Exploring Attitudes Toward Taxes: An Experiment Involving Property Tax Aversion *

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Abstract: We conduct a laboratory experiment to explore tax aversion. In the experiment, subjects alternately pay to reduce the variance of private damages and property taxes. For the property tax, we vary the recipient of the payments between a private firm and the government. We find no evidence that subjects are tax-averse. We also find that the willingness to pay to reduce uncertainty regarding property taxes does not depend on whether the uncertainty for other property owners also decreases. Our experiment allows us to provide an estimate of demand for reduced variance and find that willingness to pay for reduced variance depends on the price and the initial variance, but not the expected value. We also provide a thorough survey of the supporting literature to strengthen the foundation for future experimental study of property taxation and tax aversion.

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1. **Introduction**

Economists typically view taxes as simply another cost, so that the reaction to a change in, say, an excise tax is expected to be the same as the reaction to an equivalent change in the tax-exclusive price. For example, studies of labor supply elasticities use wage rate net of taxes as the independent variable, implicitly assuming that an increase in taxes has the same effect on labor supply as a reduction in the wage rate. In a test of that position, Rosen (1976) estimated the effect on labor supply of the gross wage separately from taxes and found the effects of the two variables were the same.

However, there is increasing empirical evidence that individuals respond differently when a cost is labeled a tax rather than, say, a fee (see, for example, Hardisty, Johnson, and Weber (2010); Kirchler (1998); Schmölders (1959); and Hill (2010)). Also, Li, Linn and Muehlegger (2014) estimated the demand for gasoline and found that the elasticity of gasoline purchases with respect to price is smaller than with respect to the excise tax. Behavioral economics labels this behavior "tax aversion bias," that is, an individual perceives that a tax has an additional burden associated with it, perhaps because he dislikes paying taxes more than an economically equivalent payment labeled differently. This behavior means that taxpayers will respond differently to tax changes than to non-tax price changes, calling into question the effects of tax changes on government revenues as well as economic welfare.

There is some similarity between tax aversion and tax salience, in that decisions are not based on the actual value of the tax. However, with tax salience the decision is based on the tax payer's perception of the tax, which leads to concerns with how to measure excess burden (Chetty, Looney, and Kroft 2009). However, with tax aversion the taxpayer's decision is based on the sum of the tax and the aversion bias, which the payer knows, meaning that excess burden would be based on the sum of the tax and aversion bias.

A tax labeling effect, or tax aversion, has been studied using survey responses. McCaffrey and Baron (2004) asked respondents to rate from "Awful" to "Excellent" the use of a "tax" to fund a particular public service, and in addition rate the use of a "payment" to the provider of the service. They find no overall differences in the preferences for taxes versus payment, although there were differences across services. Löfgren and Nordblom (2009) divided their survey respondents into two groups. The first group was asked if they wanted to increase or decrease the Swedish *CO_2 tax on gasoline*, while the second group was asked about the *gasoline tax*. About 29 percent of the first group wanted a reduction, while 56 percent of the second group supported a reduction, suggesting labeling matters. Hardisty, Johnson, and Weber (2010) find that individuals have greater preference for an optional surcharge labeled a "carbon offset" than for a surcharge labeled a "carbon tax." Sussman and Olivola (2011) pose hypothetical scenarios focused on labeling. In one scenario subjects were asked to make a choice between buying a television at a local store and a store that required a 30 minute drive. Some subjects were told that there is a 9 percent discount at the second store, while other subjects were told that the sale would be tax free at the second store, an 8 percent reduction. They find that more subjects choose to drive the longer distance in the tax free situation.

A laboratory experiment is a more desirable way to study tax aversion (i.e., tax labeling) than surveys. Among other problems, the results from questionnaires are suspect since there are no personal consequences from the choices reported. On the other hand, empirical studies based solely on observational data, such as Li, Linn and Muehlegger's (2014) study of gasoline excise taxes, cannot distinguish among multiple explanations for differential responses to changes in the tax and in the tax-exclusive price.

We identified four papers that use laboratory experiments to explore tax aversion. Kallbekken, Kroll, and Cherry (2011) explore the effect of tax labeling in a single-price market, with purchases by some buyers imposing external costs on others. In the course of the experiment the subjects are asked to vote on a choice between a (Pigouvian) “tax” and a (Pigouvian) “fee”. Three votes are taken, with the nature of the allocation of the revenue to the subjects differing across the three votes. They find no evidence of tax aversion when the revenue is distributed to the victims or polluters, but cannot reject tax averse behavior when the revenue is distributed on a per capita basis.

Ackermann, Fochmann, and Mihm (2013) explore how taxes and subsidies affect financial investment decisions. They run an experiment in which subjects make choices between investing in a risk-free asset and a risky asset. In some treatments a tax and/or subsidy is imposed on the risky asset. In all cases the returns to the risky asset net of the tax/subsidy are the same. They find that when a tax and/or subsidy is imposed on the gross return to the risky asset, a smaller percentage of the investments are made in the risky asset. These results are consistent with tax aversion.

Blaufus and Möhlmann (2014) conduct laboratory market experiments in which subjects priced differently labeled securities that had equivalent returns. Initially, the prices that are set reflect tax aversion in the trading, but tax aversion bias diminishes and eventually disappears with increasing experience in the experiment. They conclude that tax aversion predominantly occurs in one-time, unfamiliar financial decisions and to a lesser extent in repetitive choices.

The fourth paper, Djanali and Sheehan-Connor (2012), tests whether tax aversion bias is negative, i.e., whether there is tax affinity. They suggest that individuals obtain utility from taxes paid due to pro-social tendencies. Their laboratory experiment involves testing whether subjects' work effort for a given net wage differs in the presence of a tax than in the absence of a tax. Their results are consistent with their tax affinity hypothesis.

The small number and mixed results of the existing research suggest a need for additional studies of tax aversion. We study tax aversion through a laboratory experiment using a different framework from the existing research. We compare the willingness to pay to obtain a reduction in the variance, i.e., for greater certainty, of a cost associated with homeownership. One cost is damage to one's house (Case 1) and the other as property tax (Case 2). The variances in these costs can be reduced through a payment for preventative action (Case 1) or a payment for higher quality assessment (Case 2). We further consider whether the willingness to pay for improved property tax assessment depends on whether the individual payment is labeled a fee, which is paid to a private firm, or labeled a tax, which is paid to the government.

In this experiment, we rely on student subjects and focus on whether labeling something a tax rather than a fee affects subjects' choice. While the tax is referred to as a property tax, subjects need not understand the property tax in depth for us to examine tax aversion, only that it mandates a local tax payment.[1]

Our laboratory experiment considers four scenarios, which we summarize here but explain in detail below. In the first scenario, Scenario A, the subject chooses how much to pay a private firm to reduce the variance of some private cost due to damage to his home. In the second and third scenarios, Scenarios B and C, the subject can pay to reduce the variance of the assessed

[1] We recognize that the fee subjects pay to reduce the variance is not strictly a tax in that it is optional, and not a forced payment. Since the effect of labeling costs that subjects incur as "taxes" is the object of our study, we vary the labeling of this cost experimentally as well.

value of his home (and thus the variance of his property tax). In Scenario B, the subject chooses how much to pay a private firm to reduce the variance, while in Scenario C he chooses how much to pay in an additional tax to the government.[2] Decisions in these three scenarios are made independent of the decision of other scenarios; we are interested in both within-subject and across-subject variation across scenarios.

The first three scenarios are simply decisions regarding risk taking, but with different labeling of the costs and payments required to reduce the variance of the cost. In Scenario B the property tax replaces the private loss, and thus comparing Scenarios A and B allows us to explore whether the willingness to pay to avoid a loss differs if the loss is labeled a property tax. In both of these scenarios (A and B) the payments to reduce the variance are made to a private firm. In Scenario C, we replace the payment to a private firm to reduce the variance of the property tax with a payment (an additional tax) to the government. Comparing Scenarios B and C allows us to explore whether the willingness to pay differs by labeling the payment a tax. Comparing the differences in the willingness to pay across Scenarios A, B, and C provides us with the value that the subject places on tax aversion.

In the fourth scenario, Scenario D, the amount to spend via a tax on reducing the variance of the property tax is determined by a voting mechanism, with the subject and his neighbors all paying an equal amount. The payment identically reduces the variance of the assessed values of the subject's home and his neighbors' homes. Comparing Scenarios C and D allows us to explore whether the willingness to pay an extra tax depends on whether the decision is made in a group context and whether priming the decision as a social choice matters.

[2] 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, to allow direct comparison of a tax labeling effect.

To preview our findings, we find that the subjects were willing to pay to reduce the variance of the private loss and property taxes. However, we find no evidence of tax aversion.

The paper contributes to the very small literature exploring tax aversion using laboratory experiments. The existing experimental literature considers whether labeling affects outcomes, such as voting for a tax versus a fee, portfolio composition, pricing of a financial asset, or work effort. Our framework is different from that used in previous experiments, and furthermore, had there been evidence of tax aversion, our framework would have allowed us to measure the implicit value of tax aversion. In addition, since it is possible that tax aversion depends on whether others are also required to pay the tax, we explore whether tax aversion depends on whether the decision is made in a social setting in the context of a local tax.

Finally, the experiment allows us to provide some measure of the willingness to pay for reduced variance of a cost, either property damage or property tax.

The rest of the paper proceeds as follows. We develop our hypotheses in the next section. The third section presents the details of our experiment, while the results are presented in Section 4. A summary and conclusion section completes the paper. Instructions for Scenario A can be found in Appendix A; instructions for the other scenarios are similar, and are available from the authors. [The full set of instructions is presented in the appendix for the benefit of the reviewers.]

2. Development of Experimental Hypotheses

We expect that most subjects would be willing to pay something to reduce the variance of an uncertain cost. This willingness to pay may vary if the cost is a tax versus a purely private cost, i.e., if the subject is tax averse. To see this consider the following. Let cost be a random variable denoted T, let E denote the expected value of T, and let V denote the variance of T. The individual can reduce *V* by making a payment *P*, where $\frac{d^2V}{dP^2} < 0$. Assume, as is the case in our experiment, that *E* is the same for all values of *V*. Assume that *T* is the loss with zero tax aversion bias and *P* is a non-tax price. The relationship between *E*+*P* (where *E* and *P* are treated as negative values) and *V* is represented in Figure 1 by the line *VV′*.[3] Let U^1 represent the individual's indifference curve between *E*+*P* and *V*. With U^1 tangent to *VV′* at *A*, the individual will pay an amount P^1, thus reducing *V* to V^1. Of course, it is possible that the slope of U^1 could be such that the individual could maximize his utility at point *V′*, in which case he would pay nothing to reduce *V*.

Figure 1 implies that if subjects are risk averse and the variance of the loss is large when no payment is made, a subject would pay a positive amount to reduce the variance of the loss. The amount he would be willing to pay will depend on the initial variance, the cost of reducing the variance, and how risk averse he is.

The effect of tax aversion on the payment decision depends on the nature of the relationship the individual holds between tax aversion bias and the tax level. However, there is no obvious basis for specifying how the value of the tax aversion bias varies with the tax level. The tax aversion bias could be a flat amount regardless of the amount of the tax, or more likely some percentage of the tax, which perhaps increases with the tax amount. We adopt what seems a reasonable assumption that the tax aversion bias is a multiple, θ, of *T*, when *T* is labelled a tax.[4] Thus, when the tax is *T*, the individual behaves as if the perceived cost is $T^* = T \times (1 + \theta)$. Thus, the variance of the perceived taxes is $V^* = V \times (1 + \theta)^2$. Likewise, *E* shifts down to $E \times (1 + \theta)$. Line VV^* in Figure 1 represents the individual's tradeoff between the perceived

[3] We use Figure 1 to illustrate the choice problem because it provides a more intuitive discussion of the theoretical model. However, the results can be derived using a risk-return framework, which is presented in Appendix B.

[4] If the tax aversion cost is a flat amount, independent of the level of taxes, the expected loss, *E*, increases, but the variance doesn't change. The qualitative results are equivalent to those presented in the text.

expected value $(E + P)$ and the perceived variance, V^*. The line VV^* is lower and flatter than *VV'* and thus the individual, assuming a non-zero tax aversion bias, will now maximize utility at point *B*. *P* is larger at point *B* than at point *A*. [Of course, the new tangency could also be such that *P* is smaller than at point *A*.] Note that the effect of *P* on *V* is given by the line *VV'*, and thus *V* falls from V^1 to V^2, with *V* determined by point *D*. Thus, in this setting, tax aversion causes the individual to pay more to reduce the variance of the tax (i.e., Scenario B) than with a non-tax cost (i.e., Scenario A), i.e., in absolute value terms $P^2 > P^1$.

Obviously, if θ equals zero, then subjects consider a private loss or payment to a private firm to be equivalent to a tax or a payment to the government, which implies that the individual should consider the first three scenarios as equivalent.

If the payment *P* is a tax (i.e., Scenario C) and the subject has an aversion to taxes, then the cost to reduce the variance of the tax assessment will be the sum of the dollar payment (the additional tax) plus the tax aversion bias. In Figure 1, this would cause VV^* to shift down to V^*V'''. The individual will maximize utility at point *C*, which will result in the individual paying less to reduce the variance of the tax than when the payment was a non-tax. The payment is P^3. The dashed line between *C* and *E* is the tax aversion bias of the payment, so the actual payment is P^3. The effect of P^3 on *V* is given by point *E*, and thus, *V* increases from V^2 to V^3. In this case, the tax aversion bias increases the cost of reducing the variance, and thus the individual would spend less to do so.

There is a substantial literature concerning experiments associated with risk taking (see Holt and Laury (2002) and Dohmen et al (2011) for surveys), which find that generally individuals are risk averse. There are studies of risk attitude that are more closely related to our research. Einav et al. (2012), for example, examine risk attitudes in insurance decisions and

401(k) allocations. Esarey et al. (2012) examine the case of social insurance and redistribution using median-voter-controlled taxation in a laboratory experiment. But note that our treatment of risk is quite novel in that the subjects do not make choices over different gambles, but rather choose how much to pay to reduce the variance of the possible outcome.[5] Scenario A allows us to establish the subjects' attitudes toward risk in a purely non-governmental setting.

The fourth treatment involves choices to implement mandatory contributions. In Scenario D, in proposing 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 additional tax that all neighbors pay—similar to a general user fee, which in this case provides for "better" assessments. 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 subject'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.

Regarding Scenario D, there are two notions of equity that might be at play. First, there is the possibility that subjects are affected by social equity, that is, how well others are treated. In this experiment that treatment includes both that subjects pay the same share of the cost and have the same reduction in property tax variance. Second, the subject might have an aversion to inequality. Fehr and Schmidt (1999) model fairness as self-centered inequality aversion, defining inequality aversion as an interest in the fairness of their own payoff relative to others. Bolton and

[5] 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.

Ockenfels (2000), on the other hand, express inequality aversion as referring to one's own payoff relative to the average of all payoffs. Engelmann and Strobel (2004) conduct experiments to explore these two concepts of inequality aversion, as well as the role of efficiency (as measured by total payoffs), and social preferences, and in particular maximin preference. Engelmann and Strobel's tax experiment suggests that individuals are concerned with their payoff relative to others, and thus support Fehr and Schmidt's concept of inequality aversion, but that decisions over tax structures are also influenced by efficiency and are consistent with maximin social preferences.

There have been experiments in which subjects choose between tax structures. For example, Ackert, Martinez-Vazquez and Rider (2007) conducted an experiment in which they examined the subjects' taste for fairness. In the experiment subjects made choices among levels of economic efficiency, as measured by the size of the payoff, and equity. The authors find that some people are willing to accept a smaller payoff in order to reduce payoff inequality, but that the demand for fairness decreases as the cost of reducing inequality increases.

Scenario D involves equity in a different way 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.

Given Figure 1, we hypothesize that if subjects are tax averse, subjects will pay more to reduce the variance in Scenario B than in Scenario A, and will pay less in Scenario C than in Scenario B. If subjects value equity, we hypothesize that the subjects will pay more to reduce the variance in Scenario D than in Scenario C.

This experiment presents a simplification of actual decisions that a taxpayer would make outside the lab, and thus we do not claim that the responses reflect how subjects might behave when confronted with an actual property tax assessment, but instead use the property tax as a useful frame for exploring tax aversion.

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), discussed in the previous section. 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

[6] Subject instructions for Scenario A are available in Appendix A; the instructions for the other scenarios are similar.
[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.

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 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.

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 cost (they do not share 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.

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. 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 D – The subject can propose an amount that he and each of his "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.

In each treatment, subjects face 15 such decisions, with 5 sets of 3 parameters (mean home value, initial range of possible home values, and the cost of the reduction in uncertainty) that are randomly re-ordered in three sets to check for consistency of choices. For each of the treatments, the payments required to reduce the range of damages or taxes were 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 (similar to *VV'* in Figure 1). 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 maximization choice of payment, assuming concave indifference curves.

The instructions were read to the entire group of subjects and questions were answered privately. Each subject pool participates in two scenarios. 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. 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 three 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; only in Scenario D can the choice of the other 4 subjects in the group affect the subject's actual payment. 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 between September 2015 and February 2016. Each session was designed to last no more than 90 minutes with 15 to 20 subjects per session, including a brief questionnaire at the end[8]. 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.[9]

[8] Subjects completed a questionnaire coving 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.
[9] In scenario 4, they vote as members of a group, but they have no communication and are randomly rematched after each round. There is no opportunity for establishing reputation or for other repeated-game-dependent social effects.

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 cost of a tick, as well as the risky proposition subjects faced. These were selected beforehand to provide enough experimental variation for the results discussed here. 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 cost 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).

Column 7 of Table 1 presents the varying costs 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 cost of $200 (10 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 cost 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 cost 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 results are inconsistent with our expectations if subjects were tax averse. We find that subject behavior appears broadly responsive to incentives, but subjects do not appear to respond to the framing in the scenarios: we find no evidence of expressed tax aversion. Figure 2 presents within-subject average ticks in a box and whisker plot.[10] There does not appear to be an obvious difference in behavior across scenarios; we explore this more fully below. Subjects do, in general, 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 even marginally significant order effects (Scenario A, Wilcoxon within-subject test $p = 0.069$).[11] In our regressions, the order variable had no significant effect on subject choices. We report

[10] 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.

[11] 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.

results using data pooled across all subject choices, but the qualitative results are the same if we restrict ourselves only to first-scenario data.[12]

Because we have data on subjects who participated in multiple scenarios, we can look for a differential effect across scenarios within subjects as well as compare the effect of two different scenarios across different subjects. 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, this allows us to isolate the relative effects of scenarios, if any. To examine our hypotheses, we compare the number of ticks between scenarios using Wilcoxon nonparametric tests. The results are presented in Table 2.

We first consider tests for evidence of tax aversion by examining scenarios A, B, and C. We find no evidence of tax aversion using the across-subjects specification (Panel I of Table 2) or either of the within-subject specification (Panels II and III 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 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 the additional tax would have reduced the variance of the property tax for his 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.

[12] Note that this can only apply to the across-subjects tests, as the within-subjects test require repeated measurements.

It is possible that our negative result fails to capture an effect due to the variation induced by the changing parameters. To investigate this, we consider two approaches. First, we match subjects not only by their decisions but also by the set of parameters they face. Panel III in Table 2 presents the results of the equivalent tests but where subject-parameter set pairs are tested across scenarios. For example, in the A vs. C cell, we are comparing each subject's choices in scenarios A and C separately for each parameter set. The results are qualitatively unchanged from Panel II.

Our second approach is to isolate the effects of the parameters and the scenarios separately using a fixed-effects regression model[13]:

$$x_{it} = \alpha_i + \Sigma \mathrm{B}_k d_{Scenario} + \Sigma \Gamma_m d_{paramset} + u_{it}$$

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 scenario as well as for the treatment. Alternatively, we can include the varying parameters separately rather than as dummy variables:

$$x_{it} = \alpha_i + \Sigma \mathrm{B}_k d_{Scenario} + \gamma_1(mean\ home\ value) + \gamma_2(range) + \gamma_3(tick\ cost) + u_{it}$$

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.[14]

Our results are inconsistent with the hypothesis that individuals are generally tax averse. In the bottom panel 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

[13] 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.
[14] In specifications not shown, we included interactions as well as the period/round, but these were never statistically significant.

significant: Scenario B vs. C. Again, 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 suffer a larger decrease in utility for paying taxes than for paying other costs. Our subjects prefer to pay 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 cost of a tick.

Given that we have no evidence of tax aversion, 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.

This allows us to estimate a revealed demand curve for risk reduction. In this section, for ease of interpretation, we will convert units so that $1 refers to US$1. We can establish the relationship between the price of a $1 range reduction and the number of $1 range reductions chosen, and using data pooled over all four scenarios we get the demand curve shown in Figure 3. 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 cost of reducing the range of possible taxes by $1 varied from $0.10 to $0.375. At the lowest price, the average level of range reduction was $10.44. At the highest price, the average level of range reduction was $0.79. Overall, the estimated demand curve was $Q = 9.487 - 21.715P$ (robust standard errors are 0.213 for the intercept term and 0.695 for the slope term), and at the mean price and quantity, the price elasticity of demand was -1.095.[15] Therefore, we do find that potential taxpayers 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).

In order to relate the change in the range of taxes 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

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[15] 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.

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.[16] 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 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.[17] The mean estimated value of ρ was 2.021. 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

[16] 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.

[17] 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 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.

was (1.747, 2.673). This is similar to estimates reported in the literature.[18] 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 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 the procedure with a constant absolute risk aversion (CARA) utility function specification yields similar results.

5. Summary and Conclusion

Using a laboratory experiment we explore whether individuals are tax averse. We consider four scenarios that differ in the framing of a cost and payment to reduce the cost. In particular, we considered the cost of preventing damage to one's home and property taxes. As expected we find that the amount that an individual is willing to pay to reduce the variance depends on the cost of reducing the variance and the size of the pre-reduction variance of the cost.

Our experiment was designed to explore whether individuals have an aversion to taxes. Thus, we explore whether the willingness to pay for improved property tax assessment, i.e., a

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

reduction in the variance of possible assessed value, differs from what an individual would be willing to pay to reduce the variance of a non-tax loss. While we do find a willingness to pay, we find no evidence that the willingness to pay depends on whether the loss is framed as a tax or a non-tax loss and no evidence that subject behavior depends on whether a payment to improve the quality of the assessment goes to the government or goes to a private firm. We also find no evidence that an individual's willingness to pay differs if the improved assessment also applies to the subject's neighbor.

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 but do not reduce it to a level consistent with best practices in property tax assessment.

While experimental results should always be treated with some caution, our results argue against tax aversion as a strong motivation for behavior around property taxation. 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.

To isolate the potential effects of framing and tax aversion, 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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Figure 1. Utility maximizing choice of payment

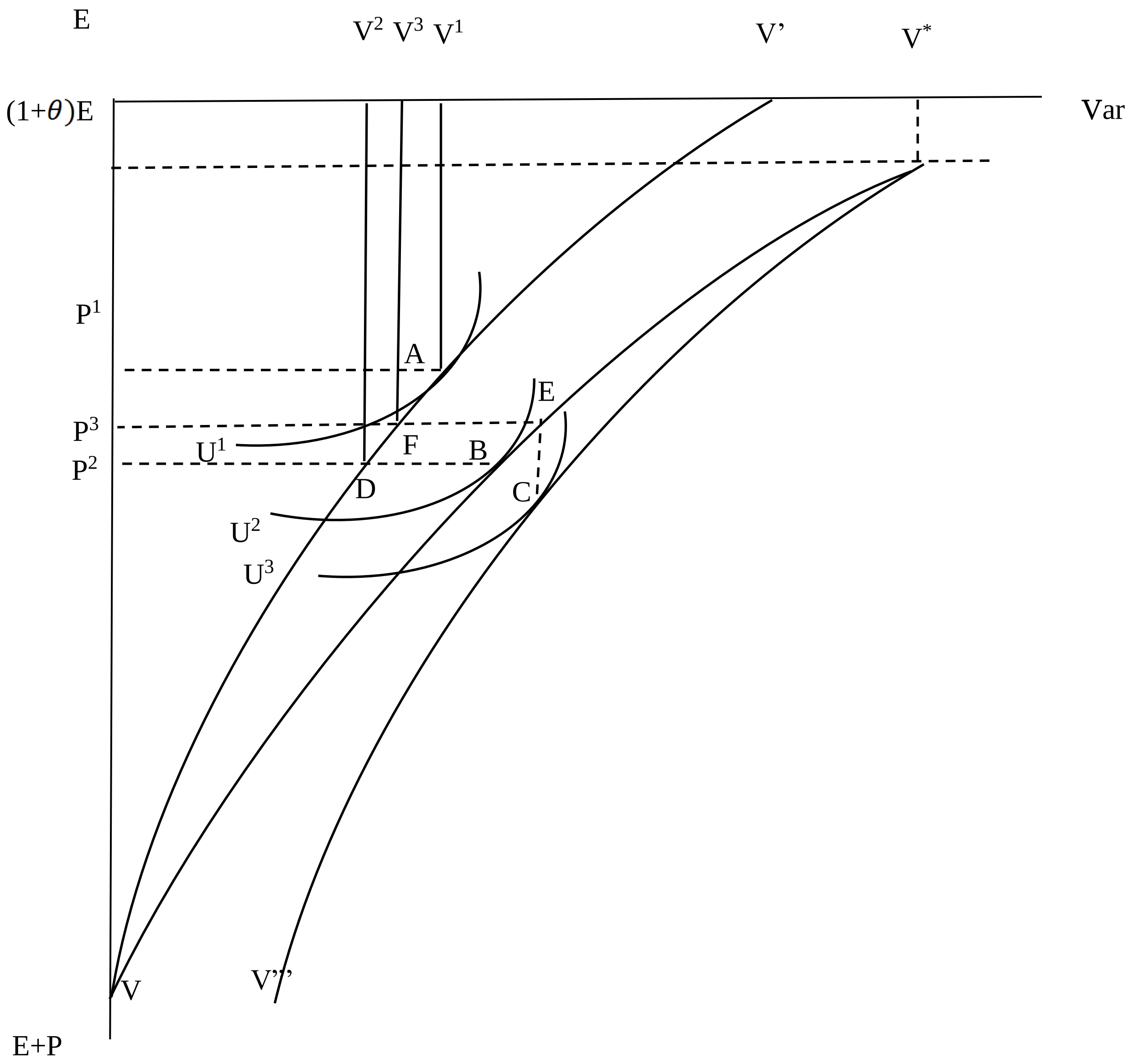


Figure 2. Box and whisker plot of average within-subject number of ticks by treatment and round

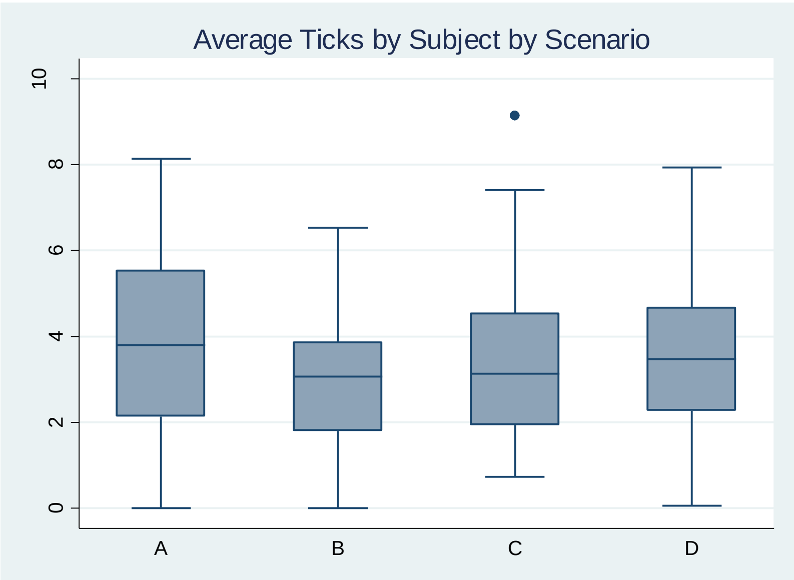


Figure 3. Revealed demand for risk reduction

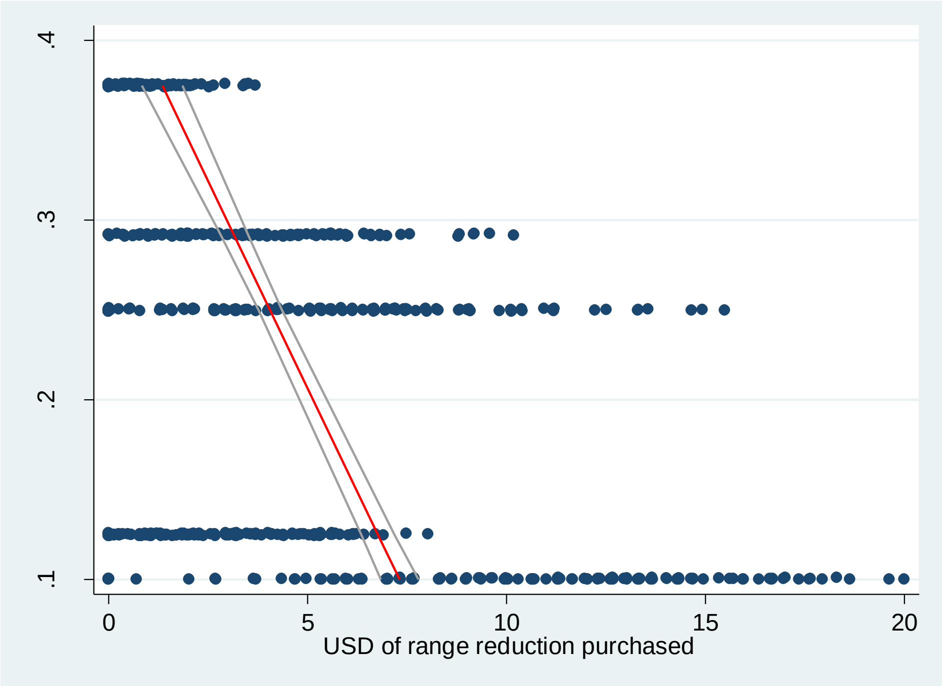


Table 1. Parameter Sets used in this experiment

Parameter Set	Endowment	Mean home value	Minimum home value	Maximum home value	Property tax rate	Cost 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. Wilcoxon tests of equality of across scenarios.

Panel I. Across Subjects

Scenarios	N	Mean ticks (S.E.)	p		
			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
		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

Panel III. Within Subjects (matching on parameter set)

Scenarios Pairs	N	Differences in ticks			p
		Positive	Negative	Tie	
A vs. B	175	91	48	36	0.001
A vs. C	75	22	30	23	0.256
B vs. C	75	28	30	17	0.911
C vs. D	175	82	60	33	0.095

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

	(1)	(2)
Scenario		
B	-0.190 (0.176)	-0.190 (0.176)
C	0.168 (0.197)	0.168 (0.197)
D	0.057 (0.228)	0.057 (0.228)
Parameter set		
2	-2.009*** (0.222)	
3	-1.856*** (0.165)	
4	-2.340*** (0.168)	
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*** (0.198)	1.944*** (0.223)
Observations	4050	4050
N	135	135
Overall R^2	0.111	0.111

Tests of Coefficient Differences

Coefficient Pairs	p
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 1000s)	Maximum Value (in 1000s)	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%

Table 5. 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	1.558	0.122	0.077	0.019	0.003	0.000
2	1.914	0.200		0.829	0.415	0.000
3	1.877	0.134			0.180	0.000
4	2.050	0.164				0.001
5	2.704	0.236				

n = 135

Appendix A. Subject Instructions

General Instructions

<u>Introduction</u>

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.

<u>Random Group Assignments and Anonymity</u>

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).

<u>Privacy</u>

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.

<u>Payment</u>

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 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.

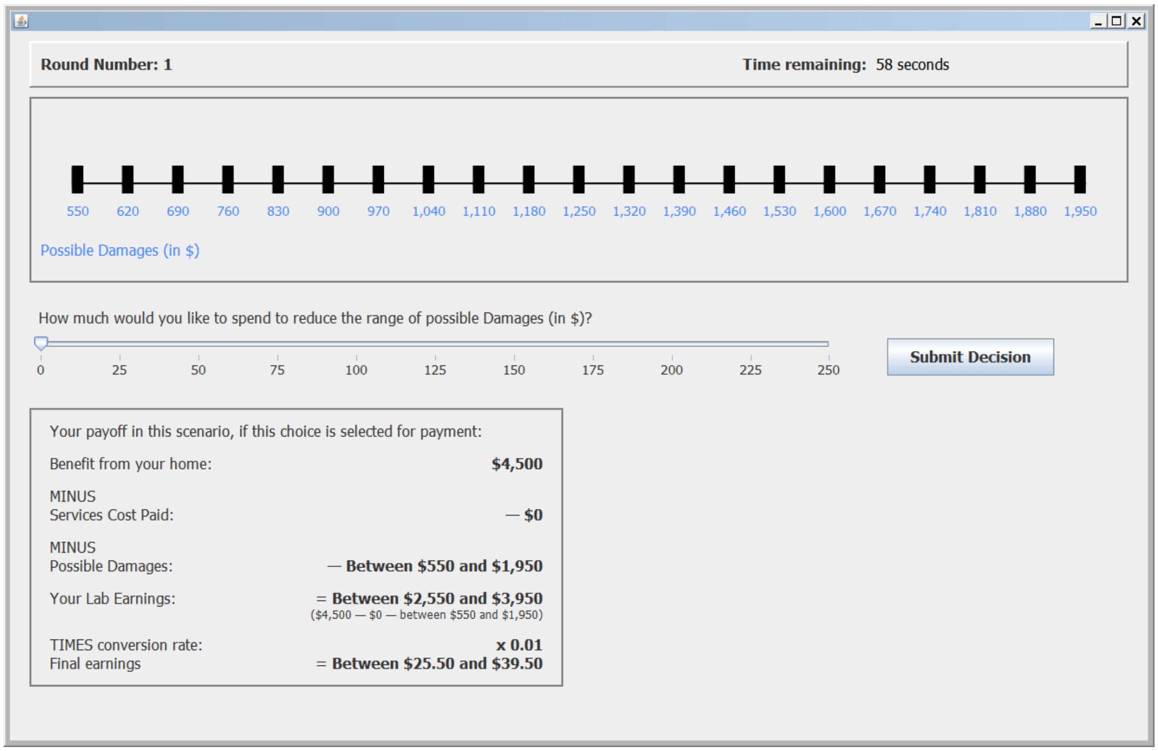
You can pay a firm to take steps that will reduce the range of possible damages for which you would have to pay for repairs. For example, before any event, the firm might come out to your house and inspect the tree and take steps to ensure that neither it nor a limb will fall, reducing the likelihood 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.

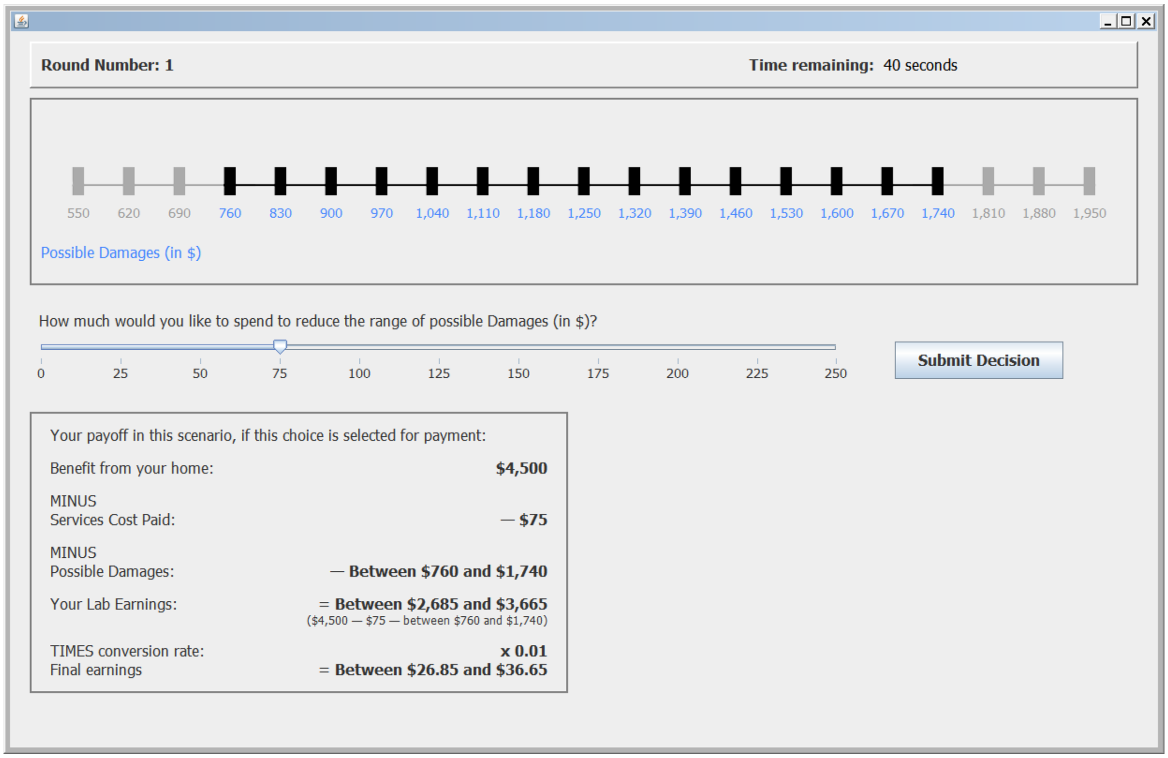
At the beginning of each round you will see a range of possible damages and you will see a "slider" that can be moved to indicate how much you will spend to reduce the range of possible damages. As you move the slider, you will see that the range of possible damages will decrease and the probability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

- 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.

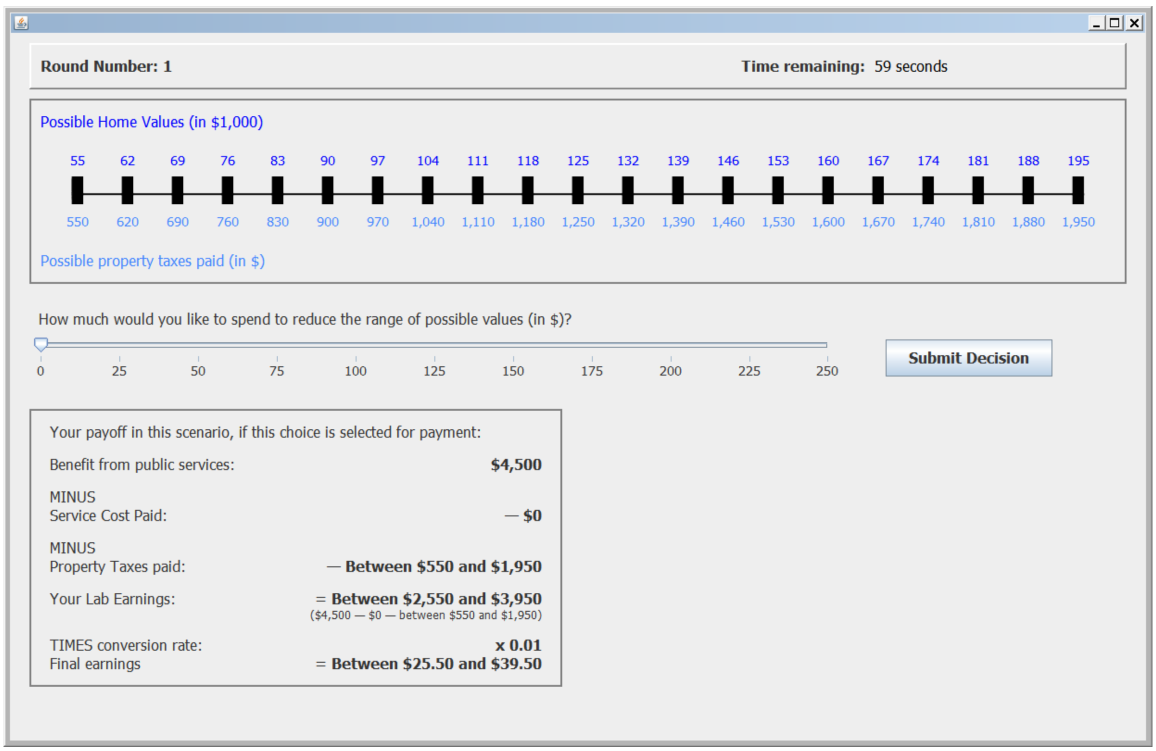
You can pay a private firm, which is known as Property Tax Advisors, to collect more detailed information like the home's interior space, quality of construction of the home, sales prices of neighboring homes, etc. This information will be provided to the government. It will help the government determine 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.

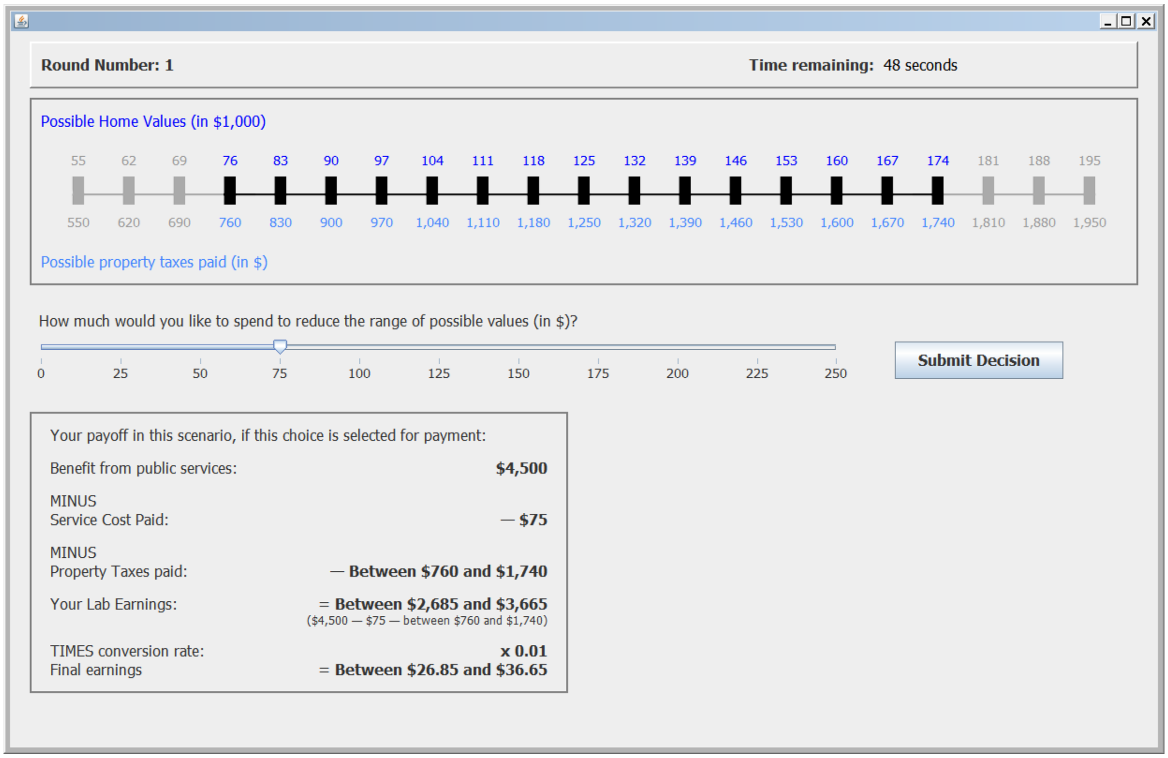
At the beginning of each round, you will see a range of possible assigned home values and the corresponding taxes you would pay for each home value. You will also see a “slider” that can be moved to indicate the amount you will spend on Property Tax Advisors to reduce the range of possible values and 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.

- 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.

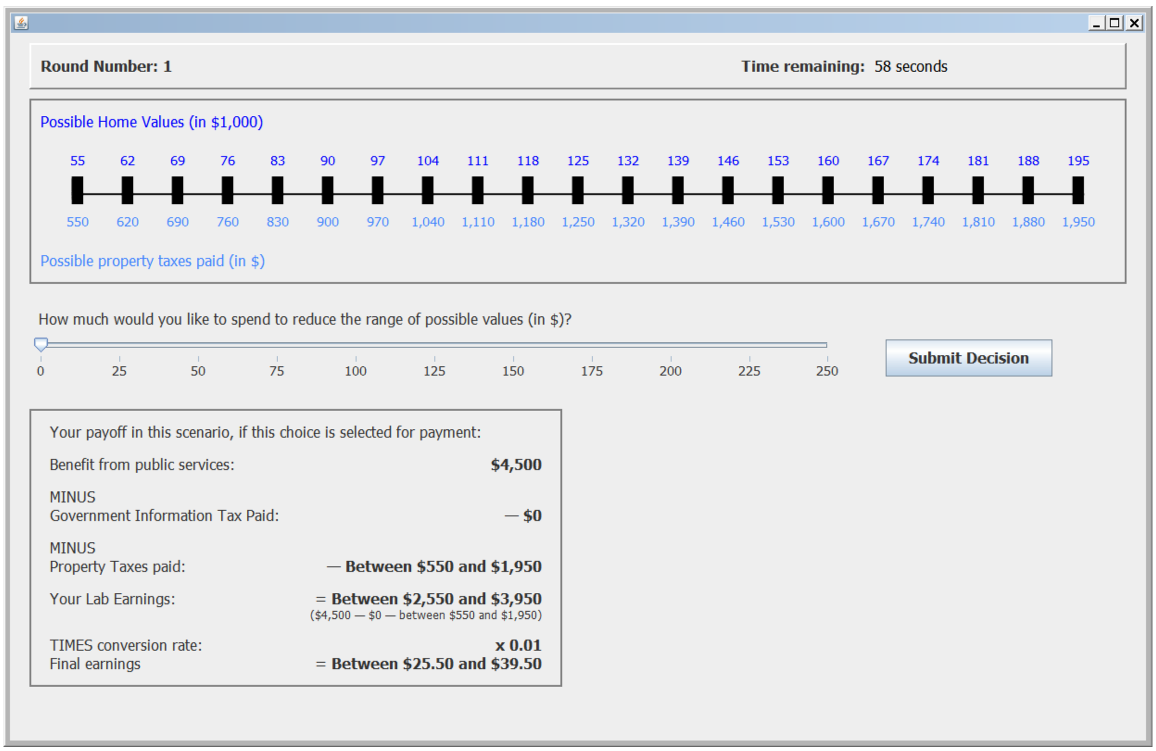
You can pay an additional tax to the government, which is referred to as the Government Information Tax, to provide the government with additional resources to collect more detailed information like the home's interior space, quality of construction of the home, sales prices of neighboring homes, etc. 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.

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.

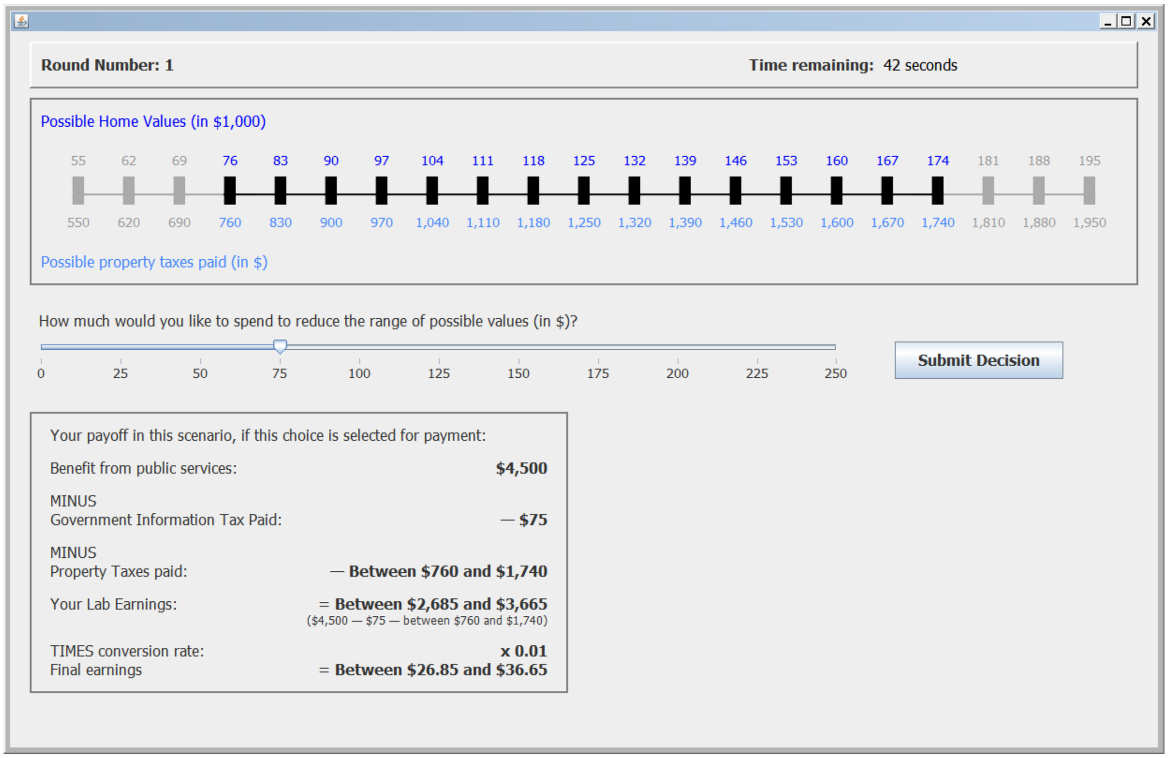
At that point, one of the possible assigned property values for your home and the associated property taxes, will be selected at random by the computer. There is an equal chance that any of the taxes shown on the screen will be selected. The amount shown will be subtracted from your INDIVIDUAL FUND.

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.

- 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.

<u>Instructions for the Next Set of Rounds</u> *[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 <u>and</u> 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.

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.

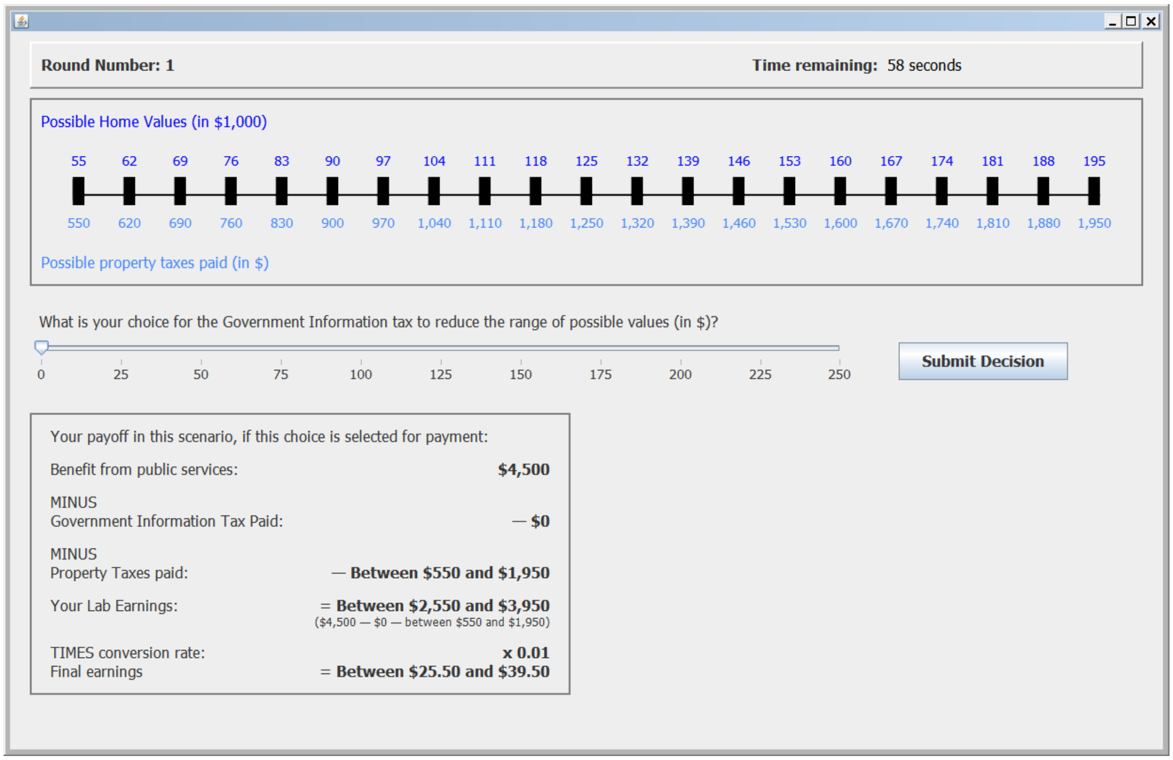
At the beginning of each round, you will see a range of possible assigned home values and the corresponding taxes you would pay for each home value. You will also see a “slider” that can be moved to indicate the per-group-member amount you would like yourself and your neighbors to spend to reduce the 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.

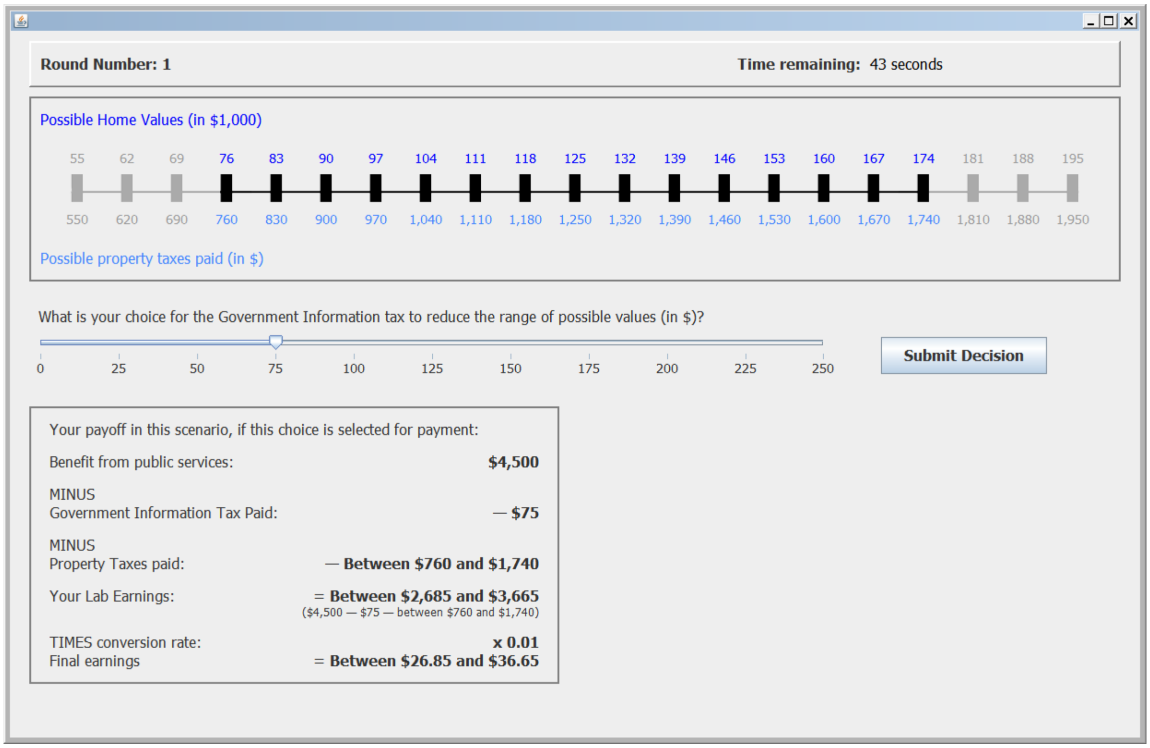
If the Government Information Tax that is selected by the group is not the level you proposed, the range of possible assigned property values will change to reflect the selected Government Information Tax.

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.



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.

Appendix B. Risk-Return Framework

In the case in which the individual pays a private firm to reduce the variance on the property tax, expected return is given by $I - (1 + \theta)E - P$ and risk (variance) is given by $(1 + \delta)V(P)$, where *I* is the endowment and the variance depends on *P*. The other terms are as defined in the text. Utility is thus given by $U\big(I - (1 + \theta)E - P, (1 + \delta)V(P)\big)$. The choice variable is *P;* let $P*$ be the utility maximizing value of *P*. We are interested in how changes in θ affects $P*$. Thus, we differentiate utility by *P* and θ, which yields

$$U_{P\theta} = -U_{1\delta} + V'U_2 + (1 + \theta)V'U_{2\delta}.$$

It is reasonable to assume that $U_{1\delta}$ is negative and that the second term on the RHS is positive. However, the sign of the third term is indeterminate, and thus we cannot sign the full expression. Thus, as with Figure 1, an increase in δ, could either increase or decrease $P*$, although we expect $P*$ will increase.