Public Acceptability and Land Value Taxation: An Experimental Economics Investigation

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Abstract

This research seeks to use economic experiments to investigate how different property tax institutions affect homeowners' investment behavior and whether land value taxation (LVT) is acceptable to homeowners and voters. The experiment is based on an economic model with heterogeneous households that was calibrated using a myopic optimal solution to satisfy two conditions that are associated with LVT theory: (1) that LVT would produce the greatest social welfare; and (2) that more households would lose from a change to LVT than would win and, therefore, LVT would be defeated by a voting mechanism. This model became the basis of an induced value experiment for 90 participants in six sessions. Experiment participants made property-investment decisions with interdependency through neighborhood land value capitalization and a revenue-neutral tax return. Using a between-subjects design, participants made decisions under uniform property tax, LVT, or split-rate taxation, and then a voting treatment. Surprisingly, the results of the experiments show that the land tax produced greater welfare than the uniform property tax in only half of the treatments, even though it was designed to produce one percent greater welfare. A statistical analysis of the choices shows that there were systematic over-investment patterns in the LVT treatment and among participants who were induced to have low preferences on improvement. The researchers argue this result is likely due to the positional-good characteristic of housing and the interdependency of land markets, which LVT will tend to enhance. The experiments also show that the participant-voters unexpectedly supported the land tax treatments. Although it is unclear whether the induced-value structure of this experiment—especially the heterogeneity in development preference—matches the real world, the results do suggest that the efficiency and acceptability of the land tax may be more complex than anticipated by economic models using entirely rational and simple profit-maximizing behavioral assumptions.

Keywords: Land Use, Property Taxation, Public Policy

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Introduction

Economists have long argued in favor of a pure land value tax (LVT) and its close cousin, a split-rate tax (SRT), because of their ability to raise revenue for public goods without distortions. Prior economic papers have found that LVT can generate more intensive capital investments, or improvements, to land (Banzhaf and Lavery 2010; Plassmann and Tideman 2000; Pollack and Shoup 1977). Benefits including attenuated tax distortions and increased investment have also been explored under a system of inaccurate assessments with positive results found for LVT (Chapman, Johnston, and Tyrrell 2009). Other papers examined whether imposing LVT may be regressive in real-world settings (Bowman and Bell 2008; Choi and Sjoquist 2015; England and Zhao 2005). Papers also investigated whether LVT can provide sufficient revenue (DiMasi 1987) and the extent to which it increases density in cities (Banzhaf and Lavery 2010; Brueckner and Kim 2003; Choi and Sjoquist 2015).

A provocative reaction to the intuitive benefits of and research findings on LVT was offered by Fischel (2015, 15), who asks, "If economists like (the land tax) so much, why does it seem so rare in practice?" The rarity of LVT must arise from more than its administrative challenges, such as assessment. Research on Pennsylvania suggests although SRT led to greater efficiency, few municipalities have adopted the tax and, surprisingly, some adoptees are returning to a uniform property tax (UPT) system (Banzhaf and Lavery 2010; Fischel 2015). Youngman (2016, 18) notes that land taxes have suffered from "administrative failures and lack of political support." There must be a perception among some that LVT is somehow "unacceptable." This paper explores the economic and political dimensions of LVT acceptability.

Bourassa (2009, 195–96) usefully articulated and explored the reasons why more jurisdictions have not adopted LVT:

1. It is a tax on unrealized capital gains, that is, wealth rather than cash flow;
2. It is difficult to administer and set rates;
3. It leads to too dense development, and thus requires careful planning;
4. It is a policy change that creates winners and losers, and losers will object; and
5. Most do not understand LVT.

Although all of Bourassa's (2009) reasons involve LVT acceptability directly or indirectly, three of the reasons (#2, #3, and #5) are professional and educational problems for planners. The other two reasons (#1 and #4), however, involve acceptability and have economic and political implications. The fact that it taxes unrealized capital gains may lead some to object to LVT on ethical or economic grounds. The fact that most of the United States currently raises local revenue with UPT means that a switch to LVT would be a policy change, which unavoidably would create "policy losers." Plummer (2009) explored the equity dimensions of LVT acceptability with both qualitative arguments and numerical examples. Plummer (2009) is especially focused on whether rejection of LVT arises from perceptions of horizontal and vertical inequity in terms of tax incidence.

In sum, this literature suggests that LVT acceptability depends on more than arguments about social efficiency or tax progressivity. LVT acceptability also depends on (1) whether those similarly situated in society are treated "the same" or "the same enough" to satisfy norms of fairness; and (2) whether those differently situated accept their differential burdens. Tax equity associated with cash flow, or income, is easier for the general public to observe and understand. Land capital inequities introduce a second "wealth" dimension upon which a tax policy is evaluated, and imperfectly observed. The public will likely be skeptical of LVT because it is more difficult to observe land capital differences and yet the tax rates will be "the same" and perceived to be vertically inequitable, on the face. As Fischel (2015, 17) wrote, "Pittsburgh rolled back its SRT system when people rejected the idea that owners in the same neighborhood pay the same taxes even when their houses are of different sizes. In other words, LVT does not seem vertically equitable because "people in larger houses should pay proportionately more." LVT acceptability becomes tied up with the positional-goods aspect of housing, and this produces an obstacle for acceptance. This paper incorporates the positional-goods aspect of neighboring houses into the experiments herein reported.

This paper contributes to the literature by offering what is to our knowledge the first economic experiment on LVT. The goals of this paper are (1) to test the social efficiency of LVT and SRT relative to UPT, or status quo, baseline; and (2) to examine the public acceptability of the LVT and SRT relative to UPT. Economic experiments are like a virtual, but simplified, world where an economic model can be tested and policy treatments can be compared. In this experiment, participants will take on the roles of different types of landowners making decisions about investing in their property (termed "improvements" in this experiment). Experimental economics techniques are ideally suited for studying LVT because there are limited instances of its adoption, the adoption of LVT is often incomplete (as is SRT), actual LVT policies do not vary as much as might be desired in empirical analysis, implementation is complicated by inaccurate assessments, and any one location only has one policy treatment. Lab experiments with induced value overcome all of these shortcomings, providing the researcher with control and allowing analyses that test causal hypotheses. Furthermore, compared with simulations, the experiment also allows for behavior to deviate from the simulated optimal, which enables the researchers to observe system dynamics arising from the propagation of suboptimal decisions made by humans. Experiments also have limitations, especially in that they are simplifications of real-world complexity. However, they offer evidence unavailable from empirical or theoretical research and thus can help planners and policy makers better understand the relative effectiveness of different policy options.

This experiment allows participants to make land investment decisions under LVT, SRT, and UPT tax regimes. Moreover, the choice of tax regime will become part of the experiment through a voting mechanism treatment. The votes will mimic the real world process of determining the acceptability of LVT. Using heterogeneous induced values, the experiment examines how different groups behave both in terms of landed wealth and income wealth. The experiment will reveal what types of groups "win" from LVT and what groups "lose." It also reveals whether winners and losers vote in their best interest or with respect to other concerns, such as equity. Thus, the research helps understand the acceptability of LVT and SRT relative to UPT in a controlled setting.

Methods

This section develops a theoretical basis for the experiments that will compare the performance of different land and improvement tax institutions. First, data are described in a real-world setting, which will provide many of the induced-value types for the experiment. Second, an economic model of improvement and consumption behavior is developed. A third subsection derives tax treatments for the experiment. Fourth, a solution strategy for the model is presented. Fifth, the experimental design is presented, combining the foregoing elements of the methodology section.

Contextualized Setting

The design started with a real-world setting; that is, participants in the experiment will make decisions and face incentives in the role of a representative property owner contextualized in an actual location. Harrisburg, Pennsylvania has an SRT system where land is taxed at 28.67 mills, while improvements are taxed at 4.78 mills, or a 6.0 ratio (Bourassa 2009). This setting provides the context for the decisions, and these data establish the "experimental dollar" values for the experiment. Table 1 reports the income and housing data collected on Harrisburg.

Table 1: Model Parameters Derived from Harrisburg, Pennsylvania

	Neighborhood Income Categories		
	Low	Mid	High
Property Value[a]	$49,200	$78,000	$169,100
Land Value[b]	$10,925	$17,320	$37,551
Improvement Value[b]	$38,275	$60,679	$131,549
Income[c]	$31,468	$49,930	$84,878

Source: Table values constructed by authors using the following data sources:

[a] Data come from three Census Tracts (213, 217, 219) in Dauphin County, Pennsylvania, measuring the high/low and middle extremes in the Harrisburg area. The U.S. Census (2016a) measure is median value of owner occupied housing units from the 2005–2009 American Community Survey 5-year estimates.

[b] Land and improvement values were imputed from the Census housing data. Specifically, the City of Harrisburg reports (The Center for the Study of Economics 2016) in their millage rates that the total taxable assessed value, *PV*, for land is $357,997,500 and the taxable value of improvements and buildings is $1,254,150,100. Thus, the ratio of improvements to land values is IV/LV=ß=3.503. These data are used to apportion housing value into land and improvement value.

[c] Data on median household income (2010–2014) come from three Census Tracts (213, 217, 219) in Dauphin County, Pennsylvania, as with housing value (U.S. Census 2016b).

During the initial design of the experiment, the researchers found that the differences in income were too extreme, leading to too high earnings for the high-income types and a lack of a salient treatment effect. As a result, the researchers reduced the income values in table 1 by 50 percent in the final parameterized version of the experiment.

Economic Model

The model allows utility-maximizing landowners to allocate their income to improvements and other consumption in an experimental environment. The experiment is contextually framed[1], and there is a complex, dynamic interdependence among landowner decisions that warrants the use of experiments. Although landowners face choices within each period, their decisions will affect their future status and that of their neighbors through the evolution of their property values. The two mechanisms of interdependency are a capitalization externality and tax redistribution.

The community consists of 15 households, *i*, and heterogeneity is introduced with three “neighborhood” types and five individual utility types. There are five households in each of three neighborhoods with low, middle, and high incomes and housing values (k=L,M,H). Census data from table 1 parameterizes income, I_i^k, and property value, PV_i^k. Property values sum land value and improvement value, $PV_i^k = LV_i^k + IV_i^k$, and they are apportioned following the observed averages in the Harrisburg, Pennsylvania assessment of these two measures: ß=IV/PV=3.503. Observed data therefore define three initial type variables (I_i^k, LV_i^k, IV_i^k), which are different for each neighborhood, *k*.

Utility is defined by choices of two goods, to which the participants devote their entire income: investment in property improvements, x_{it}, and a normalized consumption good, y_{it}. The Cobb-Douglas utility function represents a change in monetized utility from the status quo:

(1) $$U_{it} = x_{it}^{a}\, y_{it}^{1-a}$$

Assigning five values of a utility parameter, a=(0.2, 0.25, 0.3, 0.7, 0.8) to each member of a neighborhood induces additional heterogeneity. When combined with three income types, the five utility types result in 15 unique types in the experiment.

The dynamics in this model are simplified, and the variable x_{it} represents the perpetuity of impacts arising from any investment during period *t*; for instance, if a household adds a bedroom, then that bedroom provides a stream of benefits into the future. This stream of benefits has a present value represented by the improvement choice raised to the *a* parameter.[2]

The choice variable y_{it} captures all consumption and savings within a period, net of taxes, that do not involve the improvement of *i*’s property. So, optimal choices (x_{it}, y_{it}) will exhaust the net

[1] This is a game that could be neutrally framed in future research. This neutral frame might have a consumer receive an endowment in every period and decide how to allocate shares to two accounts. In the neutral frame, one account might provide current consumption while a second provides for future consumption. The tax rate varies on these two consumption allocations. The neutral-framing innovation would be that the choice of future consumption produces an externality to the tax rate. The question is, how do the tax rates affect consumption decisions over time?

[2] Consider that if someone invests $100 in improvements, then they must expect at least that much monetized utility as a stream of benefits. For instance, if the improvements create $5 in extra benefits per year and the discount rate is 0.05, then the perpetuity is $100=$5/0.05. To simplify this model, we assume that the monetized utility is exactly equal to the cost of the improvements.

income, and thus the participant's optimal choice x_{it} will determine the other optimal choice y_{it}. This approach isolates the choice of improvement for the experiment participant.

Improvements to the property trigger two types of impacts. First, the individual making the improvements produces an impact that is entirely internal to the decision maker. Improvements today trigger a perpetuity of benefits that will increase the owner's improvement value:

(2) $$IV_{it}^{k} = IV_{it-1}^{k} + x_{it}^{k}$$

Second, improvements trigger a neighborhood impact that is external and captures the fact that improvements to one property get capitalized in the neighbors' land values because the neighborhood has become "nicer":

(3) $$LV_{it}^{k} = LV_{it-1}^{k} + g\sum_{i} x_{it}^{k}$$

Gamma is parameterized as a small number, 0.05, that measures positive pecuniary externalities; however, because this model (as explained below) will have no salvage value, this effect results in a negative externality because of increased taxes. No measures of this effect were found during a review of the hedonic real estate literature. However, higher levels of investment in improvements ought to produce externalities within the neighborhood, which are capitalized as higher land values. This is one of two key mechanisms for interdependency in the treatments. In other words, one party optimizing can increase the land value for and thus the tax paid by their neighbors.

The internal and external processes (equations 2 and 3) mean that when one person in a neighborhood invests in improvements, that household's improvement values will rise, but all households' land values in the same neighborhood will rise too. This externality combined with idiosyncrasies in the experiment—the participants are endowed with an initial house value and there is no "cashing out" or salvage value at the end of the treatment—means that this model has an interdependency that is analogous to a congestible multilateral externality.[3] In other words, one participant improving property provides that participant with a benefit (via the utility function), but the neighbors only bear a cost (via the tax on LV_{it}^{k}) from that decision. Of course, the decision maker also bears some of the increased tax cost via LV_{it}^{k} and IV_{it}^{k}. Because all the neighbors follow this process, equations (1), (2), and (3) have the characteristic of a multilateral externality. Dynamically, the externality in the form of the tax on LV_{it}^{k} continues to accrue in each period, mimicking the artifact of taxing unrealized capital gains noted in Bourassa (2009). Obviously, these externalities are expected to accrue differently under different tax treatments. LVT ought to provide a greater degree of interdependency because all the tax will fall on the LV_{it}^{k} measure rather than only a portion of the tax under UPT. The impact of SRT ought to fall between the extremes of LVT and UPT.

[3] This model has few classic elements of dynamic optimization because of a desire to ensure experiment participants understood their incentives and to focus on the variables of interest. The endowment is freely provided, but there is no salvage value. There is no discounting. There is a definite end period announced at the start of each treatment.

Tax Institutions

The initial set of hypotheses test whether improvement investments change under different tax regimes. Let the UPT rate be τ_0 on both land and improvement. This means that UPT tax revenue will be $\sum_i \tau_0(LV_{it} + IV_{it})$. SRT revenue comes from a tax τ_L on land and τ_I on improvement. The total SRT revenue will be $\sum_i(\tau_L LV_{it} + \tau_I IV_{it})$. If the LVT rate is τ_{LL} on land, with no tax on improvements, then the LVT revenue will be $\sum_i(\tau_{LL} LV_{it})$. Note that the model assumes that property tax is calculated and fulfilled at the end of each period after all households make their improvement decisions. In other words, property taxes are levied on the updated property value at the conclusion of a period.

Revenue neutrality at the beginning of the game will be controlled so tax regimes are comparable across all periods. This is done by collecting the same revenue in every period: $\sum_i \tau_0(LV_{i0} + IV_{i0}) = \sum_i(\tau_L LV_{i0} + \tau_I IV_{i0}) = \sum_i(\tau_{LL} LV_{i0})$.[4] To solve this function, $\beta * LV_{i0} = IV_{i0}$ (as described in table 1), which allows substitution and simplification and results in the following revenue neutrality condition:

(4) $$\tau_0(1+\beta) = (\tau_L + \beta\tau_I) = \tau_{LL}$$

Using data in Bourassa (2009), Harrisburg has used the following rates in their SRT regime: τ_L =0.02867, τ_I =0.00478. As table 1 reports, β=3.503. Thus, the revenue neutral tax rates can be calculated for the other treatments: τ_{LL}=0.045414 and τ_0=0.010085. To enhance the treatment effect, these rates were all multiplied by 10.

To achieve revenue neutrality as improvement values, and thus tax revenue rise, all tax above the initial period baseline tax of $149,409 will be returned in equal shares to each participant within the same period that the tax is collected:

(5^{UPT}) $$TR_{it}^{UPT} = (\sum_i \tau_0(LV_{it} + IV_{it}) - 149{,}409)/15$$

(5^{SRT}) $$TR_{it}^{SRT} = (\sum_i(\tau_L LV_{it} + \tau_I IV_{it}) - 149{,}409)/15$$

(5^{LVT}) $$TR_{it}^{LVT} = (\sum_i(\tau_{LL} LV_{it}) - 149{,}409)/15$$

This equal return of excess revenue is the second major interdependency in the model. This form of tax return is progressive because the higher-income neighborhoods will have higher-valued improvements and thus pay higher tax. In other words, the equal redistribution of excess taxes will be a transfer from high to low income. This interdependency therefore links the decisions of all 15 types in the model in contrast to the externality interdependency, which only affected the five neighbors within each neighborhood. This model has no tax on consumption so as to focus on the improvement choice.[5]

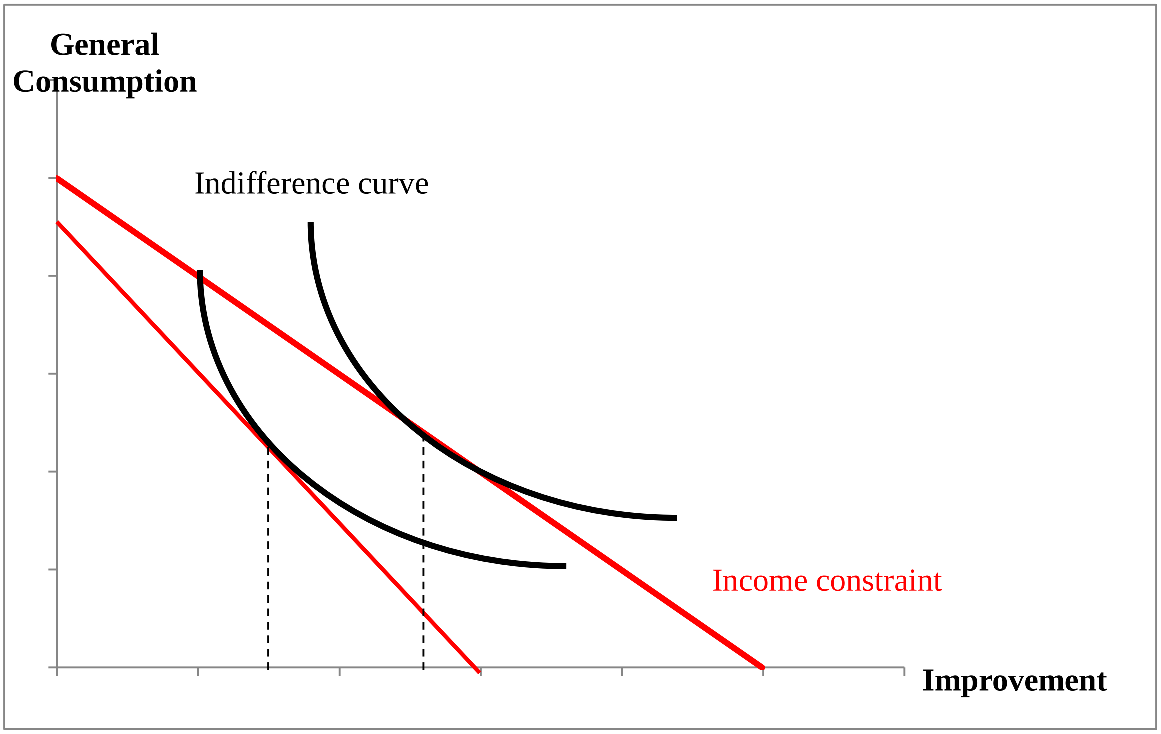
[4] LV_{i0} and IV_{i0} stand for initial land and improvement value, which are parameterized using data in table 1.

[5] Adding a tax on consumption ought not to change the results or the treatment effect. The paper concerns how property taxes change affect behavior. A consumption tax ought to work as a constant in the budget constraint, and thus its absence or inclusion should not affect the results. If a consumption tax has a redistribution effect, it will have an income effect.

Optimal Decisions and Dynamics

The utility function creates indifference curves as in figure 1. The preference parameter, *a*, determines the shape of indifference curve. The tax rate determines the slope of the income constraint. The three incomes determine three budget constraints. Figure 1 shows two example optimal bundles of (x_{it}, y_{it}).

Figure 1: Utility Maximization under an Income Constraint



Source: Original work by authors.

When the tax treatment changes, it affects both optimal choice and utility level in two ways. First, it changes the slope of the income constraint (substitution effect). Second, it changes the net-income level to be spent on improvement and general consumption (income effect). Figure 1 is an example of a household with high *a* value. When tax changes from UPT to LVT, they pay less tax, so they have higher net income to dispose of between improvement and general consumption (income effect). The constraint curve also gets flatter, which further shifts optimal improvement to a higher level (substitution effect). As the income effect and the substitution effect can move in different directions, the net change in the optimal bundle, and thus optimal improvement choice x^*, is determined by the two effects.

In each period, the experiment participants will make decisions about improvement and consumption. The constraints on their utility maximization problem are that they spend all of their net income on the two goods, for in this model there is no benefit or ability to save. Their net income is their gross income minus property tax plus their tax return. This model lends to one obvious solution approach: A myopic optimality problem in which participants only optimize within a period. Although the model is dynamic in the sense that there are multiple periods, the myopic solution strategy is the clearest to understand and communicate to experiment participants. Further, the experiment decisions were framed consistently as a myopic problem because, otherwise, confusion about the dynamic structure would introduce another form of error into decision making and thereby confound the other aspects of the treatments that are the focus of this research.

Here are the three objective functions for myopic optimization under three tax regimes:

$$(6^{UPT}) \qquad \max_{x_{i\underline{t}}}: UP_{i\underline{t}}=x_{i\underline{t}}^{a}y_{i\underline{t}}^{1-a}$$
$$\text{s.t.} \quad y_{i\underline{t}}=I_{i\underline{t}}^{k}-\tau_0(LV_{i\underline{t}}^{k}+IV_{i\underline{t}}^{k})-x_{i\underline{t}}+TR_{i\underline{t}}^{UPT}$$

$$(6^{SRT}) \qquad \max_{x_{i\underline{t}}}: UP_{i\underline{t}}=x_{i\underline{t}}^{a}y_{i\underline{t}}^{1-a}$$
$$\text{s.t.} \quad y_{i\underline{t}}=I_{i\underline{t}}^{k}-(\tau_L LV_{i\underline{t}}^{k}+\tau_I IV_{i\underline{t}}^{k})-x_{i\underline{t}}+TR_{i\underline{t}}^{SRT}$$

$$(6^{LVT}) \qquad \max_{x_{i\underline{t}}}: UP_{i\underline{t}}=x_{i\underline{t}}^{a}y_{i\underline{t}}^{1-a}$$
$$\text{s.t.} \quad y_{i\underline{t}}=I_{i\underline{t}}^{k}-\tau_{LL}LV_{i\underline{t}}^{k}-x_{i\underline{t}}+TR_{i\underline{t}}^{LVT}$$

In equation (6), $\underline{t}$ stands for optimizing within any given period—hence the myopic optimality condition. To solve for the myopic optimal, equations (2) and (3) are substituted into the objective functions in equation (6).[6] For example, the solution to the UPT objective function: household *i*'s land value is affected by the improvement choice of other households within that household's neighborhood, which after substitution reveals an unconstrained maximum:

$$(7) \qquad \max_{x_{i\underline{t}}}: UP_{i\underline{t}}=x_{i\underline{t}}^{a}[I_{i\underline{t}}^{k}-\tau_0(LV_{i\underline{t}}^{k}+IV_{i\underline{t}}^{k})-x_{i\underline{t}}+TR_{i\underline{t}}^{UPT}]^{1-a}$$

The first order condition gives the optimal value of $x_{i\underline{t}}$ as:

$$(8) \qquad x_{i\underline{t}}^{UPT*}=\frac{a}{(1+\tau_0)}[I_{i\underline{t}}^{k}-\tau_0(LV_{i\underline{t}-1}^{k}+g\Sigma_i\, x_{-i\underline{t}}^{*}+IV_{i\underline{t}-1}^{k})+TR_{i\underline{t}}^{UPT}]$$

which can be substituted into the income constraint to get:

$$(9) \qquad y_{i\underline{t}}^{UPT*}=(1-a)[I_{i\underline{t}}^{k}-\tau_0(LV_{i\underline{t}-1}^{k}+g\Sigma_i\, x_{-i\underline{t}}^{*}+IV_{i\underline{t}-1}^{k})+TR_{i\underline{t}}^{UPT}]$$

The same method solves for the myopic optimal choices under SRT and LVT as:

$$(10) \qquad x_{i\underline{t}}^{SRT*}=\frac{a}{(1+\tau_I)}[I_{i\underline{t}}^{k}-\tau_L(LV_{i\underline{t}-1}^{k}+g\Sigma_i\, x_{-i\underline{t}}^{*})-\tau_I IV_{i\underline{t}-1}^{k}+TR_{i\underline{t}}^{SRT}]$$

[6] Without considering the best response to the two interdependencies, the dynamic optimal choice, taking future tax into consideration, should be shaded lower than the myopic optimal in all periods except the last period. In the last period, the myopic solution should be optimal because there is no future period and no salvage value.

$$y_{it}^{SRT*}=(1\text{-}a)\,[I_{it}^{k}-\tau_L(LV_{it-1}^{k}+g\Sigma_i\, x_{-it}^{*})-\tau_I IV_{it-1}^{k}+TR_{it}^{SRT}] \quad (11)$$

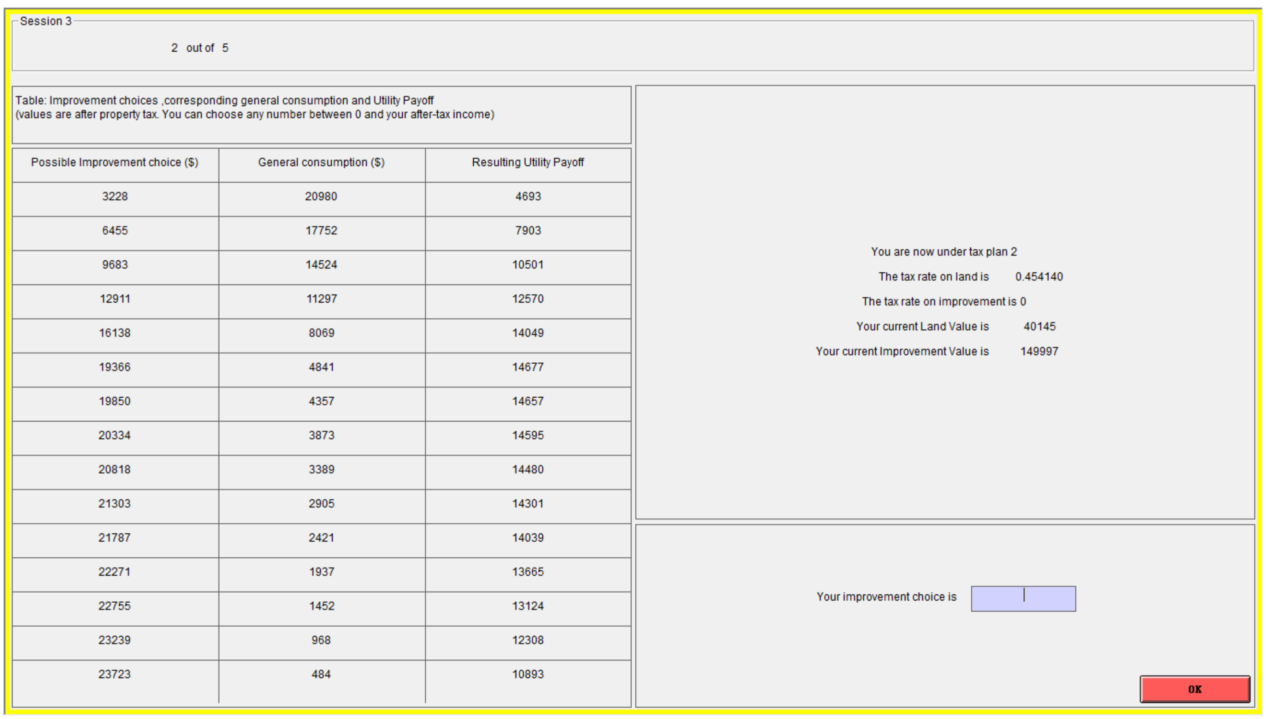
$$x_{it}^{LVT*}=a[I_{it}^{k}-\tau_{LL}(LV_{it-1}^{k}+g\Sigma_i\, x_{-it}^{*})+TR_{it}^{LVT}] \quad (12)$$

$$y_{it}^{LVT*}=(1\text{-}a)\,[I_{it}^{k}-\tau_{LL}(LV_{it-1}^{k}+g\Sigma_i\, x_{-it}^{*})+TR_{it}^{LVT}] \quad (13)$$

Experimental Design

This subsection describes how the preceding model was operationalized in the experiment. Experiment participants made one decision of investment in improvements in each period. This decision was very complex because of the mathematics of solving a nonlinear objective function, interdependencies with other participants' decisions via the gamma parameter and the tax return, a lack of information about other participants' contemporaneous decisions, and the challenge of optimizing dynamically. So, the researchers presented a calculation aid and information on the decision screen. Figure 2 is an example screenshot. The calculation aid is the table of possible improvement choices, each of which would result in a corresponding general consumption decision and a utility payoff (or cash earnings in experimental dollars).[7]

Figure 2: Screenshot of Decision Screen



Session 3

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Table: Improvement choices ,corresponding general consumption and Utility Payoff
(values are after property tax. You can choose any number between 0 and your after-tax income)

Possible Improvement choice ($)	General consumption ($)	Resulting Utility Payoff
3228	20980	4693
6455	17752	7903
9683	14524	10501
12911	11297	12570
16138	8069	14049
19366	4841	14677
19850	4357	14657
20334	3873	14595
20818	3389	14480
21303	2905	14301
21787	2421	14039
22271	1937	13665
22755	1452	13124
23239	968	12308
23723	484	10893

Source: Original programming by authors in z-Tree (see Fischbacher 2007)

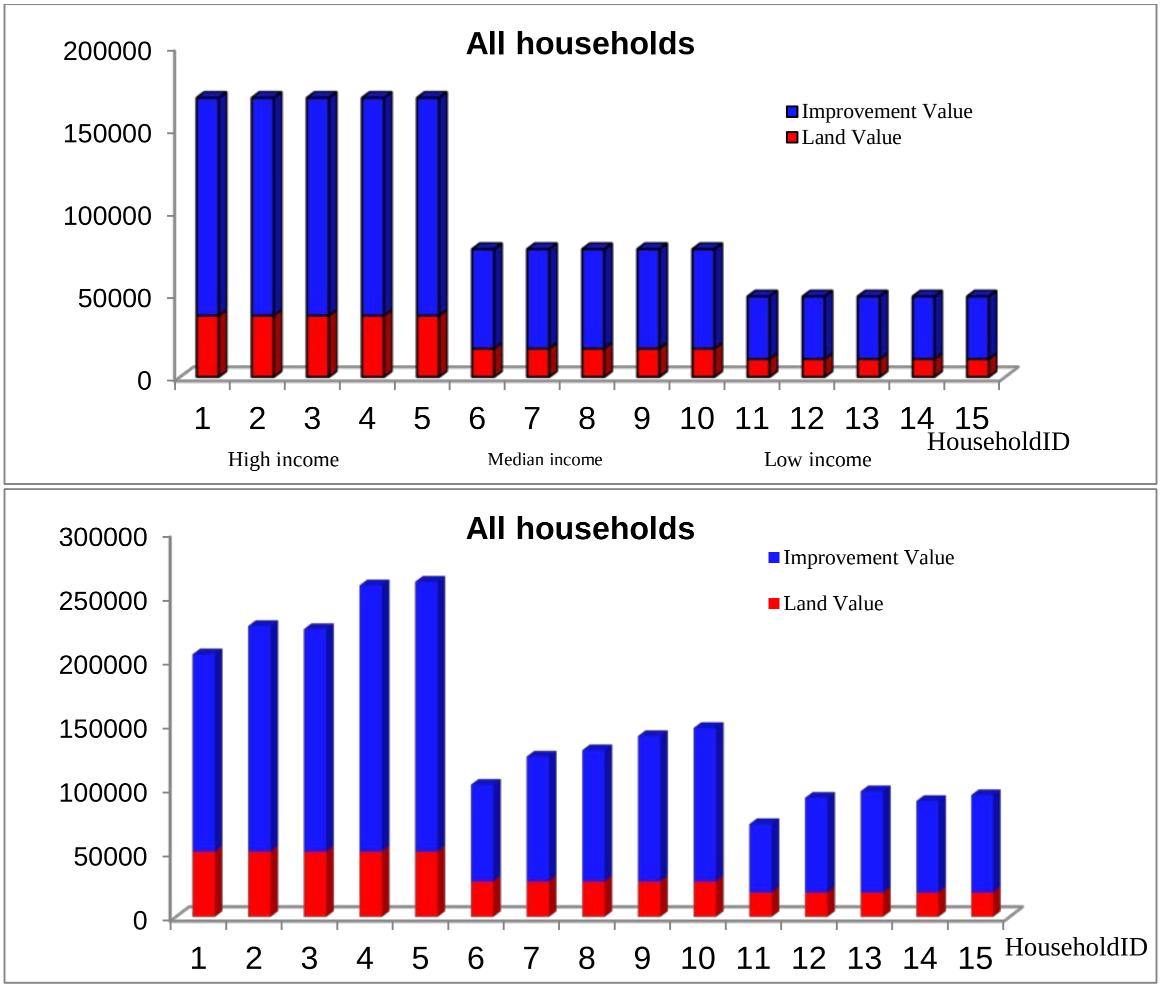
[7] The administrator computer systematically selected the values in this table in each period by first identifying the myopic optimal choice and then distributing other values across the support of income. One important simplification was that the calculations assume that the other participants made a choice of no improvements rather than a multilateral myopic optimality choice. This simplification was done so as not to impose any restriction of assumed behavior on the participant choices, but this design choice had little substantive effect because it is highly deflated by the gamma and tax parameters.

Participants received a recorded instructional presentation and then were trained over a two-period UPT-treatment practice session. Then, participants made 15 improvement choices over three different treatments. Participants in all treatments started with the UPT baseline treatment over five periods. UPT was termed “tax plan 1” in all sessions. A between-subjects design was used. The design split four sessions into LVT treatments while two other sessions saw SRT treatments (termed “tax plan 2”). The second treatment started with one period of UPT, and then the experiment administrator announced that the tax regime was changing from tax plan 1 to 2, and choices were made in this new treatment for four more periods.

The third treatment was exactly like the second, except after every improvement choice under LVT or SRT (periods 2–5), the participants would then vote to continue under LVT or SRT or revert to UPT. To aid in this decision, participants were told what their tax impact was under LVT or SRT and what it would have been in the alternate state of the world, UPT. This allowed for a precise comparison of the land tax treatment and the UPT treatment. At the end of each period, the votes were tallied and, if eight or more voted against LVT or SRT, then the remaining periods would be conducted under UPT and voting would be suspended.

The researchers believe that there will be two key drivers of this voting decision. First, participants ought to vote in their own self-interest, selecting the tax treatment that will provide them with the highest earnings. The second driver was more challenging to design in the experiment. Some participants also may believe that they are “positional good losers” under SRT or LVT or that these land taxes are somehow unfair. This belief arises from the literature cited in the introduction, which argued that some feel that they should not pay the same or near the same tax as a neighbor with a bigger house or more improvements. The researchers sought to include this effect; that is, a trigger for positional-good “jealously” or norms. The final design included a graphical representation of housing size (see figure 3).

Figure 3: Initial Value and Changed Values of Taxable Parameters (Housing-Size Graph)



Source: Original work by authors.

Figure 3 provides a graphical display of the properties, which was updated in every period. Each neighborhood started at the same initial value for improvements and land value. These values were displayed as blue and red bars, where the height corresponded to the value (see figure 3). After each period's choices were made, improvement values would evolve according to those choices. The land values would also evolve according to the capitalized externality, termed "nicer-neighborhood effect" for the participants (equation 3). The experiment had one lab assistant whose sole responsibility was to take the choices made in each period and construct a corresponding graph of this information in a spreadsheet, which would then be displayed to all participants before the next period's decisions would be made. The assistant could do this, via linked databases, in approximately 20–30 seconds. The purpose of this graph was to trigger the positional goods elements of housing.

Data and Hypotheses

This section describes the simulated data derived from the experimental model because these results will be the basis for the hypotheses and comparison to the experiment data. Then, details on the experiment data collection are presented. Finally, the hypotheses are described. Both simulated and experimental data come from the same interface. Data were collected at the University of Delaware's Center for Experimental and Applied Economics. The z-Tree software was used (Fischbacher 2007). Fifteen tablet computers were linked to the administrator computer.

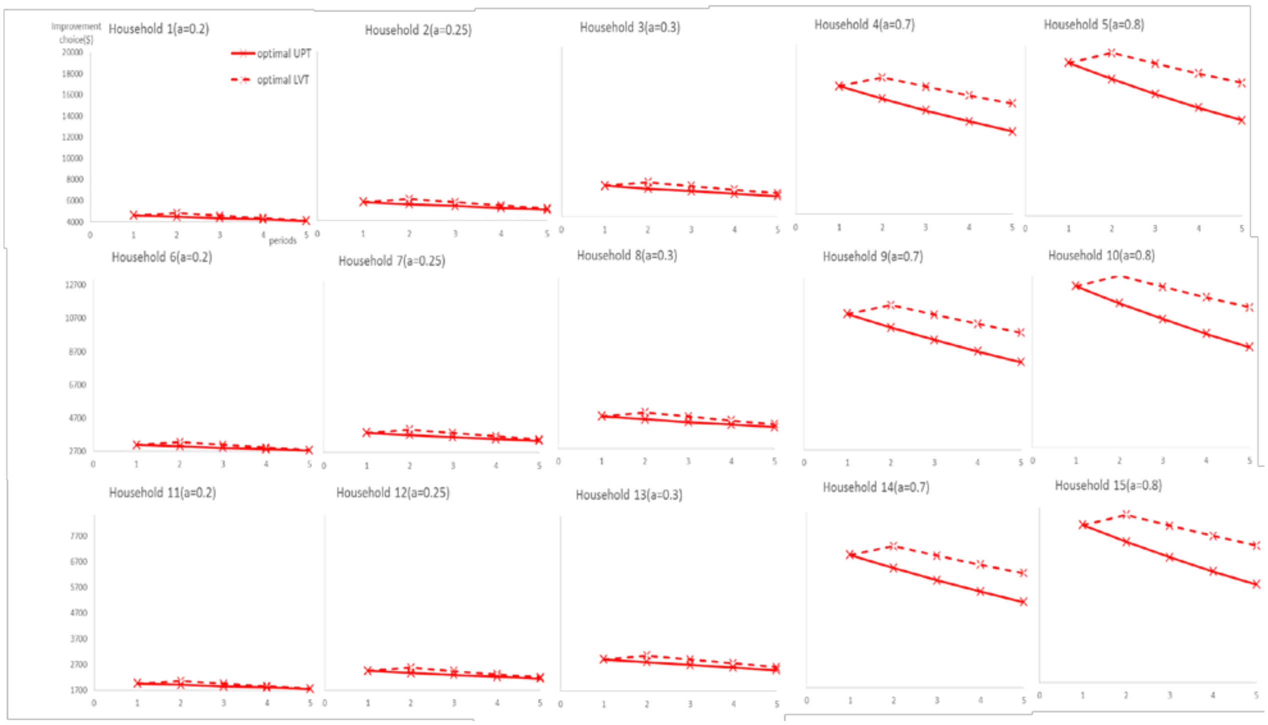
Simulated Optimal Data

The researchers designed the experiment over many iterations to create a salient treatment effect. Specifically, the researchers would make "approximately myopic optimal" choices on the tablet computers as if participants were in the laboratory. These decisions were "myopically optimal" in that they were derived using calculus within a given period as described in the methods section—they were not dynamically optimal. They were "approximate" in that they were agnostic about the behavior of other participants within a period (see footnote 7). Using this decision rule, the researchers were able to examine the performance of the system under the different treatments. The simulated results have an optimal improvement choice in each period for each type for each treatment: $x_{it}^{k,Z*}$, for i=1,…,5; k=L,M,H; t=1,…,5; Z=UPT,SRT,LVT. These optimal choices for UPT and LVT are displayed in figure 4.

Figure 4 shows that, within each neighborhood, households with higher *a* value (*a*=0.7, 0.8) choose higher improvement compared to households with lower a value (*a*=0.2, 0.25, 0.3). Also, LVT results in all households initially increasing their improvement levels, but then improvement choice drops in following periods. Overall, the change to the LVT treatment has a much bigger effect on households with higher *a* value.

Under LVT, households with higher *a* values reduce improvement levels faster than households with lower *a* value. This is consistent across different neighborhoods (different income and initial property value). In addition, households with lower *a* values reduce their improvement levels more under LVT than under UPT. Although LVT is tested for only four periods, decisions under LVT would go lower than UPT if more periods were simulated. On the other hand, for household with higher *a* value, the decision trend curve is flatter under LVT than that under UPT.

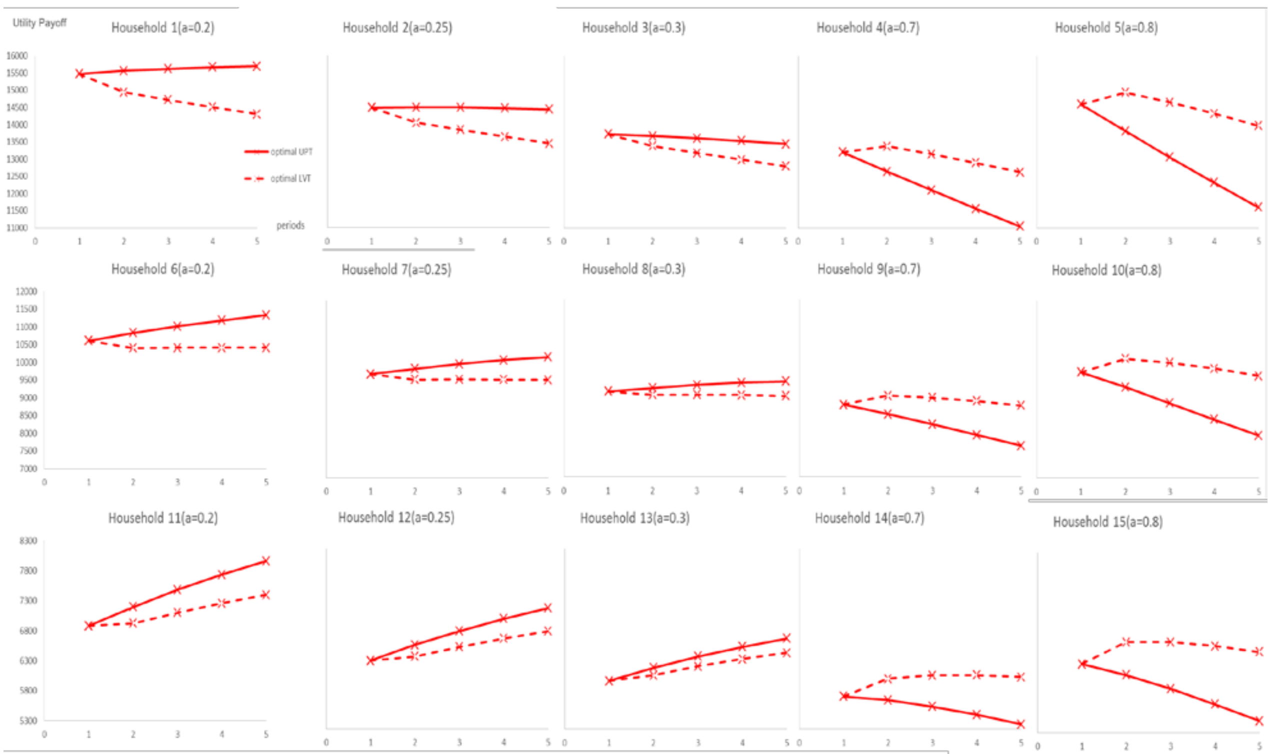
Figure 4: Simulated Optimal Behavior by Period



Source: Original work by authors. First row is the high-income neighborhood followed by mid- and low-income.

The simulation also reveals the evolution of property values ($PV_{i\underline{t}}^{k,Z*}$) (not reported) and a period-specific welfare measure termed "utility payoff": $UP_{i\underline{t}}^{k,Z*}$ (see figure 5). This welfare measure can be aggregated by individual type over five-period treatments ($UP_i^{k,Z*}=\Sigma_{\underline{t}} UP_{i\underline{t}}^{k,Z*}$) and over the entire community ($UP^{Z*}=\Sigma_i\Sigma_{\underline{t}} UP_{i\underline{t}}^{Z*}$).

Figure 5: Simulated Optimal Welfare Results by Period



Source: Original work by authors. First row is the high-income neighborhood followed by mid- and low-income.

Figure 5 shows that the welfare, or "utility payoffs," of households with higher *a* values is higher under LVT than UPT. In contrast, utility payoffs of households with lower *a* values are lower under LVT than UPT. This figure also shows that the slopes on low income are going up for some because of redistribution. Under LVT, the low-income households are mostly getting consistently better off. The mid-income range is stable in terms of welfare. It is the high-income households that almost always get worse off over time because of the progressive tax redistribution.

The experiment was designed so that it was a potential Pareto Improvement but not a Pareto Improvement; that is, that the community would be wealthier under a land tax (LVT or SRT), but that there would be policy "losers." In fact, the number of losers outweighs the number of winners so that the predicted votes would be against LVT. This required that two conditions be met when optimal choices are made. First, the three low-improvement-preference types would have lower welfare at every period and in total under LVT or SRT than under UPT:

$$UP_{i\underline{t}}^{k,UPT*} > UP_{i\underline{t}}^{k,-UPT*}, \text{ for } i=0.2,\ 0.25,\ 0.3, \text{ for all } t.$$

Conversely, the two high-improvement-preference types would have higher welfare at every period and in total under LVT or SRT:

$$UP_{i\underline{t}}^{k,-UPT*} > UP_{i\underline{t}}^{k,\ UPT*}, \text{ for } i=0.6,\ 0.7, \text{ for all } t.$$

This first constraint ensured that the predicted vote in a LVT or SRT treatment would always be nine to six in favor of returning to UPT from LVT or SRT.

The second condition was that the community (society) would be better off under LVT or SRT than under UPT. This required that the winners from the land tax (the two high-improvement-preference types) win more than the losers lose (three low-improvement-preference types):

$$UP^{-UPT*} > UP^{UPT*}.$$

In simulations, the researchers found that the sum of welfare was 1 percent greater under LVT over UPT and 0.5 percent greater under SRT over UPT.

Experiment Data

Participants were largely drawn from a pool of undergraduate business and economics majors, though some students were recruited from engineering and environmental social science majors when sessions were difficult to fill. The University of Delaware Institutional Review Board approved the experiment protocol.

Each session lasted 1.5 to 2 hours. Average session earnings for one participant were $17.53–$18.82, and the individual earnings varied from $14.00 to $20.50. Earnings potential varied by induced values, so subjects were rotated through types systematically to produce approximately equal expected earnings. Specifically, each participant drew a ball at the start of the experiment with three numbers that assigned the participant's types over the three treatments. The experimental dollars in the interface were converted to U.S. dollars at a rate of 7,900:$1.

Four sessions of the LVT treatments and two sessions of the SRT treatments were conducted. The structure of the data mirrors the simulated data. Improvement choices (N=450) are observed in six initial sessions under the UPT treatment: $x_{it}^{k,UPT}$, for i=1,…,5; k=L,M,H; t=1,…,5. Then, the four LVT treatments produce N=300 choices and the two SRT treatments produce N=150 choices: $x_{it}^{k,LVT}$, for i=1,…,5; k=L,M,H; t=1,…,5 and $x_{it}^{k,SRT}$, for i=1,…,5; k=L,M,H; t=1,…,5. All (N=900) decisions above have corresponding welfare measures ($UP_{it}^{k,Z}$). Finally, the voting treatments produced another N=300 decisions under LVT and N=150 decisions under SRT, plus votes: $v_{it}^{k,Z}$, for i=1,…,5; k=L,M,H; t=2,3,4,5. However, if the votes in period 2, 3, or 4 were in favor of UPT, then any subsequent votes were not observed because the tax regime irrevocably switched back to UPT.

Hypotheses

The simulated optimal results provide the hypotheses for the experimental data. Table 2 provides the most significant hypotheses. In general, the hypotheses suggest anticipated results where LVT produces a wealthier society than UPT, but that more households lose from LVT than UPT (because of the induced values).

Table 2: Hypotheses for the Experiment

Hypotheses for LVT (SRT omitted)	Support in Simulation	Support in Experiment
LVT increases community investment (measured as property values) relative to UPT	Yes	Yes
LVT increases social welfare relative to UPT	Yes	No. LVT generated higher social welfare in half of the experiment sessions
LVT increases investment in near term but this impact dissipates over time for the "low preference" households	Yes	Yes. But "low preference" households over-invested
Households vote against (for) LVT when they observe higher (lower) tax compared to UPT	Yes	Some support, but some failures
LVT can generate sufficient tax revenue (tested as positive tax growth)	Yes	Yes

Source: Original work by authors.

Results

This section first presents the experiment results on the community-level welfare and property value impacts of the treatments. Then, the behavioral results on improvements and voting are presented.

Results on Social Welfare and Community Characteristics

Table 3 reports the aggregate welfare by treatment for all fifteen participants in each of the six sessions (UP^{Z}). The table also presents the simulated optimum as an efficiency frontier for comparison. The results are surprising in that they show that no session was completely efficient. However, the SRT sessions were the closest to the efficiency frontier. Surprisingly, LVT outperformed UPT in only two of four sessions, even though LVT was designed to be one percent more efficient. Similarly, SRT outperformed UPT in one of two sessions. These experimental data thus do not uniformly support the hypothesis on aggregate welfare, which was derived from the simulation.

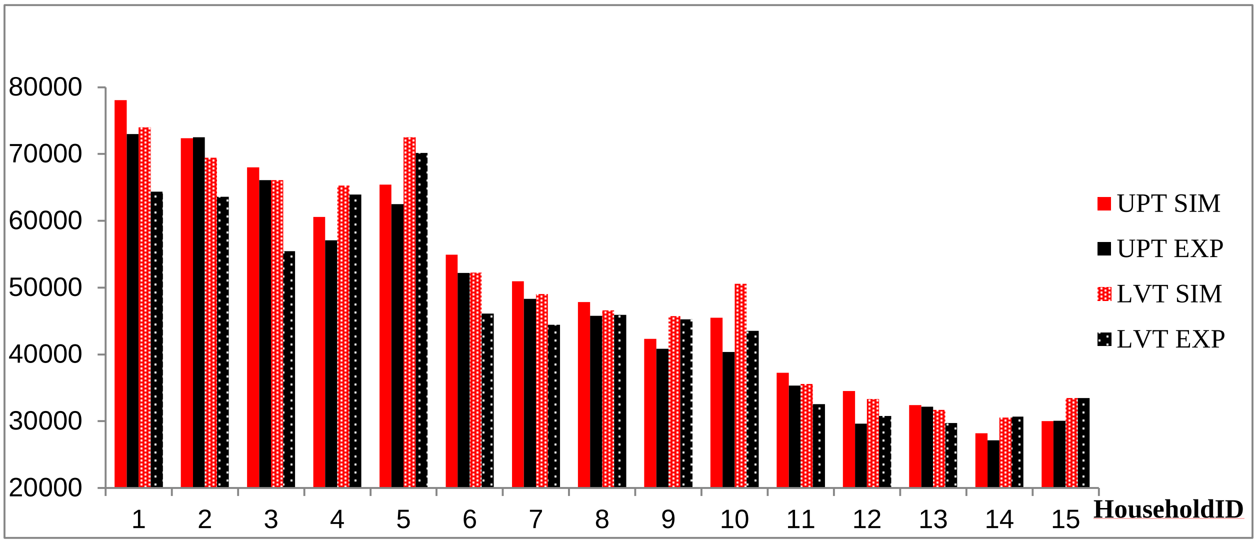
Table 3: Experimental Results Aggregate Welfare by Treatment

	Uniform Property Tax (UPT)	Land Tax (LVT)	Change in Welfare from LVT (%)	Split-Rate Tax (SRT)	Change in Welfare from SRT (%)
Simulation	$748,379	$755,991	1.02%	$752,637	0.57%
Session 1	$715,513	$674,928	-5.67%		
Session 2	$713,971	$717,869	0.55%		
Session 3	$705,417	$726,227	2.95%		
Session 4	$717,052	$680,954	-5.03%		
Session 5	$745,177			$739,355	-0.78%
Session 6	$743,536			$744,278	0.10%

Source: Original work by authors.

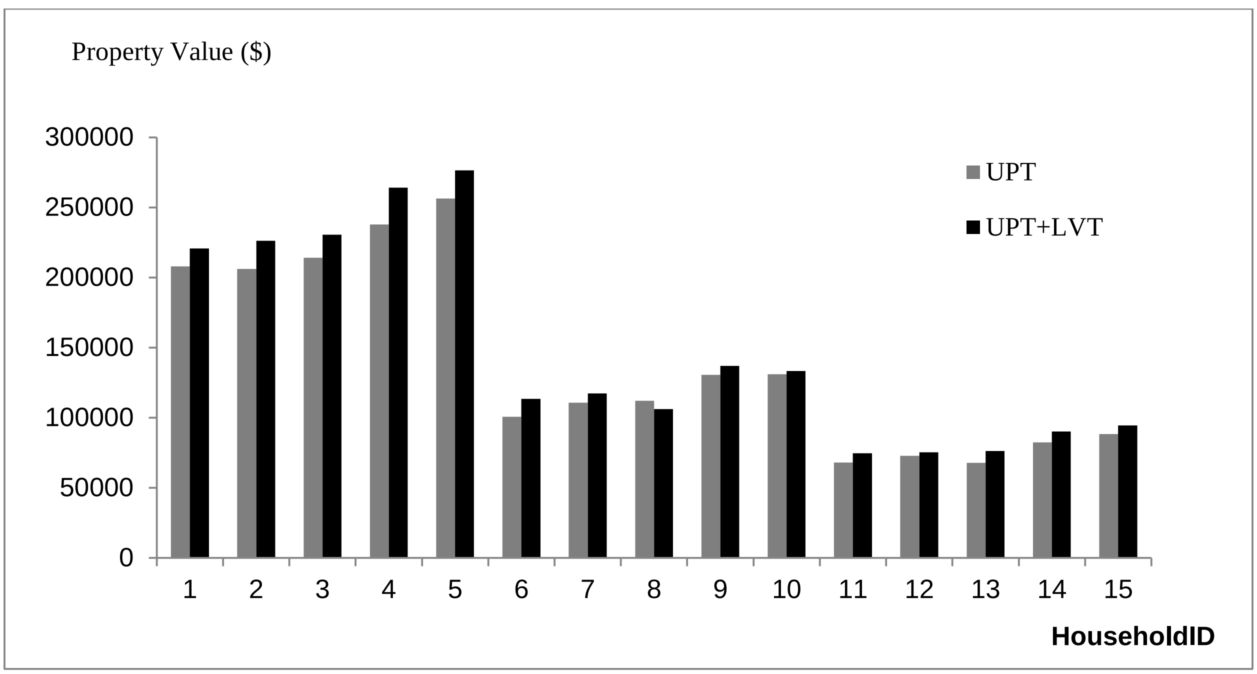
The welfare results can be examined by averaging over type. Figure 6 shows the simulated and experimental results (averaged over four sessions) for the fifteen types, comparing LVT and UPT. The figure shows that the experimental results (in black) are almost always lower than the simulated results (in red, immediately to the left). This means that the experimental sessions were not fully efficient, regardless of treatment. For the low-improvement-preference types, seven of nine times the LVT treatment effect in the experiment was negative, meaning that these types had lower average earnings under LVT than UPT. This was expected to be true for all nine low-preference types, but type 8 earned equally in both treatments and type 12 surprisingly earned more under LVT. The six high-improvement-preference types always had higher average earnings under LVT. Figure 6 also shows that the treatment effect tends to be largest for the high-income neighborhood, that is, the red bar has a large difference from the corresponding black bar. One reason for this result may be the redistribution of extra taxes.

Figure 6: Treatment Effect on Welfare by Type (LVT versus UPT)



Source: Original work by authors.

Figure 7: Treatment Effect on Property Value by Type (LVT versus UPT)



Source: Original work by authors.

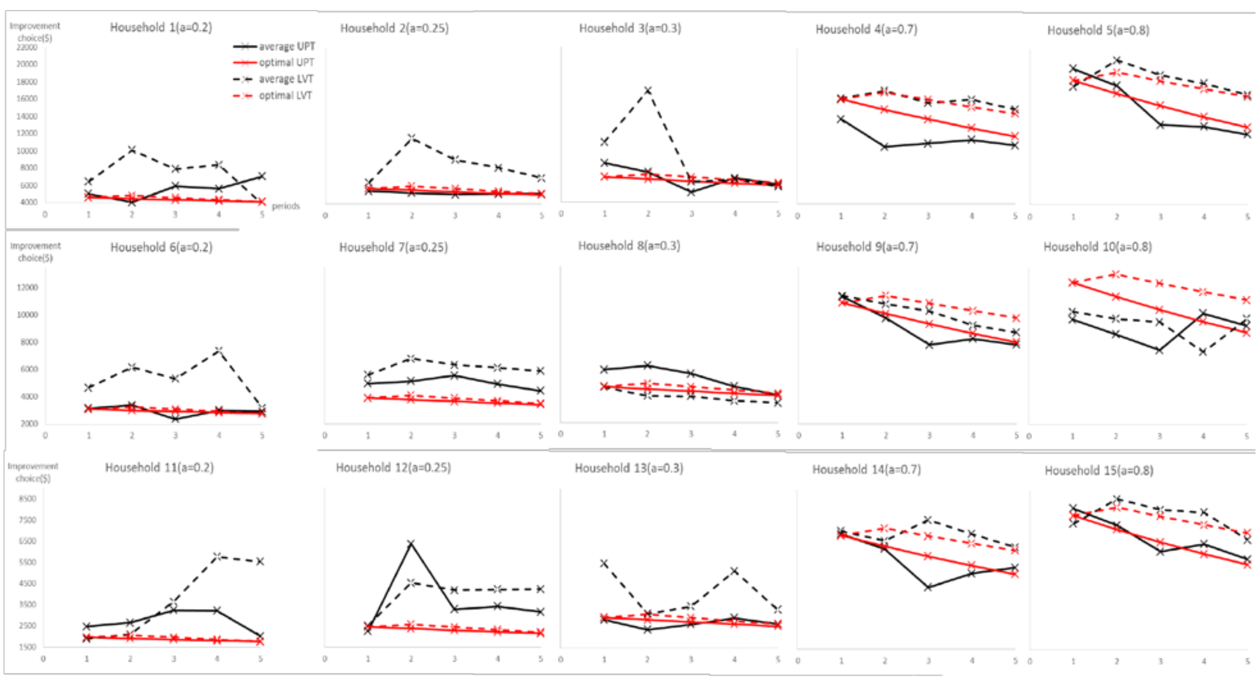
The treatment effect can also be examined for an effect on property values. Figure 7 shows the treatment effect by type under LVT and UPT. The property values are higher for 14 of 15 types under LVT. This is likely a result of LVT's lack of distortion on improvement investments, which encourages more improvements and thus higher property values.

Results on Behavior

Figure 8 shows the simulated and the experiment behavioral results for all types. Almost all types increased their improvement choice when the tax treatment changed from UPT to LVT. Compared across households within each neighborhood, households with higher *a* value (*a*=0.7, *a*=0.8) chose higher improvement compared to households with lower a value (*a*=0.2, 0.25, 0.3). Furthermore, some of the behavioral trends in the simulation were also found in the experimental data. For instance, under LVT, all households initially increased their improvement choice, but then reduced it in the following periods.

But the pattern that households with higher *a* values increase more in LVT that is shown in the simulation results are not found here. Instead, those lower *a* value types deviate more from the optimal value under LVT, which enlarges the treatment effect. Among these nine low-improvement-preference types, LVT encouraged much more improvements than expected in seven to eight of the types. This can be seen in the higher black dashed lines than the black solid lines in figure 8. This unexpected behavior will be assessed further subsequently, but it is likely true that these over-improvements caused changes to the highly interdependent system.

Figure 8: Treatment Effect on Behavior by Type (LVT versus UPT)



Source: Original work by authors. First row is the high-income neighborhood followed by mid- and low-income.

The behavioral results, especially among the low-improvement-preference types, were unexpected. At the conclusion of the experiment, the researchers administered a survey (via paper, and unfortunately un-linkable with the decision data). The respondents across all sessions reported that they paid attention to the data in the myopic optimal table (92 percent). However, many were also paying attention to their relative position. For instance, 96 percent reported that they noticed the housing-size graph, and 52 percent claimed that their decisions were affected by information in this graph. Further, 29 percent reported that the graph had "a great deal of influence" on their decision, while 48 percent reported that it had "a little influence." Only 23 percent reported that it had no influence.

The effect of the housing-size graph was somewhat surprising in that it was nonbinding and not related to the earnings. The asymmetry in housing size was induced, and any participant that deviated from the optimal choice would earn less money. The overinvestment by those types that were induced to have the smallest houses suggests that this experiment was picking up some position-good-type utility. It is impossible, though, to know if these overinvestment decisions were simply a result of mistakes—albeit with a systematic tendency to overinvest among low-improvement preference types. Nevertheless, these errors will propagate more in LVT than UPT because there should be more improvements in LVT (improvements are not taxed) and so an error will deviate the whole neighborhood from the simulated optimal path.

Acceptability of the Land Tax: Voting Results

The results show that LVT is more acceptable than expected, but this acceptability is due in part to overall suboptimal performance relative to the simulated optimal. Table 4 presents the results of the voting treatment. The simulated optimal would be that nine participants vote against LVT or SRT in period 2 (the first vote). Then the game would revert to UPT in the third period. It was unexpected that in the experiment, only one session voted against LVT or SRT (session 5 voted against SRT in period 4, so period 5 reverted to UPT). In all other sessions, the LVT or SRT treatment continued despite the prediction that it would make a majority of the community worse off.

Table 4: Results of the Voting Treatments

		Session1		Session2		Session3		Session4		Session5		Session6	
Vote Number	Simulated Optimal	Updated Rational	Exp. Data	Updated Rational	Exp. Data	Updated Rational	Exp. Data	Updated Rational	Exp. Data	Updated Rational	Exp. Data	Updated Rational	Exp. Data
1	9	5	5	8	3	8	5	6	5	9	6	7	4
2	NA	5	7	7	3	9	6	6	4	9	7	7	5
3	NA	5	7	7	5	9	6	6	4	9	8	7	7
4	NA	5	6	7	4	9	5	7	5	NA	NA	7	7

Source: Original work by authors. SRT sessions in yellow.

*When votes against reach eight, the session abandons LVT and reverts to UPT

**Induced values and optimal behavior in simulation suggested that nine would vote against in the first vote

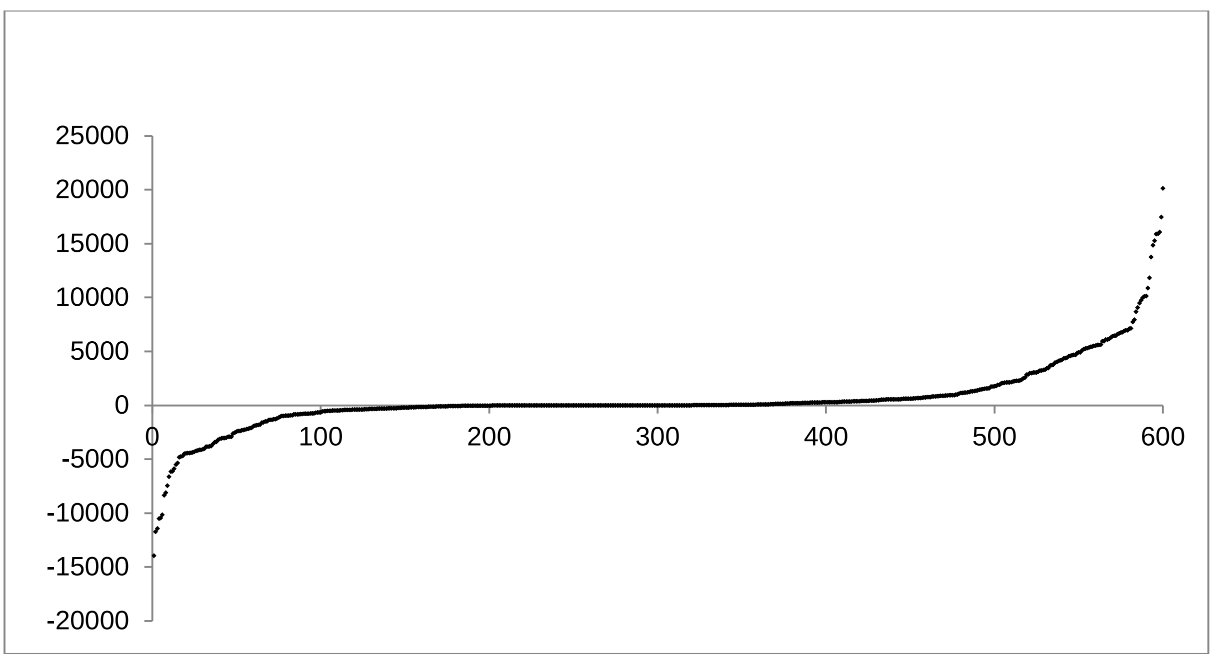
***Updated rational: recalculation of optimal response in light of prior deviations from the optimal path

The researchers were surprised at the low number of votes against SRT and LVT. As a result, the researchers recalculated the expected votes in each period by examining whether UPT or the land tax treatment would make each type better off, *conditional upon* any suboptimal deviations in prior periods. In other words, suboptimal deviations (say, from overinvestment) would require an updating of the optimal choice in subsequent periods. This is the "suggested optimal" or the "updated rational" in table 4. In light of these deviations, one sees that it was no longer necessarily rational to vote against SRT and LVT. This is likely a result of deviations in the early periods. LVT burdens those with high land values and low improvement values but not those with low *a* values. When low-*a* value households over-invest, these anticipated LVT policy "losers" instead become "winners." Despite these explanations of updated rationality, the number of votes against observed in the experiment still deviated to some extent from the "updated rational" and the deviation comes from both the "losers" and "winners." This remaining deviation could possibly be explained by concerns of fairness. It is also possible that the low rate of objection to LVT or SRT is that people are comfortable with the status quo, which was LVT or SRT in this case. Hence, there may be the equivalent of order effect in the experiment. Future research could examine a treatment in which LVT or SRT was "opt-in" rather than "opt-out."

Statistical Analysis of "Deviations" from Optimal Behavior

The data show that a substantial number of the decisions in the first two treatments (the non-voting treatments) of each session deviated from the myopic optimal, even when that myopic optimal was updated for each new period to account for prior deviations from myopic optimality. Figure 9 shows these deviations from the suggested optimal. The positive deviations indicate over-investment, which would be consistent with a mistake or the positional good explanation of behavior. The negative deviations come from several different possible reasons: (1) some participants may have been embarrassed by having a large house (a disparity that increased over time); (2) participants may have taken a higher tax bill in the future into consideration and tried to reduce the tax bill by reducing improvements; or (3) some participants may have made a mistake.

Figure 9: Ordered Deviation: From Suggested Optimal



Source: Original work by authors. These data reflect all 600 choices in the UPT treatment and the second LVT treatment for four sessions. SRT results are omitted.

The data in figure 9 were analyzed in a regression (table 5). The regression results show that there were systematic patterns to the deviations. Participants increased deviation by around 959 under LVT over UPT. The neighborhood controls show that the high-income neighborhood (#1) and the low-income neighborhood (#3) were equal in their deviations, but the middle-income neighborhood deviated less. This result likely arises from some complex interaction of the difference in income along with the redistribution through the tax return, which tends to flow from high to low income.

Table 5 also shows that the low-improvement-preference types are systematically over-improving. On average, these types overinvest by 1,334 to 2,079 on every decision. This evidence is consistent with the positional good hypothesis. All this evidence suggests that there is too much investment under LVT, well beyond the simulated expectation of more investment in LVT.

Table 5: Explaining Deviations from Suggested Optimal (LVT versus UPT): Regression Results

Variables Explaining Deviations	Coefficient
LVT	959.4117*** (3.64)
Neighborhood2 (mid)	-800.9162** (-2.54)
Neighborhood3 (low)	-322.1987 (-1.02)
Type1 (*a*=0.2)	1966.511*** (4.84)
Type2 (*a*=0.25)	2078.963*** (5.12)
Type3 (*a*=0.3)	1333.6*** (3.28)
Type4 (*a*=0.7)	20.46866 (0.05)
Constant	-558.5535 (-1.57)

Source: Original work by authors. Ordinary least squares regression. A prior fixed effect version of this model tested for period-level effects to test if more deviations occurred later or earlier. Nothing was significant.

Robust t-statistics are in parentheses

* Significant at 10% level

** Significant at 5% level

*** Significant at 1% level

The researchers also noticed that the deviations were not some unanticipated optimal strategy, which was hidden in the complex interdependencies of the interface. Table 6 reports a regression testing for the effect of deviations on earnings, showing that deviations tended to lower earnings.

Table 6: Regression Explaining Earnings by Deviation and Experimental Controls

	Model 1	Model 2	Model 3
Deviation	-0.08** (-1.98)	0.03 (0.49)	0.01 (0.33)
LVT	-248.73 (-0.91)	-113.97 (-0.41)	39.41 (0.21)
LVT*deviation		-0.22*** (-2.67)	-0.34*** (-6.21)
Neighborhood2 (mid)			-4075.84*** (-18.50)
Neighborhood3 (low)			-5608.03*** (-25.68)
Constant	9538.60*** (55.59)	9522.65*** (55.75)	12518.51*** (50.72)

Source: Original work by authors. Robust t-statistics are in parentheses

* Significant at 10% level

** Significant at 5% level

*** Significant at 1% level

Model 1 suggests that deviation has a significant and negative effect on earnings, or "Utility Payoffs." If there is one more unit of deviation in improvement choice, there will be an eight percent decrease in utility payoff for every dollar of deviation from the myopic optimal. The LVT treatment control is not significant, by itself, in any model. However, models 2 and 3 show that the LVT treatment interacts with deviation such that there are lower earnings for participants who deviate in the LVT treatment—but not in the UPT treatment. In other words, under LVT, a one- unit deviation leads to a 22 percent greater loss in earnings than under UPT. When one combines the results in model 3 and previous regression results on deviation, one sees that deviation from the myopic optimal under LVT leads to a substantive loss in earnings. In sum, it is more important for households to make optimal decisions in LVT than in UPT because errors propagate faster through the more-interdependent LVT system.

Acceptability of Mechanisms to Expand Adoption of the Land Value Tax

Some of the post-experiment survey questions were designed to collect preliminary data about the acceptability of mechanisms to make communities more likely to adopt LVT or SRT.

Because of the simulated predictions, the researchers anticipated that there would be nine participants who would vote against LVT or SRT because they were worse off than under UPT. Only six participants were anticipated to be in favor of LVT or SRT. The mechanism proposed to overcome this objection was to use a side payment; that is, to have the policy winners pay the policy losers to vote in favor of LVT or SRT. All questions were phrased in terms of “tax plan 1” and “tax plan 2.”

The survey asked several questions about the acceptability of this side payment mechanism. The first question was, “If you were better off under LVT/SRT, would you have been willing to give some of your earnings to another participant if they would vote to maintain LVT/SRT?” Some respondents (37 percent) reported that they would be willing to make the side payment, while others (39 percent) were unwilling. For the remaining respondents, the question was deemed non-applicable because they were not better off under LVT/SRT. This question provides some evidence that a side-payment treatment might be able to generate enough vote-switching to support LVT/SRT.

The survey asked a parallel question about the supply side of this side-payment-for-votes mechanism: “If you were worse off under LVT/SRT, would you have been willing to accept some of your earnings from another participant if they would vote to maintain LVT/SRT?” Respondents (48 percent) reported that they would be willing to receive payments to change their vote, while 26 percent were unwilling.

A final survey question was a simple one: “What tax plan is the fairest (i.e., treats everyone equally)?” The researchers had no a-priori beliefs about this question. UPT was deemed the fairest by 57 percent, while 24 percent viewed LVT/SRT to be the fairest. “Equally fair” was chosen by eight percent, while 11 percent responded, “don’t know.”

Discussion and Policy Implications

The experimental results produced unexpected findings with respect to the simulated optimal predictions of the model. LVT and SRT did not produce the most efficient outcome in half of the treatments, despite a design where the UPT treatments were supposed to generate slightly less welfare than LVT and SRT. The principal driver of this unexpected result seems to be systematic tendencies among the low-improvement-preference types to over-invest. All these effects are processed through the complex system of the z-Tree interface (Fischbacher 2007), where excess taxes are redistributed and there is a capitalized interdependency for improved neighborhoods. In the voting treatments, participants did not reject LVT and SRT as often as expected. But this voting behavior was more “rational” than the design predicted because deviations from myopic optimality in early periods altered the expected performance of the tax treatments. Obviously, these results are artifacts of the model, design, and induced values. Yet the behavioral economics method offers some potentially generalizable insights that warrant further research and policy consideration.

One way to think about the tendency for the low-improvement-preference types to over-invest is that improvements are “free” from tax under LVT and “partially free” under SRT, so there is less of a tax burden from improvement to be borne by the decision maker. However, there is more of a burden to the neighbors through capitalization because there will be more improvements. In other words, the externality is exacerbated in the LVT and SRT treatments. Ceteris paribus, the greater capitalization interdependency, means that when a household makes a suboptimal decision in LVT and SRT, it seems to propagate as a mistake or cost to social welfare more than under UPT.

The results therefore suggest that one might expect that real-world instances of LVT may not be delivering on the expected promises because of this unforeseen error propagation, which LVT exacerbates relative to UPT. This may imply that effective use of LVT may pose a special challenge—one in which homeowners must make optimal investment decisions. Optimal decisions require high quality information about homeowner's own utility/profit function and neighborhood characteristics. The results also suggest that informational challenges to LVT are more than just associated with the assessment process.

But optimal decisions in this experiment also assumed that positional goods accrued outside the utility function. The evidence in this experiment suggests that the positional-good aspect of housing drove many of the deviations from optimality. If positional goods are utility-relevant, then further experimental research ought to seek to operationalize this into a model.

A common question in LVT research is whether the tax is regressive. This research used a built in mechanism to predetermine that LVT would be progressive. So, it is important for policy makers to see how LVT can be assured to be progressive. But the mechanism used also introduced a new dimension of interdependency. The model and experiment reported here did not test for alternate mechanisms to return excess tax revenue. Future experiments ought to explore these mechanisms and, because of the interdependency, test for interactions with the tax treatments and other characteristics of the design. Indeed, this paper cannot say whether this tax return mechanism explained some of the over-investment observed.

One of the motivating aspects of LVT unacceptability was that it was a tax on unrealized capital gains (Bourassa 2009), and that this is very unpopular with many homeowners. The research reported here shows how LVT exacerbates a fundamental capitalization process—wherein LVT leads to more improvements, which leads to nicer neighborhoods, which leads to more unrealized capital gains, which leads to more LVT acceptability challenges. This paper contributes to the LVT literature by explicitly modeling this process. A possible policy solution to this challenge may involve using the efficiency gains of an LVT system to offset perceived costs of unrealized capital gains. If capital markets are efficient, then there really ought to be no perceived costs; homeowners enjoying appreciation can simply access this new capital to pay for the increased taxes, all of which ought to be perfectly capitalized. However, if capital markets are inefficient or if homeowners do not access them, then there is a real or perceived cost to unrealized capital gains. This cost could potentially be addressed with a side payment or a tax reduction.

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