Are Consumption Taxes Really Better Than

Income Taxes?

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Abstract

We use political-equilibrium theory and the neoclassical growth model to compare the quantitative properties of different tax systems.

We first explore whether societies which can only use consumption taxes fare better than societies which can only use income taxes. We find that if government outlays are used mainly for redistribution through transfers, then the answer is no, contradicting conventional wisdom in public finance. The reason for this is that when taxes are endogenous, and voted on by a selfish constituency, the distortionary effects of taxation are taken into account in choosing the level of taxation. Hence, political equilibria have the property that taxes which are relatively distortionary will be relatively low. These results are overturned if the government outlays are used only for the providing of public goods, implying that less distortionary taxes give better outcomes.

We also investigate the properties of a tax systems in which both consumption and income taxes are used and voted on simultaneously. Since the ability to use more tax instruments allows redistribution with less distortions, the total amount of transfers tends to be higher here than in one-tax systems.

Typically, tax systems tend to be self-perpetuating in the sense that changes of the tax system result in a reduction in the welfare of the median voter.

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1 Introduction

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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 rather 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 of distortions. The voting agents face a trade-off between the amount of redistribution and the costs associated with it. It is not obvious what the resolution of this trade-off is. It might be, as Brennan & Buchanan (1977) have suggested for slightly different 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 tools (tax systems), substantial redistribution can be accomplished with little distortion. In this paper we resolve this tradeoff 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 model the political process determining this policy. Unfortunately, the introduction of an endogenous political mechanism increases the complexity of the model for two reasons. First, it is necessary to study heterogeneous-agent economies, which increases the state space. In 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 boils down to a forecasting problem: it is necessary for an agent contemplating different current policy options to think not only about their respective effect on current prices and transfers, but on future prices, transfers, and politically

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¹See Atkinson & Stiglitz (1980, pp. 564-565) and Stiglitz (1986, pp. 533-536) for a summary. Summers (1981), Auerbach, Kotlikoff, & Skinner (1983) and Jones, Manuelli, & Rossi (1993) are examples of positions favorable to consumption taxes, while Browning & Burbidge (1990) gives a more agnostic view.

²It should be pointed out that the recent results in Aiyagari (1993) 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.

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 & Prescott (1971)): here, agents also have to correctly predict what *would* happen under circumstances which will never be realized. Ľ,

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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., 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 compare economies for each of which we postulate what set of taxes are used and what set of taxes are voted upon. 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 one-tax constitutions, income taxes are generally better than consumption taxes. This result is driven by the property mentioned above, that more distortionary tax systems imply lower amounts of total transfers.
- The comparison between two-tax and one-tax systems generally favor 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, only very rarely will the median agents (who are poorer in our economies) improve their welfare after a change of tax systems. 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, then different results typically apply: then, tax systems based on less distortionary types of taxes are 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

³See Muth (1961).

be an important factor determining economic policies, and therefore economic outcomes.⁴ 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 & Ríos-Rull (1994) and Krusell et al. (1994), which are straightforward to amend to allow a leisure choice. These methods are computational in nature, since analytical solutions cannot be obtained for this class of economies.

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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 in deterministic or stochastic environments.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 imposing our balanced-budget requirements. Second, we are primarily concerned with determining the total size of government outlays/transfers, which in the literature on optimal taxation is typically taken as given. Third, the optimal-taxation studies are typically not interested in distributional issues, which are in the focus of our study. Fourth and finally, an analysis of optimal taxation requires taking stand on the issue of time consistency, while the positive route to the determination of policies which we adopt automatically involves time-consistent policies.

Our paper starts with a brief overview of the model in Section 2, and in Section 3 we describe it formally. The analysis starts in Section 4, where we make a preliminary characterization of the set of steady states. In Section 5 we calibrate the model to postwar U.S. data, and our numerical analysis proceeds in Section 6. 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 7 we extend our analysis to economies with two taxes. We look at the provision of public goods in the following section (Section 8).

The last part of the paper, Section 9, briefly investigates some properties of tax data from the OECD economies. Recall that the quantitative implications from our political-economy

⁴Examples of papers in this literature are Alesina & Rodrik (1994), Bertola (1993), Boldrin (1993), Meltzer & Richard (1981), Fernandez & Rogerson (1994), Glomm & Ravikumar (1992), Huffman (1993), Kristov, Lindert, & McClelland (1992), Krusell & Ríos-Rull (1992), Krusell & Ríos-Rull (1994), Krusell, Quadrini, & Ríos-Rull (1994), Perotti (1993), Persson & Tabellini (1994), and Saint-Paul & Verdier (1991, 1992).

⁵For example, Lucas & 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 & Stokey (1991)) 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, & Kehoe (1994).

approach suggest that we should be able to correlate economic performance with the extent to which consumption taxes are used for raising revenue. We do find preliminary evidence in support of the theory: countries which use consumption taxes more intensely do have higher tax levels, and lower output. Section 10 concludes the paper. ľ

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2 Main Features of Our Model

The model used is a standard growth model with heterogeneity across agents in their wealth holdings and/or labor productivity. Agents share the same preferences regarding streams of consumption and leisure. Interactions between agents every period determine the policy in place for the following period.⁶

The mechanism determining what policies are chosen is representative of the politicaleconomy literature based in 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 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 deadweight 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.^{7,8} 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.

Another key feature that we introduce into the model is valued leisure. Most models that use a political-economy approach with endogenous taxation abstract from it, but we consider

⁶In Krusell & 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.

⁷Several studies assume that the proceeds from taxation are redistributed as lump-sum transfers. Examples include King & 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 & 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 & O'Higgins (1981a) for the United States. Ruggles & O'Higgins (1981b) for the United Kingdom and Saunders & Klau (1985) for the OECD countries).

⁸As 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.

its inclusion important for three reasons: (i) it allows us to explicitly differentiate between labor and capital income taxation (without leisure, labor income taxation can be costlessly increased without bound); (ii) it has quantitatively more interesting implications for the level of taxation; and, as we will see, (iii) it is necessary for deriving interesting differences between tax systems, since in economies inhabited by agents who do not care about leisure there is in a certain sense an equivalence between income and consumption taxes.

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

3 The Model

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Agents are indexed by their type $i \in \mathcal{I} \equiv \{1, \dots, I\}$, with respective fractions given by μ_i . The per-period utility function is given by u(c, l), 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 \mathcal{E}_i efficiency units of labor. They also hold assets in amounts given by a_i .⁹ 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 $A = \{A_i\}_{i \in \mathcal{I}} \in \mathcal{R}^I$, and the distribution of efficiency units of labor with $\mathcal{E} = \{\mathcal{E}_i\}_{i \in \mathcal{I}} \in \mathcal{R}^I$. Efficiency units of labor provided to the market, i.e. the labor input, which are given by $N_t = \sum_i \mu_i \mathcal{E}_i (1 - l_{it})$, combine with aggregate capital, given by $K_t = \sum_i \mu_i A_{it}$, 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 non-human wealth. We assume competition in factor markets which determines the net-of-depreciation rental price of capital r_t and the wage per efficiency unit of labor w_t .

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 $c_{it}(1 + \tau_t^c) + a_{i,t+1} = r_t a_{it} + (1 - l_{it})\mathcal{E}_i w_t + a_{it} + tr_{it}^c$; (ii) a proportional tax on total income only, which results in a period budget constraint given by $c_{it} + a_{i,t+1} = (r_t a_{it} + (1 - l_{it})\mathcal{E}_i w_t)(1 - \tau_t^y) + a_{it} + tr_{it}^y$, where τ_t^c , and τ_t^y are the tax rates for consumption and income and tr_t^c and tr_t^y are the respective transfers. Labor and capital taxation are also considered, and they involve straightforward adjustments to the above budget constraints.

To solve the problem of the agents, not only processes for prices, but also processes for tax rates and for transfers, have to be specified.

3.1 Equilibria

We follow Krusell & Ríos-Rull (1994) and concentrate on stationary Markov equilibria. This is accomplished by representing equilibria with recursive forms, and this representation

⁹As 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.

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 non-human wealth, $A \in \mathbb{R}^{\mathbb{Z}}$, and the tax rate inherited from the past, which is generically denoted by τ . We now describe these steps in detail for the case of income taxes and lump-sum transfers. The analysis for other tax systems is similar. Ł

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3.1.1 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:

$$v_{i}(A, \tau, a; \Psi) = \max_{c, a', l} u(c, l) + \beta v_{i}(A', \tau', a'; \Psi) \quad \text{s.t.} :$$
(1)

$$a' = a + (a \tau (A, N) + (1 - l) \mathcal{E}_{i} w (A, N)) (1 - \tau) + tr - c,$$

$$tr = \tau [f (A, N) - \delta \sum_{j} \mu_{j} A_{j}],$$

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

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

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

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:

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

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

3.1.2 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.

$$\tilde{v}_{i}(A, \tau, \tau', a; \Psi) = \max_{c, a', l} u(c, l) + \beta v_{i}(A', \tau', a'; \Psi) \quad \text{s.t.:}$$

$$\begin{aligned}
a' &= a + (a r(A, N) + (1 - l) \mathcal{E}_{i} w(A, N)) (1 - \tau) + tr - c, \\
tr &= \tau [f(A, N) - \delta \sum_{j} \mu_{j} A_{j}], \\
A' &= \tilde{H}(A, \tau, \tau'; \Psi), \\
N &= \tilde{N}(A, \tau, \tau'; \Psi).
\end{aligned}$$
(4)

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:

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

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

3.1.3 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

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

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. $\Psi = \psi$.

In what follows we will not look at all possible combinations of distributions of wealth and skills, but at a subset which allows us to apply the median voter theorem—in the cases that we look at the two dimensions of heterogeneity effectively reduce to one. These are situations where agents have the same labor efficiency but different wealth; the same nonhuman wealth but different labor efficiency; and a situation where all agents have the same ratio of human to non-human wealth.

4 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 econ-

order to evaluate their preferences.¹⁰

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omy 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:

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

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

It is easy to see that equal distribution and zero taxes is a steady state by noting that associated with any positive 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 & 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 level of output is not independent of the distribution of wealth. However, the distribution of wealth only matters by affecting the distribution of work effort across agents. In general, agents with higher wealth will work less than those with lower wealth, and this is the channel through which steady states are affected: different distributions of wealth, A, will imply different levels of the aggregate amount of the labor input. For standard preferences these differences are, however, small; in fact, with the Cobb-Douglas preferences we use below the total amount of work effort is independent of the distribution. Therefore, the locus of wealth distributions compatible with a steady state with a constant tax is an I - 1-dimensional hyperplane described by the equation $\sum_i \mu_i A_i = \hat{K}_i$, where \hat{K} is the amount of capital that yields an after-tax marginal productivity equal to the discount rate. When I = 2, this hyperplane defines a line with slope equal to $-\mu_1/\mu_2$. In the economies studied in this paper, the role for distribution of the government dramatically affects the selection of taxes, and therefore also the distribution of wealth. One way of illustrating the extent of this effect is to point out that the set of steady states in the 2-agent case gives a slope of the local linear approximation around the equal-distribution, zero-tax steady state which is *positive* (i.e. far from $-\mu_1/\mu_2$).

The fact that the set of steady states is large is important in our quantitative section in the sense that we need to decide what types of distributions to look at. In particular, steady states with exogenous taxes allow any correlation between asset holdings and labor income. We will typically consider three cases: one where the correlation is +1, and two where it is zero.

¹⁰In Krusell & Ríos-Rull (1994) there is a detailed description of this issue. ¹¹That analysis follows Ch. tage: (1004)

¹¹That analysis follows Chatterjee (1994).

5 Calibration

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From here on, our analysis is quantitative. This implies that we posit functional forms for preferences, technologies and certain properties of the wealth distribution. Furthermore, we give parameter values to those functional forms based on steady-state properties of the U.S. economy. For preferences and technology we follow the real-business-cycle tradition. Our growth model is very simple, and the growth aspects of the calibration are not, we hope, controversial; the calibration of the wealth distribution, however, raises new issues. We consider three different cases concerning the relation between the distribution of wealth and the distribution of labor efficiency. This methodology was chosen so as to avoid possible problems with voting cycles that could occur by obtaining non-monotone preferences over tax rates. The distributions we consider include: (1) equal labor efficiency and differences in non-human wealth; (2) equal non-human wealth and differences in labor efficiency; and (3) the same ratio of non-human 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.

We postulate CRRA per-period utility functions 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. The expression for the utility function is:

$$U = \sum_{t=0}^{\infty} \beta^t \frac{\left(c_t^{\alpha} l^{1-\alpha}\right)^{1-\sigma} - 1}{1-\sigma}$$

We consider taxes to be chosen one period in advance, and we select the length of the period to be four years. See Krusell & 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 & Ríos-Rull (1994) analyzes a number of such cases in more detail.

6 A Quantitative Comparison of Tax Systems

We now start the quantitative analysis based on the computation of equilibria for the economies described in the calibration above.¹²

6.1 Steady-state snalysis

Tables 2, 3, and 4 show the steady state levels of taxation and aggregate output for a variety of economies that differ in the relative composition of human and non-human wealth among households. We report the steady-state tax rates and levels of output for different tax

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¹²We 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.

systems (income taxes, consumption taxes, labor income taxes, and capital income taxes) and wealth distributions. 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.¹³

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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.

In Table 2 we consider economies where all agents have the same ratio of human to nonhuman wealth, while in the other two cases all agents have either the same labor efficiency or the same amount of non-human wealth. The economy with positive correlation between human and non-human wealth should be the most empirically relevant case. In this economy, all agents choose the same amount of work effort. Table 2 reports the main results for this case:

- 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 a higher level of taxation for consumption taxes than for labor taxes, and hence leads to a lower steady-state output level.
- If capital income taxation is the only way to generate transfers, then small differences in wealth across agents generate large levels of taxation and of distortion.¹⁴

In economies where agents have different ratios of human to non-human 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 non-median agents.¹⁵ As a result, the income of the median agent has a higher share coming from capital than that of the non-median agent. This means that the relative price changes that are an outcome of lower

¹³We 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.

¹⁴With our computational methods this leads to problems when the wealth differences are substantial; we use-linear-quadratic approximations and cannot impose non-negativity constraints such as one on investment. Such constraints are likely to be binding in these cases.

¹⁵This result is special to the type of preferences that we consider.

aggregate capital—an increase in the rental rate of capital relative to the wage rate—benefit the median agents. Table 3 shows the steady-state values for output and taxation for these economies. A summary of the findings is as follows:

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- All levels of taxation are lower than in the economies where all agents have the same ratio of human to non-human 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 non-human 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, the 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? The reason is very much the same as the one that leads a large country to want non-zero tariffs: the associated 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.

In our third case agents have the same labor efficiency but differ in non-human wealth, and here the median agents (the poor agents) work more than the non-median 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 from a lower aggregate capital stock benefits the non-median agents. Table 4 shows 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.
- The level of labor income taxation is 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 non-human 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. The level of taxation is an increasing function of the concentration of income. This property holds for all tax systems and all sources of income differentials.¹⁶

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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.¹⁷

6.2 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 the level of taxation is 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 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 non-human wealth. Table 5 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.

6.3 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 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

¹⁶For economies with all agents having the same labor efficiency and different wealth shown in Table 4, labor taxes are negative. Here, the absolute value of the tax rate is increasing with income concentration.

¹⁷As stated, this is not-true for economies where agents have the same non-human 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.

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 6 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. The losses are larger for the non-median (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 non-human wealth, the median agents realize small welfare losses, while the non-median agents are better off after the change in tax system. However, when the ratios of human to non-human wealth are different across types the welfare of the median agent improves with the change.

The second part of Table 6 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 non-median agents, except for the case when agents have the same labor efficiency but different non-human wealth: then, both agents gain from changing tax systems.

Finally, the third part of Table 6 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 non-human wealth: here there is a negligible gain for the median).

We summarize these findings as follows:

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- 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 non-human 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 non-human 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 2-agent case).

7 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 2-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. Ł

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7.1 Steady-state analysis for systems with two taxes

In Table 7 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 non-human wealth (parts 1 and 3 of Table 7), we have higher income subsidies (a negative income tax with a higher absolute value) than when agents have the same non-human 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 ratios of human to non-human 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 gains 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 7), 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, non-zero income taxes have a pure distortionary role.

- The highest transfers occur in the economy where agents have identical ratios of human to non-human wealth (part 1 of Table 7), followed by the economy where agents have the same non-human wealth but different labor efficiency (part 2 of Table 7), and, finally, by the economy where agents only differ in non-human wealth (part 3 of Table 7). 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 seems 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 & Buchanan (1977)'s general proposition that the more efficient the government, the worse the resulting economic performance), 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 6.3.

7.2 Welfare analysis

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7.2.1 Switching from a one-tax to a two-tax system

Table 8 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 non-human 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, there 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 non-human 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 non-human wealth, the median agents gain and the non-median 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 8 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. ŀ

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Regarding the substitution of labor taxes with the combination of consumption and income taxation, Table 8 shows that all agents lose (except the median agents in the case of an equal ratio of human to non-human wealth), but the improvements are quantitatively small.

7.2.2 Switching from a two-tax to a one-tax system

Table 9 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.

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 effects on the welfare of the non-median 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 non-human wealth; in this case the non-median agents are also worse off).¹⁸

8 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 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.¹⁹

8.1 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

¹⁸As 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.

¹⁹For-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.

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 $u(c, g, l) = \frac{[(c+\pi g)^{\alpha} l^{1-\alpha}]^{1-\sigma}}{1-\sigma}$, where c is private consumption, g public expenditures, l leisure, and $\pi \in [0, 1]$ is an index of efficiency of the public sector.²⁰

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 non-human 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 more expanded the public activity, and the worse the aggregate performance of the economy due to higher distortionary taxes.²¹

8.2 Public provision of public goods

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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 non-human 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 $u(c, g, l) = \frac{[c^{\alpha_1}g^{\alpha_2}l^{1-\alpha_1-\alpha_2}]^{1-\sigma}}{1-\sigma}$. 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 non-human 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

²⁰A discussion of a variety of formulations for how public goods affect the economy and their macroeconomic effects can be found in Aschauer & Greenwood (1985). Examples of studies using this particular specification are Aschauer (1985) in testing the Ricardian Proposition, Christiano & 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.

²¹Of course, this does not translate into utility terms since the fact that publicly provided goods are more efficient in generating utility in the case with an efficient government.

provide and the political problem turns into a pure optimal-taxation problem: the best taxes are the least distortionary taxes.

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When the ratios of human to non-human 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 optimaltaxation analysis.

If preferences are not Cobb-Douglas over the public good, as in the case $u(c, g, l) = \frac{[c^{\alpha}l^{1-\alpha}]^{1-\sigma}}{1-\sigma} + \psi(g)$, where c is private consumption, l leisure, g public spending, and $\psi(\cdot)$ is strictly increasing and concave.²² Now the agent's preferences over the optimal level of taxation, and thus the optimal provision of the public good, depends 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 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.²³ 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.²⁴

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

 $^{^{22}}$ 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, & Eichenbaum (1992). Jones et al. (1993, sec. II and III), Chari et al. (1994).

²³For example, Aschauer (1989) provides some empirical evidence for this hypothesis: he shows that the stock of non-military 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 & Rodrik (1994).

²⁴ If $\theta + \gamma \ge 1$, then the model allow endogenous growth.

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.

9 Some Properties of the Data

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As partial empirical support of our findings, we present two types of evidence. Table 10 shows how the size and composition of government revenues due to consumption and to income taxes relate to the level of output. In this table, we report the cross-correlations for per-capita GDP, the ratio of total tax revenue to GDP, the ratio of income taxation (including social security) to GDP, the ratio of consumption taxation to GDP, and the shares of government revenue due to income and to consumption taxation. The correlations are computed from a cross-section of OECD countries in 1985. In the table we see that the importance of income taxation is positively related to output, both measured as the ratio of total income and as a ratio of tax revenue. The relative importance of consumption taxation is negatively related to the level of output, again both when measured as a ratio to public revenues and as ratio to output. The relation between the level of taxation and output is, however, negative, even though our model is constructed to have the opposite property.

The other piece of qualitative evidence which can be brought forth in support of our present findings is the fact that changes in taxation systems are relative infrequent, while changes in the tax rates are much more frequent. For example, income taxes once instituted have never been removed, and the U.S. has never had a federal consumption tax.

10 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 rebates 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. 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 results also hold 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.

Finally, we have that some elements of cross-country data support our theoretical findings: there is a positive correlation of the level of per capita output across OECD countries and the share of government revenues coming from income taxation.

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Country	Income Tax	Social Security	Cons. Tax	GDP per capita
			00 5	0050
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
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Table 1: Taxation as a percentage of total tax revenue in the OECD countries: 1985.

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	Median Wealth/Average Wealth								
	0.99	0.95	0.90	0.85	0.67				
	Median L	Median Labor Efficiency/Average Labor Efficiency							
	0.99	0.95	0.90	0.85	0.67				
Income					[]				
- Tax Rate	1.253%	6.023%	11.502%	16.527%	32.111%				
- Ontput	98.738%	93.879%	88.191%	82.879%	65.872%				
Consumption									
- Tax Rate	1.973%	10.272%	21.639%	34.204%	88.210%				
- Output	98.620%	93.211%	86.699%	80.483%	61.525%				
Labor									
- Tax Rate	1.320%	6.388%	12.287%	17.764%	35.019%				
- Output	99.060%	95.385%	90.966%	86.719%	72.355%				
Capital	i i								
- Tax Rate	4.664%								
- Output	98.582%								

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Table 2: Endogenous cash transfers: steady-state tax rates and output when all agents have the same ratio of human to non-human wealth.

[Median Wealth/Average Wealth							
	1.00	1.00	1.00	1.00	1.00			
······	Median L	Median Labor Efficiency/Average Labor Efficiency						
	0.99	0.95	0.90	0.85	0.67			
Income								
- Tax Rate	1.161%	5.629%	10.854%	15.730%	31.304%			
- Output	98.830%	94.284%	88.870%	83.727%	66.770%			
Consumption								
- Tax Rate	1.418%	7.248%	14.922%	23.079%	58.280%			
- Output	99.004%	95.112%	90.433%	85.938%	70.763%			
Labor								
- Tax Rate	1.398%	6.758%	12.985%	18.753%	36.826%			
- Output	99.004%	95.112%	90.432%	85.937%	70.758%			
Capital			1					
- Tax Rate	1.457%	7.111%	13.811%					
- Output	99.565%	97.805%	95.551%					

Table 3: Endogenous cash transfers: steady-state tax rates and output when all agents have the same wealth but differ in labor efficiency.

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	Median Wealth/Average Wealth					
	0.99	0.95	0.90	0.85	0.67	
	Median	Labor Effic	iency/Avera	ige Labor E	fficiency	
	1.00	1.00	1.00	1.00	1.00	
Income						
- Tax Rate	0.095%	0.469%	0.925%	1.369%	2.896%	
- Output	99.904%	99.527%	99.068%	98.621%	97.074%	
Consumption						
- Tax Rate	0.545%	2.775%	5.676%	8.720%	21.554%	
- Output	99.614%	98.070%	96.131%	94.178%	86.744%	
Labor		}			}	
- Tax Rate	-0.078%	-0.393%	-0.788%	-1.184%	-2.264%	
- Output	100.055%	100.278%	100.557%	100.836%	101.862%	
Capital						
- Tax Rate	3.228%	16.717%	((
- Output	99.027%	94.510%			<u> </u>	

Table 4: Endogenous cash transfers: steady-state tax rates and output when all agents have the same labor efficiency but differ in wealth.

· · · ·	Median Wealth/Average Wealth							
	0.99	0.95	0.90	0.85	0.67			
	Median L	Median Labor Efficiency/Average Labor Efficiency						
	0.99	0.95	0.90	0.85	0.67			
Income								
- Tax Rate	1.253%	6.023%	11.502%	16.527%	32.111%			
- Output	100.00%	100.00%	100.00%	100.00%	100.00%			
Consumption								
- Tax Rate	1.250%	5.933%	11.090%	15.510%	26.176%			
- Output	100.39%	102.22%	105.12%	108.70%	128.04%			
Labor	ļ							
- Tax Rate	1.525%	7.321%	13.961%	20.039%	39.152%			
- Output	100.18%	100.87%	101.69%	102.45%	104.25%			
Capital								
- Tax Rate	6.782%	29.198%	50.595%	70.265%	1			
- Output	99.16%	95.37%	88.90%	76.40%				

Table 5: 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 non-human wealth.

	Same ratio of human to non-human wealth $\frac{A_m}{A_2} = 0.85, \frac{\varepsilon_m}{\varepsilon_2} = 0.85$	Same wealth, different efficiency $\frac{A_m}{A_a} = 1, \frac{\varepsilon_m}{\varepsilon_a} = 0.85$	Same efficiency, different wealth $\frac{A_m}{A_a} = 0.85, \frac{\varepsilon_m}{\varepsilon_a} = 1$
Income Tax			<u></u>
Replaced with			
Concumption Tax	ļ]
- Median Agent	0.05%	0.03%	0.10%
- Non-Median Agent	1.98%	0.21%	0.29%
Labor Tax			
- Median Agent	0.01%	-0.10%	-0.00%
- Non-Median Agent	-0.40%	0.04%	-0.01%
Concurrention Tox	<u> </u>	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·
Replaced with	I. 		
Income Tax			
- Median Agent	0.38%	0.19%	-0.06%
- Non-Median Agent	-2.10%	-0.24%	-0.26%
Labor Tax			a
- Median Agent	0.51%	0.21%	-0.06%
- Non-Median Agent	-2.35%	-0.14%	-0.27%
Labor Tax	<u> </u>	<u> </u>	<u></u>
Replaced with			
T m	4) 	1	
Income Tax	0.000/	0.1967	0.00%
- Wiedian Agent	-0.00%	0.12%	0.00%
- Non-Median Agent	0.3970	-0.0070	0.0070
- Median Agent	0.02%	0.07%	0.04%
- Non-Median Agent	1.20%	0.05%	0.13%

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Table 6: 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.

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

	Median Wealth/Average Wealth					
	0.99	0.95	0.90	0.85		
	Median La	bor Efficien	cy/Average	Labor Efficiency		
	0.99	0.95	0.90	0.85		
Cons. Tax Rate	4.001%	21.037%	44.872%	71.876%		
Income Tax Rate	-2.013%	-10.110%	-20.354%	-30.772%		
Output	99.218%	96.078%	92.134%	88.198%		
Transfer/Output	1.545%	8.428%	18.730%	31.126%		
	ļ					
<u></u>	N	ledian Weal	th/Average	Wealth		
	1.00	1.00	1.00	1.00		
	Median La	Labor Efficiency				
	0.99	0.95	0.90	0.85		
Cons. Tax Rate	1.417%	7.244%	14.915%	23.072%		
Income Tax Rate	0.001%	0.004%	0.006%	0.007%		
Output	99.004%	95.111%	90.431%	85.936%		
Transfer/Output	1.105%	5.648%	11.629%	17.987%		
]			
	Ň	Iedian Weal	lth/Average	Wealth		
	0.99	0.95	0.90	0.85		
	Median La	bor Efficien	icy/Average	Labor Efficiency		
	1.00	1.00	1.00	1.00		
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Cons. Tax Rate	2.556%	13.208%	27.494%	42.964%		
Income Tax Rate	-2.023%	-10.350%	-21.321%	-32.989%		
Output	100.217%	101.031%	101.936%	102.734%		
Transfer/Output	0.416%	2.203%	4.711%	7.541%		
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Table 7: Steady states for economies with cash transfers and two taxes available.

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Both Taxes Replace	Same ratio of human to non-human wealth $\frac{A_m}{A_a} = 0.85, \frac{\xi_m}{\xi_a} = 0.85$	Same wealth, different efficiency $\frac{A_m}{A_a} = 1, \frac{\mathcal{E}_m}{\mathcal{E}_a} = 0.85$	Same efficiency, different wealth $\frac{A_m}{A_a} = 0.85, \frac{\varepsilon_m}{\varepsilon_a} = 1$
Income lax			0.110/
- Median Agent	0.01%	-0.00%	
- Non-Median Agent	1.29%	0.27%	0.45%
Consumption Tax			
- Median Agent	-0.14%	0.00%	-0.04%
- Non-Median Agent	-0.92%	0.00%	0.12%
Labor Tax		1	
' - Median Agent	-0.01%	0.12%	0.09%
- Non-Median Agent	1.84%	0.19%	0.47%

Table 8: Welfare losses as percentage-of-consumption flows when the economy switches from a steady state with one type of tax to a system with both consumption and income taxes.

Both Taxes Are Replaced with	Same ratio of human to non-human wealth $\frac{A_m}{A_a} = 0.85, \frac{\mathcal{E}_m}{\mathcal{E}_a} = 0.85$ Same wealth different effici 		Same efficiency, different wealth $\frac{Am}{A_{\sigma}} = 0.85, \frac{\varepsilon_m}{\varepsilon_a} = 1$
·			
Income Tax			
- Median Agent	1.50%	0.20%	0.59%
- Non-Median Agent	-1.12%	-0.24%	-0.27%
Consumption Tax*			
Median Agent	0.05%	0.00%	0.05%
- Non-Median Agent	0.13%	0.00%	-0.01%
Labor Tax			
- Median Agent	1.69%	0.21%	0.58%
- Non-Median Agent	-1.29%	-0.14%	-0.25%
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Table 9: Welfare losses as percentage-of-consumption flows when the economy switches from a steady state with both consumption and income taxes to a one-tax system.

*Computational difficulties in this case led us to using ratios of 0.95 rather than 0.85 for the three consumption cases.

	<u>TotTax</u> GDP	<u>IncTax</u> GDP	$rac{Tax}{GDP}$	GDP	<u>IncTax</u> TaxRev	<u>ConsTax</u> TaxRev
$\frac{T_{ot}Tax}{GDP}$	1.000					
$\frac{IncTax}{GDP}$	0.820	1.000				
$\left \begin{array}{c} ConsTax \\ GDP \end{array} \right $	0.554	0.082	1.000			
GDP	0.459	0.512	-0.048	1.000		
$\frac{IncTax}{TaxRev}$	0.201	0.692	-0.610	0.365	1.000	
<u>ConsTax</u> TaxRev	-0.051	-0.528	0.777	-0.419	-0.931	1.000

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Table 10:

Tax, revenue, and output correlations in the OECD Countries: 1985. Source: Revenue Statistics of OECD Member Countries, OECD, Paris, 1991, and Summers & Heston (1991).

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