66.67	<0.001	0.2392	84.94	<0.001
$Good\ quality_{it}$	?	0.0011	0.58	0.559	-0.01073	-6.98	<0.001	-0.0057	-4.46	<0.001
$Above\ average\ quality_{it}$	?	0.0057	2.93	0.003	-0.0123	-7.64	<0.001	-0.0076	-5.68	<0.001

Average quality$_{it}$	?	0.0116	5.43	<0.001	-0.0135	-7.90	<0.001	-0.0069	-4.82	<0.001
Fair quality$_{it}$	?	0.0322	12.29	<0.001	0.0100	4.87	<0.001	0.0045	2.48	0.013
Poor quality$_{it}$	?	0.0530	11.17	<0.001	0.0319	8.93	<0.001	0.0266	7.91	<0.001
λ_{it}	?	0.0343	56.22	<0.001	0.0190	42.14	<0.001	0.0243	59.91	<0.001
Number of observations		96,098			154,037			162,789		
Pseudo R^2		31.0%			27.9%			24.2%		
Sum of *Agent+Formal*Agent*		-0.0338 (35.24)		<0.001	-0.0256 (40.83)		<0.001	-0.0330 (57.29)		<0.001

This table presents results from estimating equation (2) using a Heckman MLE method. Variable definitions are in Appendix 1.

Table 9
MLE Regression Results for *Log of Assessed Market Value:* Before and After Appeals Hearings

	Predicted Sign	2006		2007		2008	
		Log_InitialMKTV	*Log_FinalMKTV*	*Log_InitialMKTV*	*Log_FinalMKTV*	*Log_InitialMKTV*	*Log_FinalMKTV*
Intercept		6.8485 (419.87)	6.8672 (415.56)	6.7845 (439.26)	6.8030 (432.38)	6.6216 (425.29)	6.6279 (419.22)
$Adjustment_{it}$	?	0.2165 (129.03)	0.0940 (55.26)	0.1420 (113.37)	0.0343 (26.87)	0.1600 (128.67)	0.0769 (60.91)
$NoAdjustment_{it}$	?	0.0765 (31.50)	0.0715 (29.06)	0.0914 (42.61)	0.0648 (29.64)	0.1028 (51.94)	0.1028 (51.14)
LVR_{it-1}	+	0.5351 (241.18)	0.5266 (208.04)	0.6270 (282.98)	0.6153 (272.61)	0.7374 (336.77)	0.7247 (325.95)
Log_age_{it}	-	-0.0675 (-176.66)	-0.0661 (-170.87)	-0.0713 (-205.43)	-0.0708 (-200.40)	-0.0705 (-207.03)	-0.0701 (-202.81)
No_age_{it}	-	-1.0091 (-221.69)	-1.0160 (-220.32)	-1.0050 (-240.43)	-1.0163 (-238.66)	-0.9922 (-246.14)	-0.9963 (-243.39)
Log of building square feet$_{it}$	+	0.6622 (512.04)	0.6611 (504.59)	0.6727 (553.27)	0.6719 (542.47)	0.6914 (567.78)	0.6909 (558.76)
Log of land square feet$_{it}$	+	0.0888 (150.44)	0.0865 (144.62)	0.0908 (163.45)	0.0883 (156.08)	0.0907 (163.68)	0.0896 (159.29)

# of Bedrooms$_{it}$	?	-0.0194 (-34.83)	-0.0190 (-33.54)	-0.0218 (-41.91)	-0.0208 (-39.24)	-0.0233 (-45.77)	-0.0230 (-44.65)
# of Baths$_{it}$	+	0.0645 (114.67)	0.0647 (113.64)	0.0654 (124.54)	0.0654 (122.21)	0.0660 (128.68)	0.0657 (126.13)
Total # of rooms$_{it}$	+	0.0085 (26.58)	0.0090 (27.90)	0.0086 (29.39)	0.0093 (31.08)	0.0083 (29.14)	0.0089 (30.66)
# of stories$_{it}$	-	-0.0764 (-94.54)	-0.0764 (-93.35)	-0.0804 (-107.34)	-0.0807 (-105.88)	-0.0819 (-111.39)	-0.0819 (-109.63)
Pool$_{it}$	+	0.0750 (74.00)	0.0756 (73.59)	0.0766 (80.56)	0.0773 (79.78)	0.0792 (84.75)	0.0798 (84.15)
No HVAC$_{it}$	-	-0.1912 (-177.32)	-0.1921 (-175.80)	-0.1882 (-183.17)	-0.1901 (-181.56)	-0.1933 (-185.29)	-0.1944 (-183.55)
Good quality$_{it}$	-	-0.3170 (-82.11)	-0.3141 (-80.30)	-0.3354 (-94.77)	-0.3293 (-91.34)	-0.3241 (-94.92)	-0.3190 (-92.02)
Above average quality$_{it}$	-	-0.5673 (-145.55)	-0.5671 (-143.62)	-0.5837 (-163.71)	-0.5789 (-159.39)	-0.5787 (-168.48)	-0.5724 (-164.11)
Average quality$_{it}$	-	-0.7303 (-182.26)	-0.7343 (-180.89)	-0.7451 (-203.45)	-0.7438 (-199.38)	-0.7367 (-208.70)	-0.7338 (-204.71)
Fair quality$_{it}$	-	-1.0500 (-247.90)	-1.0544 (-245.72)	-1.0444 (-268.90)	-1.0436 (-263.77)	-1.0257 (-272.67)	-1.0222 (-267.62)
Poor quality$_{it}$	-	-1.4789 (-276.50)	-1.4858 (-274.19)	-1.4760 (-297.89)	-1.4778 (-292.79)	-1.4394 (-293.42)	-1.4402 (-289.12)

λ_{it}	?	-0.1004 (-102.45)	-0.0979 (-98.56)	-0.0711 (-91.43)	-0.0642 (-81.03)	-0.0786 (-101.31)	-0.0795 (-100.86)
Neighborhood effects		Yes (n=349)	Yes (n=349)	Yes (n=351)	Yes (n=351)	Yes (n=351)	Yes (n=351)
N		818,753	818,753	847,576	847,576	881,129	881,129
Pseudo R^2		89.3%	88.8%	89.7%	89.2%	89.7%	89.2%
t-statistic for test of difference in *Adjustment* and *NoAdjustment* coefficient estimates		66.10	10.47	26.42	-15.63	32.78	-14.63

This table presents results from estimating equation (3) using a Heckman MLE method. Variable definitions are in Appendix 1.

Table 10

MLE Regression Results for *Log of Assessed Market Value of Improvements and Land*

(measured after appeals adjustment, if any)

	2006		2007		2008	
	Log_IMPRV	*Log_LV*	*Log_IMPRV*	*Log_LV*	*Log_IMPRV*	*Log_LV*
Intercept	7.4970 (289.71)	5.0191 (223.28)	7.4355 (277.21)	5.0749 (221.78)	7.2674 (249.56)	5.0135 (232.23)
$Adjustment_{it}$	-0.0148 (-5.55)	0.0970 (41.95)	-0.0157 (-7.19)	0.0040 (2.14)	0.0180 (7.73)	0.0468 (27.17)
$NoAdjustment_{it}$	0.0916 (23.76)	0.0153 (4.57)	0.0982 (26.34)	-0.0161 (-5.07)	0.1559 (42.11)	0.0242 (8.81)
Other control variables in model	Yes	Yes	Yes	Yes	Yes	Yes
λ_{it}	-0.0994 (-63.94)	-0.0531 (-39.33)	-0.0880 (-65.23)	-0.0062 (-5.34)	-0.0961 (-66.19)	-0.0237 (-21.98)
Neighborhood effects	Yes (n=349)	Yes (n=349)	Yes (n=351)	Yes (n=351)	Yes (n=351)	Yes (n=351)
N	818,753	818,753	847,576	847,576	881,129	881,129
Pseudo R^2	79.0%	89.3%	77.1%	88.5%	74.0%	90.0%
t-statistic for test of difference in *Adjustment* and *NoAdjustment* coefficient estimates	-31.63	27.98	-34.21	7.08	-42.29	9.37

This table presents results from estimating equations (4) and (5) using a Heckman MLE method. All t-statistics are significant at <0.0001. Variable definitions are in Appendix.