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Property Tax Assessment Quality: Willingness-to-Pay for Reduced Risk in a Lab Experiment

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Abstract: We conduct a laboratory experiment to explore the willingness to pay to improve the accuracy of property assessment and three related issues regarding attitudes toward these assessments and taxes. First, we explore individual willingness to pay to improve property assessment accuracy; a more accurate assessment is one with a smaller variance of potential assessments, i.e., a lower risk of an unknown property tax bill. We compare that to what individuals are willing to pay for a reduction in the variance of an equivalent private cost. Second, we explore the extent to which the willingness to pay to improve the accuracy of property assessments depends on whether the risk for other property owners also decreases. We find that subjects do not appear to distinguish between public and private sources of risk. They are responsive to the price of the improvement of property tax assessment accuracy. Finally, we use this result to estimate demand for reduced risk and find that subjects were not willing to pay to reduce the assessment variance to a level consistent with best practices in property tax assessment.

JEL Codes: H7, C91

Keywords: Property Tax Assessment; Experiment

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1. Introduction

One of the perennial difficulties with the property tax is accurately determining the market value of taxable property, i.e., the assessment. A common refrain among taxpayers is that the property tax is unfair, due in part to the lack of uniformity of property assessments among neighbors and over time.[1] Please note that in the paper we use the terms assessment quality, uniformity of assessment, accuracy of assessment, the variance of assessment, and assessment risk interchangeably. (See Exhibit A for an explanation of how the property tax works in the United States.)

Non-uniform assessments may leave taxpayers feeling cheated and treated unfairly; and, in addition, appealing an assessment can be a time consuming and risky proposition. Are taxpayers willing to reduce the risk associated with the uncertainty of their property tax bill by paying for more accurate assessments? Currently we do not know what, if anything, taxpayers are willing to pay for improved uniformity. As Sjoquist and Walker (1999) demonstrate, additional expenditures on property assessment can increase the accuracy of the assessment, measured in that case by the coefficient of dispersion of sales-assessment ratios. However, as far as we can determine, no one has attempted to measure the willingness to pay for improved property tax assessment accuracy, whether through a survey of homeowners, an empirical model, or a laboratory experiment. Such information is necessary to determine the optimal quality of assessments, i.e., the quality at which the marginal benefit equals the marginal cost.

In this paper we report on a laboratory experiment that investigates whether subjects are willing to pay for more accurate assessments. In our experiment the subjects do not encounter any of the terms listed in the first paragraph. The reduction in the range reduces the variance of

[1] See American Enterprise Institute (2015) for public opinion survey of attitude toward taxes.

the possible assessments they might face, i.e., it reduces the assessment risk. We test whether the subjects will pay more for reduced property assessment risk than for a reduction in risk that does not involve property taxes. We also explore whether the amount that subjects are willing to pay for more accurate assessment differs if the decision is made collectively. The experiment is the first and initial attempt to measure the willingness to pay for increased quality of property tax assessment. If, as we find, the willingness to pay for reduced assessment risk does not differ from the willingness to pay for reducing other risks, then one can apply more general measures of willingness to pay to reduce the risk of financial loss to the decision regarding optimal property tax assessment quality.

The rest of the paper proceeds as follows. In the next section we discuss the development of our hypotheses, while in the third section we present details of our experiment. The results of the experiment are presented in Section 4. A summary and conclusion section completes the paper.

2. Development of Experimental Hypotheses

There is a substantial literature that provides estimates of the willingness to pay to avoid risk; see for example, Pratt and Zeckhauser (1996) and Telser and Zweifel (2002) for empirical studies, and Holt and Laury (2002) and Dohmen et al (2011) for surveys of the substantial literature concerning experiments associated with risk taking. This existing literature finds that generally individuals are risk averse. In the context of our experiment, we therefore expect that individuals would be willing to pay to reduce the risk associated with their property tax bill. One way to decrease this risk is through higher quality assessments.[2]

[2] There are many dimensions of the quality of assessment, including the coefficient of dispersion, deviation of the mean or median sales-assessment ratio from the legal assessment ratio and how the sales-assessment ratio varies

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Paying for higher quality property tax assessment, i.e., for a smaller variance in the possible assessments, might be considered a form of insurance, although not insurance in the conventional sense. Insurance typically refers to a method for reducing or eliminating the risk of a large loss, for example, the loss of one's home. In that setting, insurance reduces the expected loss. In our setting, paying for higher quality property tax assessment reduces the variance of the possible property tax payments but does not reduce the expected value of the property tax payment. Ignoring an insurance company's transaction costs, the insurance premium equals the expected loss being insured. In our setting, the expected property tax payment does not change, so the payment for higher quality assessment is a payment to reduce just the variance of the property tax payment.

Property tax risk refers to the uncertainty a taxpayer has regarding the assessed value of the property, and thus of the property tax liability. But there are other possible costs associated with the property tax. There is the possible mental/emotional cost with paying a tax, a cost that has been explored in the tax aversion literature.[3] The property tax might also violate an individual's norms of social equity; "am I paying more (or less) than my neighbor?"[4] We hypothesize that these additional costs will increase an individual's willing to pay more to reduce the property tax risk, and thus that the individual will be willing to pay more to reduce property tax assessment risk than to reduce a more private risk not associated with property taxes. We

across property value. The latter is usually measured by the price related differential (PRD), which measures the extent to which higher or lower valued properties are over or under assessed on average.

[3] There is increasing empirical evidence of such an effect; see, for example, Hardisty, Johnson, and Weber (2010); Kirchler (1998); Schmölders (1959); Hill (2010)); McCaffrey and Baron (2004); Löfgren and Nordblom (2009); Sussman and Olivola (2011); Kallbekken, Kroll, and Cherry (2011); Ackermann, Fochmann, and Mihm (2013); and Blaufus and Möhlmann (2014).

[4] For a discussion of the complications of social equity, see Fehr and Schmidt (1999), Bolton and Ockenfels (2000), Engelmann and Strobel (2004) and Ackert, Martinez-Vazquez and Rider (2007), who conduct an experiment in which subjects made choices between the size of some payoff and equity and find a willingness to accept a smaller payoff for reduced payoff inequality.

explore the willingness to pay for higher quality property tax assessment (as measured by a reduction of the variance of the assessment) relative to reducing an equivalent risk in a non-property tax setting. We also explore how the willingness to pay for increased assessment quality varies with the institutional setting. To do this we conduct a lab experiment in which we consider four scenarios, which we briefly describe here, but explain in detail below. We consider a scenario in which the subject pays to reduce a non-property tax risk (Scenario A), scenarios in which the individual pays to reduce a property tax risk, paying either a private firm (Scenario B) or the government (Scenario C), and a scenario in which the government payment to reduce property tax risk is determined by a voting mechanism (Scenario D).[5] Our experiment is unique in that it involves the interaction of individual choices under risk within the context of taxation and public service provision, as well as a public mechanism for providing this service.

Based on the evidence in the tax aversion literature, we hypothesize that subjects will be willing to pay more for a reduction in the risk associated with property tax assessment than for risk associated with a non-property tax risk. We also hypothesize that subjects will pay less for reduced property tax risk if the payment goes to the government than to a private firm. Finally, due to potential inequity aversion, we hypothesize that subjects are willing to pay more when the decision is made by a median voting mechanism.

There are some limitations to our experiment. The experiment implicitly assumes that the subject-homeowner is concerned only with the current year's assessment. Suppose however that the homeowner believes that the distribution of assessments is uniformly distributed around the owner's perceived value of the home, and that the assessment in year $t+1$ is independent of the assessment in year t. In this case the homeowner will expect to pay, on average over time, the

[5] In our experiment subjects know the distribution of outcomes, and thus the experiment is one concerned with risk. Nonetheless, we use uncertainty as a synonym for risk.

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property taxes based on his perceived value. In this case, the homeowner may only be concerned with the swings in assessed value from year to year. Our experiment, however, concerns decision in one year, and thus one-time property tax payments.

The experiment doesn't fully match actual decisions that a taxpayer would make outside the lab. The structure of our experiment assumes that in Scenario B the subject must decide how much to pay prior to learning what his assessment is. That setting seems appropriate in Scenario C, i.e., one would pay the government to do a better job of assessing in general. But a taxpayer would normally pay a private vendor to appeal the assessment only after the taxpayer learned of the value of the assessment, and most likely only if he believed the assessment was too high. Our experiment does test whether or not the taxpayer considers improved assessment worthy of additional cost as a starting point. It would be of interest to conduct an experiment involving appeals of an assessment, particularly an experiment in which the subject had different information regarding his property value and that of his neighbors.

Finally, there is the obvious concern that our subjects are students and thus may not be familiar with property taxes. However, subjects do not need to understand how the property tax works to understand the consequences of variations in assessments. But if taxpayer irritation with property taxes comes from having paid them in the past, then our subjects will not have developed that attitude. Some of our subjects do own or have owned a home and thus have paid property taxes. We find no difference in responses between homeowners and the other subjects (ranked-sum $p = 0.121$). Furthermore, students do pay other taxes, and thus they could have an aversion to taxes to the extent the general public has an aversion to taxes.

3. Design of the Experiment

The experiment involves subjects making a series of decisions.[6] In each decision, they are presented with an endowment of $4,500, a set of possible losses that are labeled differently in Scenario A and the other three scenarios, and the opportunity to make a costly choice that can influence the set of possible losses. The units used are experimental dollars, and all conversions to actual earnings are shown to subjects while they are making their decisions.

In each case, the original set of possible losses includes some mean loss, and then symmetrical increases and decreases from the mean loss at 10 fixed intervals in each direction. For example, in one case, the mean might be $3,000, and the interval might be $100, so that possible outcomes include ($2000, $2100, … , $2900, $3000, $3100, ... , $4000). These twenty-one outcomes are equiprobable. The mean and the intervals change from round to round, but the original set always includes 21 possible outcomes. Note that these are all losses.[7]

We introduce four treatments (Scenarios A – D). In each case, subjects are presented with an opportunity to make a choice to reduce the set of possible losses. The nature of the choices in Scenarios A, B, and C are equivalent, although the labeling differs. In these three scenarios, subjects can pay to reduce the set of possible losses by removing the most expensive and least expensive losses. For ease of exposition, we refer to this payment as the price. If they pay this price once, they remove the two outlying outcomes, which decreases the range of possible outcomes and increases the probability of realizing each remaining outcome. In any round they can choose to incur multiples of this price if they prefer, reducing the range of possible outcomes further. The choice subjects face, then, is choosing one of a set of 11 lotteries at their respective

[6] Subject instructions for Scenario A are available in Appendix A; the instructions for the other scenarios are similar and are available upon request.
[7] The endowment ensures that subjects cannot lose money overall, but the uncertainty is framed as an uncertain loss rather than the mathematically equivalent uncertain gain within a particular round.

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prices, varying from the original set of 21 possible outcomes to a certain outcome of the mean loss.

Once the subject has chosen how much to reduce the range of possible losses, one of the remaining losses is selected by the computer with equal probability. Note that, while the expected realization does not change (it is always the mean loss), the net realization (inclusive of the payment for the reduction in the range of possible outcomes) is decreasing in expectation as the subjects reduce the riskiness of the lottery. Subjects thus face a tradeoff in that reducing risk also reduces the net expected payoff.

An alternative to the decisions made here would have been to allow subjects to choose whether to reduce the losses (costs or taxes) at one or both ends of the distribution. While perhaps more realistic, such choice options would have required specifying different prices for each of the 21 options, significantly complicating the experiment and analysis.

In Scenario D, subjects use a median-voter mechanism to collectively decide on the payment to incur and the set of possible taxes they will face. Subjects are in groups of 5, and each subject chooses his preferred amount of risk reduction to propose given the price of reducing risk. The median of the 5 choices is implemented, and all subjects in the group each pay that price (they do not split it) and face the same resulting set of possible assessments and taxes. Note that the range of possible assessments will be the same for all 5 members of the group, but the actual assessments will likely differ since the actual assessment is separately selected at random for each subject. As previously discussed, subjects in this treatment may face considerations of their own private risk, attitudes toward taxation, as well as equity concerns. Note that equity in this setting refers to horizontal equity and not vertical equity since the subject is told that all neighbors have the same value home and same income.

Because framing is critical in our experiment, in each scenario subjects are informed that they are members of a group (owners of homes in a neighborhood). Only in Scenario D does the group setting materially affect their outcomes, but to identify the impact of the group choice mechanism separately from the group framing, they are framed as being members of a group in each scenario.

The 4 scenarios differ in their framing. The framing of the scenarios is as follows:

Scenario A – The subject makes a decision of how much to pay a private firm to take steps that will reduce the range of possible damages on the subjects' hypothetical house. The payment and effect of narrowing the potential damages is shown on the screen using the mouse to move a slider.

Scenario B – The subject chooses how much to pay a private firm to provide the government with additional information about his home, like the interior space, the age of the home, etc. This information will help the government determine the value of the home and will reduce the range of possible values that might be assigned to the home, and consequently, will reduce the range of possible property taxes that might be levied.

Scenario C – The subject chooses how much to pay as an additional tax to the government, which is referred to as the Government Information Tax, to provide the government with additional resources to collect more detailed information about his home, like the interior space, the age of the home, etc.[8] This information will help the government determine the value of the home and will reduce the range of possible values that might be assigned to the home, and consequently, will reduce the range of possible property taxes that might be levied.[9]

Scenario D – The subject can propose an amount that he and each of his four "neighbors" pay as an additional tax to the government, which is referred to as the Government Information Tax, to provide the government with additional resources to collect information about the homes in the neighborhood, like the interior space, the age of the home, etc. This information will reduce the range of possible values that might be assigned to each of the 5 homes in the neighborhood. This also reduces the range of possible property taxes the subject and each neighbor would have to pay.

[8] While in the real world this tax could be part of the property tax, and thus subject to the variance of the assessment, the experiment treats it as a separate and fixed tax payment. Note that the improvement in assessment is a fully congested service, so the cost of reducing the variance of 4 properties equals 4 times the cost of that reduction for one property.

[9] Note that for a given price or tax, the reduction in the range of assessed values in scenarios B and C are the same. Thus, there is no difference in the efficiency of the government and the private firm in providing information.

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The differences between scenarios allows us to observe willingness to pay to reduce risk and to improve assessment accuracy in such a way that we can identify tax aversion, if it is present. The first two scenarios are decisions regarding risk taking and are designed so that a payment has the same effect on risk in both scenarios. As suggested above the willingness to pay to avoid a loss may differ if the loss is a property tax. Thus, we run Scenario A to give a benchmark for an individual's willingness to reduce the uncertainty of a private loss. (Scenario A allows us to establish the subjects' attitudes toward risk in a purely non-government setting. Note that our treatment of risk is quite novel in that the subjects do not make choices over different outcomes, but rather choose how much to pay to reduce the variance of the possible outcome.[10]) Comparing the outcomes of Scenarios A and B allows us to see whether there is a greater willingness to pay to reduce property tax risk.

In Scenarios A and B the payments to reduce the variance are made to a private firm. In Scenario C the payment to reduce assessment variance is an individual tax paid to the government. Comparing Scenarios B and C allows us to further explore whether the subjects treat a tax payment differently than a payment to a private firm.

Finally, Scenario D allows us to explore whether the willingness to pay to reduce property tax risk differs if the payment decision is made collectively. In Scenario D, in choosing the amount to pay, the subject should assume, based on the construction of the experiment, that the amount chosen will determine the subject's assessment variance as well as that of his neighbors. The subject's payment does not affect his neighbors' assessment directly, only through the mandatory payment that all neighbors pay and the resulting reduction in assessment

[10] Our experiment is similar to a multiple price list as in Holt and Laury (2002), but in this case subjects pay to make a selection further down the list, and the framing is quite different.

variance (i.e., improve accuracy). The cost of reducing the variance of the assessment for all subjects equals the number of subjects times the cost of reducing the variance for one subject. Thus, this is not a decision regarding a public good or positive spillover. Rather, it concerns a mandated reduction in the assessment variance of all neighbors. If the homeowner's utility is not a function of the property tax (or more generally the utility) of others, then the decisions in Scenarios C and D should be the same. But, if the subject's utility is a function of both his and his neighbors' property tax, then the outcomes of Scenarios C and D could differ.

Our experiment involves equity in a way that differs from how equity is typically treated in that the subject pays for a reduction in the variance of the property tax and doesn't know ex ante how the property tax payments will differ across individuals. The subject only knows that the variance of the taxes will be smaller, and thus the expected differences in the subjects' taxes will be smaller.

In each treatment, subjects face 15 such decisions, with 5 sets of 3 parameters (mean home value, initial range of possible losses or taxes, and the price of the reduction in uncertainty) that are randomly re-ordered in three sets to check for consistency of choices.[11] For each of the treatments, the price required to reduce the range of damages or taxes was set so that a graph of the tradeoff between lower risk (as measured by the variance) and expected return (as measured by the mean less the payment) was concave. In this setting a subject who is risk neutral or who prefers risk would choose not to pay anything, since that would maximize his expected value. For risk averse subjects, this condition theoretically ensures a unique interior utility maximizing choice of payment, assuming concave indifference curves.

[11] While the order of parameters was random, once randomized, it was fixed across subjects so each subject faces the exact same sequence of choices. This was done to ensure comparability across subjects without concern that the order of the presentation of parameter sets would be a source of variation.

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The instructions were read to the entire group of subjects and questions were answered privately. The experiment is a mixed within- and across-subject design: each subject pool participates in two scenarios.[12] An example decision is presented to the subjects as part of the instructions before each treatment begins. Each subject is placed anonymously into a group with 4 other subjects, then each subject makes a choice. After each choice, subjects are shown the loss that was randomly selected for that round, and then subjects are randomly rearranged into a new group with 4 other subjects.[13] They continue for 15 rounds of the first scenario (which could be A, B, C, or D). New instructions are then reviewed (for one of the two scenarios not used in the first 15 rounds), and again, they make 15 choices, with random regrouping after each choice, for a second scenario. In this way, subjects make thirty decisions. Subjects do not see anyone else's choices. At the end of these thirty decisions, one is randomly selected for payment. Note that we do not have an equal number of pairs of scenarios.

4. **Results of the Experiments**

The experiments were run at the Andrew Young School's Experimental Economics Center with 135 student subjects.[14] Each session was designed to last no more than 90 minutes

[12] This allows us to conduct both within-subject tests of treatment effects (among those subjects who faced both of two particular scenarios) as well as across-subject tests of treatment effects.

[13] The random-rematching protocol is designed to prevent social influence from directly spilling over to future decisions in Scenario D (e.g., there is no incentive for direct conditional cooperation or reciprocity). This allows us to treat individual subjects as the unit of analysis. In Scenarios A, B, and C, subjects face individual choice decisions, and so the random rematching should in principle have no effect. The protocol is maintained across all four scenarios to maintain the framing of "a house in a neighborhood" and to prevent the rematching from being a potential confounding influence.

[14] Sample sizes provide sufficient power to test our main hypotheses. For the Mann-Whitney tests reported below, the required sample size to find an effect size of $d = 0.5$ (medium effect) with power 0.8 is combined $n = 106$ (our sample size is 135). For the matched-pair Wilcoxon tests reported, the required sample size is $n = 35$, our sample size for our main tests. For the other two Wilcoxon tests, where $n = 15$, the power is sufficient to detect a large difference ($d = 0.8$). For remaining tests, the power is sufficient at any meaningful effect size.

with 15 or 20 subjects per session, including a brief questionnaire at the end.[15] Earnings for the experiments averaged US$32.05, with a minimum of US$15.80 and a maximum of US$44.00. We treat individual subjects as the unit of analysis.

As discussed above, in each round subjects faced a choice: they could reduce the risk in a risky proposition by selecting between 0 and 10 fixed increments ("ticks") of payment to incur. Each tick reduces the range of possible outcomes by 10 percent of the initial range, so zero ticks implies no reduction in risk and 10 ticks provides a certainty payoff. The number of ticks a subject chooses is our outcome variable. We varied a number of things experimentally: the scenarios as discussed above, the price of a tick, as well as the risky proposition subjects faced. Subjects faced repeated choices over five fixed sets of parameters, presented in Table 1 in experimental dollars (100 experimental dollars ($) = US$1).

These parameters were chosen to allow subjects to reveal a wide range of attitudes toward risk. In parameter set 1, for example, we can see that the expected property tax is 1% of the expected home value, $200,000, for $2,000 in property tax. This implies an expected gross payoff for the round of ($4,500 – $2,000), or $2,500 (the endowment of $4,500 minus property tax, before netting out the price of ticks). This is, however, a risky proposition. When presented, the possible range of payoffs could fall anywhere from $1,500 (if the home is assessed at its maximum value) to $3,500 (if the home is assessed at its minimum value).

We varied the cost of risk reduction across parameter sets. Column 7 of Table 1 presents the varying prices of a tick, defined above. In parameter set 1, subjects could guarantee a certainty outcome of a $200,000 assessment by selecting 10 ticks at a total price paid of $200 (10

[15] Subjects completed a questionnaire covering basic demographics and attitude toward government and taxes – these responses showed no correlation with decision-making behavior in our experiment and so we do not report any results from the questionnaire.

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ticks x $20 per tick); this would yield net earnings of $2,300 (= $4,500 (endowment) - $2,000 (property tax) - $200 (payment)). In US dollars, this would be US$23.00 with certainty. Subjects then can choose any of a series of intermediate lotteries between US$23.00 for sure to a set of 21 equiprobable outcomes between US$15.00 and US$35.00. Similar logic applies to each parameter set. Each subject faced each parameter set six times across two scenarios.

Subjects participated actively throughout, with about a third of choices selecting no price paid (33.06%), 6.49% choosing 10 ticks (i.e., for a certain outcome), and the remaining 60.44% making an interior choice. Of the 135 subjects, 2 subjects chose to pay zero throughout the experiment, and 11 (including those 2) chose less than an average of 1 tick per period. These results are consistent with the premise that most, but not all, subjects are sufficiently risk averse that they would pay to reduce the variance of a loss.

Our top line results are straightforward: we find that subject behavior appears broadly responsive to incentives, but subjects do not respond to the framing in the scenarios. Our results are consistent with the notion that subjects treat uncertainty regarding property assessments the same as they do private sources of uncertain costs (comparing Scenarios A and B). A comparison of Scenarios B and C finds no evidence of expressed tax aversion. Figure 1 presents within-subject average ticks in a box and whisker plot.[16] There does not appear to be an obvious difference in behavior across scenarios; we explore this more fully below. Subjects generally appear to make interior choices.

Subjects participated in two scenarios in succession and so our first consideration is whether there are order effects. We tested whether subject behavior was different in a given scenario when it was the first scenario experienced, or the second. In only one case do we find

[16] There is one outlier in Scenario C, noted by the diamond in Figure 2. The results do not change with the exclusion of this subject.

even marginally significant order effects (Scenario A, Wilcoxon within-subject test p = 0.069).[17] In our regressions (reported below), the order variable had no significant effect on subject choices. We report results using data pooled across all subject choices, but the qualitative results are the same if we restrict ourselves only to first-scenario data.[18]

Because subjects participated in multiple scenarios, we can conduct within-subject tests as well as across-subject tests. We compare the average number of ticks chosen within a scenario with the average number of ticks selected in a different scenario. Because all other variables are unchanged across scenarios, we can isolate the relative effects of scenarios, if any. To examine our hypotheses, we compare the within-subject average number of ticks across different scenarios using Mann-Whitney and Wilcoxon nonparametric tests as appropriate. The results are presented in Table 2.

We first consider tests for evidence of differences in willingness to pay across scenarios; i.e., testing whether the willingness to pay differs for a reduction in the property tax assessment risk and the non-tax risk. We find no evidence of difference in willingness to pay using the across-subjects specification (Panel I of Table 2) or the within-subject specification (Panel II of Table 2). In Panel I, the across-subject specification, there are no statistically significant differences in subject responses across scenarios. In Panel II, the within-subject specification, we see that subjects did not pay a statistically significant larger amount in Scenarios B and C as compared to Scenario A, or between Scenarios B and C. In the one case in which there is a significant difference in the number of ticks (Scenarios A and B), it is the case that more subjects

[17] This is one indication that subject behavior does not apparently change over time within the experiment. In addition, including period number as a regressor yields insignificant results across all tested specifications. It does not appear that subject learning affects the results reported here. This is contrary to the findings of Blaufus and Möhlmann (2014) that subjects exhibited tax aversion at first, which subsequently disappeared.
[18] Note that this can only apply to the across-subjects tests, as the within-subjects test require repeated measurements.

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chose more ticks in the non-tax scenario (Scenario A) than the tax scenario (Scenario B)—that is, they paid more to reduce the private loss than they did to avoid the property tax.

Subjects do not appear to behave differently when their choices affect themselves and their neighbors (Scenario C vs. D). None of the differences between Scenario C and Scenario D is statistically significant in either Panel I or II in Table 2.

The above tests may fail to capture an effect due to the variation induced by the changing parameters. To isolate the effects of the parameters and the scenarios separately, we use a fixed-effects regression model (equation 1)[19]:

$$x_{it} = \alpha_i + \Sigma B_k d_{Scenario} + \Sigma \Gamma_m d_{paramset} + u_{it} \quad [1]$$

In the above model, x_{it} is the number of ticks chosen by subject *i* in decision round *t*, α_i is an individual fixed effect, and u_{it} is a decision-round and individual-specific error term. We include sets of dummy variables for the scenarios as well as for the treatment. Alternatively, we can include the varying parameters separately rather than as dummy variables (equation 2):

$$x_{it} = \alpha_i + \Sigma B_k d_{Scenario} + \gamma_1(mean\ home\ value) + \gamma_2(range) + \gamma_3(tick\ cost) + u_{it} \quad [2]$$

In this model, we capture not only differences between the parameter sets, but also the sources of those differences. The estimated parameters for these models are presented in Table 3.[20]

We find that individuals are generally willing to pay to improve the accuracy of property tax assessments, but that they are not willing to pay more to reduce uncertainty of property assessments than they would for an analogous private source of uncertainty. In the bottom panel

[19] In models not presented here we also considered random-effects error specifications as well as RE tobit models (to account for censoring) analogous to both those presented here. In all cases, results are qualitatively identical and quantitatively very close to those reported. We report the FE results for their ease of interpretation. We do not present any results on effects of demographic variables, as these did not reveal anything of interest, and are time-invariant and fall out with the fixed effect.

[20] In specifications not shown, we included interactions as well as the period/round, but these were never statistically significant.

of Table 3, we report tests of equality of the coefficients on $d_{Scenario}$, the scenario dummy variables using our first regression specification (both models yield the same qualitative results). In only one case was the difference between coefficients statistically significant: Scenario B vs. C. The direction here implies that subjects pay more to reduce the variance of a loss when that payment goes to a tax than when it goes to a private firm.

Taken with our other test results, the evidence implies that individuals do not treat property assessments differently than other sources of uncertain costs. Our subjects prefer to pay for neither, however: in each round, anywhere between 10.37% and 58.15% of subjects chose zero ticks. These percentages are negatively correlated with the range of the possible losses or taxes for the round ($r = -0.959$). Subjects did not make any payment if the initial risk was small. In addition, our regression results above show that the number of ticks chosen is positively associated with the range of potential losses and negatively associated with the price of a tick.

Given the consistency of subject behavior across scenarios, we can pool subject decisions across scenarios to estimate the demand for reduced variance of the cost, be it damage to one's property or property tax assessments. To identify a demand relationship, we need observed data on price-quantity pairs and exogenous variation on price such that we can be certain that the observed quantity decisions fall on the demand curve. In this experiment, what subjects are purchasing is reduced variance (or risk), which we quantify as "reduced range of possible property damage or property tax liability". This means that we can convert their decisions to "dollars of range reduction". The price variable will then be "the price of a dollar of range reduction." We can reframe their decision as one in which they are presented with a price per dollar of range reduction, and they respond with a quantity of dollars of range reduction they would like to purchase at the posted price.

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This allows us to estimate a revealed demand curve for risk reduction. In this section, for ease of interpretation, we will convert units to US$. We can establish the relationship between the price of a US$1 range reduction and the number of US$1 range reductions chosen, and using data pooled over all three scenarios we get the demand curve shown in Figure 2. In this figure, each point is an average choice by a particular subject across encounters with a particular parameter set. Each subject thus has the average of six of their choices as a point at each of the relevant prices. Within our experimental parameters, the price of reducing the range of possible costs by US$1 varied from US$0.10 to US$0.375. At the lowest price, the average level of range reduction was US$10.44. At the highest price, the average level of range reduction was US$0.79. Overall, the estimated demand curve was $Q = 9.487 - 21.715P$ (robust standard errors are 0.213 for the intercept term and 0.808 for the slope term), and at the mean price and quantity, the price elasticity of demand was -1.095.[21] Therefore, we do find that subjects respond to price incentives as we would expect and are willing to pay to reduce the variance of the cost.

Conclusions extended outside of the experimental environment should be made with caution for reasons discussed above, but we can nonetheless extrapolate some of these results to provide some ballpark estimates of willingness to pay for reduced risk. The minimum and maximum an average subject spent on risk reduction was $29.67 (in experimental dollars) in parameter set 5 and $134.60 in parameter set 3. This represented 0.66% of endowment to 2.99% of endowment for the reduction of risk. As a proportion of the property value, these choices ranged from 0.0396% of the mean home value (again in parameter set 5) to 0.1008% of the mean home value (in parameter set 4).

[21] We also considered log-linear, linear-log, and log-log specifications of the estimated demand curve here. All are similar in terms of fit, and a linear estimate has advantages of simplicity of assumptions and ease of interpretation.

In order to relate the change in the range of assessments to a more meaningful measure of property tax assessment quality, we consider the relationship between our measures of variability in the experimental setting, and the coefficient of dispersion (COD) in assessed property values. Table 4 presents the value of the COD for the first parameter set. The International Association of Assessing Officers (IAAO) suggests that for property tax assessments of single-family residential properties the acceptable value of the coefficient of dispersion is between 5.0 percent and 15.0 percent.[22] To get to a COD of less than 15 percent, subjects would have had to pay 100 experimental dollars (5 ticks × \$20 per tick).

The average implied COD selected by subjects was 18.92% (standard deviation of 5.3%). Subjects had a wide range in the COD they implicitly selected, with the first quartile preferred COD being 11.85%, the median at 16.15%, and the third quartile at 22.88%. While slightly higher than that recommended by the IAAO, subjects' choices display a great amount of variation and are responsive to prices.

Finally, given the amount of experimental control available, we take advantage of our ability to estimate parameters for commonly used models of risk preferences. By observing choices among the set of available lotteries in each round, we can examine subject behavior for consistency. First, we convert each choice to an implied level of constant relative risk aversion (CRRA). We do this as simply as possible. For each choice, there is a minimum and maximum value of the coefficient of relative risk aversion (ρ) that renders that choice preferable to the other available choices. For each choice, we assign the midpoint of the minimum and maximum values as their revealed value of ρ for the round.[23] The mean estimated value of ρ was 2.02.

[22] The COD is a standard descriptive measure of the quality of the assessment process (Gerau and Plourde 1976). The larger the COD, the larger the distribution of assessed values are around the median.

[23] Choices have to be made here about the minimum and maximum values of the ρ for corner decisions of no and full risk reduction. The results here use 0 as the minimum value and 18 as the maximum value (18 is the maximum

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Individual subjects' value of ρ fell within an estimated range of (0.043, 8.948). The 95% confidence interval estimate of the mean value of ρ across all subjects and decisions in our data was (1.747, 2.673).

Our results are similar to estimates reported in the literature but are overall inconsistent with these commonly used models of risk preference.[24] Harrison et al. (2006), for example, found similar estimates of the coefficient of relative risk aversion. They also found intertemporal stability of risk preference with repeated measures. This is not inconsistent with our results, as their subjects participated in many fewer tasks than did ours, and they repeated the same task with multiple months between measurements. Table 5 shows the mean values of ρ for each round as well as p-values from statistical tests of the equality of ρ across parameter sets. In most cases, we reject the null that the revealed coefficient is consistent across parameter sets. These variations from period to period are consistent within a given parameter set and are statistically significantly different across parameter sets. Our results appear to argue that the CRRA model does not explain our subjects' behavior well. In addition, repeating this analysis with a constant absolute risk aversion (CARA) utility function specification yields similar results.

5. Summary and Conclusion

Using a laboratory experiment we explore individual willingness to pay for improvements in the quality of property assessments. In addition, we examine whether individuals treat property assessments different from private sources of risk, and whether making

value internal to the choices under the specified parameter sets, and so it is the lowest value that would imply always choosing full investment in every decision). A straightforward robustness test is to exclude any subject's choices in parameter sets where a choice of 0 or 10 (no or full investment) was selected. Doing so reinforces the results reported here.

[24] We tested for correlations between ρ and many of the demographics from the questionnaire and interestingly found the correlations are largely zero.

a choice collectively affects behavior. We consider four scenarios that differ in the framing of a cost (property damage versus property taxes) and payment (to a private firm versus to the government) to reduce the cost, and in whether the choice affects only the individual or a group.

The amount that an individual is willing to pay to reduce the variance of property taxes (i.e., to improve assessment quality to reduce risk) or to reduce the risk of a private cost depends on the price of the improvement and the size of the pre-reduction variance of the cost. However, contrary to our expectations, we find that individuals treat the risk of private losses and property tax risk the same. Furthermore, we find that subjects do not behave differently when faced with a choice that affects others as well as themselves.

Subjects in this experiment are risk-averse in general, with levels of risk aversion consistent with those estimates reported in the literature. Their behavior is not consistent with commonly used models of utility across the parameter space we explore within our experiment. Behavior is nonetheless consistent with the law of demand, and we estimate the demand for improved property tax assessments. We also find that subjects are willing to pay to reduce the coefficient of dispersion of property assessments but do not reduce it to a level consistent with best practices in property tax assessment.

Our results argue that treating public sources of risk as different from other risks may be unwarranted. This suggests that future research should focus more specifically on other attendant concerns regarding the aversion to property taxes found in surveys. The primary motivation of subjects within this study appears to be a desire to efficiently and effectively reduce risk, and future research can improve on these results by increasing the connection between the laboratory and property taxation outside the lab.

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To isolate risky choice and property tax assessment per se, we considered behavior with very little social interaction. The existing literature argues that equity concerns may be significant in determining attitudes toward property taxation. Expanding the approach here to determine how equity might affect people's choices would be informative.

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Exhibit A: The Property Tax in the United States

In the United States, the property tax is a very important source of revenue for local governments, particularly for school districts. Property tax revenue is 72 percent of local government taxes and is 36 percent to total revenue for school districts.

Property tax liability in the United States equals the assessed value of the property, less any partial exemptions, times the property tax rate. The assessed value is some percentage of the property's estimated market value. (The percentage is the same in any jurisdiction within a state but varies across states.) The government's tax assessor is responsible for developing an estimate of the market value of each property each year, where the market value is defined as the price that the property should sell for in an open market between a willing buyer and willing seller.

The assessor relies on the sales prices of recently sold properties that are similar to the property under consideration. Many assessors use computer programs that use the characteristic of recently sold properties and the sale price to develop the estimated value of other properties. The more information that the assessor has about the characteristics of properties, the more likely the estimated value of the property will be the price the property would sell for, although that price is unknown until the property sells.

The assessor is estimating what the property should sell for, but the owner has her own idea of what the property could sell for. If she believes the property is worth less than the assessor's estimated value, she can appeal to a governmental board set up for that purpose and make the case for why her estimated value is a better than the assessor's estimate. Other than the owner's out of pocket expense in developing her case, the appeal is free. If the owner is not satisfied by the ruling of the board, she can appeal to the court system, although that step is time consuming and costly. The ruling of the court is final. The tax is paid by the property owner to her local revenue administration.

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Figure 1. Box and whisker plot of average within-subject number of ticks by Scenario

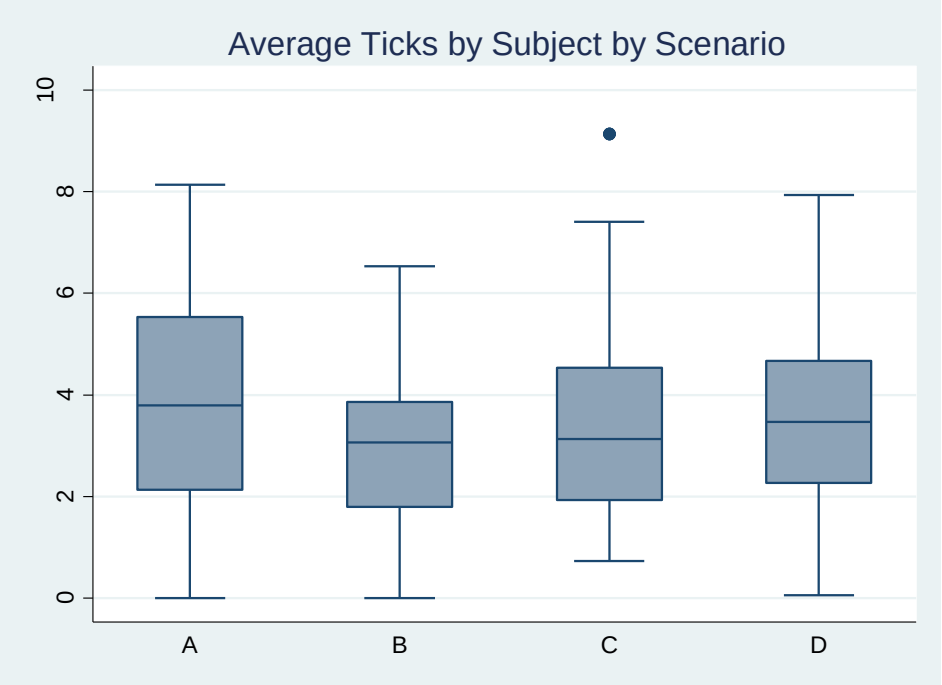

Figure 2. Revealed demand for risk reduction

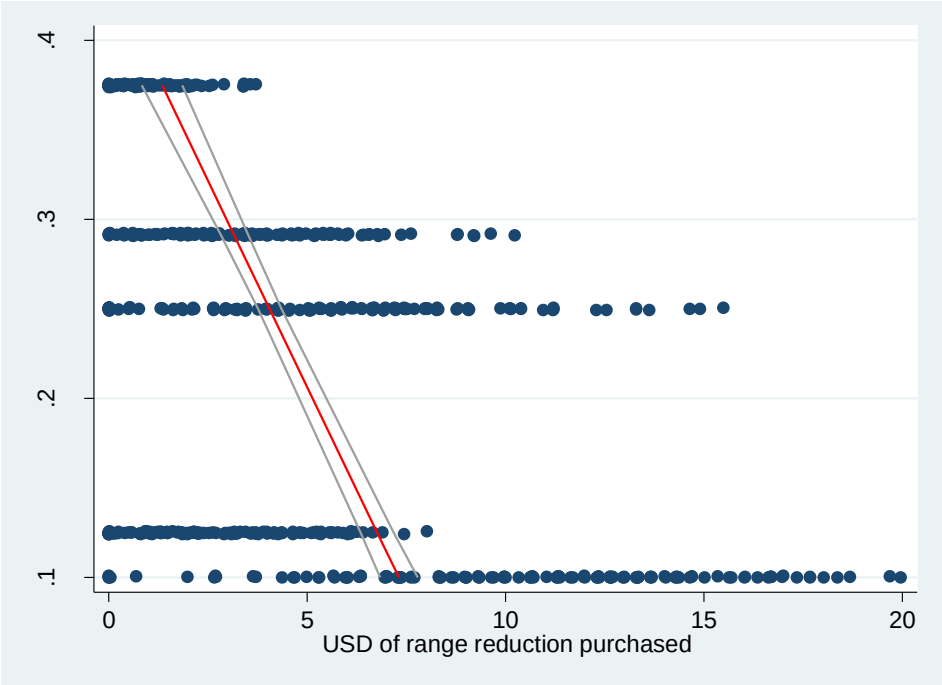

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Table 1. Parameter Sets used in this experiment

Parameter Set	Endowment	Mean home value	Minimum home value	Maximum home value	Property tax rate	Price of a tick, i.e., range reduction equal to 10 percent of initial range	Average Ticks (S.D.) (n = 270)
1	$4,500	$200,000	$100,000	$300,000	1%	$20	5.22 (2.32)
2	$4,500	$50,000	$10,000	$90,000	1%	$10	3.21 (2.58)
3	$4,500	$150,000	$70,000	$230,000	1%	$40	3.37 (2.33)
4	$4,500	$100,000	$40,000	$160,000	1%	$35	2.88 (1.93)
5	$4,500	$75,000	$55,000	$95,000	1%	$15	1.98 (2.21)

Table 2. Mann-Whitney and Wilcoxon tests of equality of across scenarios

Panel I. Across Subjects

Scenarios	N	Mean ticks (S.E.)	P-value		
			vs. B	vs. C	vs. D
A	65	3.416 (0.247)	0.270	0.923	
B	70	3.062 (0.230)		0.223	
C	65	3.570 (0.260)			0.604
D	70	3.301 (0.224)			

Panel II. Within Subjects

Scenarios Pairs	N	Differences in ticks			P-value
		Positive	Negative	Tie	
A vs. B	35	25	9	1	0.010
A vs. C	15	6	7	2	0.319
B vs. C	15	6	9	9	0.910
C vs. D	35	21	14	0	0.265

Note: Because our primary hypotheses involve Scenarios A vs. B and Scenarios C vs. D, we have larger samples of subjects facing these scenarios to increase the power of the associated within-sample tests. We are testing the difference in ticks between pairs of scenarios

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Table 3. Regression results: # of ticks, estimated with subject-level fixed effects

	(1)	(2)
Variable		
Scenario B	-0.190	-0.190
	(0.176)	(0.176)
Scenario C	0.168	0.168
	(0.197)	(0.197)
Scenario D	0.057	0.057
	(0.228)	(0.228)
Parameter Set 2	-2.009***	
	(0.222)	
Parameter Set 3	-1.856***	
	(0.165)	
Parameter Set 4	-2.340***	
	(0.168)	
Parameter Set 5	-3.243***	
	(0.238)	
Mean Home Value		-0.002
		(0.003)
Beginning Range		0.024***
		(0.003)
Tick Cost		-0.049***
		(0.005)
Constant	5.215***	1.944***
	(0.198)	(0.223)
Observations	4050	4050
N	135	135
Overall R^2	0.111	0.111

Tests of Coefficient Differences

Coefficient Pairs	Probability
β_A vs. β_B	0.283
β_A vs. β_C	0.394
β_B vs. β_C	0.038
β_C vs. β_D	0.545

Robust standard errors clustered on subject in parentheses; ***: $p < 0.01$

Table 4. Coefficient of Dispersion for Parameter Set 1

# of Ticks	Minimum Value (in 1,000s)	Maximum Value (in 1,000s)	Coefficient of Dispersion (%)
0	100	300	26.19
1	110	290	23.68
2	120	280	21.18
3	130	270	22.00
4	140	260	16.15
5	150	250	13.60
6	160	240	11.11
7	170	230	8.57
8	180	220	6.00
9	190	210	3.33
10	200	200	0.00

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Table 4. Mean implied CRRA by parameter set, p-values for differences in implied CRRA across parameter sets

Parameter set	Mean implied ρ	Robust Std. Error	vs 2	vs 3	vs 4	vs 5
1	1.467	0.127	0.011	0.002	0.003	0.000
2	2.046	0.248		0.480	0.857	0.019
3	1.940	0.150			0.247	0.003
4	2.145	0.185				0.014
5	2.667	0.272				

n = 135

Appendix A. Subject Instructions

General Instructions

Introduction

Welcome and thank you for participating!

Before we begin, please turn off and store all of your electronic devices. Thank you.

This is a study of economic decision making. Your participation is voluntary. You have the opportunity to make money in this experiment. The amount of money you can earn today will depend on your decisions, so please read carefully.

Random Group Assignments and Anonymity

Each person will be randomly matched with 4 other people to form a 5-person group. No one will learn the identity of the members of his/her group. After each round, all the groups will be rearranged and you will be randomly matched in a new group of 5 people (you and 4 others).

Privacy

As a member of a group you will be completely anonymous. No participant will be able to link your choices to your identity. Please do not reveal your identity to anyone. Do not communicate with the other participants during the experiment.

Payment

Your total payment will consist of a participation fee of $5 and the amount you earn in one of the rounds of the experiment. The earnings during the experiment will be in "experimental dollars", which will be converted to U.S. dollars at the rate displayed on your screen. You will be paid in U.S. currency privately at the end of the session.

You will participate in a number of rounds in today's experiment. In each round you will be required to make a decision, and in each round, you will be assigned an INDIVIDUAL FUND in which your earnings for the round will be placed. The decision for a given round will lead to

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consequences that change the amount of money in your INDIVIDUAL FUND. At the end of the experiment one of the rounds will be randomly chosen as the one that determines your earnings. The experimental dollars in your INDIVIDUAL FUND for that round will be converted to U.S. dollars and combined with your participation fee to determine your payment. You should think very carefully about each decision as you do not know which decision will be chosen for payment. We will discuss the decisions you will be making in a moment.

Time

Today's session will consist of the experiment itself and a brief questionnaire. The whole session should take no more than 2 hours.

Final notes

Please, read all the instructions carefully. You are welcome to ask questions at any point. Just raise your hand and an experimenter will come to assist you in private. Once you have finished reading the instructions please put the instructions face down on your workstation and the experiment will continue as soon as everyone is finished reading the instructions.

Instructions for the Next Set of Rounds *[Scenario A]*

You will now be randomly assigned by the computer into groups of 5 people.

Remember, you will be randomly assigned into new groups of 5 people after each round.

In each round, you and the other members of your group own homes in a neighborhood. Living in that home generates benefits for you, which can be measured in dollars, and which will be shown to you on the screen. This amount will be deposited into your INDIVIDUAL FUND for the round.

Unfortunately, within each round, an event will occur that will cause damage to your home and you will have to pay to repair those damages. There will be exactly one such event in each round.

For example, the tree in the front yard could fall and do major damage, requiring a very costly repair, or a single limb might fall off the tree and do a small amount of damage, requiring little repair. You expect that it will cost some amount of money to repair the damages in a given round. The actual cost of repairing the damages can fall anywhere within a range of possible values. The range of possible damages for you and your neighbors is identical, although the homes look different, and the damages that occur may differ from one home to the next.

In each round, you will be told the range of possible costs necessary to repair damages to the home.

You can pay a firm to take steps that will reduce the range of possible damages for which you would have to pay for repairs. For example, before any event, the firm might come out to your house and inspect the tree and take steps to ensure that neither it nor a limb will fall, reducing the likelihood of a large damage and a small damage. The more you pay that firm, the greater the reduction in the range of possible damages—that is, the largest and smallest possible damage amounts will be eliminated. This means that the probability of each of the remaining possible damages will increase, as the probabilities must add up to one. Each of the possible damage amounts is equally likely. Note that you can choose not to spend anything on the firm's services and accept the larger range in damages.

The cost of the firm's services may be different from one round to the next. The cost will always be shown to you on the screen.

At the beginning of each round you will see a range of possible damages and you will see a "slider" that can be moved to indicate how much you will spend to reduce the range of possible damages. As you move the slider, you will see that the range of possible damages will decrease

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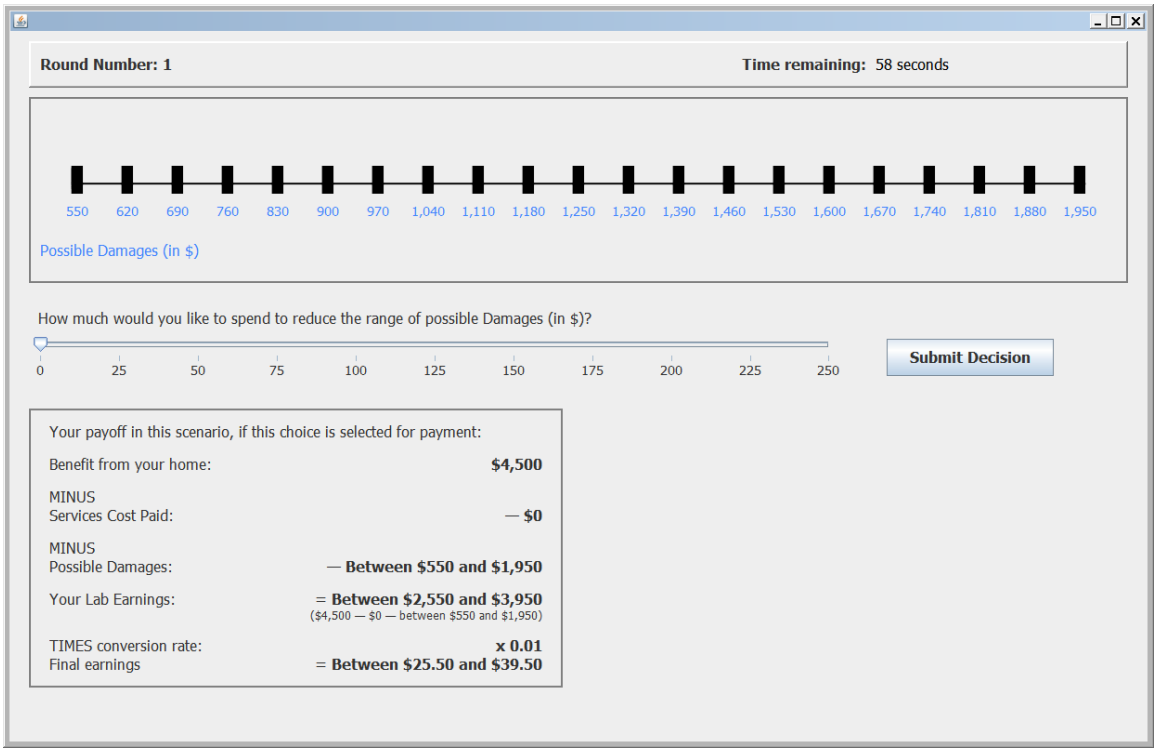
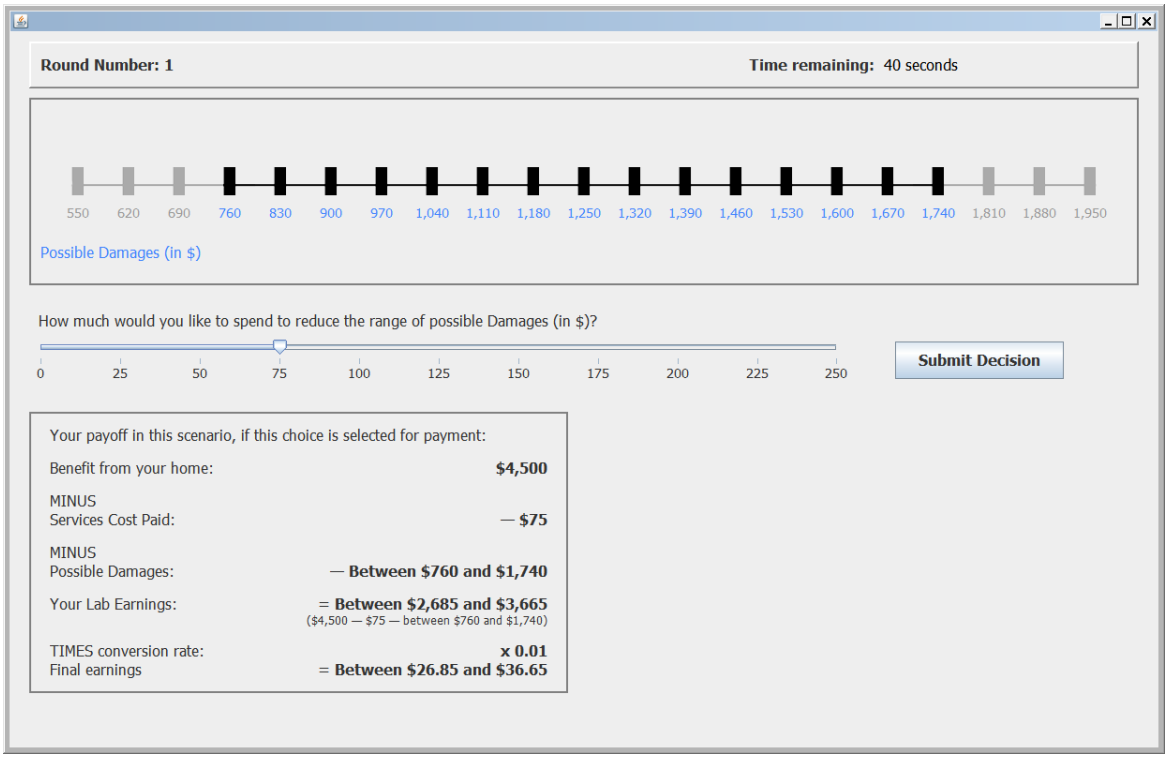
and the probability of each of the remaining damage amounts will increase. Once you have decided how much to spend on firm's services, click on the SUBMIT button. The amount you paid for the firm's services, if any, will be subtracted from your INDIVIDUAL FUND.

At that point, one of the possible damages will be selected at random by the computer. There is an equal chance that any of the damages shown on the screen will be selected. The amount shown will be subtracted from your INDIVIDUAL FUND.

Let's consider some examples. The two pictures are examples of what you will see on the screen.



The first picture is an example of the screen you will see at the beginning of the round. The top box shows the range of possible damages. The slider on the bar in the middle can be moved to select the amount you want to pay to reduce the range of possible damages. The box at the bottom summarizes the benefits and costs; the values will change as you move the slider. Once you have determined the amount you want to spend to reduce the range of damages and have set the slider on that amount, clicking the "Submit Decision" box will submit the decision.



In the second picture, the player has moved the slider to $75. This has reduced the range of damages to between $760 and $1,740. If the player were to now click the SUBMIT button, one of the values between $760 and $1,740 would be selected at random, with equal probability.

To sum up:

- At the start of each round, you will be randomly assigned to a group of 5 people.
- At the start of each round, your INDIVIDUAL FUND will be set to zero.
- You own a home in a neighborhood.
- That home provides you with a benefit, which will be **added** to your INDIVIDUAL FUND.
- Your home will receive damages. The damages and the cost of repairing these damages may be different from one round to the next. These will be randomly selected from a set of damages and associated cost of repair shown on the screen.
- You can pay a firm to reduce the range of possible damages, or choose not to pay to reduce this range. This payment will be **subtracted** from your INDIVIDUAL FUND.
- The cost of the firm's services may be different from one round to the next. The cost will always be shown to you on the screen.

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- Once you have chosen one of the payment options, the damages are randomly selected from the range of possible values and the cost of repairing these damages will be **subtracted** from your INDIVIDUAL FUND.
- At the end of each round, the amount in your INDIVIDUAL FUND will be stored by the computer. If this round is the round selected for payment, the amount in your INDIVIDUAL FUND at the end of this round will be combined with your participation fee to determine your payment.
- You do not know which decision will be chosen for payment, so you should think carefully about each decision.
- At the start of the next round your INDIVIDUAL FUND will again be set to zero.

Instructions for the Next Set of Rounds *[Scenario B]*

You will now be randomly assigned by the computer into groups of 5 people.

Remember, you will be randomly assigned into new groups of 5 people after each round.

In each round, you and the other members of your group own homes in a neighborhood. The local government provides public services that offer you benefits, which can be measured in dollars, and which will be shown to you on the screen. This amount will be deposited into your INDIVIDUAL FUND for the round.

To pay for these services the government must impose taxes on you and your neighbors. The tax used is a property tax, which works as follows. The government attempts to determine the value of everyone's home. However, valuing homes is not an exact science, and the value that the government sets for your home can fall anywhere within a range of possible values. The range of possible home values for you and your neighbors is identical, although the homes look different, and so the values the government assigns may differ from one home to the next.

In each round, you will be told the range of possible values the government could assign to your home for tax purposes. The taxes you pay will be the value of your home as determined by the government times the tax rate.

You can pay a private firm, which is known as Property Tax Advisors, to collect more detailed information like the home's interior space, quality of construction of the home, sales prices of neighboring homes, etc. This information will be provided to the government. It will help the government determine the value of your home and will reduce the range of possible values that might be assigned to your home. This also reduces the range of possible property taxes you would have to pay. The more you pay Property Tax Advisors, the more information they will collect, and the greater the reduction in the range of possible values the government will set for you home—that is, the largest and smallest possible values will be eliminated. This then reduces the range of taxes you might have to pay. This means that the probability of each of the remaining possible home values will increase, as the probabilities must add up to one. Each of the possible home values is equally likely. Note that you can choose not to hire Property Tax Advisors (in which case you would not pay them anything) and accept the larger range in home values and taxes.

The cost of Property Tax Advisors may be different from one round to the next. The cost will always be shown to you on the screen.

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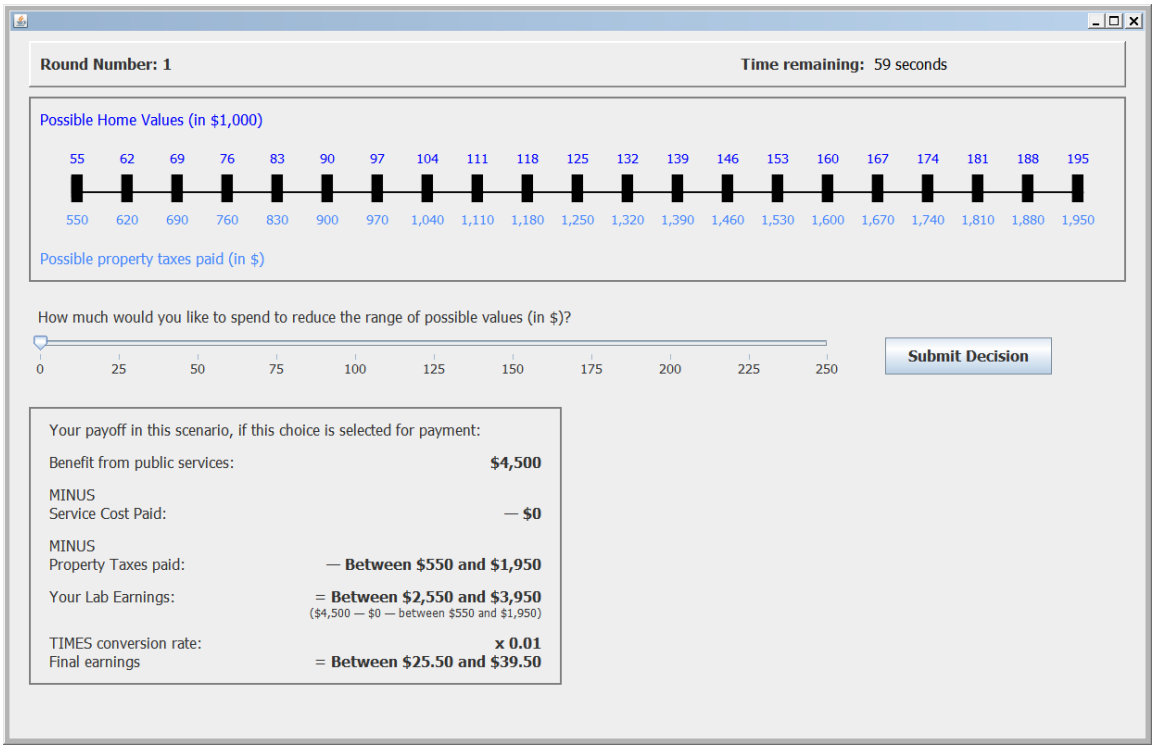
At the beginning of each round, you will see a range of possible assigned home values and the corresponding taxes you would pay for each home value. You will also see a "slider" that can be moved to indicate the amount you will spend on Property Tax Advisors to reduce the range of possible values and associated property taxes. As you move the slider, you will see that the range of taxes will decrease and the probability of each tax will increase. Once you have decided how much to spend on Property Tax Advisors, click on the SUBMIT button. The amount you paid to Property Tax Advisors, if any, will be subtracted from your INDIVIDUAL FUND.

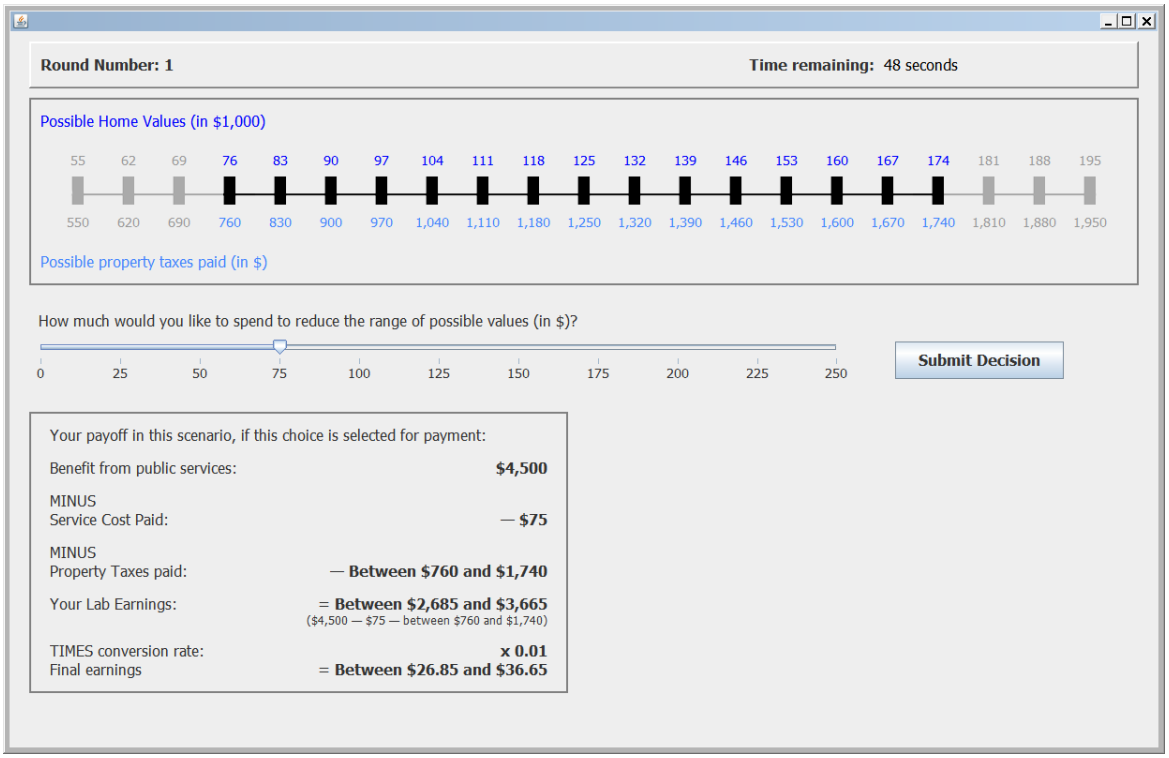
At that point, one of the possible assigned property values for your home and the associated property taxes, will be selected at random by the computer. There is an equal chance that any of the taxes shown on the screen will be selected. The amount shown will be subtracted from your INDIVIDUAL FUND.

Let's consider some examples. The two pictures are examples of what you will see on the screen.



The first picture is an example of the screen you will see at the beginning of the round. The top box shows the possible assigned home values in dark blue and the possible property taxes in light blue. The slider on the bar in the middle can be moved to select the amount you want to pay to reduce the range of assigned values. The box at the bottom summarizes the benefits and costs; the values will change as you move the slider. Once you have determined the amount you want

to spend to reduce the range of assigned home values and have set the slider on that amount, clicking on the "Submit Decision" box will submit the decision.



In the second picture, the player has moved the slider to $75. This has reduced the range of possible taxes to between $760 and $1,740. If the player were to now click the SUBMIT button, one of the values between $760 and $1,740 would be selected at random, with equal probability.

To sum up:

- At the start of each round, you will be randomly assigned to a group of 5 people.
- At the start of each round, your INDIVIDUAL FUND will be set to zero.
- You own a home in a neighborhood.
- The local government provides you with public services, which can be measured as a benefit, which will be **added** to your INDIVIDUAL FUND.
- To provide these services, the local government estimates the value of your property and collects property taxes. The assigned value of your property and the resulting taxes may be different from one round to the next. These will be randomly selected from a set of available options shown on the screen.
- You can pay Property Tax Advisors to reduce the range of possible values (and taxes), or choose not to pay to reduce this range. This tax payment will be **subtracted** from your INDIVIDUAL FUND.

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- The cost of Property Tax Advisors may be different from one round to the next. The cost will always be shown to you on the screen.
- Once you have chosen the amount to pay Property Tax Advisors, the assigned value of your home is randomly selected from the range of possible values and the associated property taxes will be **subtracted** from your INDIVIDUAL FUND.
- At the end of each round, the amount in your INDIVIDUAL FUND will be stored by the computer. If this round is the round selected for payment, the amount in your INDIVIDUAL FUND at the end of this round will be combined with your participation fee to determine your payment.
- You do not know which decision will be chosen for payment, so you should think carefully about each decision.
- At the start of the next round your INDIVIDUAL FUND will again be set to zero.

Instructions for the Next Set of Rounds *[Scenario C]*

You will now be randomly assigned by the computer into groups of 5 people.

Remember, you will be randomly assigned into new groups of 5 people after each round.

In each round, you and the other members of your group own homes in a neighborhood. The local government provides public services that offer you benefits, which can be measured in dollars, and which will be shown to you on the screen. This amount will be deposited into your INDIVIDUAL FUND for the round.

To pay for these services the government must impose taxes on you and your neighbors. The tax used is a property tax, which works as follows. The government attempts to determine the value of everyone's home. However, valuing homes is not an exact science, and the value that the government sets for your home can fall anywhere within a range of possible values. The range of possible home values for you and your neighbors is identical, although the homes look different, and so the values the government assigns may differ from one home to the next.

In each round, you will be told the range of possible values the government could assign to your home for tax purposes. The taxes you pay will be the value of your home as determined by the government times the tax rate.

You can pay an additional tax to the government, which is referred to as the Government Information Tax, to provide the government with additional resources to collect more detailed information like the home's interior space, quality of construction of the home, sales prices of neighboring homes, etc. This information will help the government determine the value of your home and will reduce the range of possible values that might be assigned to your home. This also reduces the range of possible property taxes you would have to pay. The larger the Government Information Tax you pay, the more information they will collect, and the greater the reduction in the range of possible values the government will set for you home—that is, the largest and smallest possible values will be eliminated. This then reduces the range of taxes you might have to pay. This means that the probability of each of the remaining possible home values will increase, as the probabilities must add up to one. Each of the possible home values is equally likely. Note that you can choose not to pay any Government Information Tax and accept the larger range in home values and taxes.

The cost of the Government Information Tax may be different from one round to the next. The cost will always be shown to you on the screen.

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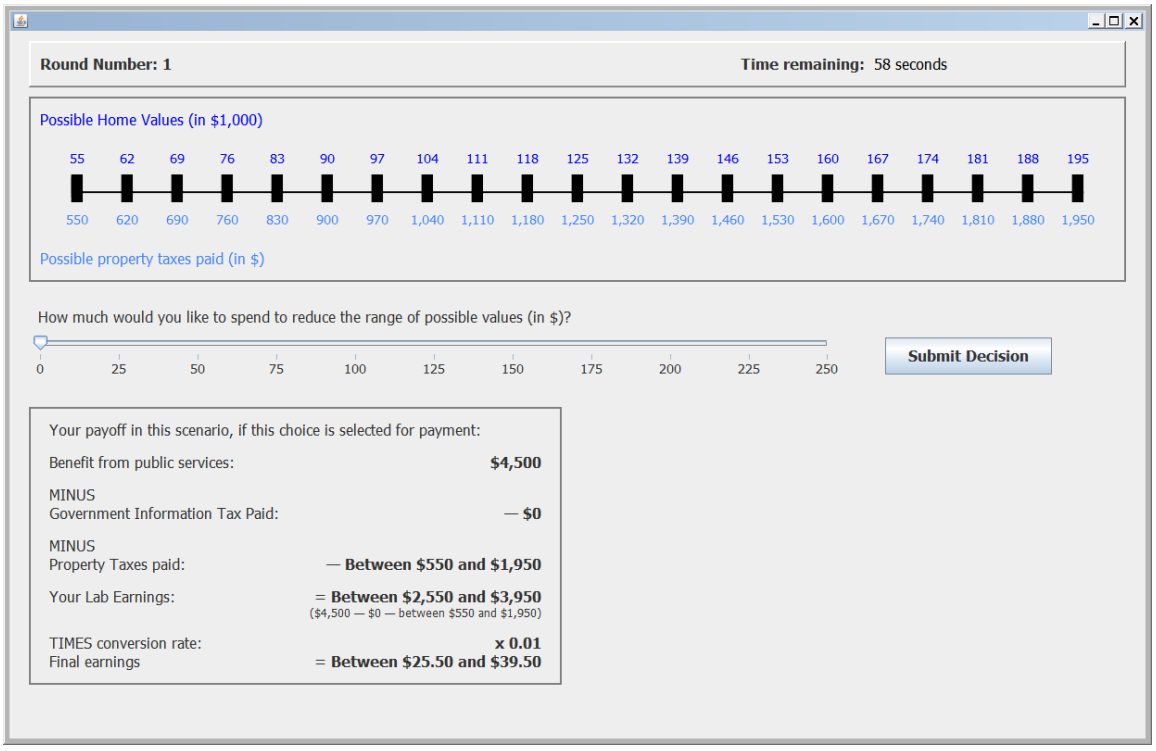
At the beginning of each round, you will see a range of possible assigned home values and the corresponding taxes you would pay for each home value. You will also see a "slider" that can be moved to indicate the amount you will spend on the Government Information Tax to reduce the range of possible values and associated property taxes. As you move the slider, you will see that the range of taxes will decrease and the probability of each tax will increase. Once you have decided how much to spend on the Government Information Tax, click on the SUBMIT button. The amount you paid for the Government Information Tax, if any, will be subtracted from your INDIVIDUAL FUND.

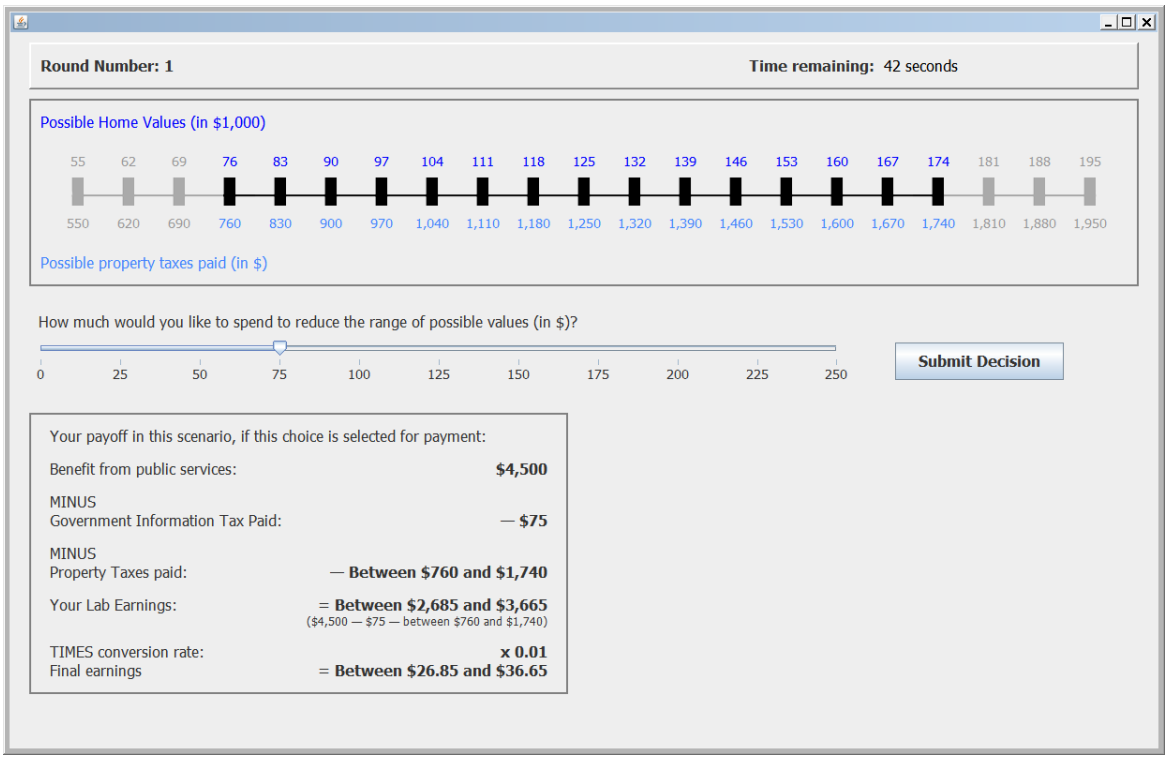
At that point, one of the possible assigned property values for your home and the associated property taxes, will be selected at random by the computer. There is an equal chance that any of the taxes shown on the screen will be selected. The amount shown will be subtracted from your INDIVIDUAL FUND.

Let's consider some examples. The two pictures are examples of what you will see on the screen.



The first picture is an example of the screen you will see at the beginning of the round. The top box shows the possible assigned home values in dark blue and the possible property taxes in light blue. The slider on the bar in the middle can be moved to select the amount you want to pay to reduce the range of assigned values. The box at the bottom summarizes the benefits and costs;

the values will change as you move the slider. Once you have determined the amount you want to spend to reduce the range of assigned home values and have set the slider on that amount, clicking on the "Submit Decision" box will submit the decision.



In the second picture, the player has moved the slider to $75. This has reduced the range of possible taxes to between $760 and $1,740. If the player were to now click the SUBMIT button, one of the values between $760 and $1,740 would be selected at random, with equal probability.

To sum up:

- At the start of each round, you will be randomly assigned to a group of 5 people.
- At the start of each round, your INDIVIDUAL FUND will be set to zero.
- You own a home in a neighborhood.
- The local government provides you with public services, which can be measured as a benefit, which will be **added** to your INDIVIDUAL FUND.
- To provide these services, the local government estimates the value of your property and collects property taxes. The assigned value of your property and the resulting taxes may be different from one round to the next. These will be randomly selected from a set of available options shown on the screen.

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- You can pay a Government Information Tax to reduce the range of possible values (and taxes), or choose not to pay to reduce this range. This tax payment will be **subtracted** from your INDIVIDUAL FUND.
- The cost of the Government Information Tax may be different from one round to the next. The cost will always be shown to you on the screen.
- Once you have chosen the Government Information Tax level, the assigned value of your home is randomly selected from the range of possible values and the associated property taxes will be **subtracted** from your INDIVIDUAL FUND.
- At the end of each round, the amount in your INDIVIDUAL FUND will be stored by the computer. If this round is the round selected for payment, the amount in your INDIVIDUAL FUND at the end of this round will be combined with your participation fee to determine your payment.
- You do not know which decision will be chosen for payment, so you should think carefully about each decision.
- At the start of the next round your INDIVIDUAL FUND will again be set to zero.

Instructions for the Next Set of Rounds *[Scenario D]*

You will now be randomly assigned by the computer into groups of 5 people.

Remember, you will be randomly assigned into new groups of 5 people after each round.

In each round, you and the other members of your group own homes in a neighborhood. The local government provides public services that offer you benefits, which can be measured in dollars, and which will be shown to you on the screen. This amount will be deposited into your INDIVIDUAL FUND for the round.

To pay for these services the government must impose taxes on you and your neighbors. The tax used is a property tax, which works as follows. The government attempts to determine the value of everyone's home. However, valuing homes is not an exact science, and thus the value that the government sets for your property can fall anywhere within a range of possible values. The range of possible values for you and your neighbors have is identical, although the homes look different, and so the values the government assigns may differ from one home to the next.

In each round, you will be told the range of possible values the government could assign to your home for tax purposes. The taxes you pay will be the value of your home as determined by the government times the tax rate.

You can propose that you and each of your neighbors pay an additional tax to the government, which is referred to as the Government Information Tax, to provide the government with additional resources to collect more detailed information about the homes in the neighborhood like the home's interior space, quality of construction of the home, sales prices of neighboring homes, etc. This information will help the government determine the value of the homes and will reduce the range of possible values that might be assigned to each of the 5 homes in your neighborhood. This also reduces the range of possible property taxes you and your neighbors would have to pay. The larger the Government Information Tax you and your neighbors pay, the greater the reduction in the range of possible values the government will set for the homes in the neighborhood—that is, the largest and smallest possible values will be eliminated. This then reduces the range of taxes you and each of your neighbors might have to pay. This means that the probability of each of the remaining possible home values will increase, as the probabilities must add up to one. Each of the possible home values is equally likely. Note that you can propose to have no Government Information Tax for you and your neighbors.

The cost of the Government Information Tax may be different from one round to the next. The cost will always be shown to you on the screen.

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Once everyone has submitted their choice for the additional per-group-member tax, the two highest and two lowest choices will be set aside by the government agency. The remaining choice, which is the choice that falls in the middle of your group of 5 members, will be the Government Information Tax paid by EVERY group member as the tax to provide additional information.

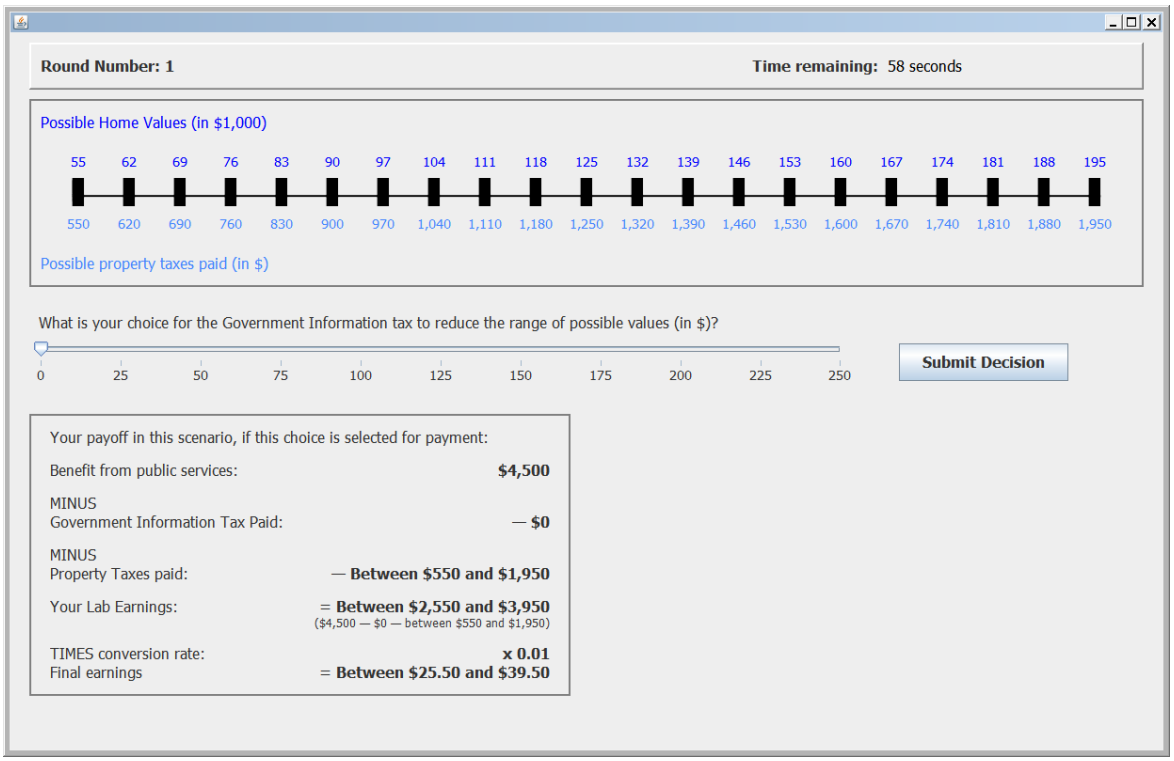
At the beginning of each round, you will see a range of possible assigned home values and the corresponding taxes you would pay for each home value. You will also see a "slider" that can be moved to indicate the per-group-member amount you would like yourself and your neighbors to spend to reduce the range of possible values and associated property taxes. As you move the slider, you will see that the range of taxes will decrease and the probability of each tax will increase. Once you have decided how much you would like you and your group members each to spend on the Government Information Tax, click on the SUBMIT button.

Once all group members have clicked SUBMIT, the middle choice of the Government Information Tax will be selected, and that amount, if any, will be subtracted from your INDIVIDUAL FUND.

If the Government Information Tax that is selected by the group is not the level you proposed, the range of possible assigned property values will change to reflect the selected Government Information Tax.

At that point, one of the possible assigned property values for your home, and the associated property taxes, will be selected at random by the computer. There is an equal chance that any of the taxes shown on the screen will be selected. The amount shown will be subtracted from your INDIVIDUAL FUND.

Let's consider some examples. The two pictures are examples of what you will see on the screen.



The first picture is an example of the screen you will see at the beginning of the round. The top box shows the possible assigned home values in dark blue and the possible property taxes in light blue. The slider on the bar in the middle can be moved to select the amount you want to pay to reduce the range of assigned home values. The box at the bottom summarizes the benefits and costs; the values will change as you move the slider. Once you have determined the amount you want to spend and have set the slider on that amount, clicking the "Submit Decision" box will submit the decision.

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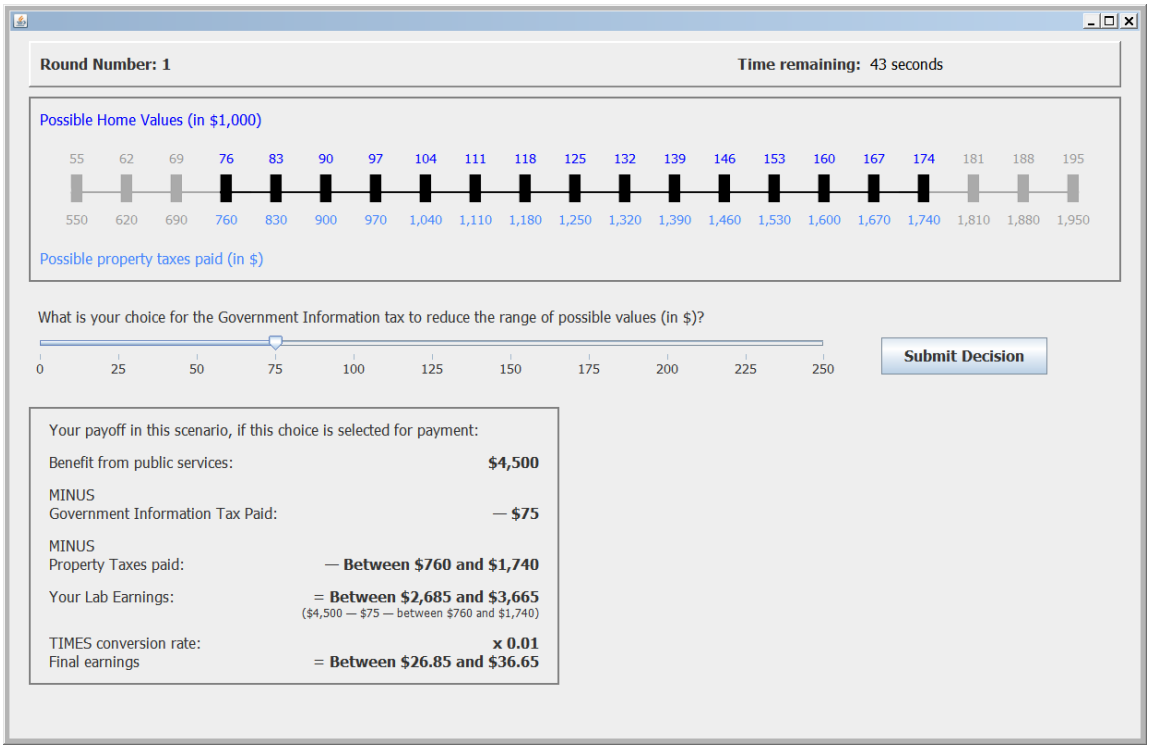

In the second picture, the player has moved the slider to $75. This represents a proposal to reduce the range of taxes to between $760 and $1,740. If the player were to now click the SUBMIT button, that choice would be proposed for the group. Once each player has clicked SUBMIT, the middle proposal will determine the range of possible assigned home values (and the associated property taxes) and one of the values in that range would be selected at random, with equal probability.

To sum up:

- At the start of each round, you will be randomly assigned to a group of 5 people.
- At the start of each round, your INDIVIDUAL FUND will be set to zero.
- You own a home in a neighborhood.
- The local government provides you with public services, which can be measured as a benefit, which will be **added** to your INDIVIDUAL FUND.
- To provide these services, the local government estimates the value of your home and collects property taxes. The assigned value of your property and the resulting taxes may be different from one round to the next. These will be randomly selected from a set of available options shown on the screen.

- You and your neighbors can pay a Government Information Tax to reduce the range of possible values (and taxes). You can propose the Government Information Tax that you would like for you and each of your neighbors to pay.
- Once everyone has proposed a desired level of the Government Information Tax, the level that falls in the middle of the Government Information Tax amounts selected by the 5 group members will be selected as the actual level that will be imposed. This payment will be **subtracted** from your INDIVIDUAL FUND.
- The cost of the Government Information Tax may be different from one round to the next. The cost will always be shown to you on the screen.
- Once the Government Information Tax level has been selected, the range of assigned values will reflect the chosen tax payment.
- The assigned value of your home is randomly selected and the associated property taxes will be **subtracted** from your INDIVIDUAL FUND.
- At the end of each round, the amount in your INDIVIDUAL FUND will be stored by the computer. If this round is the round selected for payment, the amount in your INDIVIDUAL FUND at the end of this round will be combined with your participation fee to determine your payment.
- You do not know which decision will be chosen for payment, so you should think carefully about each decision.
- At the start of the next round your INDIVIDUAL FUND will again be set to zero.

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52