Altruism and the Political Economy of Income Taxation

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Abstract

In this paper, I develop a positive model in which altruistic agents vote over quadratic (progressive) income tax schedules. The agents have heterogeneous preferences and productivities, and the model incorporates the incentive effects of taxation. The main result of the paper is that under standard assumptions, there exists a self-confirming majority rule equilibrium in which the agents' labor supply decisions are optimal given the tax policy, and the tax policy is a majority rule equilibrium given the labor supply decisions. Thus, the agents' equilibrium labor supply decisions confirm voter expectations, but such expectations may be incorrect out of equilibrium. In contrast to most of the literature on voting and taxes, the model generates majority rule voting equilibria which involve progressive taxation, the norm in all industrialized countries.

Keywords: Income taxation, voting, progressivity, altruism, majority rule, incentives.

JEL classification: D72, H24, D31, D63

1 Introduction

Virtually all western democracies have progressive (statutory) income tax schedules which have emerged from endogenous political processes. Yet most of the current literature on endogenous taxation has not been able to explain such systems either as optimal or as equilibrium outcomes. In this paper, I consider a model of the political economy of income taxation in which altruistic agents vote over quadratic (progressive) tax schedules. The model allows for heterogeneous preferences and productivities and incorporates the incentive effects of taxation on labor supply. The main result of the paper establishes that majority rule voting equilibria exist under standard assumptions and, by definition, such equilibria involve progressive taxation. In addition, for the case in which agents have identical preferences, I characterize the equilibrium tax structures that are likely to emerge.

Historically, there have been two approaches to the endogenous determination of income taxes: the optimal taxation approach of Mirrlees [16] and the political economy approach exemplified by Romer [21]. In the former, the tax system is determined not as a result of political forces, but rather as that which maximizes an exogenously specified social welfare function, taking into account the incentive effects on labor supply. In contrast, the latter specifically models the collective decision-making process, often as majority rule voting. In both cases, there is the presumption that progressive taxes are likely to emerge: in the case of optimal taxation, as a result of the preference for equality embodied in a (concave) social welfare function, and in the political economy models, as a result of the fact that when the median voter has less income than the mean, the political (redistributive) power under majority rule rests with the relatively poor. Both of these intuitions, however, prove to be unfounded. In the optimal taxation model, the efficiency gain from lowering the top marginal tax rate may very well outweigh the adverse effect of a more skewed income distribution.[1] Alternatively, in Romer's model, the majority rule (linear) tax function may entail a positive lump-sum (regressive) component. Indeed, he concludes ([21], p.177),

> In the absence of some form of altruism, therefore, it appears quite possible that even in the case where the majority of voters have incomes below the mean level of income (before tax), the majority-voting equilibrium will result in a regressive income tax function.

[1] See, for example, Seade [22].

But the fact remains that all developed countries employ progressive taxes as well as majority rule decision-making. While subsequent work on the political economy of taxation has continued to address this issue, as Marhuenda and Ortuño-Ortín [12] point out, the literature has yet to establish a firm connection between progressivity and voting. The principle difficulty in addressing such issues has been the multidimensionality of the parameter space (in describing quadratic or other nonlinear forms) and the nonexistence of majority rule equilibria. In order to ensure tractability, previous authors have pursued several recourses including (1) restricting attention to linear tax functions, thus precluding (marginal rate) progressivity[2], (2) abstracting from incentive effects, thereby taking the income or wealth distribution to be exogenous[3], (3) considering voting mechanisms other than majority rule, including representation by political parties[4], and (4) restricting the degree of heterogeneity, in particular, by assuming that agents have identical preferences[5].[6,7]

Here, I do not wish to explain progressivity[8]; rather, I simply take it

[2] Foley [8], Romer [21], Roberts [19], and Meltzer and Richard [14, 15].

[3] Foley [8]; Hettich and Winer [11]; Marhuenda and Ortuño-Ortín [12, 13]; Ok, Mitra and Koçkesen [17]; and Roemer [20].

[4] Roberts [19]; Marhuenda and Ortuño-Ortín [12, 13]; Roemer [20]; and Ok, Mitra and Koçkesen [17].

[5] This is one of the differences between Cukierman and Meltzer [6] and the model presented here. Their model also involves majority rule voting over quadratic tax functions and incorporates incentive effects. But they assume agents have identical, purely selfish preferences (as do all of the aforementioned papers).

Since the result contained herein does not require any specific degree of altruism, asymptotically, it approximates the selfish case as well. A more significant difference, therefore, is that the present model allows for heterogeneous preferences. Most importantly, the papers differ in their formulations of majority rule decision-making.

[6] A complete positive model of taxation should include the endogenous determination of the level of government spending. However, here and in each of the papers mentioned above, the level of government spending is taken to be fixed. Going somewhat further, Berliant and Gouveia [3] consider majority rule voting over general nonlinear taxes, where they take as given the amount of revenue to be collected from each finite subset of agents. In their paper, agents have identical preferences but heterogeneous abilities, and the model incorporates incentive effects.

[7] The focus of the present paper is on the endogenous determination of the tax schedule; it is assumed that all agents face the same schedule, or that taxation is anonymous. Consequently, I avoid mention of such game theoretic models as Aumann and Kurz [2] in which taxation is nonanonymous, or agent-specific.

[8] Several such explanations have been offered including Director's Law of Income Redistribution ([24]), wherein progressive taxes enable the middle class to shift the tax burden toward the extremes (minimizing the tax decrease for the poor and maximizing the tax increase for the rich), and, in a Downsian framework ([7]), as a means for political parties to gain votes.

as given that the reason for tax progression is that agents are concerned about the distribution of income, or that they are altruistic.[9,10] The principle contribution of the paper is to suggest an alternative formulation of majority rule decision-making, one which ensures the existence of voting equilibria.

To motivate the alternative, notice that in the traditional formulation it is assumed that when agents vote over tax policies, they take into consideration the optimal labor supply responses to policy changes, that is, they perfectly anticipate the consequences of such changes on behavior. This represents one extreme assumption regarding voter expectations. Here, I consider the opposite extreme, namely, that agents vote myopically, abstracting from the behavioral responses to policy changes, or, equivalently, that they vote on the basis of how alternative tax policies would affect the current distribution of income.[11] However, I require that the agents' equilibrium labor supply decisions are optimal given the tax policy, and that the tax policy is a majority rule equilibrium given the labor supply decisions. Thus, the actual labor supplies confirm voters' expectations. Or, while voters' expectations may be incorrect out of equilibrium, their actual experience never contradicts their expectations.

In the spirit of Fudenberg and Levine [9], I refer to such an equilibrium as a self-confirming (SC) majority rule equilibrium, in contrast to the tradi-

[9] On altruism and progressive taxation, see Blum and Kalven [4], Oswald [18], and Young [26].

[10] Snyder and Kramer [23] also consider majority rule tax equilibrium among altruistic agents who endogenously determine their labor supplies. There (in Section 3), agents have private and social preferences, as they do here, and they base their labor supply decisions on the former and their voting decisions on the latter. The principle difference between the models is that rather than consider the trade-off between labor and leisure, they assume there is a legal (taxed) sector and an underground (untaxed) sector, and time spent outside the former is devoted to the latter (where earnings are beyond the direct pale of redistributive tax policy).

Notice that in the standard formulation which focuses on the labor-leisure trade-off (as is the case here), leisure is a leveling force, that is, time spent away from work increases equality – at zero labor supply, all would have zero earnings. Conversely, in Snyder and Kramer's model, time spent away from legal work increases inequality. Hence, less progressive taxes encourage income equality by encouraging participation in the taxed sector, whereas highly progressive taxes encourage work in the untaxed sector and thus increase inequality. Therefore, inequality averse voters would prefer less progressive taxes. It is not surprising, therefore, that these authors obtain the result that the optimal tax would be linear, or minimally progressive.

While I think this focus on underground activities is quite interesting, I find it implausible as the primary explanation of the degree of tax progressivity.

[11] While I have no evidence to support this description of voter behavior, it seems quite plausible that voters might look at the skewness of the current income distribution in deciding how progressive the tax structure should be.

tional notion which I call a perfect foresight (PF) majority rule equilibrium. Intuitively, in an SC majority rule equilibrium, voters assume labor is inelastically supplied at the equilibrium levels, and this is confirmed by the actual (optimal) labor supply decisions. Therefore, even if agents could adjust their labor supplies, they would choose not to do so.

In practice, SC and PF majority rule equilibria may be quite similar[12], but there is no logical relationship between the two. Also, while analytically neither is more likely to exist than the other, it might appear that PF majority rule equilibria are more prevalent. For example, assuming the median income is less than the mean, a majority of (selfish) voters might be more inclined to vote for tax changes (specifically, to increase the degree of progressivity) if they were assured that this would not elicit a labor supply response on the part of the rich. Conversely, the fact that the rich might reduce their labor supply in response to an increase in the degree of progressivity may act to restrain such efforts by the relatively poor majority, thus serving as a stabilizing force.

Contrary to this presumption, however, PF equilibria often fail to exist, while the main result of the paper establishes that (among altruistic agents) SC majority rule equilibria generally exist under standard assumptions. Thus, the model generates progressive taxation as an equilibrium outcome under majority rule.

The paper is organized as follows. In the next section, I describe the standard model of consumer and voter behavior. In Section 3, I define the concept of a self-confirming majority rule equilibrium. Section 4 addresses the question of the existence of equilibrium. While the model I present is static, or atemporal, to establish the existence of an equilibrium, I imagine a fictitious temporal setting in which voting and labor supply decisions are made iteratively, or sequentially. First, I establish the existence of a majority rule equilibrium in each time period. I then show that there is a stationary equilibrium across time periods. The latter corresponds to an SC majority rule equilibrium in the original, static model. In Section 5, I explore the qualitative features of such equilibria by focusing on the case in which agents have identical preferences and thus differ only in their productive abilities. Section 6 briefly concludes.

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[12] Summarizing recent empirical results, Heckman [10] (p.118) states that "a dictim closer to the truth would be that [labor supply] elasticities are closer to 0 than to 1 ... for those who are working."

2 The Standard Model with Altruistic Agents

There is a large (finite) set of agents $N = \{1, ..., n\}$, where n is odd. Generic elements of N are denoted i and j. Each agent is endowed with one unit of leisure, and has private preferences for consumption and labor represented by the utility function $u^i(c, L)$. Also, agents differ in their innate productive abilities parameterized by $w^i \in \Omega \equiv [\underline{w}, \overline{w}]$.

I assume that agents determine their consumption/labor choices on the basis of their private preferences – in particular, since in this context the effects of such decisions are negligible. In contrast, agents have social or political preferences, represented by a social evaluation/welfare function of the form $W^i(x)$, where $x \in \mathbb{R}^n$ is the distribution of (net) income.[13] Agents' voting behavior is based on their social preferences – in particular, since such decisions have economy-wide implications.

I variously impose the following standard restrictions on u^i and W^i, respectively:

Assumptions on u^i:[14]

Au.1 Differentiability: u^i is C^2.

Au.2 Monotonicity: $u^i_c > 0$, $u^i_L < 0$.

Au.3 Strict quasiconcavity

Au.4 Interiority:

$$\begin{aligned}
\lim_{c \to 0} u^i_c(c, L) &= \infty \\
\lim_{L \to 1} u^i_L(c, L) &= -\infty \\
\lim_{L \to 0} u^i_L(c, L) &= 0
\end{aligned}$$

Au.5 Normality (of leisure): $u^i_{cL}u^i_L - u^i_{LL}u^i_c > 0$.

Assumptions on W^i:[15]

AW.1 Differentiability: W^i is C^2.

[13] Similarly, see Snyder and Kramer [23]. Also, as they point out, Atkinson [1] showed that such a social welfare function can be used to rationalize the usual income inequality measures.

[14] Subscripts denote partial derivatives. Also, note that assumption Au.5 is not required for the main result establishing the existence of a majority rule equilibrium (Theorem 6, below). Rather, it will play a role in studying the qualitative features of such equilibria in Section 5.

[15] Assumptions AW impose no restriction on the extent or degree of altruism beyond a minimal concern. Thus, as mentioned earlier, the model asymptotically approximates the case in which agents are purely selfish.

AW:2 Monotonicity: $W^i_j > 0$, for all j.
AW:3 Strict quasiconcavity
AW:4 Interiority: for all i and j,

$$\lim_{x^j \,!\, 0} W^i_j(x) = 1$$

The government must raise a given amount of revenue $G > 0$ through income taxation, and it is restricted to quadratic tax functions of the form $¿(y) = by + ay^2$, where y denotes gross earnings and a and b are nonnegative scalars.[16] I exclude uniform (head) taxes or subsidies (which would correspond to an intercept term in the quadratic form), and thus abstract from directly redistributive taxation.[17] Rather, the model focuses on how to distribute the tax burden. A tax policy is described by the parameters $(a; b)$ and is determined by majority voting.[18]

Agents' behavior is described as follows. First, taking the tax policy as given, consumers determine their individual labor/leisure response on the basis of their private preferences. I assume that production exhibits constant returns to scale. Thus, if agent i were to supply a quantity of labor L, its gross earnings would be $y = w^i L$, and given the tax policy $¿$, its after-tax, or net, earnings would be $y \,¡\, ¿(y)$. Taking the consumption good as numeraire, the after-tax budget constraint is thus $c = y \,¡\, ¿(y)$, or $c = (1 \,¡\, b)y \,¡\, ay^2$. Substituting for c and L, i would solve:

$$\max_y u^i((1 \,¡\, b)y \,¡\, ay^2; \frac{y}{w^i}), \tag{1}$$

Let $y^i(a; b)$ denote the solution to (1)[19], and let $v^i(a; b)$ denote the resulting private utility.

In light of the individual behavioral responses, the policy $(a; b)$ is feasible providing $\sum_N ¿(y^i(a; b)) = G$.[20] Let $¡$ denote the set of feasible policies.

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[16] In particular, the fact that a is restricted to be nonnegative means that tax schedules are assumed to be progressive. (Given AW:3 and the interiority assumptions Au:4 and AW:4, it will generally be the case that $a > 0$ in equilibrium.) Hence, progressivity per se is not at issue, rather it is the determination of such schedules as outcomes under majority rule.

[17] Although, G might be interpreted as providing a lump-sum subsidy.

[18] I refer equivalently to $¿$ or to $(a; b)$ as a tax policy.

[19] Under assumptions Au:1 $¡$ 3, (1) has a unique solution.

[20] Since $y^i(a; b)$ is i's optimal response to the policy $(a; b)$, it is not necessary to require that $¿(y^i(a; b)) \quad y^i(a; b)$, i.e., no agent would ever choose y for which $¿(y) > y$. Also, there is no loss of generality in requiring that tax revenue exactly equals G, for a tax policy yielding revenue in excess of G cannot be a majority rule equilibrium. In particular, on the basis of their social preferences, each individual views taxation as a (necessary) bad in that it lowers everyone's net income. Hence, G might be thought of as pure administrative cost.

While $v^i(a,b)$ describes i's private well-being under the tax policy (a,b), its preferences over alternative tax policies are based on its social evaluation of their overall impact, that is, on $V^i(a,b) \equiv W^i(c(a,b))$, where $c(a,b)$ is the after-tax income (consumption) distribution resulting from (a,b); i.e., $c^i(a,b) \equiv y^i(a,b) - \tau(y^i(a,b))$. Then, given such induced preferences over tax policies, a majority rule voting equilibrium (or a Condorcet winner) is a feasible policy $(a,b) \in \Gamma$ such that there is no other feasible policy that is strictly preferred by a majority of voters, i.e., by a coalition $S \subset N$ with cardinality greater than $\frac{n}{2}$.

As is well known, when voting over a one-dimensional issue space, a sufficient condition for the existence of a majority rule equilibrium is that voters' preferences are single-peaked, and in that case the equilibrium policy is the policy preferred by the median voter.[21] But when the issue space has more than one dimension, even single-peakedness is insufficient. Here, policies are two-dimensional. However, the government's budget constraint (that aggregate tax revenue equals G) may allow for the reduction of one dimension. That is, for each quadratic coefficient a, there may be a unique linear coefficient $b(a)$ such that the policy $(a,b(a))$ would raise revenue G.[22] Nevertheless, even if that were so, the induced social preferences over tax policies, $V^i(a,b(a))$, need not be single-peaked in the remaining parameter a. In the next section, I describe an alternative model of majority rule decision-making, one which overcomes this difficulty.

3 Self-Confirming Majority Rule Equilibrium

As described earlier, the fact that the induced voter preferences, $W^i(c(a,b))$, are defined over the actual after-tax earnings presumes that, when considering changes in the tax policy, voters perfectly anticipate the effects of such changes on the behavior of the agents. In contrast, here I consider the opposite extreme, namely, that agents vote on the basis of how changes in the tax policy would affect the current distribution of income. However, I require that in equilibrium, the actual earnings profile should be optimal with respect to the tax policy and the tax policy should be a majority rule equilibrium with respect to the current earnings.

To distinguish between the two formulations, I refer to them as perfect foresight (PF) and self-confirming (SC) majority rule equilibria, respectively.

[21] Single-peakedness over a one-dimensional (compact and convex) issue space simply means there is a unique (local) maximum.

[22] While such unicity need not hold in general, it would be the case, for instance, under assumption Au.5.

Before providing a formal definition, I introduce some additional notation.

First, let $\zeta(a;b;y) \equiv (1-b)y - ay^2$ denote the net income resulting from applying the tax $(a;b)$ to gross earnings y. Then given a distribution of gross earnings $y = (y^i)_{i \in N}$, agent i's induced social preferences over tax policies would be $\Psi^i(a;b;y) \equiv W^i(\zeta(a;b;y))$, where $\zeta(a;b;y) = (\zeta(a;b;y^i))_{i \in N}$.[23] Also, given y, the set of feasible tax policies would be

$$\Gamma(y) \equiv \{(a;b) \in R_+ \times R_+ \mid \sum_N (by^i + a(y^i)^2) = G\}. \qquad (2)$$

Definition 1 An SC majority rule equilibrium, or simply an SC equilibrium, is a tax policy $(a;b) \in \Gamma(y)$ such that $y = y(a;b)$ and there is no other policy $(a';b') \in \Gamma(y)$ for which $\Psi^i(a';b';y) > \Psi^i(a;b;y)$ for a majority of voters.

Thus, in an SC equilibrium, the individual (gross) earnings are optimal with respect to the tax policy, and taking the earnings profile to be fixed, the policy is a majority rule equilibrium among all policies yielding the required revenue.

4 The Existence of SC Equilibrium

4.1 Instantaneous Equilibria in an Artificial Temporal Model

To establish the existence of an SC equilibrium, I embed the present static model in a fictitious temporal setting in which the voting and labor supply decisions are made iteratively, or sequentially.[24] A fixed point of the iterative process will correspond to an SC equilibrium of the actual model; the main result of the paper establishes the existence of such a fixed point.

While the main result pertains to continuous time, the intuition is best described, first, in a discrete model. There, I assume that agents evaluate present tax policies on the basis of their effects on the past (one period lagged) distribution of income. In the temporal setting, this is the appropriate form

[23] The relationship between these and the former voting preferences is given by $V^i(a;b) = \Psi^i(a;b;y(a;b))$.

[24] This argument is analogous to the Walrasian tâtonnement, where for the purpose of establishing the existence of a competitive equilibrium in a static model, we imagine a fictitious iterative (temporal) communication process between an auctioneer and the economic agents; a fixed point of the fictitious process corresponds to a Walrasian equilibrium in the actual, atemporal model.

of the assumption that voters are myopic, abstracting from contemporaneous behavioral responses to policy changes. Then, after a tax policy is enacted, agents adjust their labor supply behavior before reevaluating the tax policy.[25]

First, I show that under such adaptive expectations, there is an easily tractable current period majority policy. I then establish that in continuous (analytical) time, there exists a stationary equilibrium (of the fictitious iterative process) in which neither the behavioral responses nor the majority policy change over time.

Formally, let $T = \{1, 2, \ldots\}$ denote the infinite set of (discrete) time periods with generic element t. When indicated, all variables described above will be subscripted to denote the relevant period in which they are determined. In particular, let $y_t^i \equiv y^i(a_t; b_t)$; that is, y_t^i is the period t income choice of agent i in response to the policy $(a_t; b_t)$. Then the timing of decisions is as follows (see Figure 1, below).

First, assume the earnings profile y_{t-1} has been determined in response to the tax policy prevailing at time $t-1$. Then at the start of period t, I assume agents reevaluate the tax policy on the basis of the income distribution y_{t-1}. That is, letting $\tau_t(y) = b_t y + a_t y^2$, τ_t is applied to y_{t-1}. After τ_t has been enacted, agents then determine their optimal earnings y_t at the conclusion of t.

(insert Figure 1: here)

Under such adaptive expectations, the set of feasible policy choices at time t, those satisfying the revenue constraint, are given by $\Gamma(y_{t-1})$ in (2), which I abbreviate Γ_t. Notice that Γ_t is linear in the tax parameters a and b.[26] Also, as above, agent i's adaptive preferences over tax policies in period t are given by $\Omega^i(a; b; y_{t-1})$, which I abbreviate $\Omega_t^i(a; b)$. The following lemma establishes the properties of Ω_t^i, which are inherited directly from W^i:

Lemma 2 Under assumptions AW.1 − 3, $\Omega_t^i(a; b)$ is C^2, decreasing and strictly quasiconcave.

In period t voting, agent i's most preferred policy is determined by solving

$$\max_{a;b} \Omega_t^i(a; b) \text{ subject to } (a; b) \in \Gamma_t \qquad (3)$$

[25] Within the temporal setting, a PF majority rule equilibrium would correspond to the case in which voting and labor supply decisions are contemporaneous, or agents evaluate present tax policies on the basis of their effects on the present (perfectly anticipated) distribution of income.

[26] Obviously, in the event of perfect foresight this relation would be highly nonlinear.

In light of Lemma 2, there is a unique solution to (3) for each i, which I denote $(a^i_t; b^i_t)$. The voting problem facing agent i is depicted in Figure 2.

(insert Figure 2: here)

Note that under the assumption of perfect foresight, it was not necessary to impose the condition that individual tax payments should not exceed earnings. Here, however, since the behavioral response is not immediate, it is possible, in principle, that the policy is such that for some individuals the requisite tax payments at time t would exceed their period $t - 1$ earnings. But under assumptions Au.4 and AW.4, that could not occur. That is, the boundary conditions on u^i ensure that in response to $(a_{t-1}; b_{t-1})$, $y^i_{t-1} > 0$ for all i, and the boundary conditions on W^i ensure that at $(a^i_t; b^i_t)$, each agent's after-tax income is positive.[27] This is stated formerly in the next lemma.

Lemma 3 Under assumptions Au.4 and AW.4, $y^j_{t-1} - b^i_t y^j_{t-1} - a^i_t (y^j_{t-1})^2 > 0$ for all i,j.

Next, it follows from Lemma 2 that, when restricted to the feasible set Γ_t, the induced social preferences Ω^i_t are single-peaked.[28] And as mentioned earlier, the condition that voters have single-peaked preferences over a one-dimensional issue space is sufficient to ensure the existence of a majority rule equilibrium, which indeed is the preferred policy by the median voter. We thus have the following:

Theorem 4 Under assumptions Au.1 – 4 and AW, there exists a majority rule tax policy at each t; moreover, by assumption, such equilibria involve progressive taxation.

4.2 Stationary Equilibria

4.2.1 The Case of Identical Social Preferences

To describe the long-run evolution of majority rule equilibria in the temporal model would require that we trace the path of the preferred policy of the

[27] This imposes an upperbound on the tax parameters in each period. But to appreciate the magnitude of the bound, consider that a 50% marginal tax rate on, say, \$1 million, could be achieved, in the extreme, by a linear rate of $b = 0.5$ or by a quadratic rate of $a = 2.5 \times 10^{-7}$. At rates intermediate between the two, say, $b = 0.25$ and $a = 1.25 \times 10^{-7}$, the maximum marginal tax rate (100%) would be achieved at \$3 million, and income as high as \$200,000 would be subject to only a 30% marginal rate.

[28] Simply note that deviations from $(a^i_t; b^i_t)$ along Γ_t necessarily decrease Ω^i_t. (See Figure 2, above.)

median voter as agents periodically update their behavior in response to the current tax policy. While the preferred policy of a particular individual is easily tractable, the identity of the median voter may change from period to period. For this reason, I first consider the case in which agents have identical social preferences and thus vote unanimously. Hence, the issue of identifying the median voter does not arise. Generalizing the above iterative process to continuous time, I will show that there is a fixed point in the policy space such that the majority rule policy engenders the actual behavioral responses. This corresponds to an SC equilibrium in the actual, atemporal model. I then extend the result to the case in which agents have heterogeneous social preferences as well.

First, using the iterative model, I will motivate the mapping used to establish the fixed point result. Referring again to Figure 1, suppose y_{t-1} is the prevailing income distribution at time $t-1$ determined in response to a policy $(a_{t-1}; b_{t-1})$. Then the new majority rule policy at time t is the following:[29]

$$(a_t; b_t) = \underset{a;b}{\operatorname{argmax}} \ \Psi_t(a; b) \text{ subject to } (a; b) \in \Gamma_t. \tag{4}$$

Since the solution to (4) is feasible, it generates an exact distribution of the tax burden, i.e., a distribution of tax payments totaling G. Each such distribution lies in the simplex $\Delta \equiv \{x \in \mathbb{R}^n_+ \mid \sum_N x^i = G\}$, which is nonempty, compact, convex, and invariant over time. Let $\tau_t(y_{t-1}) = (\tau_t(y^i_{t-1}))_{i \in N} \in \Delta$ denote the tax distribution resulting from $(a_t; b_t)$ prior to the contemporaneous behavioral responses at time t. (In terms of Figure 1, $\tau_t(y_{t-1})$ is evaluated between $(a_t; b_t)$ and y_t.) Then, as discussed above, $(a_t; b_t)$ will induce labor and hence income responses y_t, which by (4) will induce a new majority tax policy $(a_{t+1}; b_{t+1})$ at time $t+1$ with associated tax distribution $\tau_{t+1}(y_t)$, and so on. The mapping I will use is the continuous time analogue of this iterative process, and the image of the mapping corresponds to the trajectory of $\tau_t(y_{t-1})$ (in Δ) over time. I denote the composite mapping from Δ to itself by D. Then in discrete terms, the ith component of D is given by $D_i(\tau_t(y_{t-1})) = \tau_{t+1}(y^i(a_t; b_t))$. Since the private utility functions as well as the common social evaluation function are continuous, D will be continuous as well according to Berge's Maximum Theorem (see [5], p.64). Hence, by the Brouwer Fixed Point Theorem (see [5], p.28), we have the following for the continuous time model:

[29] In the event agents have identical social preferences, their induced preferences over tax policies are identical as well. Hence, I omit the index i.

Theorem 5 Suppose $W^i = W$ for all $i \in N$, and u^i and W satisfy assumptions $Au.1 - 4$ and AW, respectively. Then in the continuous time model, there exists a tax policy $\tau^* = (a^*, b^*)$ such that $(a^*, b^*) = \arg\max_{a,b} \Psi(a, b)$ over Γ^*, where Γ^* is the feasible set defined by (2) for the income distribution $y(a^*, b^*)$.[30]

Remark 1 As described above, a stationary equilibrium of the temporal model corresponds to an SC majority rule equilibrium (indeed, in this case, by unanimous decision) in the actual model. Such a policy (a^*, b^*) would engender the actual behavioral responses $y(a^*, b^*)$, and thus voters' expectations would be correct.

4.2.2 The Heterogeneous Case

To generalize the previous theorem to the case in which agents have heterogeneous social preferences and thus vote differently, notice that the above argument can be applied to each Ψ^i. In particular, for each Ψ^i there is a mapping from Δ to Δ analogous to D. I denote this by $D^i : \Delta \to \Delta$. Thus, corresponding to each i there is a D^i, and this would be the trajectory of the tax distribution if agent i were to be the median voter.

Let (a_{t-1}, b_{t-1}) be the prevailing policy at time $t - 1$, and consider the period t voting problem of determining (a_t, b_t) relative to the income distribution $y_{t-1}(a_{t-1}, b_{t-1})$. By Theorem 4, there exists a majority rule equilibrium, and the equilibrium policy would be that preferred by the median voter. Clearly, over the one-dimensional issue space Γ_t, such a voter exists.[31] Let mt denote the identity of the median voter in the period t voting. Then the key to extending the fixed point result is simply to notice that in the continuous time version, the median mapping is continuous. Intuitively, even though the identity of the median voter may change from mt to $m(t+1)$, the transition of the tax distribution from $D^{mt}(\tau_t(y_{t-1}))$ to $D^{m(t+1)}(\tau_{t+1}(y_t))$ (in the continuous time version) would vary continuously, since the voting and labor supply decisions of each member of the electorate are continuous. This establishes the main result of the paper:

Theorem 6 In the continuous time model, under assumptions $Au.1 - 4$ and AW, there exists a stationary equilibrium. Hence, in the actual model, there exists an SC majority rule equilibrium.

[30] For obvious reasons, I omit the subscript t on Ψ and Γ^*.

[31] If there is more than one median voter, then they must necessarily propose the same policy. Hence, the following continuity argument remains valid.

While the existence of an SC equilibrium is thus assured, nevertheless, it would be difficult to identify such an equilibrium since the theorem allows for the full range of heterogeneity (of productivities as well as private and social preferences) and there is no single parameter with which we can associate the median voter. In the next section, I focus on the special case in which agents have identical preferences and thus differ only in their productivities. There, I briefly consider the qualitative aspects of an SC majority rule equilibrium.

5 SC Equilibrium Tax Systems when Agents have Identical Preferences

Suppose agents have identical private and social preferences. Then we can focus on the regularity of stationary income and tax distributions without concern for the effects of idiosyncratic tastes. Also, voting will be unanimous. Here, since agents differ only in their productivities, it is sufficient to show that the relevant variables are monotonic in w in order to characterize the stationary system.

Let τ^*, or equivalently (a^*, b^*), be a stationary income tax system as described above. Notice that since $\tau^*(y)$ is monotonic, each tax payment is associated with a unique pre-tax income. Thus, the tax distribution τ^* corresponds to a stationary income distribution, which I denote y^*. The following two lemmas establish, respectively, that equilibrium incomes (and hence tax payments) are increasing in w as are the equilibrium (private) welfare levels.[32]

Lemma 7 Under assumptions $Au.1 - 5$, for all $(a, b) \in \Gamma$, $y^i(a, b)$ is monotonically increasing in w^i.

Proof. As often described in the optimal income tax literature[33], while the agents have the same preferences for (c, L), upon substituting $\frac{y}{w^i}$ for L, their indirect preferences for (y, c) indeed differ. In fact, it is easy to show that under assumption $Au.5$, at any point (y, c), the marginal rate of substitution is decreasing (in absolute value) in w.[34] This, together with the strict concavity of the after-tax income function $(1 - b)y - ay^2$, ensures that if $w^i > w^j$, then $y^i(a, b) > y^j(a, b)$. (See Figure 3, where $w^2 > w^1$.) ■

[32] The fact that equilibrium welfare is increasing in w suggests that no agent with greater ability would wish to trade places (productivities) with one with lesser ability. This provides a test that the progressive tax system is not treating the rich too harshly.

[33] Cf. [25], pp.70-71.

[34] This property has variously been referred to as hierarchical adherence or single-crossing.

(insert Figure 3: here)

Lemma 8 Under assumptions $Au.1 - 5$, for all $(a, b) \in \Gamma$, $v^i(a, b)$ is monotonically increasing in w^i.

Proof. Let $(a, b) \in \Gamma$ be given. Then as described in Section 2, agent i solves (1). Here, for notational simplicity, I denote the solution $y^i(a, b)$ by $y(w^i)$ and the indirect utility $v^i(a, b)$ by $v(w^i)$. Then $y(w^i)$ is the solution to the first order condition $u^i_c \cdot (1 - b - 2ay) + u^i_L \cdot \frac{1}{w^i} = 0$, and $v(w^i) \equiv u^i((1 - b)y(w^i) - a(y(w^i))^2, \frac{y(w^i)}{w^i})$. Differentiating $v(w^i)$ with respect to w^i yields $(u^i_c \cdot (1 - b - 2ay) + u^i_L \cdot \frac{1}{w^i})y' - u_L \cdot \frac{y}{(w^i)^2}$. Since the first term is zero, this is simply $-u_L \cdot \frac{y}{(w^i)^2}$, which by $Au.2$ is positive. ■

Figures 4 and 5 depict a stationary income and tax distribution. (Figure 5 is an orthogonal view of the simplex Δ, where the ith vertex corresponds to the tax distribution $\tau^i = G$ and $\tau^j = 0$ for $j \neq i$.)

(insert Figures 4 and 5: here)

Remark 2 In light of Lemmas 7 and 8, the fact that τ^* is the unanimous choice of all agents, rich and poor alike, means that each agent thinks τ^* generates a fair distribution of the tax burden, and that, facing τ^*, all agents would continue to supply their constant quantity of labor and thus maintain their present before-tax earnings.

Remark 3 The fact that the stationary system does not imply leveling the income distribution, even in the event that the median income is less than the mean, can be interpreted as including a role for individual responsibility, or just dessert, in determining one's labor supply.

6 Conclusion

In this paper I have presented a model in which progressive taxation, the norm in all industrialized countries, emerges under a system of majority voting among altruistic agents. The model allows for heterogeneities in preferences and productivities, and it incorporates the incentive effects of taxation. The principle differences between this model and the previous literature concern the fact that, here, agents are altruistic and, more importantly, that they abstract from the behavioral responses in determining their voting decisions, i.e., agents evaluate alternative tax policies on the basis of their effects on the current distribution of income. However, in equilibrium, voter expectations of the labor supply behavior are confirmed by the actual labor supply decisions.

The most important outstanding issue in the development of a complete positive model of income taxation concerns the determination of the level of government spending. In addition, there are other possible extensions of the present paper including studying the qualitative features of SC equilibria in the heterogeneous case and, from a normative point of view, analyzing the efficiency properties of such equilibria. Also, while it may be difficult to estimate the model in its most general form (including all sources of heterogeneity)[35], for the purpose of policy analysis, it may prove to be useful in simulation. Finally, it may well be the case that the notion of a self-confirming majority rule equilibrium is applicable in other domains of political economy as well, where similar difficulties arise concerning the nonexistence of (standard) majority rule equilibrium.

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