The Effects of Income Mobility and Tax Persistence on Income Redistribution and Inequality*

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Abstract

We conduct a controlled laboratory experiment to explore the effect of income mobility and tax persistence on equilibrium tax rates and inequality. The theoretical framework of the experiment captures the essential elements of the prospect of upward mobility (POUM) hypothesis in a two-period model and characterizes the dynamic equilibrium tax rates. The experiment allows for a clean test of causality between income mobility and redistributive taxes. Outcomes observed in the experiment are mostly consistent with the comparative static predictions of the model. Mobility and stickiness of taxes lead to lower tax rates, but neither is sufficient by itself. When tax rates are persistent, mobility has a significant negative effect on median implemented taxes. An increase in tax persistence decreases tax rates and increases inequality when mobility is present. An increase in mobility decreases inequality but the effect is modest and not statistically significant.

Keywords: income mobility, taxation and redistribution, laboratory experiments

JEL codes: D7, C9, H21

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1 Introduction

Income tax rates vary a great deal across countries, and even across states within countries. It is important for a variety of policy reasons to understand why and to untangle the many possible sources of this wide variation. One potentially important source of variation that has received considerable attention from economists is *social mobility*. Income taxation, by design, is redistributive in two senses. First, public goods provided by the tax revenues - such as free education, clean water, fresh air, fire and police protection, and national defense - generate a distribution of benefits that is roughly equal across income groups, or at least far less skewed than the distribution of income. Second, tax revenues are also used for income-tested policies that have direct redistributional consequences, such as food stamps, medical insurance subsidies, and cash grants. Because of the key redistributional effects of taxation, one might expect that in more-mobile societies, or in societies in which considerable upward mobility is expected, poor and middle class voters may favor relatively lower tax rates than they would if there were no tomorrow. One may be on the low end of the income scale today - where higher tax rates are helpful - but have beliefs (realistic or otherwise) of being considerably higher on the income scale tomorrow, in which case lower tax rates would be better.

An underlying premise for this intuition, and one that is widely accepted as a stylized fact, is that redistributive tax policy is relatively "sticky." That is, in modern democratic institutions, income tax rates are very difficult to change once they are in place, except for relatively minor adjustments. So it is the combination of the *persistence* of unchanged tax rates over many years and expectations of upward mobility that dampens voter preferences for redistribution. This is called the *prospect of upward mobility (POUM)* hypothesis (Benabou and Ok, 2001). While the prospect of upward mobility, in principle, can work in the opposite direction - that is, rich voters preferring higher taxes to insure their potential downward mobility - in a majoritarian political system, at least theoretically, it is the median voter's tax preferences that determine the equilibrium tax rate. As long as the median voter's income is less than the average income among the electorate, a virtually universal empirical fact, the overall effect of income mobility on equilibrium tax rates will theoretically result in lower income tax rates than in the absence of income mobility.

In this paper we use controlled laboratory experiments to investigate the POUM hypothesis, and, more generally, the preferences for redistribution in the presence of uncertainty about future income. To do so, we construct to serve as a baseline for our experiment a two-period model of equilibrium tax rates to explore the effects of stochastic income mobility and tax persistence, allowing for both upward and downward mobility. The resulting game and its equilibrium capture the most relevant elements of the POUM logic described above, and allows for a clean test of causality between income mobility and individual preferences for redistribution holding other elements of the environment constant. The experiment also allows us to separately identify the effects of tax persistence and mobility on inequality. The latter effect is complicated by two confounding forces. On the one hand, mobility allows low income earners in the first period to become high income earners in the second period, and vice versa thereby reducing expected lifetime income inequality for any given tax rate. On the other hand, the POUM effect on equilibrium tax rates works in the opposite direction: greater mobility implies lower equilibrium tax rates in the first period, which increases inequality.

The two-period game that provides the framework for the experiment is a stochastic dynamic version of the classic model of equilibrium tax rates under majority rule (Romer (1975), Roberts (1977), Meltzer and Richard (1981)). The environment is characterized by a fixed distribution of wages in the population in both periods, which assumes away aggregate uncertainty. In each period, each individual in the economy is endowed with a wage which is drawn from a fixed distribution. The stochastic process governing income mobility is modeled in the following way. With some fixed probability, $1-\mu$, there is no mobility and each individual's period two wage rate is the same as it was in period one. With probability μ wage rates are randomly redrawn using the same fixed distribution of wages. The stochastic process governing tax persistence is modeled as follows. The period one linear tax rate, t, is initially determined as the equilibrium outcome of a majoritarian political process, which yields the median voter's ideal tax rate for that period. Voters are forward looking, taking account of the mobility process and with rational expectations about the equilibrium tax rate in period two. The aggregate taxes that are collected are then redistributed equally to all individuals. Then each individual chooses her labor supply optimally, given her period one wage and the period one tax rate, and pays a fraction t of her income in taxes. In the second period, with probability p, the period one tax rate remains in place, and with probability $1-p$, the tax rate is voted on a second and final time, which leads to a new equilibrium tax rate for period two.

We note that our model is intentionally designed to be the simplest possible setup in which the main forces of POUM hypotheses are present and uncertainty about future changes in income prospects more generally can play a role. Indeed, the result that the equilibrium level of redistribution is lower in the game with income mobility compared to the one without mobility is driven by the fact that the median voter's income is below that of the average income of the electorate and the tax rate is at least partially persistent. These are the main ingredients of the model. We deliberately abstract away from aggregate uncertainty considerations, according to which the total welfare generated in the future periods might differ from the current one, for instance, be on average higher than the current one. This additional force would confound the results we are seeking to investigate in this paper, as this would further lower future tax rates. Thus, to isolate the effect of mobility on the equilibrium level of redistribution, we stack the cards against us and keep the aggregate distribution of productivity fixed between periods.[1]

The experiment is designed to test the comparative static predictions of the model, which are the following. The period one equilibrium tax rate declines monotonically in the mobility and tax persistence parameters. Mobility and tax persistence also affect after-tax lifetime inequality. For any positive degree of mobility, greater stickiness of the tax policy (i.e., persistence) leads to higher inequality. Moreover, for the parameters used in our experiment, regardless of whether the tax regime is persistent, an increase in income mobility leads to lower inequality.

The experimental design implements four treatments which allow for a direct test of the comparative static predictions of our POUM model. The treatments vary according to the mobility (μ) and persistence (p) parameters. We investigate two values of the persistence parameter ($p = 0$ and $p = 1$) and three values of the mobility parameter ($\mu = 0$, $\mu = 0.6$ and $\mu = 1$). In the first, baseline treatment, there is no mobility ($\mu = 0$), so, the equilibrium tax rate is the same as in a one-period model and does not depend on the persistence parameter. Thus, for the baseline treatment, we only study the outcome for one value of persistence ($p = 0$). In the second and third treatments, the first-period tax is always carried over to the second period without a re-vote. In these treatments ($p = 1, \mu = 0.6$) and ($p = 1, \mu = 1$), individuals must take into account the stochastic mobility process when they vote over tax rates in the first period. The period one tax rates are predicted to be lower than in the baseline treatment. This effect is predicted to be larger in magnitude in the high mobility treatment ($p = 1, \mu = 1$) than the moderate mobility treatment ($p = 1, \mu = 0.6$). Our fourth treatment considers intermediate mobility and no tax persistence ($p = 0, \mu = 0.6$) to test for a null comparative static prediction of the model. That is, increasing mobility with no tax persistence should have no effect, and the tax rates should be the same as in the baseline treatment. However, inequality in

[1] This simplification is inconsequential for the POUM hypothesis. We show in the Online Appendix that the results continue to hold when one allows for either aggregate productivity trends or random shocks to aggregate productivity.

the fourth treatment should be lower than in the baseline, because of mobility. In all four treatments, we also elicited risk attitudes of each individual using a standard incentivized method, and allowed subjects to gain experience with the game by having ten repetitions with feedback after each time.

We have four main findings. First, we confirm in both the baseline treatment and in the fourth treatment that if tax policy is not persistent but instead is voted on by majority rule in every period, then implemented tax rates are unaffected by income mobility and income mobility without tax persistence decreases inequality. Second, as predicted, we find that with mobility, tax persistence leads to lower tax rates and greater inequality. Third, as predicted, when tax policy is persistent ($p = 1$), higher mobility ($\mu = 1$ versus $\mu = 0.6$) leads to lower tax rates; the effect is significant for the median implemented taxes, but not significant for the average implemented taxes. Finally, regardless of whether the tax regime is persistent or not, the marginal effect of increasing mobility also decreases inequality, as predicted, however this decrease is modest and not statistically significant. We make two other observations about the magnitude of the effects: in all treatments, the observed tax rates are lower than the theoretical equilibrium; and the interactive effects of tax persistence and income mobility are larger in magnitude than the theory predicts.

In addition to the main findings, we also observe an interesting and unexpected behavioral phenomenon. Subjects revealed preferences over tax rates depended not only on the treatment parameters and their wage, but were affected by "experienced mobility". That is, in the positive mobility treatments, low-wage subjects who experienced upward mobility in previous plays of the game tended to vote for lower tax rates than low-wage subjects who did not experience upward mobility.

One might plausibly wonder how a laboratory experiment could be relevant to understanding something as complex as the effect of income mobility and tax persistence on redistributive tax policy. There exist a few empirical studies that attempt to assess the validity of the hypothesis that expectations about social mobility will lower taxes and possibly have a negative impact on income inequality. While some support is found for these effects, the estimates of their magnitude vary widely (across countries and across time) and, more importantly, these studies are plagued with measurement issues since they can only coarsely control for confounding factors. Moreover, none of these studies investigates tax persistence, which is a key variable from a theoretical perspective. All the studies are based on unincentivized survey data about preferences for redistribution. The strongest findings indicate that there is a negative relationship between subjectively perceived probabilities of upward mobility, as elicited by survey methods, and preferences for redistribution from the rich to the poor. There is relatively little support for the hypothesis that there is a relationship between objectively measured mobility indices and preferences for redistribution.[2] To our knowledge, there is no empirical study that explores a causal link between income or social mobility combined with tax persistence and redistributive policy, which is the focal point of the present study. Rather, all the existing studies focus on identifying correlations between self-reported mobility and survey responses to qualitative questions related to redistribution from the rich to the poor.

Laboratory experiments, by implementing a simple environment to which theory is expected to apply, offer a clean methodology for directly testing the effects of mobility and tax persistence on the level of redistribution. Thus, our experiment allows us to examine the causal effect of mobility on post-tax inequality. This is very difficult to accomplish with field data because there are two confounding effects. Not only can the qualitative comparative statics be tested, but our laboratory experiment allows for a quantitative evaluation of the magnitudes of the effects that are predicted by theory. It also allows for the possibility of clear rejections of the basic theory. If the theoretical predictions fail in the simplest and most transparent version of the model, then that casts doubt on the usefulness of the theory for application to complex economies and political systems, the properties of which the field of political economy seeks to understand.[3]

The rest of the paper is organized as follows. Section 1.1 reviews the related literature. Section 2 presents the two-period model and derives the main theoretical results. Section 3 describes the design and procedures of the experiment. Section 4 analyzes the results

[2]See, for example, the Checchi and Dardanoni (2002) study of occupational and social prestige mobility in Italy, which finds that the results are very sensitive to the choice of index. Alesina and La Ferrara (2005) construct a different index from the PSID, which has somewhat more explanatory power, and apply it to a state-level analysis of mobility and redistributive preferences in the US. Several studies use survey instruments to document relationship between mobility and preferences for redistribution, but in these types of studies there is a disconnect between perceived mobility and actual mobility. Ravallion and Loshkin (2000) find survey evidence connecting perceived mobility and preferences for redistribution. Rainer and Siedler (2008) also find similar survey evidence for Germany, but their survey question addresses the progressivity of taxation rather than the overall level of taxes. Alesina et al (2017) use survey data to document what people think about intergenerational mobility across five countries (France, Italy, Sweden, the U.K., and the U.S.) and how social mobility perception affects support for redistribution. Finally, Kuziemko et al. (2015) conduct randomized online survey experiments in which they provide experimental subjects with customized information on US income inequality and measure subjects' attitudes towards taxation and redistribution.

[3]There are many reasons the theory could fail. For example, the assumption about preferences maybe mis-specified. The standard model, which is the basis for our experimental hypotheses assumes that agents maximize their own long-run utility and do not care about other agents' payoffs, i.e., the model ignores the possibility of other-regarding preferences such as inequality aversion. Our experimental data will be able to speak to the validity of this assumption and the potential need to modify it for the development of future theoretical models.

of the experiment. Section 5 offers some concluding remarks.

1.1 Related Literature

In the theoretical literature on social mobility and redistributive taxes, the pioneering paper by Benabou and Ok (2001) is most closely related to the present paper, but their model of social mobility is quite different from ours in a number of ways, including the mechanism driving the mobility effects. There are at least five differences.

First, the distribution of income is exogenously specified in their model and is assumed to be unaffected by income taxation. In our model, individuals choose their labor supply optimally, conditional on the tax rate, so income is endogenous and taxes distort both the distribution and absolute levels of income, as in Meltzer and Richard (1981). Second, they consider only two possible redistributive tax regimes - one regime with a zero tax rate and a second regime in which all income is taxed and evenly redistributed to all individuals. While it may be useful for pedagogical purposes to consider these extreme cases, it is not realistic; more to the point, neither of these two regimes is consistent with majority rule equilibrium in a model of voting over linear tax schemes. In our model, we characterize majority rule equilibrium in the space of linear tax schemes. The mechanism driving POUM in our model is that the individual with the median income today expects her income to be closer to the mean tomorrow, which marginally depresses their demand for redistribution, resulting in a lower ideal tax rate than they would prefer in a world without mobility. Third, Benabou and Ok require strict concavity of the social mobility transition function for their result.[4] The mobility transition function in our model does not share this property: it is linear, not concave. That is, for all individuals, expected future income is a linear increasing function of today's current income. Finally, our model and the experiment that follows highlight the importance of considering tax persistence in conjunction with income mobility. As will become clear in the next section, the extent to which income mobility affects both inequality and individual preferences for redistribution depends on the degree of stickiness of the tax regime.[5]

Also related, but for a different reason, is work by Piketty (1995), which focuses on

[4]Loosely stated, this implies that tomorrow's proportion of voters with incomes below the mean is less than the proportion of voters below the mean today. Such transition functions will depress today's median income voter's demand for redistribution if the tax policy persists for both periods.

[5]Our model also differs in more superficial ways, as well: we have a finite number of voters; a fixed distribution of productivities; and tax persistence that is modeled differently. As in their article, the present paper assumes risk neutrality, while risk aversion would tend to dampen the mobility and persistence effects.

the evolution of voter expectations about their own future social mobility. In his model, these expectations diverge as a result of their different past mobility experiences. In our theoretical model, we assume that voters know precisely the social mobility stochastic process, and so, in principle, such theoretical learning effects do not play any role in our model. A surprising finding from our experiment, however, is that learning from past mobility experiences within the experiment has a significant effect on individual agents' revealed preferences for redistribution that appears to be consistent with Piketty's learning theory.

Finally, for a more distant theoretical literature that studies effects of social mobility in settings with possibility of regime transition see Leventoglu (2005) and Acemoglu, Egorov, and Sonin (2016).

Three experimental papers investigate social mobility effects in the laboratory: Konrad and Morath (2013a, 2013b) and Checchi and Filippini (2004). The two Konrad-Morath papers report results from a one period experiment based on the Meltzer-Richard model, with three-voter groups, but where two of the voters in each group are simulated by a computer that is programmed to choose the equilibrium strategy (tax rate and labor supply) conditional on the wage assigned to the computerized voter. The median proposed tax is implemented 80% of the time, with the lowest and highest proposed tax rate each implemented 10% of the time.[6] In Konrad and Morath (2013a) the main treatment variation is to compare the tax rates depending on whether or not a subject's wage rates are reassigned between matches. However, in contrast to our dynamic model and the POUM literature more generally, taxes are not persistent in their one-period model, as each match is independent of each other, so theoretically there should be no effect, roughly analogous to comparing our two treatments with $p = 0$. They find a highly significant effect. The paper also reports a comparison between the two treatments using only human subjects, and find a much smaller treatment effect, suggesting that the simulation procedure with computerized voters has a significant effect on subject behavior. In Konrad and Morath (2013b), the main treatment variation is whether subjects' wage rates are randomly reassigned in each match and subjects have uncertainty about their reassigned wage before they propose a tax rate. Unlike our dynamic multi-player approach, that experiment is only a one-period single-agent decision problem because types are randomly reassigned in each match and the other voters in the group are simulated by a computer. Nonetheless the experiment in principle could indirectly address social mobility issues,

[6] This implies that the implemented tax rate was decided by the computer rather than the actual voters more than 80% of the time in all treatments.

because proposed tax rates in that design are predicted to be lower with uncertainty. However, the results are very mixed. In particular, the study finds that the tax rates proposed with uncertainty about randomly reassigned wage rates are not significantly different from the tax rates proposed with when wage rates are randomly reassigned between matches and known before proposing tax rates. This contradicts the POUM hypothesis. Given the findings in Konrad and Morath (2013a) about the significant differences between results with human and simulated voters, this discrepancy might be attributable to the simulated voter design.

Checchi and Filippini (2004) report an experiment that tries to directly implement the Benabou and Ok (2001) model of social mobility - an incentivized survey experiment that involves no voting or group interaction. For various scenarios about current and future income prospects subjects are asked to declare a tax on their own income. The results are mixed, but in scenarios where their income is expected to become very high in the future, the subjects do indeed declare a lower tax. The authors also investigate the effect of socio-economic, demographic, and attitudinal characteristics that were also measured in the survey. Neither the theoretical model underlying the experiment nor the experimental design and procedures are comparable to those in the present paper.

2 The Model

In this section, we lay out the primitives of the model and characterize equilibrium tax rates and labor supply. This model will serve as a basis for the experiment that follows. The society consists of an odd number $n > 1$ agents who live for two periods. In each period, agents operate in a perfectly competitive and frictionless labor market. In the initial period, $k = 1$, agents are endowed with productivities

$$w^1 = (w_1^1, ..., w_i^1, ..., w_n^1), \tag{1}$$

where w_i^1 denotes the productivity of agent i in period 1. To represent mobility, we assume that at the end of period 1, there is a probability μ that the productivities are randomly reshuffled. Thus, agent i's productivity in period 2 is $w_i^2 = w_i^1$ with probability $(1 - \mu)$ and is equal to $w_i^2 = w_j^1$ with probability $\frac{\mu}{n}$ for each $j = 1, ..., n$. That means, the transition function is $w_i^2 = w_i^1$ with probability $(1 - \mu + \frac{\mu}{n})$ and $w_i^2 = w_j$ with probability

$\frac{\mu}{n}$ for each $w_j \neq w_i^1$.[7]

Productivity plays an important role in determining agents' labor market behavior and incomes. In the labor market, which operates in both periods, each agent chooses how much labor to supply. In a given period $k \in \{1, 2\}$, an agent i with productivity w_i^k that supplies x_i^k units of labor earns pre-tax income $y_i^k = w_i^k \cdot x_i^k$ and bears an effort cost of $\frac{1}{2}(x_i^k)^2$, which represents the tradeoff between labor and leisure. Income and costs are measured in units of consumption. In addition, each agent pays a fraction t^k of earned income in taxes. Below, we will describe in detail how tax rates are determined. Taxes are linear and are used solely for redistributive purposes: tax revenues are redistributed in equal shares among all agents in the society. Therefore, the payoff u_i^k of agent i in period k consists of three parts: after-tax disposable income, cost of labor, and an equal share of collected taxes, with the last part depending on the labor decisions of other agents:

$$u_i^k(w_i^k, x_i^k, t^k) = (1 - t^k) \cdot w_i^k \cdot x_i^k - \frac{1}{2}\left(x_i^k\right)^2 + \frac{1}{n}\sum_{j=1}^{n} t \cdot w_j^k \cdot x_j^k \tag{2}$$

The overall utility of agent i is $V_i = u_i^1 + u_i^2$.[8]

Tax Regime. Tax rates are determined by the following voting game: each agent proposes a tax rate and the median of the proposed tax rates is selected as the tax rate in the society. As we will discuss in the next section, this voting game implements the majority rule equilibrium, where voter preferences over tax rates are based on rational expectations about how aggregate labor supply responds to changes in the income tax rates. In our framework, voter preferences over tax rates are single-peaked, so there exists a unique tax rate that defeats all other tax rates by majority rule, i.e., a Condorcet winning tax rate. This is why we refer to it as the majority rule equilibrium tax rate, and note that it coincides with the median of the individual ideal tax rates.[9] Voting over taxes occurs after agents learn their current-period productivities. In each period, given the implemented tax rate, agents choose their labor supply after observing their current-period productivity and the tax rate, to maximize (2).

Tax persistence depends on a persistence parameter, p. Specifically, p is the probability

[7] In general, this allows for possibility of upward and downward mobility regardless of first-period productivity. The only exception are the extreme voters.

[8] Note that this implies that agents are risk neutral.

[9] Our voting game is not the only way to implement majority rule equilibrium tax rate. For example, it can also be implemented as the dominant strategy equilibrium outcome of the Downsian candidate competition game where two office-seeking candidates propose tax rates and then each voter votes for whichever proposed tax rate they prefer.

that the tax rate implemented in period 1 persists in period 2. With probability $1 - p$, there is a new vote over the tax rate in period 2. The distribution of productivity types does not change over time, so there is no aggregate uncertainty. As we show in the next section, agents' preferences over tax rates in period 1 will depend on both mobility process governed by parameter μ and tax persistence governed by parameter p.[10]

We assume throughout the paper that the median income is strictly less than the average income - i.e., $(w^k_{med})^2 < \frac{1}{n}Z$, where $Z \equiv \sum_{i=1}^{n}(w^k_i)^2$ denotes per period aggregate income of the economy in every period k if the tax rate is zero.[11] This condition guarantees that in the static one-period model, the majority rule equilibrium is characterized by a positive amount of redistribution. If this condition does not hold, then the majority rule equilibrium tax rate equals 0, there is no redistribution, and neither mobility nor tax persistence has an effect.

In an Online Appendix we show that the main results continue to hold in several variations of the basic model: (a) allowing discounting between the two periods; (b) an extension of the two-period model to an infinite-horizon with discounting; (c) allowing for productivity trends and random shocks to aggregate productivity.

2.1 Equilibrium Tax Rates

In this section, we characterize agents' equilibrium behavior in both the labor market and the voting game. We assume that agents hold rational expectations regarding the aggregate labor supply response to changes in the tax rates in each period of the game and correctly anticipate the probabilities of upward and downward mobility and the persistence of the tax regime. We present here the main intuition of the results and relegate the formal proofs to Appendix A.

The **equilibrium** in our game consists of the following objects: (a) a one-period labor supply function for each agent type, which depends on the agent's current productivity and the current tax rate, (b) an ideal tax rate for each productivity type for each period which is based on rational expectations of aggregate labor supply and the dynamics of tax persistence and mobility, and (c) the majority rule equilibrium tax rate for each period,

[10] Note that the mobility process specified above is completely governed by the parameters of the game $(\mu, \{w_i\}_{i=1}^n)$ and is unrelated to agents' performance in the labor market in the preceding periods. We deliberately abstract away from additional forces that affect agents' behavior in a world where the prospect of upward mobility might depend positively on labor market performance. This allows us to isolate the effect of expectations of future mobility and tax persistence on preferences for redistribution, which is the main focus of this paper.

[11] This inequality condition also implies that median after-tax income is less that mean after-tax income, for all $t \in [0, 1]$.

which coincides with the median of the individual ideal tax rates in the period. Formally, we study the subgame perfect equilibrium in stage undominated strategies of the voting game followed by the choice of the labor supply in each period described in detail in Section 2.

Lemma 1. *For any given tax rate t^k in period $k \in \{1, 2\}$, an agent with productivity w_i^k supplies $x_i^{k^*}$ units of labor, where $x_i^{k^*}(w_i^k, t^k) = \left(1 - t^k + \frac{t^k}{n}\right) w_i^k$.*

The optimal labor supply of an agent depends only on the current tax rate and current wage (productivity) and is independent of the labor supply decision of other agents, the prospects of upward mobility, and the persistence of taxes. This follows from the structure of the game, according to which agents can adjust their labor supply in every period, after experiencing mobility and/or changes in tax policy.

Next, we characterize the ideal tax rate for each productivity type, assuming that all agents choose their labor supply optimally in both periods of the game, as characterized in Lemma 1. First note that since the second period of the game is the last one, agents' preferences for taxes in the second period are the same as the one in the static one-period model of taxation and redistribution without mobility and tax persistence. Because median income is assumed to be strictly less than average income, agents with relatively low current productivity (below the mean) demand positive taxes, while those with relatively high productivities prefer zero taxation since their contribution to total collected taxes exceeds the tax refund that they would receive from redistribution. Therefore the equilibrium tax rate is strictly positive.

Lemma 2 describes the ideal tax rates of all agents in the second period of the game and equilibrium tax rate that would emerge in the second period in case there is a vote for new level of redistribution. This result follows from the one-period static model of Agranov and Palfrey (2015).[12]

Lemma 2. *In period $k = 2$, the ideal tax rate of agent i with productivity w_i^2 is*

$$t_i^{2^*}(w_i^2) = \begin{cases} \dfrac{n^2}{n^2-1} \cdot \dfrac{\frac{Z}{n} - (w_i^2)^2}{\frac{2Z}{n+1} - (w_i^2)^2} & \textit{if } (w_i^2)^2 < \dfrac{Z}{n} \\ 0 & \textit{otherwise.} \end{cases} \tag{3}$$

In case there is a vote for a new level of redistribution in period $k = 2$, the median proposed

[12] In particular, Agranov and Palfrey (2015) show that in the one-period static model, agents' preferences over redistribution levels are single-peaked and ordered by productivity, which means that there exists a Condorcet winning tax rate.

tax rate $t^{2^*} = t_m^{2^*}(w_m^2)$ *is implemented.*

In contrast, agents' preferences over tax rates in period 1 depend not only on agent's current productivities, but also on their mobility prospects for future productivity, the persistence of the tax rate, and the future tax rate if the current tax regime expires and is re-voted in the second period.

Consider agent i, who is endowed with productivity w_i^1 in period 1. This agent will have a two-period value associated with the current tax rate t that depends on the mobility parameter, μ, the tax persistence parameter, p, as well as the second-period equilibrium tax rate t^{2^*} that would emerge if the first-period tax rate will be re-voted in the second period. This generates, for each productivity type, the following equation:

$$\begin{aligned} V_i(w_i^1, t, t^{2^*}) = u_i^*(w_i^1, t) + p\left[(1-\mu)u_i^*(w_i^1, t) + \frac{\mu}{n}\sum_{j=1}^{n} u_j^*(w_j^1, t)\right] \\ + (1-p)\left[(1-\mu)u_i^*(w_i^1, t^{2^*}) + \frac{\mu}{n}\sum_{j=1}^{n} u_j^*(w_j^1, t^{2^*})\right] \quad \text{for } i = 1, ..., n, \end{aligned} \tag{4}$$

where $u_i^*(w_i^1, t)$ denotes the optimal one-period utility of an agent with productivity w_i^1 if the current tax rate is t. Using Lemma 1, one obtains:

$$u_i^*(w_i^1, t) = \frac{(w_i^1)^2}{2} \cdot \left((1-t)^2 - \frac{t^2}{n^2}\right) + Z \cdot \frac{t}{n}\left(1 - t + \frac{t}{n}\right), \tag{5}$$

as the utility of a type w_i^1 agent in the first period if the current tax rate is t.

From this, one obtains the first-period ideal tax rate for each agent type by solving the first-order condition with respect to t, and verifying second-order conditions. This is summarized below as Proposition 1.

Proposition 1. *The first-period ideal tax rate of agent* i *with productivity* w_i^1 *is*

$$t_i^{1^*}(w_i^1) = \begin{cases} \dfrac{n^2}{n^2-1} \cdot \dfrac{\frac{Z}{n} - (w_i^1)^2}{\frac{Z}{n+1}\left(2 + \frac{\mu p}{1+p(1-\mu)} \cdot \frac{n-1}{n}\right) - (w_i^1)^2} & \textit{if } (w_i^1)^2 < \dfrac{Z}{n} \\ 0 & \textit{otherwise.} \end{cases} \tag{6}$$

The tax rate implemented in the society in the first period is $t^{1^*} = t_m^{1^*}(w_m^1)$.

When there is no mobility, $\mu = 0$, or taxes are non-persistent, $p = 0$, the model reduces to the one-period static model and agents' preferences for tax rates in period 1 and 2 are identical. However, if $\mu \in (0,1)$ and $p \in (0,1)$, then in period 1, the ideal period one tax rate of agents with relatively low current productivity (below the mean) is positive, but strictly less than in the static model. Therefore, $0 < t^{1^*} < t^{2^*}$, which is the essence of the prospect of upward mobility hypothesis.[13] One can show (see Appendix A) that each voter's indirect preference over tax rates is single-peaked in each period, so the equilibrium tax rate depends on the preferences of the median-productivity agent: since $(w_m^1)^2 = (w_m^2)^2 < \frac{Z}{n}$, the majority rule equilibrium tax rate in each period is a positive tax rate coinciding with the ideal tax rate of the median voter in that period, i.e., (t^{1^*}, t^{2^*}).[14]

Next, we show how equilibrium tax rate in the first period changes in response to an increase in tax persistence, p, and mobility, μ.

Corollary 1. *If $\mu > 0$, then higher tax persistence leads to lower equilibrium taxes in the first period.*

Intuitively, all else equal, the longer the current tax regime lasts (the higher the p), the more likely currently low-productivity agents are to transition upwards and improve their economic status, in which case they would enjoy lower tax rates.

Corollary 2. *If $p > 0$, then higher mobility leads to lower equilibrium taxes in the first period.*

Agents with relatively low productivity in the first period have a greater chance of upward mobility in the future when the mobility parameter, μ, increases, all else equal.[15] Observe that there is also a counteracting effect by the higher types' prospect of downward mobility, which one might think would put upward pressure on the equilibrium tax rate. However, there is no such effect in equilibrium because the median voter is pivotal and has an income that is always below the average income.

2.2 The POUM Effect on Inequality

How do tax persistence and economic mobility affect the level of inequality in the society? To measure inequality, we consider the dispersion of the equilibrium expected two-period

[13] Risk aversion could lead to higher first period equilibrium tax rates.

[14] In fact, this is the unique subgame perfect equilibrium of the game in stage undominated voting strategies. Restriction to stage undominated voting strategies is standard in the voting models (both dynamic and static). The reason is that even in one shot voting games, there exist many uninteresting equilibria supported with simultaneous voting and majority rule.

[15] Note that the driving force of this result is the fact that the median voter anticipates higher *expected* productivity in the second period, which dampens her demand for the redistribution conditional on the fact that tax regime is persistent to some degree.

welfare of agents. Specifically, the equilibrium value of agent i with first-period productivity w_i^1 can be written as:

$$
\begin{aligned}
V_i(w_i^1, t^{1^*}, t^{2^*}) = &(1 + p(1-\mu))u_i^*(w_i^1, t^{1^*}) \\
&+ \mu p \bar{u}_i^*(t^{1^*}) + (1-p)(1-\mu)u_i^*(w_i^1, t^{2^*}) + (1-p)\mu\bar{u}_i^*(t^{2^*})
\end{aligned}
\tag{7}
$$

where

$$
\bar{u}^*(t^{k^*}) = \frac{1}{n}\sum_{j=1}^{n} u_j^*(w_j^1, t^{k^*}) \text{ for } k \in \{1, 2\}
$$

is k^{th}-period utility in equilibrium averaged across agents, and $u_i^*(w_i^k, t^{k^*})$ is k^{th}-period utility of agent i with productivity w_i^k in equilibrium, which is given by equation (5) evaluated at t^{k^*}.

Thus, long-run inequality in the society can be measured by the variance of these long-run equilibrium values of the agents - i.e.,

$$
\text{var}\left(V_i(w_i^1, t^{1^*}, t^{2^*})\right) = \frac{1}{n}\sum_{j=1}^{n}\Big(V_j(w_j^1, t^{1^*}, t^{2^*}) - \bar{V}(t^{1^*}, t^{2^*})\Big)^2, \tag{8}
$$

where

$$
\bar{V}(t^{1^*}, t^{2^*}) = \frac{1}{n}\sum_{j=1}^{n} V_j(w_j^1, t^{1^*}, t^{2^*}). \tag{9}
$$

Proposition 2. *If $\mu > 0$, an increase in tax persistence increases inequality in the society - i.e.,*

$$
\frac{\partial var\left(V_i(w_i^1, t^{1^*}, t^{2^*})\right)}{\partial p} > 0. \tag{10}
$$

The logic is straightforward. From Corollary 1, higher tax persistence leads to a lower first-period equilibrium tax rate, as long as there is some mobility. This, in turn, increases efficiency since lower taxes reduce distortions in the labor market, but also increases long-run inequality between agents.[16]

While greater persistence of the tax regime unambiguously increases the dispersion of agents' incomes, the effect of income mobility on inequality is more complicated because an increase in mobility has two effects that work in opposite directions. On the one hand, greater mobility mechanically reduces inequality, as agents move up and down the income

[16] Proposition 2 also holds if long-run inequality is measured by the variance of equilibrium expected long run after-tax *income* instead of the variance of V_i, where the latter includes the total expected cost of labor supply (see Online Appendix).

ladder more often and low productivity in one period is more likely to be offset by high productivity in another period. On the other hand, greater mobility reduces equilibrium tax rates in the first period, which reduces redistribution and thus increases inequality. The overall effect depends on the exact parameters of the game.[17] In the next section, we describe the parameters we use in our experiments and provide theoretical predictions regarding predicted levels of redistribution and inequality levels in all treatments.

3 Experimental Design

3.1 Parameterization

The experiment implements the two-period environment described above. Each experimental treatment is characterized by a different combination of tax persistence p and mobility parameter μ. We used two extreme values of persistence, $p = 0$ and $p = 1$, and three values of mobility, $\mu = 0$, $\mu = 0.6$, and $\mu = 1$. Overall, there are four different treatments with the following combinations of (p, μ): $(0, 0)$, $(0, 0.6)$, $(1, 0.6)$ and $(1, 1)$. All treatments used groups of five agents, $n = 5$, and the following profile of productivities:

$$(w_1^1, w_2^1, w_3^1, w_4^1, w_5^1) = (5, 5, 5, 10, 10) \tag{11}$$

In other words, there were two types of agents: those with low productivity ("poor", denoted w_l) and those with high productivity ("rich", denoted w_h). Since the majority is poor, the assumption $(w_m^1)^2 < \frac{1}{n}Z$ is satisfied, with $\frac{1}{n}Z = 55$ and $(w_m^1)^2 = 25$. The overall payoff of agents in the two-period model is given by the sum of agents' payoffs in two periods, where the per-period payoff of agent i is given by equation (5) evaluated at equilibrium tax rates (t^{1^*}, t^{2^*}) in periods 1 and 2. The optimal tax rates in each period follow from Lemma 2 and Proposition 1.

The equilibrium tax rate, $t^*_{(p,\mu)}$, is determined by the ideal tax rate of the poor majority and depends on the combination of tax persistence and mobility parameters. When taxes are not persistent - i.e., $p = 0$ - the equilibrium tax rate in both periods is the same, independent of μ and is given by equation (6) with $p = 0$ substituted in:

$$t^*_{(0,\mu)} \equiv t^{1^*}_{(0,\mu)} = t^{2^*}_{(0,\mu)} = \frac{n^2}{n^2 - 1} \cdot \frac{\frac{Z}{n} - (w_l)^2}{\frac{2Z}{n+1} - (w_l)^2} = 0.47 \tag{12}$$

[17] In the experiment, the parameters are such that the first effect dominates the second effect, so mobility is predicted to reduce inequality.

When the tax rate chosen in period 1 persists in period 2 - i.e., $p = 1$ - the equilibrium tax rate selected in period 1 depends on the mobility parameter, μ, and is given by:

$$t^*_{(1,\mu)} \equiv t^{1^*}_{(1,\mu)} = t^{2^*}_{(1,\mu)} = \frac{n^2}{n^2-1} \cdot \frac{\frac{Z}{n} - (w_l)^2}{\frac{Z}{n+1}\left(2 + \frac{\mu}{2-\mu} \cdot \frac{n-1}{n}\right) - (w_l)^2} = \frac{75(2-\mu)}{8(40-9\mu)} \tag{13}$$

For all our experimental parameters, the ideal tax rate for the rich agents is zero. However, since rich agents constitute the minority group in every period, they are not pivotal in determining level of redistribution, and the majority preferred tax rate is the ideal tax rate of the poor agents. The long run values for poor and rich agents in the two-period model also depend on the parameters, (p, μ):

$$V_i(w_i, t^*_{(p,\mu)}) \equiv V_i(w_i, t^{1^*}_{(p,\mu)}, t^{2^*}_{(p,\mu)}) = (2-\mu) \cdot u^*(w_i, t^*_{(p,\mu)}) + \mu \cdot \bar{u}^*_i(t^*_{(p,\mu)}) \quad \text{for } w_i \in \{w_l, w_h\}$$

Therefore,

$$V_l(w_l, t^*_{(p,\mu)}) = \left(2 - \frac{2\mu}{5}\right) \cdot u^*(w_l, t^*_{(p,\mu)}) + \frac{2\mu}{5} \cdot u^*(w_h, t^*_{(p,\mu)})$$

$$V_h(w_h, t^*_{(p,\mu)}) = \left(2 - \frac{3\mu}{5}\right) \cdot u^*(w_h, t^*_{(p,\mu)}) + \frac{3\mu}{5} \cdot u^*(w_l, t^*_{(p,\mu)})$$

These expressions are used to calculate the level of inequality in the society, as measured by the variance of the long-run expected utility conditional on period one's productivities. Table 1 summarizes the theoretically predicted equilibrium tax rates and inequality in our four experimental treatments.

Table 1: Parameters and Experimental Design

Treatment	Tax Persistence	Mobility	$t^*_{(p,\mu)}$	var(V_i)	# sessions	# groups	# subjects
NM	$p = 0$	$\mu = 0$	0.47	99.93	3	12	60
M1	$p = 0$	$\mu = 0.6$	0.47	48.96	4	17	85
M2	$p = 1$	$\mu = 0.6$	0.38	94.83	5	28	140
M3	$p = 1$	$\mu = 1$	0.30	79.85	5	29	145

The theoretical model described above yields testable predictions about both the equilibrium tax rates in different treatments as well as individual tax proposals during the voting stage. We summarize these main predictions as experimental hypotheses below:

Hypothesis 1: When taxes are not persistent, prospects of income mobility have no effect on equilibrium tax rates - i.e., $t^*_{(0,0)} = t^*_{(0,0.6)}$.

Hypothesis 2: For a fixed mobility μ, tax persistence leads to lower equilibrium tax rates - i.e., $t^*_{(0,0.6)} > t^*_{(1,0.6)}$.

Hypothesis 3: For a fixed and positive level of tax persistence, p, an increase in the mobility parameter, μ, leads to lower equilibrium tax rates - i.e., $t^*_{(1,0.6)} > t^*_{(1,1)}$.

Hypothesis 4: For fixed mobility, μ, an increase in the persistence of taxes leads to higher inequality - i.e., $\text{var}(V_i(w_i, t^*_{(0,0.6)})) < \text{var}(V_i(w_i, t^*_{(1,0.6)}))$.

Hypothesis 5: Higher mobility leads to lower inequality both when taxes are persistent - i.e., $\text{var}(V_i(w_i, t^*_{(0,0)})) > \text{var}(V_i(w_i, t^*_{(0,0.6)}))$, and when taxes are re-voted in every period - i.e., $\text{var}(V_i(w_i, t^*_{(1,0.6)})) > \text{var}(V_i(w_i, t^*_{(1,1)}))$.

Hypothesis 6: Rich agents propose zero tax rates in all treatments and in all periods in which there is a vote for a new level of redistribution. Poor agents propose current period equilibrium tax rates in all treatments (summarized in Table 1).

3.2 Experimental Protocol

All experimental sessions were conducted at the ESSL (Experimental Social Science Laboratory) at University of California, Irvine. Subjects were recruited from the general undergraduate population, from all majors. Experiments were conducted using Multistage software, which was developed from the open source Multistage package.[18] We conducted 17 sessions, using a total of 430 subjects. No subject participated in more than one session. Each session lasted, on average, one and a half hours, and subjects' average earnings were $28, including the $7 show-up fee.[19]

For all four treatments, an experimental session consisted of three parts. In Part I, we elicited the subjects' risk attitudes using the investment task of Gneezy and Potters (1997).[20] In this task, subjects are given 100 points, which are worth $2, and they allocate these points between a safe investment, which returns one point for each point invested, and a risky investment, which returns 2.2 points for each point invested with probability 50% and produces no returns for the investment with probability 50%. Any amount earned from this task was added to the overall earnings in the session.[21]

[18] The Multistage software package is publicly available for download at at http://software.ssel.caltech.edu/.

[19] The complete instructions and screenshots for one of the treatments is in Online Appendix.

[20] This method is among the more common methods for eliciting risk attitudes of subjects in laboratory experiments (see survey of Charness, Gneezy and Imas (2013)).

[21] The reason we included this risk attitude task is that in principle risk attitudes could affect individual behavior in the M2 and M3 treatments. In fact, we did not find evidence of such effects. See section 4.2.2 and Online Appendix C for this discussion.

For Parts II and III of the experiment, subjects were divided into groups of five subjects: three were assigned low productivity of 5, and two were assigned high productivity of 10. During the entire experiment, subjects interacted only with other subjects assigned to their own group, so each group of five people represents an independent observation for the statistical analysis, hereafter.

Part II consisted of ten periods. In this part of the experiment, subjects gained experience with the labor market. At the beginning of each period, agents were informed of the tax rate for that period. Then they chose how much labor to supply without knowing what other subjects in their group chose. Labor supply decisions could be any number between 0 and 15 with up to two decimal places.[22] After all five agents had made their choices, subjects received feedback that specified the labor supply of each agent in their group, and an agent's own payoff was displayed on the screen, broken down into three parts: after-tax income, the quadratic cost of labor, and their tax rebate (equal share of collected taxes). When the period ended, the group moved on to the next period, which was identical to the previous one, except for the tax rate imposed at the beginning of the period. In this part of the session, subjects went through different possible tax rates, in the following order: 0.50, 0.15, 0.70, 0.62, 0.35, 0.05, 0.27, 0.75, 0.90, and 0.20.

Part III is the main part of the experiment. This is also the only part that differed across the four treatments. Like Part II, it consisted of ten matches, with each match being the two-period game described in Section 2. In each of the ten matches, the productivity of each subject in period 1 was fixed and was the same as the productivity they were assigned at the beginning of Part II. Second-period productivities were reassigned depending on the value of μ in each treatment: in the NM treatment, there was no income mobility - i.e., $\mu_{NM} = 0$; in Treatments M1 and M2, the mobility parameter was $\mu_{M1} = \mu_{M2} = 0.6$; and in M3, the mobility parameter was $\mu_{M3} = 1$. In treatments with $\mu > 0$, when subjects were reassigned productivities in period 2, exactly three out of five subjects in a group were randomly chosen to receive low productivity of 5, and the two remaining subjects received high productivity of 10.

In the NM and M1 sessions, at the beginning of each period of each match, subjects observed their productivity for the current period and were asked to submit a proposal

[22]We used terminology in the experiment that avoided references to work, effort, productivity or other terms associated with labor market or relative income. Instead, individual labor supply decisions were called investment levels and productivities were called values. This terminology is used extensively in a variety of settings including public good games, risk elicitation tasks, extensive form games with different market structures. Its advantages include the observation that it is easy to grasp for subjects in the experiments and it is neutral with respect to the contextual details of the environment one wishes to study.

for the tax rate in the current period. The median proposal (third-lowest tax rate) was announced to all subjects and implemented for that period. We chose this mechanism because every member has a dominant strategy to propose her ideal tax rate.[23] After the tax rate for the current period was determined, subjects chose their labor supply as in Part II of the experiment. At the end of the period, subjects observed their own payoff for this period along with all labor supply decisions and tax proposals of the other subjects in their group. In the NM treatment, period 2 productivities were the same as in period 1, and subjects were informed in advance that this would be the case. In Treatment M1, depending on the realization of μ, period 2 productivities were either the same or different. Note that the subjects knew that period 2 tax rates would be determined after they learned their period 2 productivities. This two-period game was repeated ten times (ten matches).

In the M2 and M3 sessions, subjects proposed tax rates only once, in period 1. The tax proposals were elicited after they were informed of their own period 1 productivities, but before they knew whether or not their productivity would change in period 2. The instructions provided subjects with explicit calculations of their chances of experiencing mobility in period 2. The median proposal was then announced to all subjects and implemented in both periods of that match. The remaining details of treatments M2 and M3 were exactly the same as those of NM and M1. That is, after the tax rate in period 1 was determined, subjects chose their labor supply for period 1. After that, subjects learned their payoff for period 1, as well as the period 1 labor supply decisions and tax proposals made by other members of their group. Then, subjects proceeded to period 2, in which they each first learned the (possibly different) period 2 productivities of all group members, including their own, chose labor supply given the tax rate previously determined in period 1, and observed the period 2 payoffs and choices made by other subjects in their group. This two-period game was repeated ten times (ten matches).

To help subjects calculate hypothetical earnings from different labor supply and tax choices, we provided them with a built-in calculator that appeared on their monitors. Subjects could use the calculator before submitting their tax proposals and before making their labor decisions. For labor supply decisions, to use the calculator, subjects had to make three choices: the productivity for which they wanted to observe the hypothetical payoff; a labor supply decision for the chosen productivity level; and a guess of the total taxes collected from the other members in the group. For proposing tax rates, subjects also had to enter a fourth parameter: the tax rate for which the hypothetical period

[23] Agranov and Palfrey (2015) also used this voting method.

earnings would be computed. After the subjects entered all of their information, the calculator computed the payoff of a subject in this hypothetical scenario. Subjects could use this calculator as many times as they wished.

There were several reasons we chose to keep group assignments and subjects' first-period productivities constant across all 10 matches in Part III of the experiment in all our treatments. First, this design allows us to treat each group of five subjects as an independent observation for the purpose of the statistical analysis. Second, this design is consistent with the previous study of the static Meltzer-Richard model (Agranov and Palfrey (2015)).[24] Third, the game that subjects play already includes a lot of chance moves, so to minimize complexity of the environment we chose to keep subjects' first period productivities fixed across matches in Part III rather than randomizing them. Finally, reshuffling subjects' first-period productivities a different kind of mobility across matches, which could lead to confusion, and might also provide each subject an incentive to maintain low tax rates throughout the experiment in order to maximize the sum of the payoffs across matches. Keeping first-period productivities constant across matches attenuates these potential problems.

The number of sessions conducted and the number of participants in each treatment are summarized in Table 1.[25] We collected more independent observations for M2 and M3 treatments compared with NM and M1 treatments, as these feature both mobility and tax persistence - two components which are the main focus of the current paper. The NM and M1 treatments serve as the baseline treatments and, in some sense, also provide a robustness check of the one-period model of redistribution given the lack of persistence of taxes in these two treatments.

4 Results

We structure the presentation the results of the experiment using the theoretical model described above as our basis. We start by comparing implemented taxes, labor supply decisions and overall inequality levels across our experimental treatments. We test the

[24]Consistency with previous experiments is good practice in order to be able to attribute differences in outcomes in case such are observed to the fact that the current experiment implements a dynamic model with mobility and tax persistence rather than to the differences in experimental protocols between the two experiments.

[25]Two groups of five subjects in the NM treatment were interrupted during the session due to computer crashes. However, since subjects interacted only within their own group and were never rematched with other subjects, these difficulties did not affect the functioning of other subjects in these sessions. We exclude these two groups from the analysis.

hypotheses about treatment effects, as summarized in Section 3.1, and document some quantitative and qualitative differences between observed and predicted outcomes (Section 4.1). We then investigate several mechanisms that could account for these differences (Section 4.2).

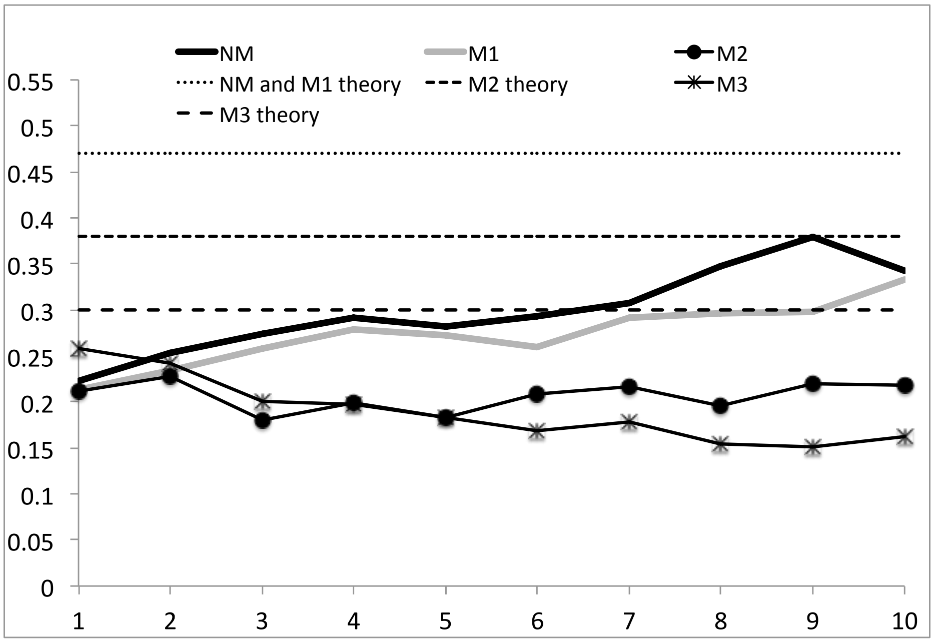
Our *empirical strategy* is as follows. The first five hypotheses outlined in Section 3.1 are evaluated in two complementary ways. For each hypothesis we compare separately the average and the median outcomes in the two considered groups. Specifically, we use random effects Tobit regression to compare *average outcomes* between two groups (either two periods of the same treatment or two different treatments). We regress the outcome of interest - i.e., implemented tax rates, labor supply decisions or income dispersion - on a dummy variable that indicates one of the two considered groups, with standard errors clustered at the group level, to account for interdependencies of observations that come from the same group. We say that the difference between outcomes in the two groups is statistically significant if the estimated coefficient on the dummy variable is different from zero at the standard 5% significance level or better, and we report the p-values associated with it. To compare *median outcomes* between two groups we use similar approach but run median (least absolute deviation) regressions instead of Tobit regressions. To compare both average or median outcomes with those predicted by the theory, we use random effects GLS regressions, in which we regress the variable of interest on a constant term alone, while clustering observations by groups. We report the p-value of a test where the null hypothesis is that the estimate equals the theoretically predicted value.

4.1 Treatment Effects

4.1.1 Implemented Taxes

Figure 1 displays the time path of the average implemented taxes in each treatment. The evolution of tax rates over the repeated trials in the experiment shows a clear dynamic. When subjects have no experience with the environment, the *initial* implemented tax rates are approximately the same in all of our treatments. As subjects gain experience, the tax rates diverge and evolve over time in the direction of the equilibrium corresponding to the different treatments. Thus, after a few initial rounds, this convergence dynamic typically leads to significant separation across the treatments, as predicted. Tax rates in the treatments with no mobility (NM) or no persistence (M1) drift upwards in the direction of equilibrium. There is no such upward dynamic in the M2 and M3 treatments with tax persistence and mobility; and over time there is separation between these two treatments, with M2 leading to higher taxes than M3.

Figure 1: Implemented Taxes (averaged across groups in a match)



Notes: In the NM and M1 treatments, we pool the data from the first and second periods.

We are testing an equilibrium model, so our main interest is to study behavior that results from the learning and equilibrium convergence dynamic and compare that to the equilibrium predictions, the initial rounds during which subjects are gaining experience with a complex game. Figure 1 shows clear presence of an initial learning phase, which is a common feature observed in many laboratory experimental studies of equilibrium models. We, therefore, present statistical tests of our hypotheses about treatment differences both for all 10 repetitions of the game, to which we refer as *all games*, and for the last five matches separately, to which we refer as *experienced games*. We stress, however, that the judgement about whether or not the equilibrium model described in Section 2 organizes the data to a satisfactory degree should be made based on the statistical tests conducted using the experienced games.[26]

When taxes are not persistent and agents make decisions about the tax rate after they

[26]The division of the data set into the first five and last five repetitions of the game is somewhat arbitrary and meant to capture the idea that in the first few repetitions subjects are learning by playing the game. In an Online Appendix, we repeat the statistical analysis of our main hypotheses for the last 3 repetitions of the game in each experimental session instead of the last 5 repetitions and show that the qualitative results remain the same.

Table 2: Average Implemented Tax Rates

	NM ($t^* = 0.47$) $(p,\mu) = (0,0)$ mean (se)	M1 ($t^* = 0.47$) $(p,\mu) = (0,0.6)$ mean (se)	M2 ($t^* = 0.38$) $(p,\mu) = (1,0.6)$ mean (se)	M3 ($t^* = 0.30$) $(p,\mu) = (1,1)$ mean (se)
All games				
Period 1	0.30 (0.04)	0.27 (0.03)		
Period 2	0.29 (0.04)	0.28 (0.03)		
Periods 1&2 pooled	0.30 (0.04)	0.27 (0.03)	0.21 (0.02)	0.19 (0.02)
Experienced games				
Period 1	0.34 (0.04)	0.30 (0.04)		
Period 2	0.32 (0.04)	0.29 (0.03)		
Periods 1&2 pooled	0.33 (0.04)	0.30 (0.03)	0.21 (0.03)	0.16 (0.03)

Notes: t^* depicts the theoretically predicted equilibrium tax rate in each treatment. For M2 and M3 treatments, tax rates in two periods are the same by design. We list those in the line that corresponds to Periods 1&2 pooled data. *All games* consider all 10 repetitions of the game in each treatment, while *experienced games* look at the last 5 repetitions. Robust standard errors are in parentheses, clustered by group.

learn their productivities in each period of the game, the presence of income mobility is predicted to have no equilibrium effect on the amount of redistribution (Hypothesis 1), and furthermore the equilibrium tax rates in periods 1 and 2 are predicted to be equal. To test this hypothesis, we compare implemented taxes in the M1 and NM treatments. As is evident from Table 2, this hypothesis cannot be rejected in our data: pooling the data from both periods, we observe no significant difference between average or median tax rates in the NM and M1 treatments ($p = 0.616$ for average tax rates in all games, $p = 0.454$ for average taxes in the experienced games, $p = 0.698$ for median tax rates in all games, and $p = 0.754$ for median taxes in the experienced games). We reach the same conclusion when we perform a regression analysis separately for each of the two periods of the game.[27] Moreover, given that our setup features no aggregate uncertainty, tax rates in both periods of the NM and M1 treatments are predicted to be the same. Regression analysis also confirms that both average and median tax rates in both periods of the NM and M1 treatments are the same.[28]

[27] For the average tax rates we obtain $p = 0.486$ ($p = 0.412$) and $p = 0.765$ ($p = 0.521$) for comparison of the NM and M1 treatments in the first and the second periods in all (experienced) games, respectively. For the median tax rates we obtain $p = 0.629$ ($p = 0.761$) and $p = 0.624$ ($p = 1.000$) for comparison of the NM and M1 treatments in the first and the second periods in all (experienced) games, respectively.

[28] For the average tax rates we obtain $p = 0.492$ ($p = 0.332$) for all (experienced) games in NM treatment, and $p = 0.465$ ($p = 0.619$) for all (experienced) games in M1 treatment. For the median tax rates we obtain $p = 1.000$ ($p = 0.297$) for all (experienced) games in NM treatment, and $p = 1.000$ ($p = 0.664$) for all (experienced) games in M1 treatment.

For a fixed and positive level of income mobility, tax persistence leads to less redistribution, as the pivotal voter expects to climb the income ladder with some positive probability and is willing to trade off some current income in anticipation of this potential move (Hypothesis 2). To test this hypothesis, we compare tax rates in the M1 and M2 treatments, which both feature $\mu = 0.6$ and differ only in the tax persistence parameter, p. Hypothesis 2 is borne out in our data: average implemented tax rates in the M2 treatment are significantly lower than those in both periods of the M1 treatment with the effect being stronger in the experienced games in each treatment ($p = 0.075$ and $p = 0.047$ in all and experienced games, respectively).[29]

Finally, for a fixed and positive level of tax persistence, higher income mobility is predicted to lower equilibrium tax rates, as upward mobility is more likely for the pivotal voter (Hypothesis 3). While the comparison between average implemented taxes in the M2 and M3 treatments is not statistically significant at the standard 5% level ($p = 0.498$ for all games and $p = 0.166$ for the experienced games in each treatment), median implemented taxes in the experienced games of M3 are significantly lower than those in M2 ($p = 0.037$).[30]

While comparative static hypotheses about implemented tax rates across the treatments follow theoretical hypotheses, the levels are off. As is apparent in Figure 1 and Table 2, and is confirmed by regression analysis, for each treatment, we reject the null that the average and the median implemented tax rate equals the theoretically predicted one ($p < 0.01$ for all comparisons in all treatments both when using all games and experienced games in each treatment). In all cases, the average and the median implemented tax rates are lower than predicted. We explore a possible explanation for these differences in Section 4.2.

4.1.2 Labor Supply Decisions

Lemma 1 predicts no treatment effects on labor supply functions. Indeed, the optimal choice of labor depends exclusively on the tax rate and an agent's own productivity, both of which are known at the time agents make their labor decisions. To test this hypothesis, we regress the *normalized* labor supply on the tax rate and a constant, where the normalized labor supply is equal to labor supply divided by productivity. Theory

[29] The comparison between median tax rates in the M2 and the M1 treatments shows that median tax rates are only marginally significant in the experienced games with $p = 0.115$ and not statistically significant when we look at all games $p = 0.516$.

[30] There is no significant difference between median implemented taxes in M2 and M3 treatments when using data from all games ($p = 0.151$).

Table 3: Estimated Normalized Labor Supply Functions

	NM		M1		M2		M3	
	const (se)	slope (se)	const (se)	slope (se)	const (se)	slope (se)	const (se)	slope (se)
All games								
Poor	0.99 (0.02)	-0.76 (0.04)	1.01 (0.02)	-0.78 (0.04)	0.99 (0.02)	-0.68** (0.04)	0.98 (0.01)	-0.70** (0.03)
Rich	0.98 (0.03)	-0.76 (0.04)	1.01 (0.02)	-0.84 (0.04)	0.97 (0.01)	-0.76 (0.04)	0.96** (0.01)	-0.75 (0.03)
Experienced games								
Poor	0.97 (0.02)	-0.74 (0.05)	0.98 (0.02)	-0.68** (0.05)	1.02 (0.02)	-0.79 (0.06)	0.98 (0.01)	-0.73 (0.04)
Rich	0.96 (0.03)	-0.70 (0.07)	1.00 (0.03)	-0.79 (0.07)	0.99 (0.01)	-0.78 (0.05)	0.97 (0.01)	-0.76 (0.04)

Notes: Random effects TOBIT regressions of normalized labor supply decisions regressed on implemented tax rates and a constant, using data from both periods and clustering standard errors by the group. Clustering by individuals yields similar results. Normalized labor supply is labor supply divided by productivity. ** indicates that theoretically predicted value of a coefficient falls outside of 95% confidence interval of estimated coefficients. *All games* use the data from all 10 repetitions of the game, while *experienced games* focus on the last 5 repetitions in each treatment.

predicts that the coefficient on the tax rate is -0.8 with a constant term equal to 1, for both productivity types, independently of the treatment and the period of the game. Table 3 reports the estimated coefficients from random-effects TOBIT regressions using data from all games and experienced games in each treatment for each productivity level separately, with standard errors clustered at the group level.[31] As is evident from Table 3 in all but three cases in all games and in all but one case in the experienced games (out of 16 cases for each data cut), theoretically predicted values fall inside a 95% confidence interval of the estimated coefficient. Thus, we conclude that labor supply decisions of both poor and rich agents in all four treatments are generally consistent with the theoretically predicted ones. In particular, we observe no systematic deviations in the labor market decisions that would indicate the presence of other-regarding preferences such as altruism or inequity aversion.[32]

[31] In an Online Appendix, we report similar regressions conducted separately for each period of the game using all games in each treatment. We also conduct similar regression analysis while clustering standard error by individuals to account for heterogeneity between different subjects and present results of this analysis in Online Appendix. Both types of analysis yield results similar to the ones presented here.

[32] The absence of evidence for an effect of social preferences in this experiment replicates a similar finding in Agranov and Palfrey (2015). That paper includes an extensive theoretical and empirical analysis to document the finding.

4.1.3 Inequality

In this section, we turn our attention to the overall level of inequality in the society, which, in theory, depends on the persistence of the tax regime, the (endogenous) tax rate, and the degree of mobility, all of which interact in a non-trivial way, as discussed in Section 2.2. We measure the inequality in society by the dispersion (variance) of agents' total utility over the course of both periods.[33] Supplementary analysis in Online Appendix shows that the same conclusions are reached using GINI coefficients as the measure of inequality. Table 4 presents observed and theoretical levels of inequality across the four experimental treatments.

Table 4: Inequality Levels Across Treatments

	Theoretical Variance	Observed Variance			
		all games		*experienced games*	
	expected	mean (se)	median	mean (se)	median
NM	99.93	480.81 (78.74)	319.28	403.44 (81.50)	304.75
M1	48.96	340.89 (55.06)	224.75	305.90 (60.53)	165.93
M2	94.83	421.11 (33.99)	326.77	430.40 (43.30)	337.10
M3	79.85	368.75 (27.74)	246.14	405.57 (41.46)	321.08

Notes: The variance of agents' total incomes is reported for each treatment separately. The total income is the sum of agents' utilities in both periods of the game, which consists of after-tax income, costs of labor and tax rebate. The first column, labeled 'expected', under Theoretical Variance gives the expected variance calculated using equation (8). Observed variance is computed using subjects' total incomes separately for each group in all games and in the experienced games separately. The robust standard errors are obtained by clustering observations by groups.

For a given level of mobility, an increase in persistence of taxes is predicted to increase inequality, as it lowers the equilibrium tax rates (Hypothesis 4). To test this hypothesis, we compare the inequality levels in M1 and M2, which hold the mobility parameter constant and vary the tax persistence parameter. This hypothesis is borne out in our data when we compare inequality levels between M1 and M2 treatments using the experienced games: $p = 0.03$ for comparison of medians and $p = 0.08$ for comparison of averages. The statistical significance of the difference in inequality levels between M1 and M2 treatments emerges only after subjects have gained experience, as both average and median inequality levels are not statistically different when using the data from all games in each treatment ($p = 0.189$ for comparison of average inequality levels and $p = 0.115$ for comparison of

[33] To be consistent with the theoretical analysis, our measure of total utility of agents across two periods sums up agents' utility in both periods, which includes after-tax income, costs of labor and tax rebate.

medians levels).

For a given level of tax persistence, Hypothesis 5 states that an increase in income mobility decreases inequality. Our design provides two distinct tests of this hypothesis: in one case where taxes are re-voted in every period (NM versus M1 treatments) and in a second case where taxes are fully persistent (M2 versus M3 treatments). For each level of tax persistence, consistent with theoretical predictions, we observe that both the average and the median levels of inequality are lower in M1 than in NM and lower in M3 than in M2. However, these differences are not statistically significant ($p > 0.10$ in all pairwise comparisons).[34]

Finally, in all four treatments, the levels of observed inequality are substantially larger in magnitude than those predicted by theory. There are two reasons. First, as we documented above, the average implemented tax rates are below the equilibrium rates. This by itself increases inequality since lower levels of redistribution increase the dispersion of agents' after-tax incomes. Second, in all treatments, there are a few group outliers that implement zero tax rates; and these groups drive up the levels of inequality in all treatments.

4.2 Understanding deviations from the theory

There are several interesting features of the data in terms of both the dynamic evolution of tax rates across the ten matches and the tax rate levels. In both periods and in all four treatments, the implemented tax rates are significantly below the theoretical rates. Even after subjects experienced the game for five matches, in both the NM and M1 treatments, the average implemented taxes were around 30%, while the theoretical equilibrium tax rate is 47%.[35] While in both treatments, there is a clear upward trend in the direction of the equilibrium tax rate, it remains below 40% even in the last few matches. This effect of below-equilibrium taxes is present also in the two treatments with income mobility and persistent taxes (M2 and M3). There, we observe tax rates that are slightly more than one half of the equilibrium tax rates, and the time series of implemented taxes across matches does not show any upward trend, as was the case in NM and M1.

[34] We obtain $p = 0.135$ and $p = 0.327$ ($p = 0.320$ and $p = 0.269$) for average (median) levels of inequality in NM versus M1 treatments in all games and in the experienced games, respectively. Similarly, we find that $p = 0.231$ and $p = 0.679$ ($p = 0.134$ and $p = 0.849$) for average (median) levels of inequality in M2 versus M3 treatments in all games and in the experienced games, respectively.

[35] This finding is surprising in light of past findings to the contrary documented in Agranov and Palfrey (2015), who study taxation and redistribution in a one-period setup similar to the one studied here, except that in their setup, societies consist of five different productivity levels, rather than the two levels (poor and rich) in our setup.

Note that our hypotheses for equilibrium tax rates were derived under the assumption of agents' risk neutrality. A natural question is: what happens if one allows for risk-averse preferences? It is easy to see that allowing for risk-averse preferences would change our hypotheses only in the treatments that feature persistent tax regimes. When the tax regime is non-persistent, agents' risk attitudes do not affect the equilibrium tax rates since taxes are adjusted in every period following any changes in agents' productivities. Furthermore, for treatments with persistent taxes (M2 and M3), the equilibrium tax rates with risk-averse agents are predicted to be *higher* than the equilibrium tax rates with risk-neutral agents. This is a direct implication of the concavity of the utility function of pivotal poor agents. Therefore, risk aversion cannot account for the deviations observed in our experiments.

What can account for the fact that observed tax rates are significantly below equilibrium tax rates in all of our treatments? Why do the learning patterns look very different between treatments with non-persistent and persistent taxes?

4.2.1 Mechanical downward bias of implemented taxes

Our first observation is that the current setup features a purely mechanical bias in the direction of lower-than-equilibrium implemented taxes, and when one adjusts for this bias, the results indeed replicate the past findings of Agranov and Palfrey (2015). Because the ideal tax rate of poor voters is 47% and the ideal tax rate of rich voters is 0%, the pivotal voter is (theoretically) a poor voter. Although this is what is usually observed in the data, there is significant variation in the poor voters' proposals.[36] Thus, it is nearly always the case that the *lowest proposed tax rate among the poor voters* is implemented since the two rich voters usually propose very low or zero tax rates.

As a consequence of this variation, even if, *on average*, the taxes proposed by the poor voters are equal to the equilibrium tax rate, the implemented tax rate under the proposal mechanism will be biased downward.

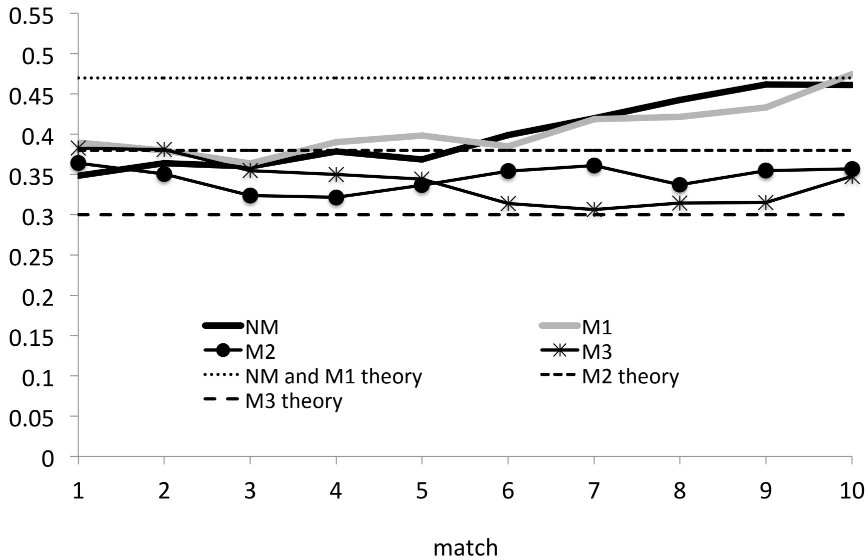
To check and see if it is this mechanical bias that causes the low taxes in NM and M1, Figure 2 displays the time series of the median tax rate proposed by the three poor voters in a group, averaged across groups. In both treatments without persistence of taxes (NM and M1), the average median proposed tax rate by poor voters starts below the equilibrium level but adjusts upward over time, reaching a level approximately equal

[36]Despite this heterogeneity, in the vast majority of elections, the group's median proposal comes from one of the poor voters: this happens in 85% (83%) of elections in all (experienced) games of the NM treatment. The corresponding fractions in the remaining treatments are 75% (76%), 76% (83%) and 81% (83%) for M1, M2 and M3 treatments in all (experienced) games, respectively.

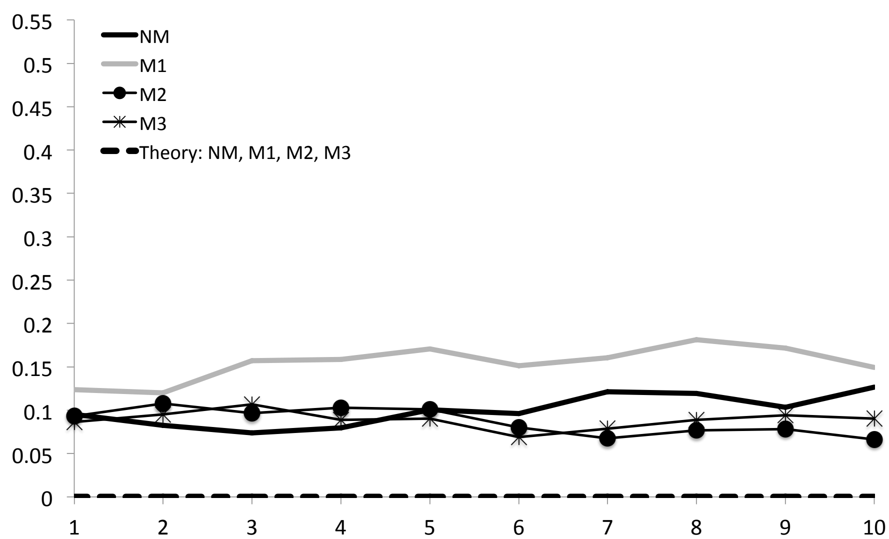
to the equilibrium tax rate by the end of the experiment.

Figure 2: Tax Rate Proposed by Poor and Rich Voters (averages per match)

(a) Poor Voters



(b) Rich Voters



Notes: In the NM and M1 treatments, we pool the data from the first and the second periods.

In all four treatments, correction for this mechanical bias has a large effect. While in all treatments, this de-biasing raises the level of tax rates upward towards the equilibrium tax rate, the evolution over matches of proposed tax rates is different across treatments. In all treatments, median tax proposals of poor voters in the first match are similar across the treatments, mirroring the results for implemented tax rates, clustering around 35%-40% tax rates. However, as subjects gain experience with the game, the treatments separate out, with a noticeable increase in treatments with non-persistent taxes (NM and M1) and a decrease in treatments with persistent taxes (M2 and M3).

To evaluate the effect of the mechanical bias in a statistical sense, the first three columns in Table 5 depict the average tax proposals of poor voters in each treatment in all games and in experienced games and the corresponding theoretical predictions for such proposals. Statistical analysis reveals that one cannot reject the null hypothesis that tax proposals of poor voters in the experienced games are equal to the theoretically predicted ones in all four treatments: $p = 0.426$ in NM, $p = 0.231$ in M1, $p = 0.390$ in M2, and $p = 0.492$ in M3.[37] In other words, we find that with the correction for the mechanical bias, the average tax rate proposed by poor voters converges to their ideal tax rate, as predicted by the theory and summarized in Hypothesis 6.

Table 5: Average Proposed Tax Rates

	Proposals by Poor			Proposals by Rich		
		all games	*experienced games*		*all games*	*experienced games*
	theory	mean (se)	mean (se)	theory	mean (se)	mean (se)
NM	0.47	0.41 (0.04)	0.44 (0.04)	0.00	0.10 (0.03)	0.11 (0.03)
M1	0.47	0.41 (0.03)	0.43 (0.04)	0.00	0.15 (0.02)	0.16 (0.03)
M2	0.38	0.35 (0.03)	0.35 (0.03)	0.00	0.09 (0.01)	0.07 (0.01)
M3	0.30	0.34 (0.02)	0.32 (0.03)	0.00	0.09 (0.01)	0.08 (0.02)

Notes: In the NM and M1 treatments, we pool the data from the first and the second periods. *All games* use the data from all 10 repetitions of the game in each treatment, while *experienced games* look at the last 5 repetitions only. Robust standard errors are clustered at the group level.

In addition, we look at the comparative static predictions between treatments using tax rates proposed by all poor agents instead of tax rates implemented in each group (similar to the analysis in Section 4.1.1). Most of these comparisons replicate results reported in Section 4.1.1. When taxes are not persistent, the prospect of income mobility has no effect on tax rates proposed by poor agents which is seen by comparing tax proposals of poor agents in the NM and M1 treatments ($p = 0.809$ and $p = 0.541$ for comparison of average and median tax proposals in experienced games, respectively). For fixed mobility, higher tax persistence is predicted to lead to lower tax rates proposed by poor. The average

[37]This however requires learning, as using the data from all games reveals that average tax rates proposed by poor agents is (marginally) different from the theoretically predicted ones in NM ($p = 0.086$), M1 ($p = 0.047$) and M3 ($p = 0.098$) treatments and not significantly different from theoretically predicted ones in M2 treatment ($p = 0.228$).

tax rate proposed by poor agents in the M1 and M2 treatments follow this ranking but the relationship is not statistically significant ($p = 0.129$ and $p = 0.130$ for comparison of average and median tax proposals in experienced games, respectively). Finally, theory predicts that for a fixed and positive level of tax persistence, an increase in mobility leads to lower tax rates proposed by poor. While Section 4.1.1. reported no statistical difference between observed average tax rates proposed by poor agents in M2 and M3 treatments in the experienced games ($p = 0.361$), the median tax rates proposed by poor in the experienced games are significantly different at the 10% level ($p = 0.097$).

Hypothesis 6 also speaks about tax rates proposed by rich agents. Panel (b) in Figure 2 and the last three columns of Table 5 depict average tax proposals of rich voters in each treatment. While the theory predicts that in all four treatments rich voters should propose zero tax rate, we observe that average proposed taxes of rich voters are above zero and are quite stable across matches in all four treatments. This is expected since any variation in behavior of rich voters produces this result, given that negative taxes are not allowed.

4.2.2 Experienced mobility

Besides the mechanical effect described above, whereby heterogeneity alone can lead to a downward bias in taxes, we consider another factor that may affect subjects' preferences for redistribution in the presence of mobility and a persistent tax regime. This is a purely behavioral factor, which we refer to as the *experienced mobility* hypothesis. According to this hypothesis, poor voters' beliefs about the likelihood of upward mobility may be affected by the frequency of experienced mobility in the early matches of a session. This is a purely behavioral explanation in the sense that subjects were told at the start of the experiment the exact details of the match-independent stochastic mobility process used in the experiment. Thus, in the framework of our equilibrium model there is no theoretical reason for subjects to update their beliefs about it in response to past observations. Nonetheless, one can imagine them doing so.[38] This experienced mobility hypothesis resembles the inference problem of agents explored by Piketty (1995), according to which agents learn about the determinants of economic success and likelihood of mobility through personal and dynastic experimentation. Heterogeneity in long-run beliefs about the prospects of mobility in that model is a natural consequence of this learning

[38] For example, subjects may initially be overly optimistic about the probability of their upward mobility.

process.[39]

To test the experienced mobility hypothesis, Table 6 presents the results of separate random effects TOBIT regressions for the M2 and M3 treatments, in which we regress tax rates proposed by poor voters on a measure of an individual voter's experience with mobility, controlling for her previous match proposal, the match number and her risk attitudes. In addition, for each voter we create a variable that measures voter's observed cumulative frequency (between 0 and 1) of experiencing upward mobility in previous matches.

Table 6: Effect of Experienced Mobility on Tax Proposals of the Poor

	M2	**M3**
Cumulative frequency of own mobility at $t-1$	-9.65** (4.15)	-8.52** (3.86)
Tax rate proposed in $t-1$	0.31** (0.04)	0.33** (0.05)
Match number	0.29 (0.28)	-0.38 (0.29)
Risky investment	-0.04 (0.09)	0.09 (0.07)
Constant	23.65** (6.34)	26.61** (6.40)
# of observations	756	783
# of clusters	84	87
Log Likelihood	-3156.35	-3260.17

Notes: Random effects TOBIT regressions. The dependent variable is taxes proposed by poor agents in match t, for $t > 1$. We use data from all 10 games of the two-period game (Part III of the experiment). Risky investment is a number between 0 and 100 (inclusive), with lower numbers indicating a higher degree of risk aversion. Standard errors are clustered at the individual level. ** (*) indicates significance at 5% (10%) level, and p-values are reported in parentheses.

Several interesting patterns emerge from the estimations presented in Table 6. First, poor voters respond to past mobility experience in their choices of the current tax proposals. Specifically, in both M2 and M3, poor voters propose lower taxes in response to experiencing upward mobility in previous matches. The effect is highly significant, substantial and of the same magnitude for both the M2 and M3 treatments. In particular, if a subject were to experience mobility in half of the previous matches, this would, on average, decrease her tax proposal by about 5 percentage points compared to never having experienced upward mobility. Second, we observe significant inertia in a voter's tax proposals in both the M2 and M3 treatment, as measured by the coefficient on a voter's

[39] See also Ravallion and Lokshin (2000), as well as Corneo and Gruner (2002), who consider the perception of mobility experienced at the community level and argue that individuals form their expectations through the lens of observing what happens around them.

$t-1$ tax proposal, which is also quite similar between the two treatments. Finally, there is no effect of match number or risk attitude for either M2 or M3 treatments.[40]

5 Conclusions

We study experimentally the preferences for redistribution in the presence of uncertainty about future incomes in a simple two-period model which captures the interplay between tax persistence and income mobility and provides a parsimonious framework to analyze the effects of these two factors on the degree of redistribution and post-tax inequality. The primary hypothesis is that if tax rates are persistent, then the prospect of upward mobility will lead to lower tax rates and less redistribution.

The experiment varied both the likelihood of income mobility (zero, moderate, high) and the tax regimes, which differ in how often society can adjust tax rates - i.e., persistence of taxes. The results provide mixed support for the theoretical hypotheses. The key finding is that mobility results in a significantly lower median implemented tax rate but only if tax rates are persistent. Tax persistence combined with mobility also leads to greater inequality, compared with non-persistent tax regimes. Mobility without tax persistence does not affect tax rates. Increasing mobility from moderate to high levels when taxes are persistent reduces inequality, but the effect is modest and not statistically significant.

In terms of magnitudes of the observed endogenous variables, we find that tax rates are lower than theoretically predicted and that levels of inequality are significantly higher. This effect cannot be attributed to subjects' risk aversion, because risk aversion would push the results in the opposite direction (i.e., higher tax rates). Our analysis of individual and group behavior suggests that this pattern is partly explained by a learning dynamic whereby agents use past observations of experienced mobility to update beliefs about future mobility.

Our results offer a first step toward exploring dynamic models of voting over redistribution in the presence of social mobility. From a theoretical perspective, our approach introduces dynamic considerations into the classic setup of equilibrium taxation and redistribution, by modeling the dynamics as the two-period stochastic game and then characterizing its solution. In the basic model introduced here, a tractable and unique equilibrium is obtained. From a substantive perspective, despite its simplicity, the basic

[40]More broadly, we find no effect of measured risk aversion on individual behavior in the experiment. For further details see Online Appendix.

model delivers non-trivial results regarding the interaction between tax regime persistence, income mobility, and the underlying distribution of wage inequality in the labor market. Comparative statics results about the effect of these factors on after-tax inequality and efficiency follow naturally. We confirm that these effects are robust to extending the model to an infinite-horizon (online appendix). The experimental results confirm the main causal hypotheses generated by theory.

The philosophy behind theory-based experiments is to create simple yet real economic environments, which isolate and capture the main tradeoffs that economic agents face in such environments, and to observe real people making decisions with real economic consequences. Our experimental results indicate that the model correctly identifies a basic tradeoff that people face in this dynamic environment. The results of the experiment indicate that the POUM hypothesis and its theoretical implications about inequality, redistribution, and equilibrium tax policy are empirically plausible, and cannot be dismissed out of hand as mere theorizing.

Of course, the basic model is very stark and one would like to see the model extended to incorporate other important factors that can affect the dynamics of equilibrium taxes and inequality. For example it would be interesting to generalize the model by relaxing the assumption of no aggregate uncertainty, in which case the equilibrium tax rate would vary across states. There are a number of ways to develop this, such as incorporating productivity shocks to the economy[41] or allow for investment in human capital. The approach could also be further developed by enriching the model of the political process to include important institutions such as elections and legislatures, and by allowing the tax receipts to be used for public good expenditures as well as pure redistribution. We are hopeful that this approach can be useful as a basis for exploring these and other interesting extensions in future research, including empirical work that explores the interplay between persistence of taxes and income mobility and how this interplay affects levels of redistribution that emerge across countries and across time.

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Appendix A. Proofs

Proof of Lemma 1. The maximization problem of an agent i in period k with productivity w_i^k when the tax rate is t^k is

$$\max_{x_i^k} \left[(1-t^k) w_i^k x_i^k - \frac{1}{2} \left(x_i^k \right)^2 + \frac{1}{n} \cdot \sum_{j=1}^{n} t^k w_j^k x_j^k \right]$$

This is a well-defined concave problem with unique solution $x_i^{k^*}$ which depends only on the tax rate t^k and agent own productivity w_i^k

$$x_i^{k^*} = \left(1 - t^k + \frac{t^k}{n} \right) w_i^k \tag{14}$$

Moreover, the optimal per-period utility is

$$u_i^*(w_i^k, t^k) = \frac{(w_i^k)^2}{2} \left((1-t^k)^2 - \frac{(t^k)^2}{n^2} \right) + Z \frac{t^k}{n} \left(1 - t^k + \frac{t^k}{n} \right) \tag{15}$$

where

$$Z = \sum_{j=1}^{n} (w_j^k)^2$$

represents aggregate income of the economy if the tax rate is zero and all workers choose labor optimally. ■

Proof of Proposition 1. Preferences for taxes in the second (and last) period of the game are the same as the ones in the static one-period model of taxation and redistribution analyzed in Agranov and Palfrey (2015). Thus, in the remainder of this proof we will deal with characterization of preferences for taxes in the first period for an agent with productivity w_i^1, which (contrary to the second period) need to take into account not only the current productivity of the agent, but his prospects for future productivity in the second period. From now on, we will write w_i instead of w_i^1 for brevity and x_i instead of x_i^1. This generates, for each i the following equation:

$$\begin{aligned} V_i(w_i, t, t^{2^*}) = u_i^*(w_i, t) + p\left[(1-\mu)u_i^*(w_i, t) + \frac{\mu}{n}\sum_{j=1}^{n} u_j^*(w_j, t)\right] \\ + (1-p)\left[(1-\mu)u_i^*(w_i, t^{2^*}) + \frac{\mu}{n}\sum_{j=1}^{n} u_j^*(w_j, t^{2^*})\right] \quad \text{for } i = 1, ..., n, \end{aligned} \tag{16}$$

where $u_i^*(w_i, t)$ is the optimal first period utility of an agent with productivity w_i if the current tax rate is t and t^{2^*} is the second-period tax rate that would emerge if first-period taxes will be re-voted in the second period. Recall, that

$$u_i^*(w_i, t) = \frac{(w_i)^2}{2} \cdot \left((1-t)^2 - \frac{t^2}{n^2}\right) + Z \cdot \frac{t}{n}\left(1 - t + \frac{t}{n}\right)$$

From this, one obtains the ideal tax rate for each agent type by solving the first-order condition with respect to t, and verifying second-order conditions. Note that the third term in (16) is a constant with respect to t as it only depends on the tax rate t^{2^*}, so, the first-order conditions can be written as

$$\frac{\partial V_i(w_i, t, t^{2^*})}{\partial t} = (1 + p(1-\mu))\frac{\partial u_i^*(w_i, t)}{t} + p\mu\frac{\partial \bar{u}^*(t)}{\partial t} \leq 0 \tag{17}$$

where

$$\frac{\partial u_i^*(w_i,t)}{\partial t} = \left(\frac{Z}{n} - w_i^2\right) - t\frac{n^2-1}{n^2}\cdot\left(\frac{2Z}{n+1} - w_i^2\right).$$

$$\bar{u}^*(t) = \frac{1}{n}\sum_{j=1}^{n} u_j^*(w_j,t) = \frac{Z}{2n}\left((1-t)^2 - \frac{t^2}{n^2}\right) + Z\frac{t}{n}\left(1 - t + \frac{t}{n}\right) \tag{18}$$

$$\Rightarrow \frac{\partial \bar{u}^*(t)}{\partial t} = -Z\frac{(n-1)^2}{n^3}t$$

Thus, re-writing the first-order condition above we get

$$\frac{\partial V_i(w_i,t,t^{2^*})}{\partial t} = (1+p(1-\mu))\left[\frac{Z}{n} - w_i^2 - t\cdot\frac{n^2-1}{n^2}\cdot\left(\frac{2Z}{n+1} - w_i^2\right)\right] - p\mu Z\frac{(n-1)^2}{n^3}t$$

$$= (1+p(1-\mu))\left(\frac{Z}{n} - w_i^2\right) - t\frac{n^2-1}{n^2}\left[(1+p(1-\mu))\left(\frac{2Z}{n+1} - w_i^2\right) + p\mu\frac{Z(n-1)}{n(n+1)}\right] \le 0$$

The second-order condition is

$$\frac{\partial^2 V_i(w_i,t,t^{2^*})}{\partial t^2} = -\frac{n^2-1}{n^2}\left[(1+p(1-\mu))\left(\frac{2Z}{n+1} - w_i^2\right) - p\mu\frac{Z(n-1)}{n(n+1)}\right]$$

When $w_i^2 < \frac{Z}{n}$ we have interior solution because there exists $t^{1^*} \in (0,1)$ such that

$$\frac{\partial V_i(w_i,t,t^{2^*})}{\partial t}|_{t=t^{1^*}} = 0 \text{ and } \frac{\partial^2 V_i(w_i,t,t^{2^*})}{\partial t^2} < 0$$

This interior solution is

$$t_i^{1^*} = \frac{n^2}{n^2-1}\frac{\frac{Z}{n} - w_i^2}{\frac{Z}{n+1}\left(2 + \frac{p\mu}{1+p(1-\mu)}\cdot\frac{n-1}{n}\right) - w_i^2}$$

When $w_i^2 \in \left[\frac{Z}{n}, \frac{Z}{n+1}\left(2 + \frac{p\mu}{1+p(1-\mu)}\cdot\frac{n-1}{n}\right)\right)$, we have $\frac{\partial^2 V_i(w_i,t)}{\partial t^2} < 0$, thus, $\max \frac{\partial V_i(w_i,t,t^{2^*})}{\partial t} = \frac{\partial V_i(w_i,t,t^{2^*})}{\partial t}|_{t=0} = \frac{1}{1-p(1-\mu)}\cdot\left(\frac{Z}{n} - w_i^2\right) < 0$, thus $\frac{\partial V_i(w_i,t,t^{2^*})}{\partial t} < 0$ for all $t \in [0,1]$, which means $t^{1^*} = 0$ in this region. Finally, when $w_i^2 > \frac{Z}{n+1}\left(2 + \frac{p\mu}{1+p(1-\mu)}\cdot\frac{n-1}{n}\right)$, we have $\frac{\partial^2 V_i(w_i,t,t^{2^*})}{\partial t^2} > 0$ which means that $\max \frac{\partial V_i(w_i,t,t^{2^*})}{\partial t} = \frac{\partial V_i(w_i,t,t^{2^*})}{\partial t}|_{t=1} < 0$, and, therefore, $t^{1^*} = 0$ in this region as well. Combining all the conditions, we obtain

$$t_i^{1^*} = \begin{cases} \frac{n^2}{n^2-1}\cdot\frac{\frac{Z}{n} - w_i^2}{\frac{Z}{n+1}\left(2 + \frac{p\mu}{1+p(1-\mu)}\cdot\frac{n-1}{n}\right) - (w_i)^2} & \text{if } w_i^2 < \frac{Z}{n} \\ 0 & \text{otherwise} \end{cases}$$

■

Proof of Corollary 1. Here we consider the effect of an increase in tax persistence p on the first period equilibrium tax rate t^{1^*} when $w_m^2 < \frac{Z}{n}$ (recall the equilibrium tax rate is the ideal tax rate of the median productivity agent).

$$\frac{\partial t^{1^*}}{\partial p} = -\frac{n^2}{n^2-1}\left(\frac{Z}{n} - w_m^2\right)\frac{Z(n-1)}{n(n+1)}\frac{\frac{\mu}{(1+p(1-\mu))^2}}{\left[\frac{Z}{n+1}\left(2+\frac{p\mu}{1+p(1-\mu)}\cdot\frac{n-1}{n}\right) - (w_m)^2\right]^2} < 0$$

■

Proof of Corollary 2. Next we consider the effect of an increase in μ on the first period equilibrium tax rate when $w_m^2 < \frac{Z}{n}$ (recall the equilibrium tax rate is the ideal tax rate of the median productivity agent).

$$\frac{\partial t^{1^*}}{\partial \mu} = -\frac{n^2}{n^2-1}\left(\frac{Z}{n} - w_m^2\right)\frac{Z(n-1)}{n(n+1)}\frac{\frac{p(1+p)}{(1+p(1-\mu))^2}}{\left[\frac{Z}{n+1}\left(2+\frac{p\mu}{1+p(1-\mu)}\cdot\frac{n-1}{n}\right) - (w_m)^2\right]^2} < 0$$

■

Proof of Proposition 2. Here we evaluate $\frac{\partial \operatorname{var}(V_i(w_i,t^{1^*},t^{2^*}))}{\partial p}$ where

$$\operatorname{var}(V_i(w_i,t^{1^*},t^{2^*})) = \frac{1}{n}\sum_{j=1}^{n}\left(V_j(w_j,t^{1^*},t^{2^*}) - \bar{V}(t^{1^*},t^{2^*})\right)^2$$

and $V_i(w_i,t^{1^*},t^{2^*})$ is the long-run (two-period) income of agent i with productivity w_i net of labor costs. As shown in the proof of Proposition 1, $V_i(w_i,t^{1^*},t^{2^*})$ can be written as

$$\begin{aligned}
V_i(w_i,t^{1^*},t^{2^*}) &= (1+p(1-\mu))\,u_i^*(w_i,t^{1^*}) + \mu p\cdot\frac{1}{n}\sum_{j=1}^{n}u_j^*(w_j,t^{1^*}) \\
&\quad + (1-p)(1-\mu)u_i^*(w_i,t^{2^*}) + (1-p)\mu\cdot\frac{1}{n}\sum_{j=1}^{n}u_j^*(w_j,t^{2^*}) \\
&= (1+p(1-\mu))\,u_i^*(w_i,t^{1^*}) + \mu p\bar{u}^*(t^{1^*}) + (1-p)(1-\mu)u_i^*(w_i,t^{2^*}) \\
&\quad + (1-p)\mu\cdot\bar{u}^*(t^{2^*})
\end{aligned}$$

Moreover,

$$\bar{V}(t^{1^*}, t^{2^*}) = \frac{1}{n}\sum_{j=1}^{n} V_j(w_j, t^{1^*}) = (1+p)\bar{u}^*(t^{1^*}) + (1-p)\bar{u}^*(t^{2^*})$$

Therefore,

$$\mathrm{var}(V_i(w_i, t^{1^*}, t^{2^*})) = \frac{1}{n}\sum_{j=1}^{n} \begin{pmatrix} (1+p(1-\mu))\big[u_i^*(w_i, t^{1^*}) - \bar{u}^*(t^{1^*})\big] \\ +(1-p)(1-\mu)\big[u_i^*)(w_i, t^{2^*}) - \bar{u}^*(t^{2^*})\big] \end{pmatrix}^2 \tag{19}$$

From previous derivations, we obtain

$$u_i^*(w_i, t^{1^*}) - \bar{u}^*(t^{1^*}) = -\frac{1}{2}\left(\frac{Z}{n} - w_i^2\right)\left((1-t^{1^*})^2 - \frac{(t^{1^*})^2}{n^2}\right)$$

and

$$u_i^*(w_i, t^{2^*}) - \bar{u}^*(t^{2^*}) = -\frac{1}{2}\left(\frac{Z}{n} - w_i^2\right)\left((1-t^{2^*})^2 - \frac{(t^{2^*})^2}{n^2}\right)$$

Substituting this back into equation (19) gives:

$$\begin{aligned}
\mathrm{var}(V_i(w_i, t^{1^*}, t^{2^*})) &= \frac{1}{n}\sum_{j=1}^{n}\begin{pmatrix} \frac{1+p(1-\mu)}{2}\left(\frac{Z}{n} - w_i^2\right)\left((1-t^{1^*})^2 - \frac{(t^{1^*})^2}{n^2}\right) \\ +\frac{(1-p)(1-\mu)}{2}\left(\frac{Z}{n} - w_i^2\right)\cdot\left((1-t^{2^*})^2 - \frac{(t^{2^*})^2}{n^2}\right)\end{pmatrix}^2 \\
&= \frac{1}{4n}\begin{pmatrix} (1+p(1-\mu))\left((1-t^{1^*})^2 - \frac{(t^{1^*})^2}{n^2}\right) \\ +((1-p)(1-\mu))\left((1-t^{2^*})^2 - \frac{(t^{2^*})^2}{n^2}\right)\end{pmatrix}^2 \sum_{j=1}^{n}\left(\frac{Z}{n} - w_i^2\right)^2 \\
&\equiv \frac{1}{4n}\mathbb{A}(p,\mu)\sum_{j=1}^{n}\left(\frac{Z}{n} - w_i^2\right)^2
\end{aligned}$$

where

$$\mathbb{A}(p,\mu) = \left((1+p(1-\mu))\left((1-t^{1^*})^2 - \frac{(t^{1^*})^2}{n^2}\right) + ((1-p)(1-\mu))\left((1-t^{2^*})^2 - \frac{(t^{2^*})^2}{n^2}\right)\right)^2$$

Thus, to determine the sign of the $\frac{\partial \mathrm{var}\left(V_i(w_i, t^{1^*}, t^{2^*})\right)}{\partial p}$ we need to determine the sign of $\frac{\partial \mathbb{A}(p,\mu)}{\partial p}$.

$$\frac{\partial \mathbb{A}(p,\mu)}{\partial p} = 2\left((1+p(1-\mu))\left((1-t^{1^*})^2 - \frac{(t^{1^*})^2}{n^2}\right) + ((1-p)(1-\mu))\left((1-t^{2^*})^2 - \frac{(t^{2^*})^2}{n^2}\right)\right)$$
$$\cdot \begin{bmatrix} (1-\mu)\left((1-t^{1^*})^2 - \frac{(t^{1^*})^2}{n^2}\right) + (1+p(1-\mu))\left(-2(1-t^{1^*}) - \frac{2t^{1^*}}{n^2}\right)\frac{\partial t^{1^*}}{\partial p} \\ -(1-\mu)\left((1-t^{2^*})^2 - \frac{(t^{2^*})^2}{n^2}\right) \end{bmatrix} > 0$$

because $\frac{\partial t^{1^*}}{\partial p} < 0$ as we have established in Corollary 1 and

$$(1-t^{1^*})^2 - \frac{(t^{1^*})^2}{n^2} > (1-t^{2^*})^2 - \frac{(t^{2^*})^2}{n^2}$$

This completes the proof that long-run inequality increases with an increase in tax persistence. ■