Property Assessments and Information Asymmetry in Residential Real Estate

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Abstract

We present a game theoretic model of property tax assessment that allows a tax appraiser to either choose a high a low assessment. The owner either accepts or challenges this assessment. We then use a "fixed effects" regression model to evaluate the differences in assessed values of a sample of houses from Bexar County, Texas during 2000 and 2001. Where the owner of the house is identified as a state licensed property tax consultant, the assessed value, after adjusting for size, age, and other economic characteristics, ranged from a statistically robust 2.5% to 6.2% lower than neighboring houses.

Key words: property appraisal, property tax consultant, asymmetric information, board determined

1. Introduction

Do real estate experts benefit from their superior information? George A. Akerlof, A. Michael Spence, and Joseph E. Stiglitz, were awarded the 2001 Nobel Memorial Prize for Economic Sciences, for providing a basis for a multitude of studies which assess economic outcomes when the information held by various participants in an economy vary; that is, when there is asymmetric information. Akerlof (1970), for example, uses information asymmetry to explain why people over 65 years of age find it difficult to buy medical insurance, and why employers, based on a profit motive, may refuse to hire minorities. Information economics suggests that there are numerous situations where distinct equilibriums will occur if groups can be stratified by the information each possesses. Leland and Pyle (1977) note that many financial markets exhibit informational asymmetries. Borrowers have more information about their own collateral, industriousness, and moral rectitude than do lenders, and entrepreneurs have more information about their projects than do potential financiers.

Clapp, Dolde, and Tirtitoglu (1995) find evidence of diffusion of housing price changes that is temporal within individual towns and spatial between neighboring towns. They posit this diffusion is probably a reaction to information flows. Dolde and Tirtiroglu (1997) present a model of real estate price dynamics to examine information diffusion in real estate prices and extend the empirical work of Tirtiroglu (1992) and Clapp and Tirtiroglu (1994). Milgrom and Stokey (1982) argue that uninformed agents are reluctant to trade with informed agents. Garmaise and Moskowitz (2004) find strong evidence for asymmetric information in commercial real estate markets. They provide evidence that information asymmetries result in favoring the purchase of nearby properties and properties with long income histories, and a reduction in trade with informed brokers. As a result, there is a type of market segmentation between informed and uninformed markets, in which informed brokers are more likely to sell to other informed brokers. The authors argue that market segmentation illustrates the importance of information asymmetries in the commercial real estate market. While many examples of asymmetric information have been proffered, Garmaise and Moskowitz suggest there have been few empirical tests of the theory of asymmetric information.

Two recent papers assess informational asymmetry in residential real estate markets by probing whether real estate agents sell their own houses for more than they sell similar client owned houses. Rutherford, Springer and Yavas (2005), using data from the Dallas-Forth Worth metropolitan area find that agent owned houses sell for approximately 4.5% more than other houses. Levitt and Syverson (2005) report on a similar study using data from the Chicago area and find similar results. They estimate a 3.7% selling price premium for real estate agents selling their own home. Both papers suggest that real estate agents use their superior information to obtain the higher price.

In the valuation of property for tax purposes, property tax consultants possess superior information regarding the house appraisal process, a feel for the local market, and knowledge of the protest procedure. If a tax consultant deems the county determined property assessment high, he or she can, with a relatively low cost, evaluate the evidence and file a protest. A more typical property owner would first have to realize that the appraisal was high and then would either have to learn the appraisal and protest methods, or hire outside expertise such as a licensed tax consultant to represent him or her. Either way the typical homeowner incurs greater costs than does the consultant. Whether there would be a benefit in the form of a lower appraisal is uncertain. This asymmetry in information suggests a potential for differing appraisals in the same market. It is reasonable to hypothesize, that on average, licensed tax consultants will have lower assessed values than other property owners, as it is unlikely that all other property owners hire a consultant or successfully appeal on their own.

An appraisal is an estimate of fair market value, and is subject to some error. It is often stated that an appraisal should provide a value that is accurate within 10% of the true fair market value of a property. In other words, there is some reasonable range in which various appraisers may disagree on value. A property tax consultant trained in appraisal might exploit this fact by presenting evidence that could result in a modest decrement of appraised value that would still be a valid estimate of fair market value. The cost to the consultant would be low, due to his expertise, while the cost to an ordinary property owner could be significant, and perceived payoff may be low.

In sum, it seems reasonable to suggest the existence of information based final appraisals that carry a bias in form of a modest gain to property tax consultants. If high gains were likely, other owners would realize their property appraisal seemed high, and would either learn to protest themselves, or would employ a consultant. The primary hypothesis of this paper proposes is that *ceteris paribus,* a property tax consultant will exploit his or her information asymmetry to gain a somewhat lower appraised value than his neighbors. If properties are commonly over-assessed, we should also detect that property assessments are lower for property owners who protest their appraisals in an attempt to lower their assessments. While we have no priors about whether protests in general lead to lower assessments, it is an important question that we can test.

To test our stated hypotheses, we examine assessed values of houses in Bexar County, Texas, for state licensed property tax consultants and other homeowners. We first present a game theoretic model of property tax assessment that allows the appraised value to depend on the likelihood that a homeowner will challenge the assessment. We then present a brief summary of the property taxation and the appeal process for Bexar County. Next we discuss the empirical data, and then specify an econometric model to detect whether information asymmetry exists, i.e., whether tax consultants have lower assessed values. We then discuss the empirical findings and conclude with a summary of our findings. To preview the results, we find that; 1) licensed property tax consultants benefit from lower tax appraisals, and 2) overall, Board Determined values are no different than Certified Values (i.e. values determined without a formal protest).

2. A Game-Theoretic Model of Property Assessment

In this section we present a model that illustrates game-theoretic interactions between assessors (A) and homeowners (H). We show in a rational context that a property assessor's choice of assessed value will depend on the assessor's estimation of the likelihood that homeowners will challenge the assessment value, and on the expected payoffs and penalties associated with assessments challenges. The presentation here incorporates elements of interactive structure and rationality that provides a testable prediction regarding assessment outcomes. The strategic results generate interesting optimality implications for assessors and homeowners that serve as a foundation for the empirical investigation that follows. A numerical example illustrates the results.

Consider an assessor who is expected to generate revenue while maintaining assessment credibility within the homeowner community. For simplicity we assume a neighborhood with similar housing attributes for which the assessor must choose between one of the following assessed values for each home:

$A_L \equiv$ Assess at a low value that has low probability of being challenged by homeowners.

A_H ≡ Assess at a high value that has greater probability of being challenged by homeowners.

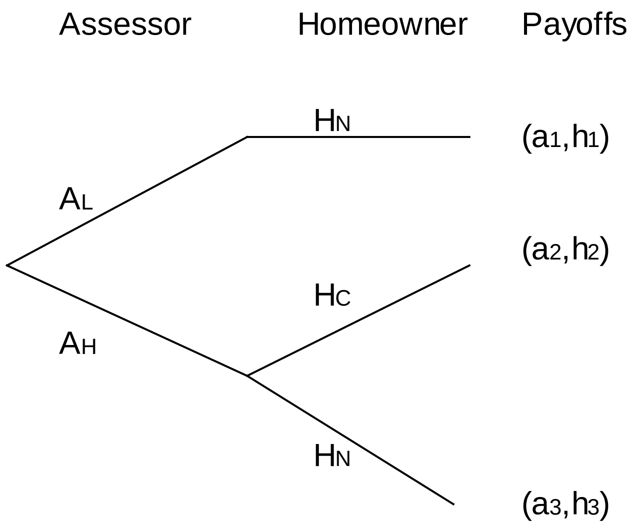
Homeowners in the neighborhood must choose how to respond to the appraisal that is presented to them. Homeowners choose from one of two strategies defined below:

H_C ≡ Homeowner challenges the assessment. A high knowledge homeowner has a low-cost to recognize and challenge the high assessment (A_H) due to his or her superior information regarding home values and the assessment and challenge process. Knowledgeable homeowners can be expected to challenge a high assessment.

H_N ≡ Homeowner does not challenge the assessment. Homeowners with little knowledge or information about property assessment and the challenge procedure incur a high-cost to recognize and to challenge a high assessment (A_H). Such homeowners are not expected to challenge any assessment. High knowledge homeowners realize there is no gain to challenge a low assessment and thus will choose this strategy for low assessments (A_L).

For the parameters defined so far, the set of pure strategies for the assessor is $\{A_H, A_L\}$, and the set of pure strategies for the homeowner is $\{H_C, H_N\}$.

We present a two-stage dynamic game where the assessor plays first[1]. The homeowner plays after observing the assessor's choice. The extensive form of this game is presented below:



The payoffs shown above are:

a_i = payoff to the assessor from outcome i = 1, 2, 3

h_i = payoff to the homeowner from outcome i = 1, 2, 3

The three payoff outcomes are:

(a_1,h_1) = payoff when the assessor plays the low assessment. Because the low assessment is played, there is no incentive for any homeowner to challenge so the homeowners choose not to challenge

(a_2,h_2) = payoff when the assessor plays the high assessment and the homeowner responds by challenging this high assessment

(a_3,h_3) = payoff when the assessor plays the high assessment and the homeowner does not challenge this high assessment

We first evaluate the case of complete information and then the more relevant case of incomplete information. In the case of complete information, there can be only one type of homeowner – those with high knowledge (i.e. low cost to challenge) and all parameters of the game are common knowledge. Every homeowner who faces the A_H assessment will challenge and will be successful. For the assessor, a successful challenge of A_H will have two cost components; i) reduction of the assessment to A_L, and ii) some administrative costs and credibility loss. The second component of this cost is the penalty that causes the assessor to avoid excessively high assessments. Accordingly, the following rationality conditions are imposed on the assessor's payoffs. First, an unchallenged high assessment generates a superior payoff for the assessor reflected by $a_1 < a_3$ and $a_2 < a_3$. Second, there is a penalty for generating an assessment that is successfully challenged which is reflected by $a_2 < a_1$.

A homeowner who faces the high assessment A_H and does not challenge will be worse off than the case of facing the low assessment A_L. Further, for simplicity and without compromising the main results, in the numerical example that follows we assume that a homeowner who faces the high assessment A_H and challenges will end up better off than the case where the assessor had applied the low assessment A_L. The stated features are reflected in the following symmetric example of payoffs:

$$(a_1, h_1) = (0, 0), \qquad (a_2, h_2) = (-1, 1), \qquad (a_3, h_3) = (1, -1)$$

Under complete information, backward induction for this example leads to the low assessment (A_L) as the Nash equilibrium. This outcome emerges because every homeowner would choose the payoff profile (-1, 1) over (1, -1), so the assessor chooses the payoff profile (0, 0) to prevent the worse outcome, from the assessor point of view, of (-1, 1).

We now consider the more relevant case of incomplete information. In the incomplete information case, there are homeowners who have inferior knowledge of assessment and challenge process and thus face a high cost to challenge. In this situation the assessor knows that only a fraction of the homeowners will challenge the high assessment A_H. There is a positive probability that a homeowner facing the high assessment A_H will challenge. Let μ be the belief of the assessor of the probability that a homeowner facing A_H will challenge. Because only high type owners will challenge, μ can also be seen as the assessor estimate of the probability that the homeowner is the high type. We abstract from many formal issues associated with the Bayesian Nash equilibrium for such games and instead focus on the backward induction under the belief of the assessor.   Under the payoffs and the belief stated above, the assessor's expected payoff from choosing the high assessment A_H is:

$$\mu(a_2) + (1-\mu)(a_3)$$

It is clear that the assessor will optimally choose the high assessment A_H over the low assessment A_L if the assessor's belief, μ, is low enough so that the expected payoff from choosing the high assessment is higher than simply playing low assessment. Stated more formally, the following condition must be satisfied for the assessor to choose the high assessment:

$$\mu(a_2) + (1-\mu)(a_3) > a_1 \qquad (1)$$

This result can be alternatively stated in terms of the μ values for which a high assessment is the rational choice for the assessor, that is:

$$\mu < (a_1 - a_3) / (a_2 - a_3) \qquad (2)$$

The rationality conditions stated earlier, $a_1 < a_3$ and $a_2 < a_3$ demonstrate that $(a_1 - a_3) < 0$ and $(a_2 - a_3) < 0$. These conditions guarantee that μ is positive. The rationality condition of $a_2 < a_1$ ensures that $\mu < 1$. Stated alternately, if $\mu = 1$, Equation (1) states $a_2 > a_1$, contradicting the rationality condition $a_2 < a_1$ showing that a high assessment A_H cannot be optimal.

For the values given in the symmetric numerical example stated above, ($a_1 = 0$, $a_2 = -1$, and $a_3 = 1$), the high assessment A_H, will be chosen only if the assessor's belief satisfies $\mu < ½$.

In other words, for our numerical example, the assessor will assign the high assessed value A_H, only if he believes that less than 50% of the homeowners will challenge this assessment.

The above general and numerical results demonstrate that the choice of property assessment value by a rational assessor depends on the assessor's estimation of the likelihood that homeowners will challenge and on the structure of the payoffs. A rational assessor will incorporate a best estimate of the likelihood of challenge when setting the initial assessment value. In a posterior sense, however, differences in homeowner knowledge (and thus cost to successfully challenge a high assessment) will lead to adjustments in the final assessment houses because when the assessor assigns the high assessment to a knowledgeable homeowner, that owner will successfully challenge the assessment.

Two primary predictions can be established from the imperfect information model. First, when the number of high knowledge homeowners is a low fraction of the population being assessed, and appraisers have no information to evaluate the type of an individual homeowner, the value maximizing choice for the appraiser is to choose the high assessment for everyone. The low knowledge homeowner will accept this assessment. In response to the high assessment the high knowledge homeowner will challenge the assessment to achieve the lower appraisal. The overall payoff to the assessor will be higher following this strategy rather than giving everyone the low assessment. An effect of the appraiser choosing this strategy will be to observe that high knowledge homeowners successfully challenge their initial assessment.

Second, if the assessor has some information that can help him refine his estimate of type, μ, he will choose to give the owners that he expects to be high knowledge (i.e. low cost) the low assessment so as not to trigger a successful challenge. Alternately, if there were cronyism or fraud between the tax assessors and property tax consultants, we would also observe the low assessment to benefit the preferred party. The remaining homeowners whom the assessor believes are low knowledge, or have no connections, will receive the high assessment.

The observed final assessment outcome from either alternative will be the same. We can expect high knowledge homeowners to have a lower assessment either because such owners are uncommon so their successful challenges are not overly costly, or that the appraiser has identified these homeowners and has initially assessed them at the low value to prevent a challenge. The empirical model presented in the next section separates owners who are licensed property tax consultants, who are deemed to be high knowledge homeowners, from other owners who are deemed to be low knowledge homeowners. The empirical study tests the hypothesis of whether these different homeowner groups receive equal property assessments.

3. Property Taxation in Bexar County, Texas.

San Antonio is the largest city in Bexar County and most of our sample properties are located in San Antonio. The Bexar County Appraisal District assesses property at "100% of the Market Value except as otherwise provided by law"[2]. Residential property assessments are made via a mass appraisal method based primarily on the sales comparison approach, with updated appraisals being made at least every three years. For any random sample of appraisals, one can expect that at least 1/3 have been updated that year while others may be based on determinations made in the past one or two years with simple adjustments to measure current value. If the owner believes the appraised value is too high, he or she can file an appeal and take the case to an Appraisal Review Board, where the owner (or the agent representing the owner) will present evidence of value, and the Chief Appraiser represents the Appraisal District. Prior to this formal hearing panel, the owner may choose to undergo an informal review with a District Appraiser.

At the review stage the property owner presents the case of why he or she believes the assessment is high. Based on the evidence presented, the review appraiser can adjust the appraised value. If the two parties work out a mutually agreeable appraisal, this new value will be assigned to the property and the case will not proceed to the Appraisal Review Board. If the property owner is not satisfied, or does not choose to undergo informal review, the case will proceed to a hearing panel before the Appraisal Review Board. The Board, based on the evidence presented on both sides, can accept the value presented by either side or some other value. The Board may increase or decrease the assessment originally provided resulting in a "Board Determined" value or it might dismiss the case resulting in a "Board Dismissed" result, which is the value originally proposed. Appraised values that are not protested to the Appraisal Review Board are called "Certified Values."

4. Data and Methodology

We obtained a list of Licensed Property Tax Consultants in Bexar County from the State of Texas Appraiser and Licensing Board[3]. Of our initial sample of 73 consultants in Bexar County, we were able to identify 46 that owned a house and had neighboring houses. The total panel sample over two years, matched by location, consists of 503 property observations. Forty-six houses were owned by tax consultants in 2000, with forty-five of those houses owned by the same consultant in 2001, resulting in 91 tax consultants observations and 412 observations of houses owned by neighbors of property tax consultants. The property appraisal data for each of the 503 house observations was collected by searching the Bexar County Appraisal District website. In addition to the appraisal data, the website provides a map that allows one to identify the neighboring houses. Our empirical analysis is limited by the variables that are carried in the public record. Available variables are the appraised (assessed) value, the size of the house, the size of the lot, the age of the house, the number of rooms in the house, the number of stories in the house, and an indicator of the quality of the house. With the exception of the indicators for licensed property tax consultant, the remaining covariates mainly serve as control variables. Table 1 describes the variables that were created from this data.

Table 2 presents the descriptive statistics for these variables and presents tests that indicate that for most variables, there is no statistical difference in the means of the characteristics between the properties owned by consultants and those of their neighbors. In the sample, the average appraised value is $160,802 with an average size of 2,271 square feet, and an average age of about 21 years. The one variable that shows a statistical difference is the likelihood of the assessment being Board Determined. For non-consultants, about 12% of the values are Board Determined, whereas for consultants, about 31% of the values are Board Determined, indicating that consultants take their case to the Review Board more than 2.5 times as often as non-consultants.

One of our objectives is to test whether there is an information separation between property tax consultants and other homeowners that can be reliably measured by a difference in assessed value. Our second objective is to determine whether Board Determined values differ from Certified Values. Specifically, we posit that property tax consultants exploit their superior knowledge to obtain lower assessed values and that homeowners may find it beneficial to appeal to the Review Board. Stated more formally, we wish to test that *ceteris paribus*:

$H1_0$: Homeowners who are property tax consultants have the same assessed house values as other homeowners.

versus

$H1_A$: Homeowners who are property tax consultants have lower assessed house values than other homeowners.

and,

$H2_0$: Board Determined values are the same as Certified Values.

versus

$H2_A$: Board Determined values differ from Certified Values.

To test our hypothesis, we employ a "fixed effects" regression model[4] (see Greene, 2003, p. 285, or Maddala 1977), employing the common appraisal approach of the log-linear specification:

$$ln(V_{ij}) = \alpha_j + \beta'\mathbf{X}_{ij} + \varepsilon_{ij} \qquad (4)$$

where $\ln(V_{ij})$ is the natural log of the appraised value for home i at location j. The ε_{ij} term is a classical disturbance with $E[\varepsilon_{ij}] = 0$ and $Var[\varepsilon_{ij}] = \sigma_\varepsilon^2$. $\mathbf{X}_{ij}$ is a matrix of attributes (as noted in Table 1) describing home i at location j. β' is a vector of regression coefficients and α_j are the location intercepts. This model assumes a set of constant β' coefficients across locations with each location having its own intercept and error terms. The variation across groups (i.e. property tax consultant locations) is captured by the intercept for each location.

5. Results

By choosing the widely accepted approach in hedonic appraisals of using the natural log of the appraised value as the independent variable, the coefficient for an indicator variable is approximately the average percentage difference in assessed value when the indicator takes the value 1. Model 1 evaluates the appraisal results without reference to whether the value was a Certified Value or a Board Determined. Model 2 includes indicator variables for Board Value and Board Dismissed to determine whether appealing to the Board affects the assessment. Model 3 replaces the single indicator variable for tax consultant with a set of three indicator variables that are the interaction of tax consultant with Certified Value, Board Determined and Board Dismissed. This allows us to investigate whether differences for consultants' appraisals vary by whether a protest was filed.

Our regression results are presented in Table 3. For all three models, the negative signs coupled with statistical significance demonstrate that property tax consultants receive lower appraisals; thus, we reject our first null hypothesis implying *ceteris paribus*, that property tax consultants have a lower assessed value. In particular, Model 1 indicates that property tax consultants have an assessed value that is a statistically reliable 3.4% lower than their neighbors. Most of the control variables are significant at the 0.05 level or better, showing that these variables are important in determining the assessed value of the houses evaluated. The coefficient for Year 2001 shows that assessments are about 4.6% higher than the previous year. Total Rooms and the Excellent Quality indicators show no statistically important effects.

Our second hypothesis concerned whether lower tax valuations can be obtained through protesting to the Review Board. Table 2 shows that property tax consultants undertake more than 2.5 times as many appeals to the Review Board than do other owners suggesting they expect their appeals to be successful. Model 2, presented in Table 3, includes the indicators of Board Determined and Board Dismissed in the analysis to evaluate whether a difference can be detected. Both of these indicator variables designate that an appeal to the Board has been made. Board Dismissed means the Board accepted the original appraisal while Board Determined could be a higher or lower value than the appraisal district determination. Model 2 finds no significant distinction for Board Determined and Board Dismissed assessments compared to the left out category of Certified Value, indicating that protesting to the Review Board appears neutral in terms of its effect on the assessed value. Note that this result does not lend insight as to whether it is valuable to appeal to the board. In general appeals are only made when the initial appraisal is deemed too high, so this result can be interpreted as showing that the appeals process leads to the fair appraisal value homeowners were seeking, rather than a chance to get an unduly low appraisal. We cannot determine whether an appraisal was reduced through appeal. We determine that the final value is statistically no different whether achieved through the Certified Value or the Board Determined alternative.

To further understand the relationship between the values realized by tax consultants, and the fact that they are more likely to appeal, Model 3 interacts the tax consultant variable with Certified Value, Board Value, and Board Dismissed indicators. These variables separate the consultants into those that protested to the Board and those which did not, and it evaluates the effect of their appeal. Consultants who did not appeal to the Board, realize a value that is about 2.5% lower than would otherwise be expected. There are two potential explanations for this result, and both may be operative. On one hand, this lower value may be due to effect of past protests that presented reasons why their property should be evaluated at a lower value. In other words, this finding may indicate that a positive protest result may persist over time so that the value of successful protest remains for more than a single year. On the other hand, this may simply indicate that the consultant proceeded to the informal review stage where a somewhat lower appraisal was negotiated and the consultant did not feel it was worthwhile to pursue the appeal process further. The consultant no doubt uses his superior knowledge to estimate the likelihood of gaining further relief by taking the appeal to the next stage. The available data does not allow us to distinguish whether it is the persistence of a previous protest, or informal review, or a combination of both that yields the noted 2.5% reduction. When a consultant chooses to take his or her case to the Board and receives a Board Determined value, our results indicate the consultant receives a 6.2% lower appraised value (which is statistically significant at the 0.01 level). By converting the means in Table 2 to raw values one can determine there were only two observations of Board Dismissed appraisals for consultants. This lack of data results in no statistical inference being possible for this situation, which is confirmed by the insignificant t-statistic for the covariate of Board Dismissed interacted with Property Tax Consultant.

The average appraised value (see Table 2) is about $161,000. Given that property tax consultants, in general, have an assessed value about 3.4% lower than the typical homeowner, and given the average tax rate in Bexar County is approximately 3%[5], the average yearly property tax savings to a licensed property tax consultant is about $160. The annual property tax savings for consultants on the median house in this sample would be about $115. Tax consultants that did not complete an appeal to the Review Board save less than these amounts while those that achieve a Board Determined value save more on their annual tax bill. These findings indicate that information asymmetry exists in this residential property assessment market. As noted in the game-theory section, assessors could simply identify tax consultants and choose to award them the low appraisal, so an alternate explanation for this result could be cronyism or fraud. In this case the information asymmetry would be of the form “who you know” rather than “what you know.” This information asymmetry may not provide a large enough discrepancy to result in low knowledge homeowners employing consultants, thus retaining different appraisal outcomes. If a reduction in assessment persisted over time, the tax savings would be an annuity which would be much more valuable than a reduction for the year protested followed by an increase the next assessment period[6].

6. Summary

This paper provides empirical evidence of asymmetric information in the market for residential property assessments. The results here provide statistically reliable evidence that property tax consultants, after controlling for the size and type of house as well as other factors, are assessed at somewhat lower values. The average reduction in assessment is estimated to be about 3.4%. This leads to an annual savings in taxes of about $115 for a median house, and $160 for an average house in the sample drawn. The reductions appear to be well within acceptable bounds for appraisal. The modest annual tax saving, generally less than $160, appears to be small enough to allow this discrepancy to persist. In other words, the average gain appears to be sufficiently small so that it may not worth many homeowners' time to learn about appraisal and the protest procedure for the small gain offered. Alternatively the homeowner could hire a property tax consultant, but after paying the consultant, the potential for gain would be low on average. The fact that property tax consultants exist demonstrates there is a demand for their services, which may be due the larger gains available when houses are excessively over-appraised, rather than from the gain one might expect from protesting the assessment on an average house.

Endnotes

1. There is a large body of literature incorporating many formal game theoretic extensions of the setup and discussion we present here, which includes issues associated with signaling, credibility, and bargaining (see for example, Fundenberg and Tirole (1991) or Gibbons (1992)).
2. From the Bexar County Appraisal District Assessment and Property Tax Notice. The Bexar County Appraisal District web site (www.bcad.org) provides information on the appraisal and protest process.
3. This information is posted at its website, http://www.talcb.state.tx.us.
4. An alternative method for our analysis would be to employ a "random effects" model (see Maddala, 1977, p. 326, or Greene 2003, p. 285). We initially evaluated both models. The Hausman test, reported for each model in Table 3 indicates that fixed effects model is preferred relative to the random effects model so for parsimony we only report our findings using the fixed effects model. The Breusch-Pagan Lagrange Multiplier test, also reported for each model in Table 3, indicates that either of the fixed or random effects model is preferred to the classical OLS model.
5. Tax rates vary by school district and also by municipality if not part of San Antonio.
6. One tax consultant firm has advertised a fixed fee of $300 for representing a residential property appeal (see www.propertytaxprotest.com). Anecdotal evidence from one of the authors found that a protest that resulted in a reduction one year was followed by an increased assessment the next year when none of the neighbors received increases. A further protest that year resulted in a reduction that was followed by another increase the next year that was then successfully protested again.

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Table 1
Definition of variables used in the estimation of the appraised value fixed effects regression models.

Variable	Description
Appraised Value	the assessed value for each house
Price per square foot	the assessed value divided by total square feet
Property Tax Consultant	a dummy variable indicating that the property is owned by a state licensed property tax consultant
Size	the size of the house in hundred square feet
Size squared	size squared
Age	the age of house in decades (year of assessment minus year built divided by ten).
Age squared	age squared
Total Rooms	the total number of rooms in the house
Fair Quality	a dummy variable indicating a house of fair to average condition/desirability/quality as defined by the appraisal district
Good Quality	a dummy variable indicating a house of good condition/desirability/quality as defined by the appraisal district, this variable is held out in the regression models
Excellent Quality	a dummy variable indicating a house of excellent condition/desirability/quality as defined by the appraisal district
Lot Size	the size of the lot measured in thousand square feet
Number of Stories	the number of stories in house as reported by the appraisal district
Year 2001	a dummy variable indicating the data was from year 2001 (year 2000 indicator is held out in the model)
Certified Value	a dummy variable indicating the assessed value is the value certified by the appraisal district (this variable is held out in the regression models)
Board Determined	a dummy variable indicating an appeal was made to the appraisal board and the assessed value was determined by the appraisal board
Board Dismissed	a dummy variable indicating an appeal to the appraisal board that ended in dismissal with the assessed value remaining the certified value
Location Group Identifier	a set of dummy variables indicating the group identifier (1-44) for the house (Because location group identifiers are not in themselves interesting, they are not reported in the results sections)

Table 2
Descriptive statistics for the full sample and subsamples of property tax consultant owned and nearest neighbors (non-property tax consultant owned) for data from Bexar County, Texas appraisal files for years 2000 and 2001.

Excluding houses with missing data, the final sample includes 503 residential property assessments during 2000 and 2001 of which 91 are for houses owned by a licensed property tax consultant. Univariate test statistics for the difference in characteristics between licensed property tax consultant owned and non-property tax consultant owned houses are presented. The t-statistics are calculated to test the null: mean(licensed property tax consultant owned) – mean(non-property tax consultant owned) = 0, under the assumption that the two subsamples are random and independently selected and the sampled population is approximately normal. The nonparametric Wilcoxon statistic is to test whether the licensed property consultant owned and non-property tax consultant owned houses have identical distributions, with the assumption that the two samples are random and independent. Statistics with significance at the 5% level are denoted with a *.

	Full Sample		property owned by neighbor		property owned by licensed tax consultant			Wilcoxon rank
Variable	Mean	Median	Mean	Median	Mean	Median	t-statistic	sum test
Appraised Value	160,802	116,000	162,824	118,300	151,651	109,000	-0.74	-0.83
Price per square foot 2001	66.528	59.091	66.127	59.77	62.815	55.43	-1.25	-2.03*
Property Tax Consultant	0.181	0.00	-	-	1.000	1.00	-	
Size	22.712	20.48	22.712	20.72	22.714	19.32	0.00	0.31
Size squared	590.978	419.43	592.226	429.32	585.331	373.26	-0.12	0.31
Age	2.087	1.60	2.089	1.60	2.078	1.60	-0.05	-0.02
Age squared	7.490	2.56	7.489	2.56	7.497	2.56	0.01	-0.02
Total Rooms	7.026	7.00	7.039	7.00	6.967	7.00	-0.37	-0.28
Fair Quality	0.408	0.00	0.403	0.00	0.429	0.00	0.45	0.45
Good Quality	0.402	0.00	0.408	0.00	0.374	0.00	-0.60	-0.60
Excellent Quality	0.191	0.00	0.189	0.00	0.198	0.00	0.19	0.19
Lot Size	11.125	9.71	11.031	9.60	11.552	9.96	0.84	0.57
Number of Stories	1.333	1.00	1.331	1.00	1.341	1.00	0.19	0.16
Year 2001	0.50	0.00	0.50	0.00	0.50	0.0	-0.09	-0.09
Certified Value	0.835	1.00	0.871	1.00	0.670	1.00	-4.77*	-4.67*
Board Determined	0.151	0.00	0.117	0.00	0.308	0.00	4.70*	4.60*
Board Dismissed	0.014	0.00	0.012	0.00	0.022	0.00	0.72	0.72
Location Group Identifier	21.99	21.00	21.86	22.00	22.02	21.00	0.17	0.11
Sample size	n=503		n=412		n=91			

Table 3
Fixed effects regression models of appraised values based on a sample from 2000 and 2001 of 503 property assessments. In the sample 91 observations are from drawn from licensed property tax consultants and 412 observations are drawn from nearest neighbor non-property tax consultants.
The dependent variable is the log of the assessed value for the sample of 503 property tax assessments from year 2000 and 2001. All regressions are estimated using fixed effects to account for the location of the properties. Coefficients estimates are presented in the table, with t-statistics reported underneath calculated using heteroskedasticity-robust Huebner/White standard errors. Statistics (two-tailed test) with significance at the 5% level are denoted with a *.

Independent variable	Model 1	Model 2	Model 3
Intercept	11.283	11.286	11.282
	189.93*	188.79*	188.63*
Property Tax Consultant	-0.034	-0.034	N/A
	-3.47*	-3.35*	N/A
Size	0.036	0.036	0.036
	10.34*	10.31*	10.36*
Size squared	-0.0001	-0.0001	-0.0001
	-2.50*	-2.47*	-2.57*
Age	-0.154	-0.154	-0.153
	-5.30*	-5.30*	-5.27*
Age squared	0.020	0.020	0.020
	5.98*	5.95*	5.94*
Total Rooms	-0.004	-0.004	-0.004
	-0.93	-0.97	-1.00
Fair Quality	-0.134	-0.134	-0.134
	-6.22*	-6.21*	-6.20*
Excellent Quality	0.007	0.007	0.009
	0.25	0.24	0.32
Lot size	0.006	0.006	0.006
	3.17*	3.19*	3.16*
Number of Stories	-0.040	-0.041	-0.040
	-3.02*	-3.03*	-2.99*
Year 2001	0.046	0.046	0.046
	6.13*	5.96*	5.95*
Board Determined		-0.003	0.009
		-0.23	0.64
Board Dismissed		0.039	0.032
		1.17	0.84
Interaction variable (Certified Value x Property Tax Consultant)			-0.025
			-2.16*
Interaction variable (Board Determined x Property Tax Consultant)			-0.062
			-2.97*
Interaction variable (Board Dismissed x Property Tax Consultant)			-0.005
			-0.07
F-statistic	103.480	87.570	76.140
Adjusted R-squared	0.796	0.795	0.796
Akaike's Information Criterion	-2.041	-2.036	-2.034
Ramesy RESET test: Ho: model has no omitted variables			
Calculated F-test	1.380	1.380	1.190
Prob > F	0.247	0.249	0.314
Breusch-Pagan Lagrangian multiplier effect: Ho: Var(ε) =0			
Calculated Chi-Square(1)	484.32	460.18	447.97
Prob > chi-square	0.000*	0.000*	0.000*
Hausman Specification test for random versus fixed effects			
Ho: No systematic differences in the coefficients			
Calculated Chi-Square(1)	2882.040	2249.120	2321.360
Prob > chi-square	0.000*	0.000*	0.000*