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Are consumption taxes really better than income taxes?

Per Krusell[a,b,c], Vincenzo Quadrini[d,e], José-Víctor Ríos-Rull*[,f,g]

[a] *University of Rochester, Rochester, NY 14627, USA*
[b] *Institute for International Economic Studies, Stockholm, Sweden*
[c] *Centre for Economic Policy Research, London, UK*
[d] *University of Pennsylvania, Philadelphia, PA 19104, USA*
[e] *Universitat Pompeu Fabra, Barcelona, Spain*
[f] *Research Department, Federal Reserve Bank of Minneapolis, Minneapolis, MN 55480, USA*
[g] *University of Pennsylvania, Philadelphia, PA 19104, USA*

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Abstract

We use political-equilibrium theory and the neoclassical growth model to compare consumption and income tax systems. If government outlays are used for redistribution through transfers, then steady-state equilibria in societies that use income taxes are not necessarily worse in welfare terms, and may even be better. Income taxes are attractive precisely because they are more distortionary, since this implies low equilibrium transfer levels. We also find that switching tax systems typically does not benefit the median voter; moreover, a change from income to consumption taxes may make everybody worse off.

Key words: Political equilibrium; Consumption taxes; Income taxes

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* Corresponding author.

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1. Introduction

Conventional public finance wisdom argues in favor of consumption taxes over income taxes.[1] At the same time, most industrialized economies rely much more on income taxes than on consumption taxes. This is illustrated in Table 1, where we tabulate the shares of government revenue due to consumption, income, and social security taxes (we consider the latter as a form of income taxation) for the OECD countries. Is the reason for this discrepancy that the economic models studied in the literature are poor representatives of the economic reality? Or, is it that taxes are not chosen based on economic efficiency arguments alone?

We are inclined to believe that the second of these explanations is the most accurate one.[2] In particular, political decisions over taxes invariably have distributional consequences, and as long as this is the case we should expect outcomes to not only reflect economic efficiency arguments. Although this view suggests that our role as policy advisers is limited, it does not make economic analysis meaningless. What it does suggest, however, is that it may be important to analyze how economics interacts with the political process. Accordingly, we study properties of different tax systems in a context where actual tax levels are not chosen by us, but by the agents who inhabit our model economies.

Different tax systems imply different types and amounts of distortions. The voting agents face a trade-off between the amount of redistribution and the costs associated with it, and it is not obvious what the resolution of this trade-off is. It might be, as Brennan and Buchanan (1977) have suggested for similar reasons, that more distortionary taxes give better outcomes because they restrict the amount of government activity undertaken. But it might also be that with the proper policy instruments (tax systems), substantial redistribution can be accomplished with little distortion. In this paper we resolve this trade-off by making quantitative comparisons between different tax systems.

In dynamic economies, economic policies are not determined once and for all but they are continuously changed, or at least allowed to change. Political parties alternate, and once in charge they implement policies that can be changed by the party winning the following election. Therefore, a realistic analysis of fiscal policy has to consider the political process determining this policy. Unfortunately, the introduction of an endogenous political mechanism increases the complexity of the model substantially. There are two reasons for this. First, it is necessary to study heterogeneous-agent economies, which increases the state space. In

[1] See Atkinson and Stiglitz (1980) and Stiglitz (1986) for a summary. Summers (1981), Auerbach, Kotlikoff, and Skinner (1983), and Jones, Manuelli, and Rossi (1993) are examples of positions favorable to consumption taxes, while Browning and Burbidge (1990) give a more agnostic view.

[2] It should be pointed out that the recent results in Aiyagari (1995) are suggestive of an alternative way of rationalizing the absence of large consumption taxes in the data. He argues that there are empirically plausible economic environments which call for permanent positive taxes on capital income.

Table 1
Taxation as percentage of total tax revenue in the OECD countries: 1985

Country	Income tax	Social security	Cons. tax	GDP per capita
Australia	54.6	–	28.7	8850
Austria	26.4	31.8	31.0	8929
Belgium	40.6	33.1	22.7	9717
Canada	44.1	13.5	26.1	12196
Denmark	56.8	3.8	32.9	10884
Finland	51.0	9.1	35.7	9232
France	17.3	43.3	28.7	9918
Germany	34.8	36.5	24.6	10708
Greece	17.5	35.6	40.0	4464
Iceland	22.7	2.4	59.5	9037
Ireland	34.5	14.8	42.6	5205
Italy	36.8	34.7	23.6	7425
Japan	45.8	30.3	12.1	9447
Luxembourg	44.6	25.2	23.4	10540
Netherlands	26.3	44.3	23.4	9092
New Zealand	68.7	–	22.0	8000
Norway	39.3	20.6	36.3	12623
Portugal	25.7	25.9	41.3	3729
Spain	26.2	41.3	27.7	6437
Sweden	42.0	24.8	25.4	9904
Switzerland	40.9	32.0	17.5	10640
Turkey	37.0	14.3	35.7	2533
United Kingdom	39.1	17.6	29.4	8665
United States	42.8	29.4	15.4	12532

our present model, we keep this complication minimal by studying an economy with two types of infinitely-lived agents. Second, the political-equilibrium analysis requires that we derive each agent's preferences over policies. This derivation involves a complex forecasting problem: it is necessary for an agent contemplating different current policy options to think not only about their respective effects on current prices and transfers, but on future prices, transfers, and politically determined policies as well. Here we adopt the rational-expectations methodology: agents think through all the equilibrium consequences of the different policies, without making errors in calculation.[3] Note, however, that in a sense we are requiring 'more' rationality from our agents than what needed to be required from the agents in the original contributions by Lucas and Prescott (Lucas, 1972; Lucas and Prescott, 1971): here, agents also have to correctly predict what *would* happen under circumstances which will never be realized.

The alterations to standard public finance which we consider do not come for free, of course. For example, we need to specify the fiscal framework (e.g.,

[3] See Muth (1961).

what taxes are available) and the political framework (e.g., what taxes are voted on) and these modeling choices necessarily introduce some arbitrariness. We confront the taxation problem by comparing tax *systems*, or *constitutions*, i.e., we postulate what set of taxes are used and what set of taxes are voted upon for each economy under study. We first focus on comparing economies with only one kind of tax; e.g., we compare an economy where there is only a consumption tax to an economy with only an income tax. We then extend the analysis to a case in which two taxes are voted upon simultaneously. We also assume that all constitutions demand proportional taxation, and that government debt is not allowed as a policy instrument. Although it is not obvious what features of policy should be regarded as constitutional in the theory and not subject to vote, and what should be voted on – we are mainly guided by tractability and an appeal to realism – this is one of the main problems of any politico-economic theorizing which is not based on pure mechanism design.

Our main findings can be summarized as follows:

- For the case of steady-state equilibria of one-tax constitutions, income and consumption tax systems are quite similar in welfare terms (note, however, that these welfare comparisons are not of direct normative interest). Since income taxes are more distortionary, an income tax system has a lower steady-state level of taxation and higher steady-state output.

- The comparison between two-tax and one-tax systems generally favors the two-tax system, although it is true here as well that there will be more transfers with the less distortionary system, which in this case is the one with more instruments.

- The tax constitutions we look at have features that should make them *persist*: if a switch to an alternative constitution is contemplated, then there will almost always be losers. In particular, we find in almost all of our examples that the median agents (who are poorer in our economies) do worse after a change of tax systems, and that a switch from income to consumption taxes never makes both agents better off. Thus, if we think of constitutional change as requiring (at least) a majority, then most of our constitutions will be hard to overturn.

- When the purpose of taxation is the provision of public goods or services and there is no element of pure income transfers between groups, different results may apply: then, tax systems based on less distortionary types of taxes can be better.

Several recent studies do make the political mechanism endogenous, and the result which is common among these studies is that the distribution of agents over income and wealth can be an important factor determining economic policies, and therefore economic outcomes.[4] In the context of a standard growth model, however, no attempt has been made to analyze the equilibrium allocations associated with different types of taxation when the level of taxes is endogenously determined. The main reason for this is that in order to analyze the effect of different tax systems, a richer and more complex model is required than what is typically studied in this literature. For example, most of the existing models (i) have limited dynamics, i.e., they are considerably simpler than the standard neoclassical growth model, and/or (ii) abstract from the leisure choice. We make use of the methods developed in Krusell and Ríos-Rull (1994) and Krusell et al. (1994), which are straightforward to amend to allow for a leisure choice. These methods are computational in nature, since analytical solutions cannot be obtained for this class of economies.

Our work can be compared to the more standard optimal taxation literature, which in dynamic environments specifically asks what time path of taxes maximizes some welfare objective.[5] There are, however, important differences between the optimal-taxation approach and ours. First, one of the concerns of the optimal-taxation literature is debt management, something that we ignore by requiring budget balance. Second, we are primarily concerned with determining the total size of government outlays/transfers, which is typically taken as given in the literature on optimal taxation. Third and finally, whereas the optimal-taxation studies are often not concerned with distributional issues, they are in focus in our study.

Our paper starts with a description of the model in Section 2. The analysis starts in Section 3, where we make a preliminary characterization of the set of steady states. In Section 4 we describe how we choose our parameter values, and our numerical analysis proceeds in Section 5. In this section, the baseline model is studied: there, all government revenue is used for transfers. We first look at the properties of the steady states of different tax systems, and we then study the welfare properties of tax systems by looking to the transition paths that follow a change of tax systems. In Section 6 we extend our analysis to economies with

[4] Examples of papers in this literature are Alesina and Rodrik (1994), Bertola (1993), Meltzer and Richard (1981), Fernandez and Rogerson (1994), Glomm and Ravikumar (1992), Kristov, Lindert, and McClelland (1992), Krusell and Ríos-Rull (1996), Krusell and Ríos-Rull (1994), Krusell, Quadrini, and Ríos-Rull (1994), Perotti (1993), Persson and Tabellini (1994), and Saint-Paul and Verdier (1993,1992).

[5] For example, Lucas and Stokey (1983) analyze optimal fiscal policy in a stochastic economy without capital, and Chamley (1986) considers optimal capital and labor income taxation in a deterministic economy with capital accumulation. Zhu (1992) extends the analysis by studying the Ramsey taxation problem in an economy with both capital accumulation and uncertainty. Lucas (1990) reviews the capital vs. labor income taxation results in light of the new growth theory, and others (e.g., Jones et al. (1993) and Rebelo and Stokey (1995)) continue the study of how endogenous growth models differ with respect to tax prescriptions. For an analysis of optimal capital and labor income taxation over the cycle, see Chari, Christiano, and Kehoe (1994).

two taxes. We look at the provision of public goods in the following section, Section 7.

2. The model

The model used is a standard growth model with heterogeneity across agents in their wealth holdings and/or labor productivity. There is a continuum of agents of total mass one. Agents are indexed by their type $i \in \mathscr{I} \equiv \{1,\ldots,I\}$, with respective fractions given by μ_i. The per-period utility function is the same for all types, $u(c,l) = ((c^{\alpha}, l^{1-\alpha})^{1-\sigma} - 1)/(1-\sigma)$, and total utility is the discounted sum of the per-period utilities, i.e., $\sum_{t=0}^{\infty} \beta^t u(c_t, l_t)$.

Agents are endowed with ε_i efficiency units of labor. They also hold assets in amounts given by a_i.[6] We use capital letters to denote the assets held by all individuals of the same type, allowing us to denote the distribution of wealth with $A = \{A_i\}_{i \in \mathscr{I}} \in \mathscr{R}^I$, and the distribution of efficiency units of labor with $\varepsilon = \{\mathscr{E}_i\}_{i \in \mathscr{I}} \in \mathscr{R}^I$. Efficiency units of labor provided to the market, i.e., the labor input, which are given by $N_t = \sum_i \mu_i \varepsilon_i (1 - l_{it})$, combine with aggregate capital, given by $K = \sum_i \mu_i A_i$, to produce output through an aggregate production function, $F(K,N)$; we use the notation $f(A,N) = F(K,N)$ to make explicit the dependence of output on the distribution of nonhuman wealth. We assume competition in factor markets which determines the net-of-depreciation rental price of capital r and the wage per efficiency unit of labor w.

In each period the current tax rate is given and people vote on next period's tax rate. Agents face either of two tax systems: (i) a proportional tax on consumption only, which since there is equal per-capita distribution of the proceeds to all agents results in a period budget constraint given by $c_i(1+\tau^c) + a_i' = ra_i + (1 - l_i)\varepsilon_i w + a_i + tr^c$; (ii) a proportional tax on total income only, which results in a period budget constraint given by $c_i + a_i' = (ra_i + (1 - l_i)\varepsilon_i w)(1-\tau^y) + a_i + tr^y$, where τ^c and τ^y are the tax rates for consumption and income and tr^c and tr^y are the respective transfers. Labor and capital taxation are also considered, and they involve straightforward adjustments to the above budget constraints.

Interactions between agents every period determine the policy in place for the following period.[7] The mechanism determining what policies are chosen is representative of the political-economy literature based on majority voting. In economies with only one policy parameter to be determined, a single-peakedness condition on the derived preferences for this parameter is sufficient for implying

[6] As we will see, all agents of the same type behave the same way in equilibrium, which allows us to abstract from their names. Obviously, all endowments of efficiency units need not be different; the same is true for wealth levels.

[7] In Krusell and Ríos-Rull (1994) it is shown how the fact that the policies are chosen every period is tangential. The key issue is the amount of real time in between policy changes. This parameter is set at the calibration stage.

that the median voter will be decisive. In calibrated versions of the standard neoclassical growth environment, we found that the single-peakedness condition is indeed satisfied. Furthermore, for our parameterizations the median agent has less than mean income, a feature which characterizes the data, and this agent will want redistribution even at the cost of some distortions.

The uses of public funds may be important in the study of taxation. These include: direct cash transfers with and without dead-weight losses associated with the management of the tax system, public supply of private goods on an equal per-capita basis, supply of public goods having direct impact on agents' utility, and supply of public goods having direct impact on productivity.[8,9] In this paper our main efforts are concentrated on the first use of public funds, although we will also consider the supply of public goods for consumption purposes and as an externality in production.

The theoretical tools needed to study political equilibria in this type of environment were developed in Krusell and Ríos-Rull (1994), and we refer readers interested in a detailed discussion of these tools to the mentioned paper.

2.1. Equilibria

We follow Krusell and Ríos-Rull (1994), and concentrate on stationary Markov equilibria. This is accomplished by representing equilibria with recursive forms, and this representation includes three parts. First, we postulate a policy as a mapping from the economy-wide state variables to tax rates and transfers, and we compute the economic equilibria associated with these policies. Second, we characterize the economic behavior implied by a one-period deviation from this policy mapping. Third, we use these deviations to construct preferences over policies and a political mechanism to aggregate these preferences into an equilibrium policy. The state variables are the distribution of nonhuman wealth, $A \in \mathscr{R}^{\mathscr{I}}$, and the tax rate inherited from the past, which is generically denoted by τ. We

[8] Several studies assume that the proceeds from taxation are redistributed as lump-sum transfers. Examples include King and Rebelo (1990), which considers the effect of progressive taxes on economic growth in a model of physical and human capital accumulation; Bertola (1993), which studies the functional distribution of income and its importance for long-run growth in a model with capital externalities; Krusell et al. (1994), which determines the equilibrium growth rate when income taxes are determined by a political mechanism and elections are repeated every period; and Krusell and Ríos-Rull (1994), which analyzes the impact of different political and fiscal constitutions on the equilibrium allocation. Public finance data show that cash transfers are not pure lump-sum transfers: different agents receive different amounts of transfers from the public sector. However, public cash transfers on the whole do redistribute: even though in some countries the level of cash transfers increases with the level of income, the ratio of transfers to income decreases as the position of agents in the income ladder increases (see Ruggles and O'Higgins, 1981a, for the United States; Ruggles and O'Higgins, 1981b, for the United Kingdom; Saunders and Klau, 1985, for the OECD countries).

[9] As long as the provision of the specific goods supplied is made in a small enough quantity that agents are indifferent between the transfer of the goods and a direct cash transfer, this use of public funds is in effect identical to direct cash transfers.

now describe these steps in detail for the case of income taxes and lump-sum transfers. The analysis for other tax systems is similar.

2.1.1. Economic equilibria given a policy

Consider a policy function $\tau' = \Psi(A,\tau)$. To avoid excessive notation, we do not make explicit the implied transfers, but derive their exact form in each instance. The problem of a given agent of type i who has wealth a can be written in recursive form as follows:

$$v_i(A,\tau,a;\Psi) = \max_{c,a',l} u(c,l) + \beta v_i(A',\tau',a';\Psi), \tag{1}$$

subject to

$$a' = a + (a\,r(A,N) + (1-l)\varepsilon_i w(A,N))(1-\tau) + tr - c,$$

$$tr = \tau\left[f(A,N) - \delta\sum_j \mu_j A_j\right],$$

$$\tau' = \Psi(A,\tau),$$

$$A' = H(A,\tau;\Psi),$$

$$N = N(A,\tau;\Psi).$$

The functions $w(A,N)$ and $r(A,N)$ are before-tax rental prices of factors of production and they are determined in competitive factor markets. The function $H(A,\tau;\Psi)$ is the law of motion of the distribution of assets that the agents take as given, and the function $N(A,\tau;\Psi)$ gives the aggregate amount of labor which the agent also takes as given. The solution to this problem gives next period's asset holdings as a function $h_i(A,\tau,a;\Psi)$ and leisure as $l_i(A,\tau,a;\Psi)$. Note that we index value functions, decision rules, and economy-wide laws of motion with the policy function Ψ. The standard equilibrium conditions in this context are

$$H_i(A,\tau;\Psi) = h_i(A,\tau,A_i;\Psi) \quad \text{for all} \quad i \in \mathscr{I}, \tag{2}$$

$$N(A,\tau;\Psi) = \sum_{i\in\mathscr{I}} \mu_i\varepsilon_i(1 - l_i(A,\tau,A_i;\Psi)). \tag{3}$$

2.1.2. Economic equilibria for a one-period policy deviation

Consider now the following problem for an agent who, given the state (A,τ), faces an arbitrary policy τ' next period, *whereafter the function Ψ will be used to determine the policy.*

$$\tilde{v}_i(A,\tau,\tau',a;\Psi) = \max_{c,a',l} u(c,l) + \beta\, v_i(A',\tau',a';\Psi), \tag{4}$$

subject to

$$a' = a + (a\,r(A,N) + (1-l)\varepsilon_i w(A,N))(1-\tau) + tr - c,$$

$$tr = \tau \left[f(A,N) - \delta \sum_j \mu_j A_j \right],$$

$$A' = \tilde{H}(A,\tau,\tau';\Psi),$$

$$N = \tilde{N}(A,\tau,\tau';\Psi).$$

The function $\tilde{H}(A,\tau,\tau';\Psi)$ is the law of motion for the distribution of assets that the agents take as given, and the function $\tilde{N}(A,\tau,\tau';\Psi)$ determines aggregate employment. The solution to this problem gives next period's asset holdings as functions $\tilde{h}_i(A,\tau,\tau',a;\Psi)$ and $\tilde{l}_i(A,\tau,\tau',a;\Psi)$. The equilibrium conditions in this context are

$$\tilde{H}_i(A,\tau,\tau';\Psi) = \tilde{h}_i(A,\tau,\tau',A_i;\Psi) \quad \text{for all} \quad i \in \mathcal{I}, \tag{5}$$

$$\tilde{N}(A,\tau,\tau';\Psi) = \sum_{i \in \mathcal{I}} \mu_i \varepsilon_i (1 - \tilde{l}_i(A,\tau,\tau',A_i;\Psi)). \tag{6}$$

2.1.3. Politico-economic equilibrium

The function $\tilde{v}_i(A,\tau,\tau',a;\Psi)$ delivers the utility of a type i agent under tax rate τ' tomorrow and tax rates thereafter given by whatever is implied by Ψ and the associated accumulation of assets: these are the induced preferences over policies that we are searching for. Hence, with the median voter referred to as agent m, the preferred policy of the median voter becomes

$$\psi(A,\tau : \Psi) = \underset{\tau'}{\text{Argmax}}\ \tilde{v}_m(A,\tau,\tau',A_m;\Psi). \tag{7}$$

A politico-economic equilibrium is now a pair of functions Ψ and H such that, given Ψ, H is an economic equilibrium, and such that Ψ is a political equilibrium, i.e., $\Psi = \psi$.

3. Properties of steady states

In this section, we describe some of the key properties of steady states of the model. The first thing to note is that a steady state cannot be characterized independently of the whole recursive equilibrium. The reason for this is that agents need to know the paths of the economy for all possible tax rates in the following period in order to evaluate their preferences.[10] In particular, to find a steady state we have to calculate the equilibrium functions H and Ψ. A steady state is a solution A^*, τ^* to the following system of equations:

$$A^* = H(A^*,\tau^*), \tag{8}$$

$$\tau^* = \Psi(A^*,\tau^*). \tag{9}$$

[10] In Krusell and Ríos-Rull (1994) there is a detailed discussion of this issue.

It is easy to see that equal distribution and zero taxes is a steady state by noting that associated with any nonzero level of taxation there are distortions, but no redistribution. Another property to notice is that in a steady state there is no net investment and, therefore, both income and consumption taxes have the same tax base, i.e., a given consumption tax rate implies exactly the same revenue collection as the same rate applied to income.

We want to compare the set of steady states of economies with endogenously determined taxes with those of more traditional models where taxes are determined exogenously. In Krusell and Ríos-Rull (1994), there is a detailed analysis of the implications for economies where leisure does not enter the utility function; there, it is shown that with exogenous taxation the distribution of wealth is irrelevant.[11] In economies with leisure, the analysis is slightly more complex, since the steady state level of capital is determined jointly with the level of work effort. However, the set of distributions of wealth that are possible as steady states is the same as in the economy without leisure.

To be more precise, note that any steady state with an exogenous tax on income can be summarized by $(F_1(\hat{K}, 1 - \hat{L}) - \delta)(1 - \tau^y) + 1 = 1/\beta$ and $(1 - \alpha)(F(\hat{K}, 1 - \hat{L}) - \delta\hat{K}) = \alpha F_2(\hat{K}, 1 - \hat{L})\hat{L}$, where $\hat{K}$ is total capital and $\hat{L}$ is total leisure. These equations can be used to solve for $\hat{K}$ and $\hat{L}$. Given these totals, the locus of wealth distributions is an $(I - 1)$-dimensional hyperplane described by the equation $\sum_i \mu_i A_i = \hat{K}$. For example, when $I = 2$ this hyperplane defines a line with slope equal to $-\mu_1/\mu_2$. Moreover, with the preferences we assume, agents' ratios of consumption to leisure are proportional to their labor efficiency. Since consumption is a linear function of wealth, this also means that the set of steady-state distributions of leisure choice is an $(I - 1)$-dimensional hyperplane.[12]

It follows from the indeterminacy of steady-state distributions that any combination of relative labor efficiency levels and relative wealth levels is possible. In real-world economies, both the distributions of wages and wealth tend to be skewed to the right, and wealth distributions tend to be more skewed than wage distributions. In our example economies, we examine the role of the relative distributions of labor efficiency and wealth by varying the correlation between asset holdings and labor efficiency.

In the economies we study, the endogenous redistribution of resources among agents affects the selection of taxes dramatically, and it also affects the distribution of wealth. In particular, the set of steady states changes character. One way of illustrating the extent of this effect is to point out that the set of steady states in the two-agent case without leisure choice gives a slope of the local linear approximation to the zero-tax steady-state wealth distribution which is *positive* (i.e., far from $-\mu_1/\mu_2$).

[11] That analysis follows Chatterjee (1994).

[12] Everything else given, rich agents work less than poor agents in this economy.

In fact, the preferences we assume admit aggregation in the absence of endogenous policy choice. Therefore, not only the set of steady states but also the dynamic paths of prices and aggregates are affected by changes in the initial distribution of a given amount of capital. It is convenient to use this class of preferences, since it tells us that any short- or long-run macroeconomic effects of the initial wealth distribution are due solely to the politics in the model. We turn to this in Section 5.

4. Parameter selection in our example economies

We posit functional forms for preferences and technologies and use parameter values that match the standard post-war growth properties of the U.S. economy. This is in the real-business-cycle tradition; our growth model is very simple, and the growth aspects of the calibration are not, we hope, controversial. As regards the wealth distribution, we preferred to present some different cases in order to highlight the role of the relative distributions of capital wealth and labor efficiency for the policy outcomes. We look at three different cases: (1) equal labor efficiency and differences in nonhuman wealth, (2) equal nonhuman wealth and differences in labor efficiency, and (3) the same ratio of nonhuman wealth to the endowment of labor efficiency units across the two groups of agents.

The production function is Cobb–Douglas, i.e., $Y = K^{\theta}N^{1-\theta}$, with $\theta = 0.36$. Capital depreciates at rate δ on an annual basis, and we set it to 0.08.

In our CRRA utility function of a Cobb–Douglas consumption-leisure index, the coefficient on consumption, α, is taken to be 0.33, and the coefficient of relative risk aversion, σ, is 2. The discount rate is set so that the steady state without taxes implies an interest rate of 4% annually.

We consider taxes to be chosen one period in advance, and we select the length of the period to be four years. See Krusell and Ríos-Rull (1994) for an account of the role of the time period in this type of economy. Finally, the economies we look at have two types of agents of equal size, and we consider the poorer agent the median voter. Introduction of more types of agents is straightforward, and Krusell and Ríos-Rull (1994) analyzes a number of such cases in more detail.

5. A comparison of tax systems

We now start the analysis based on the computation of equilibria for the economies described in the calibration above.[13]

[13] We do not know whether in general equilibria are unique for our class of models. However, we have not encountered any case of multiplicity of equilibria in our computations.

5.1. Steady-state analysis

Table 2 shows the steady-state levels of taxation and aggregate output for a variety of economies that differ in the relative composition of human and nonhuman wealth among households. We report the steady-state tax rates, levels of output, and utility levels of both types of agents for different tax systems (income taxes, consumption taxes, labor income taxes, and capital income taxes) and wealth distributions.[14] The aggregate output level is reported as a percentage of the level of output that results in the steady state where zero taxes are imposed exogenously, and for a variety of spreads in the distribution. The utility levels are not of direct normative interest, since the initial conditions differ across steady states. Also, the utility levels indirectly indicate work effort differences across tax systems.

A common feature to all economies is that the level of taxation is increasing with the degree of inequality. This result is standard in the political-economy literature (see the references above). Moreover, because taxes have a distortionary effect on the economy, there is a negative relation between levels of taxation and aggregate output for all types of taxation.

The first three columns of Table 2 refer to economies where all agents have the same ratio of human to nonhuman wealth, while in the last six columns all agents have either the same labor efficiency or the same amount of nonhuman wealth. In the economy with positive correlation between human and nonhuman wealth, which is probably the most empirically relevant case, all agents choose the same amount of work effort. The main results for these economies (the first three columns of Table 2) can be summarized by:

- Consumption taxes generate lower steady-state output than do income taxes. The reason for this is that rational agents internalize the smaller amount of distortion per unit of transfer associated with consumption taxes, which induces them to choose a higher level of taxation.
- Even though it is often thought that consumption and labor income taxes have similar properties in terms of the distortions that they generate, this is not the case in our environment. Here, consumption taxation provides a broader tax base for redistribution than do labor taxes, making them more attractive for the median voter. This feature results in higher tax rates for consumption than for labor income, and hence leads to lower steady-state output.
- If capital income taxation is the only way to generate transfers, then small differences in wealth across agents generate high tax rates and distortions.[15]

[14] We did not report equilibria for economies with only capital income taxes in the cases of a very skewed distribution of wealth; we were unable to compute equilibria in these cases.

[15] With our computational methods this leads to problems when the wealth differences are substantial; we use linear-quadratic approximations and cannot impose nonnegativity constraints such as one on investment. Such constraints are likely to be binding in these cases.

Table 2
Endogenous cash transfers – steady-state tax rates and output for a variety of ratios of human to nonhuman wealth; tax rates are percentages, and output levels are percentages relative to the zero-tax steady state

Med./av. wealth	0.99	0.85	0.67	1.0	1.0	1.0	0.99	0.85	0.67
Med./av. lab. eff.	0.99	0.85	0.67	0.99	0.85	0.67	1.0	1.0	1.0
Income									
– Tax rate	1.25	16.53	32.11	1.16	15.73	31.30	0.09	1.37	2.90
– Output	98.74	82.88	65.87	98.83	83.73	66.77	99.90	98.62	97.07
– Med. util.	−1.160	−1.294	−1.463	−1.159	−1.270	−1.406	−1.153	−1.173	−1.199
– Nonmed. util.	−1.146	−1.109	−1.119	−1.147	−1.121	−1.140	−1.150	−1.135	−1.115
Consumption									
– Tax rate	1.97	34.20	88.21	1.42	23.08	58.28	0.54	8.72	21.55
– Output	98.62	80.48	61.52	99.00	85.94	70.76	99.61	94.18	86.74
– Med. util.	−1.160	−1.285	−1.434	−1.158	−1.256	−1.370	−1.153	−1.178	−1.213
– Nonmed. util.	−1.146	−1.120	−1.170	−1.147	−1.111	−1.120	−1.150	−1.143	−1.142
Labor									
– Tax rate	1.32	17.76	35.02	1.40	18.75	36.83	−0.08	−1.18	−2.26
– Output	99.06	86.72	72.36	99.00	85.94	70.76	100.05	100.84	101.86
– Med. util.	−1.159	−1.279	−1.434	−1.158	−1.256	−1.370	−1.152	−1.169	−1.192
– Nonmed. util.	−1.145	−1.109	−1.077	−1.147	−1.111	−1.120	−1.150	−1.131	−1.108
Capital									
– Tax rate	4.66			1.46			3.23		
– Output	98.58			99.56			99.03		
– Med. util.	−1.162			−1.158			−1.155		
– Nonmed. util.	−1.148			−1.146			−1.153		

In economies where agents have different ratios of human to nonhuman wealth, a new consideration appears: taxation can now not only be used for direct redistribution through the lump-sum transfers, but it can also be used to affect relative prices in a way that benefits the median group at the expense of the other group. This feature is particularly important in the study of capital and labor taxes, but it is also present in the cases of income and consumption taxation.

In economies where agents have the same wealth but differ in labor efficiency, the median agents (the low-efficiency agents) work less than the nonmedian agents.[16] As a result, the income of the median agent has a higher share coming from capital than that of the nonmedian agent. This means that the relative price changes triggered by lower aggregate capital – an increase in the rental rate of capital relative to the wage rate – benefit the median agents. The middle columns of Table 2 show the steady-state values for taxation, output, and utilities for these economies. A summary of the findings is as follows:

- All tax rates are lower than in the economies where all agents have the same ratio of human to nonhuman wealth. This is because the differences in income between agents are smaller in this case.
- Income taxes now lead to lower output than do consumption taxes. The reason for this is that the reduction of total future capital has an effect on the relative prices of factors of production that favors the median agents, and this in turn induces a heavier use of income taxes than of consumption taxes.
- Labor taxes are perfect substitutes for consumption taxes even though their tax base is different, because the higher revenues of consumption taxation cannot give any net redistribution since all agents hold equal amounts of nonhuman wealth, and because the two taxes have the same distortionary effects. (The tax rates are only nominally different because of the form in which they enter the budget constraint.)
- Capital income taxation has very interesting properties. First, it cannot be used to redistribute, just to distort, since all agents have the same amount of capital. Why, then, do the median agents want to distort? As said before, the distortion is not neutral. There is a change in after-tax relative prices benefitting those with a higher proportion of their income coming from capital, which in this case means the median households.

The third possibility is that agents have the same labor efficiency but differ in nonhuman wealth, and here the median agents (the poor agents) work more than the nonmedian agents. Because of their lower asset holdings and the higher work effort, the relative composition of the median agents' income is thus tilted towards labor income. This means that a change in the relative price following

[16] This result is special to the type of preferences that we consider.

from a lower aggregate capital stock benefits the nonmedian agents. The last three columns of Table 2 show this economy's steady-state values for output and taxation for all these tax systems. Some of the key properties of the findings are:

- Income taxes lead to higher levels of income than do consumption taxes.
- Labor income taxes are negative. This is due to the fact that poorer agents work harder, and, hence, they want to subsidize labor earnings.
- Even though the capital income tax rate is quite high, it is still lower than the one that results in the economy where all agents have the same ratio of human to nonhuman wealth. This comes from the negative effect of the lower capital stock, via relative prices, on the relative income of the median households. The same qualitative result holds for income and consumption taxes, which are also lower in this case.

We summarize the key findings of the steady-state analysis of different tax systems with the following:

1. Tax rates are an increasing function of the skewedness of the income and wealth distribution. This property holds for all tax systems and all sources of income and wealth differentials.[17]
2. Typically, income taxation leads to a higher level of output than does consumption taxation. This is due to the fact that income taxation is more distortionary, so that it will tend to be used less than consumption taxation.[18]

5.2. A comparison with environments where the level of transfers is exogenous

In order to highlight the importance of endogenizing the determination of the level of taxation through the political mechanism, we also computed the steady-state equilibrium allocations when tax rates are determined by an exogenous level of transfers. In other words, assume that the level of transfers is predetermined. Consequently, the level of taxation must be such that the public budget is balanced. We thus computed the steady-state equilibria associated with different types of taxation. As an example, we selected the given amount of per-capita transfers to equal that amount determined in the politico-economic equilibrium with income taxes. This type of analysis is similar to a simplified version of the optimal taxation approach, and it shows how the introduction of an endogenous

[17] For economies with all agents having the same labor efficiency and different wealth shown in the last columns of Table 2, labor taxes are negative. Here, the absolute value of the tax rate is increasing with income concentration.

[18] As stated, this is not true for economies where agents have the same nonhuman wealth but differ in their labor efficiency, but we consider this case more as a consistency check on our results than as a plausible case.

Table 3
Exogenous cash transfers – steady-state tax rates and output when the level of transfers is exogenous for different types of taxes; all agents have the same ratio of human to nonhuman wealth

Med./av. wealth	0.99	0.85	0.67
Med./av. lab. eff.	0.99	0.85	0.67
Income			
– Tax rate	1.25%	16.53%	32.11%
– Output	100.00%	100.00%	100.00%
– Med. util.	−1.160	−1.294	−1.463
– Nonmed. util.	−1.146	−1.109	−1.119
Consumption			
– Tax rate	1.25%	15.51%	26.18%
– Output	100.39%	108.70%	128.04%
– Med. util.	−1.159	−1.271	−1.414
– Nonmed. util.	−1.145	−1.108	−1.021
Labor			
– Tax rate	1.52%	20.04%	39.15%
– Output	100.18%	102.45%	104.25%
– Med. util.	−1.160	−1.282	−1.441
– Nonmed. util.	−1.145	−1.098	−1.101
Capital			
– Tax rate	6.78%	70.26%	
– Output	99.16%	76.40%	
– Med. util.	−1.165	−1.448	
– Nonmed. util.	−1.150	−1.258	

political mechanism can change the views on the preferability of different systems of taxation. For the case in which all agents have the same ratio of human to nonhuman wealth, Table 3 shows the steady-state levels of taxation and aggregate output required to raise the same amount of revenue that the equilibria with income taxes generate. Output is reported as a percentage of the level obtained in the case of income taxes. In the table, we see that consumption taxes are capable of raising this amount at a much higher level of output.

Of course, the above experiments are not immediately informative about welfare; we just used the level of output as an indirect measure of the level of distortions, and as a first pass at the study of the quantitative properties of the economies that we are interested in.

5.3. *Welfare analysis*

In the welfare analysis of the alternative tax systems it is crucial to make the comparisons starting from identical initial conditions. This implies not only a specific wealth distribution, but also an initial level of taxation. We choose as initial conditions the steady states that are realized under the different tax

Table 4
Welfare losses as percentage-of-consumption flows when the economy switches from a steady state with one type of tax to a system with another type of tax

Replacing	Same ratio of human to nonhuman wealth $A_m/A_a = 0.85$, $\varepsilon_m/\varepsilon_a = 0.85$	Same wealth, different efficiency $A_m/A_a = 1$, $\varepsilon_m/\varepsilon_a = 0.85$	Same efficiency, different wealth $A_m/A_a = 0.85$, $\varepsilon_m/\varepsilon_a = 1$
Income tax with			
Consumption tax			
– Median agent	0.05%	0.03%	0.10%
– Nonmedian agent	1.98%	0.21%	0.29%
Labor tax			
– Median agent	0.01%	−0.10%	−0.00%
– Nonmedian agent	−0.40%	0.04%	−0.01%
Consumption tax with			
Income tax			
– Median agent	0.38%	0.19%	−0.06%
– Nonmedian agent	−2.10%	−0.24%	−0.26%
Labor tax			
– Median agent	0.51%	0.21%	−0.06%
– Nonmedian agent	−2.35%	−0.14%	−0.27%
Labor tax with			
Income tax			
– Median agent	−0.00%	0.12%	0.00%
– Nonmedian agent	0.39%	−0.06%	0.00%
*Consumption tax**			
– Median agent	0.02%	0.07%	0.04%
– Nonmedian agent	1.20%	0.05%	0.13%

*Computational difficulties in this case led us to using ratios of 0.90 rather than 0.85 for the three consumption cases.

systems. In the first period, the economy still has the taxes associated with the old tax system set in the previous period, but the following period's tax rate, which belongs to a different tax system, is now voted on. We then compute the equilibrium paths associated with the switches to alternative tax systems and we compare the implied utilities for both types of agents with those obtained in the steady states. Next, we compute the constant proportional increase in per-period consumption that has to be given to the agents when the economy switches tax systems so that they are indifferent between switching and not switching. Our procedure implies that a positive (negative) reported number arises from a welfare loss (gain) when the economy switches tax systems. We have found all our numerical examples to exhibit stability, i.e., the economy moves from the original steady state towards a new steady state.

Table 4 shows the findings associated with these experiments. In the first part of this table, we see that both types of agents suffer utility losses when switching from a system with income taxes to one with consumption taxes. This is in clear contrast with the steady-state comparison. The losses are larger for the nonmedian (rich) agents. If we considered the switch from income taxation to labor taxation, the findings are not so clear: when all agents have the same ratio of human to nonhuman wealth, the median agents realize small welfare losses, while the nonmedian agents are better off after the change in tax system. However, when the ratios of human to nonhuman wealth are different across types the welfare of the median agent improves with the change.

The second part of Table 4 shows a switch from the steady state with consumption taxes to a system with income taxation and to one with labor taxation. There are small losses for the median agents and larger gains for the nonmedian agents, except for the case when agents have the same labor efficiency but different nonhuman wealth: then, both agents gain from changing tax systems.

Finally, the third part of Table 4 shows the properties of switches from labor taxation to income and consumption taxation. In this case, the welfare changes are small and entail welfare losses for the median (except when switching to an income tax system in economies with the same ratio of human to nonhuman wealth: here there is a negligible gain for the median).

We summarize these findings as follows:

1) There is only one case in which all the groups increase their welfare after a change in the tax system. This is when consumption taxes are replaced by income taxes in an economy where all agents have the same nonhuman wealth but different labor efficiency.

2) The median agents improve their welfare after a change in tax systems only in two cases: in the case noted before, and in the case of a replacement of labor taxation by income taxation in an economy where all agents have the same ratio of human to nonhuman wealth (and in these cases the median agents prefer a change by the slightest of margins).

3) The two above points lead to the insight that tax systems have an important stability property: once a tax system is in place it will be hard to replace with another tax system. This is particularly true if the change in tax systems requires some form of qualified majority (unanimity in our two-agent case).

6. Economies with both consumption and income taxes

It is natural to also ask about the properties of economies in which two taxes, say an income and a consumption tax, are contemporaneously voted on. There are well-known problems associated with multidimensional voting (majority voting may not be (quasi-)transitive, and the median-voter theorem may not apply). These problems do not arise in a two-agent economy in which one group of agents is larger than the other one – then, all we need is to maximize the indirect preferences for the more numerous agent over the tax pair. As before, we let the decisive voter be the poorer agent.

6.1. Steady-state analysis for systems with two taxes

In Table 5 we report the steady-state tax rates of the economies with both consumption and income taxes for different degrees of income concentration coming from differences in asset holdings, differences in labor efficiencies and differences in both asset holdings and labor efficiencies. The key properties that we observe are:

- When agents differ in asset holdings, the consumption tax is used for collecting revenue and the income tax is used for partially offsetting the distortionary effect of the consumption tax. More specifically, there will be a positive consumption tax and a *negative* income tax, producing the following result: (i) a negative income tax partially offsets the distortionary effect of consumption taxes on the labor/leisure choice; (ii) at the same time, negative income taxes increase next period's capital stock and income, which implies a higher tax base for collection of future revenues and thus future transfers, as the differences in assets between the groups are permanent. Thus, the intertemporal distortion that the income tax creates by subsidizing capital accumulation is somewhat offset, from the point of view of the (poor) median agent, by the higher future tax base that it induces.
- When agents differ in their nonhuman wealth (parts 1 and 3 of Table 5), we have higher income subsidies (a negative income tax with a higher absolute value) than when agents have the same nonhuman wealth. The reason behind this result is that in this economy the median agents work longer than the richer ones, and therefore the share of income due to labor is higher. The median agents thus internalize the role that higher capital tomorrow has in determining relative prices: higher capital implies higher wages. In the economy where the

Table 5
Steady states for economies with cash transfers and two taxes available

Med./av. wealth	0.99	0.85	1.0	1.0	0.99	0.85
Med./av. lab. eff.	0.99	0.85	0.99	0.85	1.0	1.0
Cons. tax rate	4.00	71.88	1.42	23.07	2.56	42.96
Income tax rate	−2.01	−30.77	0.00	0.01	−2.02	−32.99
Output	99.22	88.20	99.00	85.94	100.22	102.73
Transfer/output	1.54	31.13	1.11	17.99	0.42	7.54
Median util.	−1.158	−1.257	−1.158	−1.256	−1.151	−1.152
Nonmedian util.	−1.144	−1.091	−1.147	−1.111	−1.148	−1.121

ratios of human to nonhuman wealth are equated across agents, all agents work the same amount of hours, implying that everybody receives the same functional composition of income. This implies that the gain for the median agents from distorting the relative prices of labor and capital is lower in the case of equal labor efficiencies.

- When agents have the same wealth but different labor abilities (part 2 of Table 5), income taxes are not used and the properties of the equilibrium are the same as those of the economies with only consumption taxes. In this case, the distortion of the intertemporal margin does not change the effective redistribution that can be implemented through the taxation of capital income because both types of agents have the same asset holdings. At the same time, an increase in the relative price of labor is not worthwhile for the median agents given that their labor efficiency is low and they work less; in fact, as in the case with a capital income tax only in the previous section, this argument speaks for positive income taxes. In sum, however, this effect and the need to partially offset the labor/leisure distortion created by the consumption tax will cancel, so from the median's point of view, nonzero income taxes have a pure distortionary role.
- The highest transfers occur in the economy where agents have identical ratios of human to nonhuman wealth (part 1 of Table 5), followed by the economy where agents have the same nonhuman wealth but different labor efficiency (part 2 of Table 5), and, finally, by the economy where agents only differ in nonhuman wealth (part 3 of Table 5). Given the parameterization of the model economies, this hierarchy also corresponds to that of total income.
- The steady states are associated with at least as high levels of output as in societies with only one type of taxation.

We found the fact that income taxes are never positive (and almost always negative) in the case when two taxes are voted on quite striking. This is true even in the case when there is a large difference among groups in asset holdings. Although this type of tax focuses more on the asset base, consumption taxes remain more efficient for the purpose of taxing agents with high asset holdings: consumption does rise as a function of the asset holding, and taxing this base is less distortionary.

The fact that there seem to be higher levels of output in the two-tax steady states than in economies with one type of taxation is indicative of the desirability of a system with two taxes – thus casting doubt on Brennan and Buchanan's (1977) general proposition that the more efficient the government, the worse the resulting economic performance. However, it cannot be directly used to make welfare comparisons across tax systems. To be able to make welfare comparisons we have to perform the same type of dynamic analysis as in Section 5.3.

6.2. *Welfare analysis*

6.2.1. *Switching from a one-tax to a two-tax system*

The upper part of Table 6 describes the welfare losses for the two types of agents that result when the economy starts at a steady state with one type of tax and it moves to a tax system with both consumption and income taxes.

We see that a replacement of income taxes with two taxes worsens the welfare of the nonmedian agents. The median agent is also worse off except for the case of equal nonhuman wealth and differential labor efficiency. However, the quantitative amount of the welfare improvement in this latter case is almost zero. This, again, suggests that if a society is at a point where income taxes are used but consumption taxes are not, the latter is unlikely to be introduced. This model thus offers one explanation for the lack of federal consumption taxes in the United States.

On the other hand, adding income taxes to a society which is in a steady state with consumption taxes may increase the welfare of all the agents involved. This occurs when all agents have the same ratio of human to nonhuman wealth. As we saw in the previous subsection, when all agents have the same asset holdings and different labor efficiencies, income taxes are not used, which implies that the economy remains in the same position as it was before the introduction of income taxes; therefore, the welfare of the agents does not change. When agents have the same labor efficiency and different nonhuman wealth, the median agents gain and the nonmedian agents lose. We saw in the previous section that in societies with consumption taxes, a replacement of the existing tax with income taxes is unlikely. What Table 6 tells us, instead, is that for these societies the addition of an income tax to the preexisting consumption tax is much more likely. Most countries that base most of their fiscal revenue on income taxes have introduced them later and in addition to consumption taxes as this model predicts. However, as a positive theory, the model with simultaneous voting on income and consumption taxes is problematic since it predicts negative income taxes.[19]

Regarding the substitution of labor taxes with the combination of consumption and income taxation, Table 6 shows that all agents lose (except the median agents in the case of an equal ratio of human to nonhuman wealth), but the improvements are quantitatively small.

6.2.2. *Switching from a two-tax to a one-tax system*

The lower part of Table 6 describes the welfare losses for the two types of agents that result when the economy is in the steady state with both consumption and income taxes and it moves to a tax system with only one tax.

[19] It is possible that this result disappears if one assumes a large enough exogenous source of government revenue.

Table 6
Welfare losses as percentage-of-consumption flows when the economy switches between one- and two-tax systems

Rel. wealth and lab eff.'s	$A_m/A_a = 0.85$, $\varepsilon_m/\varepsilon_a = 0.85$	$A_m/A_a = 1$, $\varepsilon_m/\varepsilon_a = 0.85$	$A_m/A_a = 0.85$, $\varepsilon_m/\varepsilon_a = 1$
Both taxes replace			
Income tax			
– Median agent	0.01%	−0.00%	0.11%
– Nonmedian agent	1.29%	0.27%	0.45%
Consumption tax			
– Median agent	−0.14%	0.00%	−0.04%
– Nonmedian agent	−0.92%	0.00%	0.12%
Labor tax			
– Median agent	−0.01%	0.12%	0.09%
– Nonmedian agent	1.84%	0.19%	0.47%
Both taxes are replaced with			
Income tax			
– Median agent	1.50%	0.20%	0.59%
– Nonmedian agent	−1.12%	−0.24%	−0.27%
*Consumption tax**			
– Median agent	0.05%	0.00%	0.05%
– Nonmedian agent	0.13%	0.00%	−0.01%
Labor tax			
– Median agent	1.69%	0.21%	0.58%
– Nonmedian agent	−1.29%	−0.14%	−0.25%

*Computational difficulties in this case led us to using ratios of 0.90 rather than 0.85 for the three consumption cases.

We see that the replacement of a tax system based on both consumption and income taxes with a system with only one tax always reduces the welfare of the median agent. This change in the tax system has the opposite effect on the welfare of the nonmedian agent in almost all cases (the only exception is the replacement of the two taxes with a consumption tax when all agents have the same ratio of human to nonhuman wealth; in this case the nonmedian agents are also worse off).[20]

7. Other roles for government

So far, we have been assuming that government outlays are used for redistributing goods in equal amounts to all agents. However, many of the government's

[20] As for the reverse switch of systems, the replacement of a two-tax system with one with consumption taxes in the case where all agents have the same asset holdings has no effect on the equilibrium allocation, as the resulting income tax rate is zero and the economy maintains its wealth distribution over time.

activities are associated with the provision of goods and services. In this section we explore the properties of alternative tax systems when all of the government revenue is used for purchasing goods, and the political system determines the levels of spending.[21]

7.1. Public provision of private goods

Public provision of private goods which are highly substitutable with private consumption include education and certain forms of public support like health assistance. If the public goods are indeed perfect substitutes with private goods, and they are distributed on an equal per-capita basis where no agents have zero private provision of the good, then the properties of this economy are identical to that with direct cash transfers.

An interesting variation is the assumption that the government is inefficient in providing these goods. There are different rationales for this: costly information acquisition may be necessary, the incentive structure in the public sector may make it inefficient, and so on.

To implement the notion of inefficient public provision of private goods, we consider a widely used specification for the utility function given by $u(c,g,l) = [(c+\pi g)^{\alpha} l^{1-\alpha}]^{1-\sigma}/(1-\sigma)$, where c is private consumption, g public expenditures, l leisure, and $\pi \in [0,1]$ is an index of efficiency of the public sector.[22]

We compared economies with the same fundamentals but different degrees of government efficiency, π. Our findings are parallel to those in the economies with lump-sum redistribution: economies with higher efficiency in the government provision of the goods will tend to have more active governments. For example, an income tax economy where all agents have the same ratio of human to nonhuman wealth and where the median agents have 85% of the average wealth and which has $\pi = 1$ gives a steady-state tax rate of 16.53%. However, when $\pi = 0.9$, meaning that the public sector is not perfectly efficient in the provision of the good, the steady-state tax rate is 7.58%. Correspondingly, steady-state output in the economy with a fully efficient government economy is only 89.3% of the value in the economy with an inefficient government. Thus, this constitutes further evidence that the more efficient the fiscal instruments of redistribution, the

[21] For brevity of exposition, we do not report the results of the simulations nor the proofs of the claims we make in the present section. However, they are available upon request from the authors.

[22] A discussion of a variety of formulations for how public goods affect the economy and their macroeconomic effects can be found in Aschauer and Greenwood (1985). Examples of studies using this particular specification are Aschauer (1985) in testing the Ricardian Proposition, Christiano and Eichenbaum (1992) in analyzing the contribution of government consumption in the generation of aggregate fluctuations, and McGrattan (1994) in analyzing the influence of capital taxes, labor taxes, and government consumption for the business cycle.

more expanded the public activity, and the worse the aggregate performance of the economy due to higher distortionary taxes.[23]

7.2. Public provision of public goods

Another key activity undertaken by the government is the provision of public goods. It turns out that the properties of the equilibrium of economies where government outlays are used to provide public goods depend crucially on the specification of the role these goods play in utility, and on the ratios of human to nonhuman wealth for the different agents. For example, the public good can enter the utility function in the same form as the private goods under Cobb–Douglas preferences, i.e., as $u(c,g,l) = [c^{\alpha_1} g^{\alpha_2} l^{1-\alpha_1-\alpha_2}]^{1-\sigma}/(1-\sigma)$. In this case, Engel curves are linear: the shares of expenditures for each good are independent of the level of income and all agents would like to spend the same ratio of their income on the public good. This means that when all agents have the same ratios of human to nonhuman wealth, they also have the same preferences over tax rates since now government policy plays no role for redistribution (both the costs and the benefits are proportional to their wealth). The preferred choice balances the distortion that the taxes generate with the utility they provide and the political problem turns into a pure optimal-taxation problem: the best taxes are the least distortionary taxes.

When the ratios of human to nonhuman wealth differ across agents, the situation changes slightly since now the contribution to the finance of the public goods is not proportional to individual incomes (with capital or labor taxes) and the distortions caused by taxation are not identical for all groups. Consequently, the preferred tax rates are not the same across types of agents. The differences, however, are small because the variations across groups of the tax-induced distortions are also small. This leads to the finding that the political system generates policies that are very similar to the ones that we would obtain from optimal-taxation analysis.

If preferences are not Cobb–Douglas over the public good, as in the case $u(c,g,l) = [c^{\alpha} l^{1-\alpha}]^{1-\sigma}/(1-\sigma) + \psi(g)$, where c is private consumption, l leisure, g public spending, and $\psi(\cdot)$ is strictly increasing and concave.[24] Now the agent's preferences over the optimal level of taxation, and thus the optimal provision of the public good, depend not only on the relative sources of income, but also on the absolute value of individual income. The extent of the differences in preferences across agents over the amount of the public good then depends on

[23] Of course, this does not translate into utility terms since publicly provided goods are more efficient in generating utility in the case with an efficient government.

[24] If the process generating g is exogenous, this functional form is particularly convenient because the agent's maximization problem is not affected by g at the margin. For this reason it has been used in several studies on taxation. Examples are Aiyagari, Christiano, and Eichenbaum (1992), Jones et al. (1993, Sec. II, III), and Chari et al. (1994).

the extent of the income dispersion. However, in our numerical examples, the dependence of the equilibrium level of taxation on distribution is not as strong as in the case of cash transfers, and therefore the steady state level of output is larger with less distortionary taxes, implying that consumption taxes are typically better than income taxes.

If we consider a public good that acts as an input to production, similar findings arise.[25] In particular, we assume the following specification for the production function: $Y = K^{\theta}N^{1-\theta}I_g^{\gamma}$ where K is private capital, N labor input, and I_g is public expenditures.[26]

In this case, the relation between distribution and taxation depends on the type of taxes used to finance public expenditures. More specifically, with a Cobb–Douglas production function with three inputs, one of them being a public good, and with income or consumption taxes, the distribution of income has no effect on the level of taxation, except for the effect through the tax exemption of depreciated capital. The reason for this finding is that the increase in the level of provision of the public good has the effect of increasing the prices for the services of both capital and labor. This in turn means that all agents benefit proportionally to their endowment of capital and labor. Because the cost is also proportional to the endowment of capital and labor, we obtain agreement over policies and the standard finding that the less distortionary the taxes are, the better.

If we assume that tax rates for different kinds of income differ, then unless the proportion of capital income on labor income is the same for all agents, the distribution of wealth has an influence on the equilibrium level of taxation as it affects the relative factor prices, and hence it affects the various groups of agents differently.

8. Conclusions

In this paper, we have described the properties of a neoclassical growth model where agents are heterogeneous in asset holdings and/or labor earnings ability when the level of taxation is determined through a politico-economic mechanism and the tax proceeds are rebated as lump-sum transfers. We have shown that, in general, consumption taxes induce lower output than income taxes as agents internalize the higher distortionary cost induced by income taxes. Table 1 provides some support for this finding; the countries with the least reliance on consumption

[25] For example, Aschauer (1989) provides some empirical evidence for this hypothesis: he shows that the stock of nonmilitary public capital (in particular that of structures) has a significant effect on private factor productivities. Other examples of studies that consider the role of public expenditures as an input to the aggregate production function are Barro (1990), Jones et al. (1993, Sec. IV), and Alesina and Rodrik (1994).

[26] If $\theta + \gamma \geq 1$, then the models allow endogenous growth.

taxes – Japan, the U.S., and Switzerland – are all associated with relatively small transfer systems and high output levels; the reverse is roughly true for the countries with the largest reliance on consumption taxes. We have also shown that switches from one tax system to another tend not to increase the welfare of the median voters. This suggests stability in tax systems, and a permanence of status quo. This result also holds for tax systems that allow for the simultaneous taxation of consumption and income, albeit there are some exceptions in this case. The most important of these exceptions refers to the case of an addition of income taxes to a society that only uses consumption taxes; this addition results in welfare gains for both types of agents.

We have also looked at economies where government outlays are not used for redistribution but for the provision of public goods. We found that the determination of the level of taxation through a politico-economic mechanism tends to lead to the same properties as those of the standard optimal taxation literature, i.e., less distortionary taxes are preferable.

Appendix: Computational procedure

A.1. Algorithm for finding steady states

There is typically an $(I-1)$-dimensional subspace of steady states. We search for those with a given ratio of asset holdings and labor efficiencies between the different types of agents. For each ratio, the search for a steady state involves a search for a tax rate. The procedure for computing such a tax rate can be described as follows:

(i) Guess a steady-state value for tax rate τ_0 and compute the implied stationary values of the other variables, $S(\tau_0)$.

(ii) Let $R_i^0(A,\tau,a,N,A',n,a')$ be a quadratic approximation to the per-period utility function of agent i around $S(\tau_0)$.

(iii) Fix an initial affine tax policy function Ψ_0.

(iv) Given Ψ_0, use standard methods to solve for the equilibrium elements associated with the dynamic problem described in (1). This step yields linear functions N_0 and H_0 and quadratic functions v_{i0} for $i = 1,\dots,I$.

(v) Given $\{v_{i0}\}_{i\in\mathscr{I}}$, use standard methods to compute equilibria associated to the dynamic problem described in (4). This step yields linear functions $\tilde{N}_0$ and $\tilde{H}_0$ and quadratic functions $\tilde{v}_{i0}$. These quadratic functions have τ' as an argument.

(vi) Maximize $\tilde{v}_{i0}$ with respect to τ' to obtain functions ψ_{i0} describing the preferred tax rate of the agents. Check for the concavity of the function $\tilde{v}_{i0}$

with respect to τ', to ensure that the first-order conditions deliver a maximum.

(vii) Use the representative-type condition on the median agent to obtain the function Ψ_1 by letting $\Psi_1(A, \tau) \equiv \psi_m(A, \tau, A_m; \Psi)$.

(viii) Compare Ψ_1 to Ψ_0. If these functions are close enough, continue to (ix). If not go back to step (iii) and update the guess for the policy function Ψ_0. We update to let the new tax policy function equal Ψ_1.

(ix) Verify that the policy function Ψ_0 reproduces the conjectured tax rate: $\tau_0 = \Psi_0(A, \tau_0)$. If it does not, go back to step (i) and update the guess for τ_0. We update using $\tau_0 = (\tau_0 + \Psi_0(A, \tau_0))/2$.

A.2. Algorithms for computing transitional dynamics

The second procedure follows steps (ii)–(ix) above. It also involves a separate linearization around each new point the economy passes through. The slight complication needed is an additional round of iterations 'within' step (ii); it is necessary to ensure that, at each point on the dynamic path, the points $\{A, \tau, N, A'\}$ and $\{A, \tau, \tau', N, A'\}$ around which the linearization is made coincide with the equilibrium outcome.

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