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The Politics of Flat Taxes

Daniel R. Carroll, Jim Dolmas, and Eric R. Young

We study the political determination of flat tax systems using a workhorse macroeconomic model of inequality. There is significant variation in preferred tax policy across the wealth and income distribution. The majority voting outcome features (i) zero labor income taxation, (ii) simultaneous use of capital income and consumption taxation, and (iii) essentially zero transfers. This policy is supported by a coalition of low- and middle-wealth households. Zero labor income taxation is supported by households with below average wealth, while the middle-wealth households prefer to keep the transfer (and thus other tax rates) low. We also show that the outcome is sensitive to assumptions about the voting power of household groups, the degree of wealth and income mobility, and the forward-looking nature of votes.

Keywords: Political Economy, Essential Set, Voting, Inequality, Incomplete Markets.

JEL Codes: D52, D72, E62.

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1 Introduction

“Don’t tax you, don’t tax me, tax that fellow behind the tree.” - Russell B. Long

Our goal in this paper is to understand the political selection of flat tax systems. We use the workhorse macroeconomic model of Aiyagari (1994), extended to include an array of fiscal instruments and elastic labor supply. We then ask which tax system would be selected at time zero, conditional on a fixed initial distribution and taking into account the transitional dynamics. The specific systems we permit allow for differential flat tax rates on labor and capital income as well as on consumption, with a time-varying lump-sum transfer. That is, our policy space is inherently multidimensional.

This multidimensionality poses a problem for some political economy mechanisms, especially those that rely on the median voter theorem; in general, Condorcet winners do not exist in more than one dimension. Moreover, we cannot appeal to a single-crossing property because households in our model differ along two dimensions (labor productivity and wealth) and cannot be ordered according to their preferences over taxes.

We present two solutions to this problem. First, following a large literature, we investigate the taxes that survive under probabilistic voting. With probabilistic voting, agents experience a random “non-economic” shock and candidates attempt to maximize the expected number of votes they receive; the resulting equilibrium maximizes a social welfare function, which allows us to easily characterize the outcomes.

However, one may be concerned (and rightly in our opinion) that non-economic shocks put little discipline on outcomes. We show that the model’s prediction is quite sensitive to the assumed distribution of these non-economic shocks. For this reason, we also consider a generalized solution concept to the Downsian voting game (pairwise competition) that permits set-valued solutions. Specifically, we consider the uncovered set from McKelvey (1986), which contains the strategies that survive under agenda setting and sophisticated voting (that is, what strategies could be implemented under some assumption about the order of votes). If the uncovered set is a singleton, then that policy is a Condorcet winner.

We find that our benchmark probabilistic voting case and the uncovered set approach deliver similar outcomes. For convenience, since the outcomes are the same, we will refer the outcome of the probabilistic voting process as the Condorcet winner. We will also discuss the outcomes in terms of the policy game; we hope that the reader will not be confused by this switch, as we think it clarifies the political aspects of our study.

We first list our three main results, then discuss the features of the model that are crucial for obtaining them. First, we find a Condorcet winner: at least up to a fairly fine grid approximation, outcomes are unique, and any variation we miss due to the discrete approximation is small enough that it has no economic consequences. Second, the Condorcet winner chooses to set labor income taxes to zero, relying on a combination of capital income and consumption taxes. And third, the Condorcet winner sets lump-sum transfers to zero in the long run, after one period of positive transfers. These results arise as a combination of three factors: the shape of the initial distribution (in terms of income source and the marginal propensity to consume), the mobility of earnings and wealth of agents (how quickly the poor become the middle class), and the patience of agents (how forward-looking their voting behavior is).

Why do we obtain a Condorcet winner? In a model with a small number of types, one can in principle assemble a majority in many different ways. If those majorities can be assembled using types with very different preferred tax systems, then the range of equilibrium outcomes can be large. Thus, an agenda setter, by properly sequencing votes, can obtain very different equilibrium policies. Our model endogenously delivers a large number of types, but the measure of these types is such that effective majorities cannot be constructed that prefer very different outcomes: the winning coalition must include the middle class, who, in general, prefer the same kinds of taxes as the poor. The rich are quite different but insufficiently numerous to win, even though our model somewhat understates

the measure of rich agents.¹

Why does the Condorcet winner have zero labor taxes? Here, patience and mobility play an important role. Our vote is once-and-for-all, meaning that once in place the taxes cannot be changed. Even without commitment, the currently “middle class” are reluctant to tax labor income since that is their primary source of income (labor’s share of total income in our model is 0.64, and is higher for most agents and lower for the very wealthy). With commitment, even the poor become reluctant to tax labor income, as they anticipate their wages will rise (due to mean reversion in idiosyncratic productivity) and they place a relatively high weight on future periods (due to the low discounting needed to match the aggregate wealth-income ratio). Only the currently wealthy wish to impose labor taxes as they do not work, but these agents are not sufficiently numerous to win. Furthermore, even the non-working wealthy do not like very high labor taxes, because these taxes reduce the return to capital. If we relax the constraint that labor income taxes cannot be negative, we find that the winning policy generates a rather large subsidy on labor income.

Why does the Condorcet winner choose both capital income and consumption taxes? Both taxes attack the inelastic initial distribution of capital, meaning that they are attractive to the initially poor. The consumption tax, however, is regressive: it affects the initially poor more than the initially wealthy because the marginal propensity to consume is higher for the poor. As a result, voters are reluctant to impose high consumption taxes. In contrast, the capital income tax is progressive, but has negative long-run effects by reducing wages; as with labor income taxation, most voters oppose low wages. The result is a compromise that is reminiscent of the theory of the second best (Lipsey and Lancaster (1956)), where all instruments are used a little rather than one instrument a lot. Again, the lower bound on the labor income tax rate plays a role here: with subsidies, the consumption tax rate blows up and capital taxes move close to zero.

¹In the appendix we show that it does not require very many types for the range of outcomes to be heavily restricted; specifically, going from four types to nine types in Dolmas (2008) is sufficient to get (nearly) a Condorcet winner.

Why does the Condorcet winner choose zero transfers in the long run? Again, patience and mobility are crucial. Similar to labor taxes, transfers are limited by the expectation of the poor that they will be middle class in the near future. The middle class pays more in taxes than they receive in transfers (in general), and therefore, they oppose a transfer; many of the poor agree since they expect to be middle class soon. The wealthy are, of course, also opposed, since they will pay more in taxes than they receive in transfers. Note that zero transfers are chosen despite the presence of substantial market incompleteness and wage risk; as a result, the distribution of wealth changes very little over the transition.² As with the previous two results, relaxing the prohibition on subsidizing labor income changes the outcomes: now the transfer is quite large.

We conduct experiments designed to illuminate results two, three, and four. First, we examine a version of the model with wage risk shut down: there is still heterogeneity, but it is now time-invariant.³ As shown in Chatterjee (1994) and Krusell and Ríos-Rull (1999), the resulting model has no mobility; if one household is initially wealthier than another, they remain so forever.⁴ In this case, we find that transfers increase substantially, with the concomitant increase in capital income and consumption taxes, but labor income taxes remain zero. Furthermore, if we impose the condition that income taxation must be uniform – the only available choices tax capital and labor at equal rates – we get complete dependence on consumption taxation. Finally, we study a version where agents vote “myopically”; their economic decisions are made using one discount factor, while their votes are evaluated using a lower one. The result is that transfers again rise, but labor income taxes are still zero. Thus, we conclude that the zero labor tax result is very robust and is driven by the shape of the initial distribution, while the zero transfer result is more

²Davila et al. (2012) show that significant welfare gains are available to a planner that cannot transfer resources between agents.

³Note that this setup is not quite equivalent to complete markets, as under complete markets leisure would fluctuate with wages but the agent would be compensated with consumption via contingent claims. Since labor supply is convex, Jensen’s inequality implies that some small differences emerge in total labor input.

⁴This result is not general; see discussions in Caselli and Ventura (2000) or Carroll and Young (2011).

fragile and depends critically on mobility and patience.

Since mobility is important for understanding our results, we turn to confronting our model with some facts. Using the PSID we estimate mobility for both earnings and wealth across quintiles over five-year horizons (as in Budría et al. (2002)). Our model overstates the amount of mobility for earnings and understates it for wealth over five-year horizons, but the support for the Condorcet winner is strong enough that a closer fit would be unlikely to change the result. Furthermore, the quintiles for which the deviations are largest are the top and bottom; under equal-weighted voting these groups are not decisive.⁵

We then study how outcomes would differ under “wealth-weighted” voting; as in Bachmann and Bai (2013), we assume that wealthier agents effectively have “more votes” than poorer agents. Here, we find that labor income taxes win: as votes become more concentrated in wealthy agents, consumption and capital income taxes are set to zero and labor income taxes are used to finance government spending. Transfers remain zero. This result cements our intuition that the initial distribution is key for the zero labor tax result (this result is the same if subsidies are permitted).

Obviously our experiments have limitations. Our policy space is heavily restricted, for feasibility reasons: we assume that households vote over time-invariant tax systems only, and they vote only once. To explore whether this commitment is crucial, we introduce a revote: at some point along the transition to the new steady state, we allow households to reconsider their tax system. We find that the Condorcet winner continues to win, and this result includes the new steady state as well. There are two reasons for this result. First, the Condorcet winner enjoys very strong support; in fact, it would survive under standard supermajority requirements. Second, the distribution of wealth does not change significantly along the transition, so agents are almost in the same situation as when they started; as a result, the voting outcome is unchanged. Thus, we believe that commitment may not be critical, and given that abandoning it is very computationally burdensome we

⁵Carroll et al. (2016) explore more in-depth the fit between the basic Bewley model and the mobility data. In general, wealth mobility is too low, while here we are more concerned with earnings mobility.

do not explore this extension.⁶

We expect things may change if we expand the vote to permit time-varying tax systems. Dyrda and Pedroni (2018) find that the Ramsey optimal tax plan involves capital and labor income taxes that change over the transition to the new steady state, suggesting that more flexibility in the policy space could give us different answers.⁷ Unfortunately, computational considerations prevent us from exploring this direction at this time (and for the foreseeable future).

1.1 Related literature

Dolmas (2008) is the paper most closely related to this one, as he uses the same solution concepts; we discuss that paper explicitly in the appendix, rather than the main body of the paper, because the underlying economic environment is very different. Some papers that study the politics of multidimensional tax systems, such as Krusell et al. (1996), set up their models to have a single decisive type whose identity is known. Others, such as Bassetto and Benhabib (2006) or Piguillem and Schneider (2013), have multidimensional voting but are able to prove the existence of a Condorcet winner; in effect, their models reduce to a single policy dimension and the median voter theorem applies. None of these papers have mobility, which is key for obtaining the analytical results.

We want to mention several papers that study political outcomes in the Aiyagari (1994) framework (and therefore have mobility). We have already mentioned Bachmann and Bai (2013), who examine how the government determines the supply of public goods. Corbae et al. (2009) study how a majority voting would select an income tax/lump-sum transfer system and how that choice changes in response to rising idiosyncratic labor income risk. Aiyagari and Peled (1995) also study voting equilibria in a model of idiosyncratic risk, but

⁶Multiple equilibria may be an issue without commitment, in the sense that the uncovered set for the current vote may be affected by beliefs about the uncovered set of future votes.

⁷Dyrda and Pedroni (2018) also permit the government to accumulate assets or issue debt, which has implications for the speed and direction of tax changes. The point we make here is merely that constant taxes are unlikely to be the preferred choice of any type.

they assume the economy instantly transits to the terminal steady state. All of these papers have single-dimensional policy spaces, so that they can apply the median voter theorem if preferences are single-peaked (which is difficult to verify in general).

A number of other papers study political outcomes in the growth model. Rather than exhaustively list them here, we just note that our paper seems to be the only one that combines multidimensional voting with mobility and non-trivial decisive voter types.⁸

2 Model

The model economy is populated by a continuum of *ex ante* identical, infinitely lived households as in Aiyagari (1994). Each household receives an uninsurable shock ε to its wage in each period, which follows the process

$$\log(\varepsilon') = \rho \log(\varepsilon) + \sigma \zeta'$$

with $\zeta \sim N(0, 1)$ (primes denote next period values); these shocks are uncorrelated across individuals, implying that the distribution of ε can be assumed constant over time.⁹ Each period households choose how much to consume, c , how many claims, k' , to the capital stock to purchase, and how many labor hours to supply (possibly zero). They pay taxes on their consumption, capital income net of depreciation, and labor income at rates $\tau_{c,t}$, $\tau_{k,t}$, $\tau_{\ell,t}$, respectively, and receive a lump-sum transfer T_t that clears the government budget constraint each period.

The initial tax rates are assumed to have been set at some point in the infinite past so that the economy begins in a steady state. At time $t = 1$, we allow households to vote, once-and-for-all, for a permanent change in rates that will take effect in periods $t = 2, \dots, \infty$.

⁸DeDonder (2000) also studies tax system determination using multi-valued solution concepts and finds, as we do, that the uncovered set is small (although he does not have a Condorcet winner in general). However, his model is static, so capital income taxation is not distortionary, and his parameters are not calibrated to match any cross-sectional facts. In contrast, our model is fully dynamic and we are explicit about the connection between our parameters and US data.

⁹We invoke an appropriate law of large numbers, such as the one from Sun (2006)

When evaluating any candidate tax policy, households take into consideration their welfare from living through a transition to the final steady state generated under that policy. This means that in any period t the rental rate, r_t , wage, w_t , and transfers, T_t , all depend upon the distribution of wealth, $\Gamma_t(k, \varepsilon)$, which will evolve differently depending upon the tax policy.

We can represent recursively the utility derived from time period t onward arising from a particular tax policy as

$$v_t(k, \varepsilon; \Gamma_t) = \max_{c, h, k'} \left\{ \frac{c^{1-\gamma}}{1-\gamma} + \theta \log(1-h) + \beta E[v_{t+1}(k', \varepsilon'; \Gamma_{t+1}) | \varepsilon] \right\}$$

subject to

$$(1 + \tau_c)c + k' \leq (1 + (1 - \tau_k)(r(\Gamma_t) - \delta))k + (1 - \tau_\ell)w(\Gamma_t)\varepsilon h + T(\Gamma_t); \quad (1)$$

$$c \geq 0; h \geq 0; k' \geq 0; \quad (2)$$

$$\Gamma_{t+1} = \mathcal{H}_t(\Gamma_t), \quad (3)$$

where \mathcal{H}_t is the law of motion for the distribution of individual households. For households with sufficiently high wealth or with sufficiently low productivity, the non-negativity constraint on hours will bind.

The production sector consists of a single firm that operates the technology

$$Y = ZK^\alpha N^{1-\alpha}$$

where Z is total factor productivity, K is the aggregate capital stock, and N is aggregate labor input.¹⁰ The optimal factor demands implicitly satisfy the equations

$$r = \alpha Z \left(\frac{K}{N} \right)^{\alpha-1}$$

$$w = (1 - \alpha) Z \left(\frac{K}{N} \right)^\alpha.$$

The government budget constraint is

$$G + T = \tau_c C + \tau_\ell w N + \tau_k (r - \delta) K,$$

¹⁰ Z facilitates calibration, but otherwise merely serves to normalize units.

where G is wasteful government spending.¹¹

Markets clear if

$$\begin{aligned} K &= \int_k \int_\varepsilon k \Gamma(k, \varepsilon) \\ N &= \int_k \int_\varepsilon \varepsilon h(k, \varepsilon) \Gamma(k, \varepsilon) \\ C &= \int_k \int_\varepsilon c(k, \varepsilon) \Gamma(k, \varepsilon) \end{aligned}$$

and

$$C + K' - (1 - \delta) K + G = Y.$$

2.1 How taxes matter

How a household ranks candidate policies will depend upon how each policy affects its current and future resources. This is encapsulated through utils in $V(\tau; k, \varepsilon)$, and we can think of it as resulting from two effects: the direct effect and the indirect effect operating through changes in equilibrium prices. We discuss each in turn.

2.1.1 Direct effects

Setting aside general equilibrium effects, a household favors tax policies that place the lowest net tax burden on it, where the net tax burden is

$$T - \tau_c c - \tau_k (r - \delta) k - \tau_\ell w \varepsilon h.$$

Households therefore vote for a policy that places a low tax rate on the household's primary income source and a high rate on the other sources. For instance, households with high wealth work fewer hours and thus favor labor income taxes. Asset-poor households, on the other hand, derive most of their income from labor and so prefer to tax capital or consumption instead.

¹¹We abstract from government debt partly for computational reasons and partly due to issues regarding the intertemporal solvency of the government.

2.1.2 General equilibrium effects

In addition to this direct tax consideration, households also take into account how policies indirectly tax them through their effect on equilibrium prices. That is, they internalize the behavioral responses of other agents through substitution effects. The key conditions are the first-order conditions that describe trade-offs between (i) consumption and leisure today and (ii) consumption today and consumption tomorrow.

The intratemporal condition

$$\left(\frac{1 - \tau_{\ell,t}}{1 + \tau_{c,t}} \right) \frac{w_t \varepsilon_t}{c_t^\gamma} \leq \frac{\theta}{1 - h_t}$$

holds with equality when the non-negativity constraint on hours does not bind. Because the ratio $\frac{1 - \tau_{\ell,t}}{1 + \tau_{c,t}}$ can be the same for an infinite number of (τ_c, τ_ℓ) combinations, it can be tempting to view labor taxes and consumption taxes as equivalent. Even in a representative agent environment where there is no wealth effect and labor supply is always positive, the general equilibrium consequences of tax policy can lead to different equilibria even for identical tax ratios. In our environment, the two taxes are equivalent in terms of the substitution effect only for agents that work; for households that supply zero hours, local variations in taxes generate no substitution effect. Furthermore, since households differ in terms of their wealth, the wealth effects are not equivalent. It is easiest to see this point by noting that households that supply zero hours suffer no wealth loss from a labor tax but do lose from consumption taxation. Also, across tax combinations with the same ratio, the differing sizes of their tax bases will generate different levels of revenue and, therefore, transfers.

The intertemporal condition

$$\beta E_t \left\{ \left(\frac{1 + \tau_{c,t}}{1 + \tau_{c,t+1}} \right) \left(\frac{c_t}{c_{t+1}} \right)^\gamma [(1 - \tau_{k,t+1})(r_{t+1} - \delta) + 1] \right\} \geq 1$$

holds with equality if the household holds a positive amount of capital. Here, we see that consumption taxes can act as taxes on gross financial returns, if they fall over time; since

we assume constant taxes, the intertemporal channel is shut down so that consumption taxes act only on initial wealth. Capital income taxes distort the consumption decision by reducing the return to saving and push consumption forward in time for all agents who are not borrowing constrained.

Ultimately, an individual household cares only about changes in r , w , and T that arise through changes in the aggregates C , K , and N . The total effect of individual behavior on these aggregates is unclear because it depends on the stationary distribution of wealth across households, and this distribution is an equilibrium outcome about which we can say little analytically (we know it exists and depends continuously on prices, but that's about all we can say). We therefore move to calibrate and numerically solve the model in order to quantify the cross-sectional distribution of wealth and substitution effects..

3 Calibration

We set a model period to one quarter and choose the parameters of our model to match some facts about the US economy. Specifically, we target a capital/output ratio of 12, a government/output ratio of 0.2, an investment/output ratio of 0.15, aggregate hours equal to 0.3, and capital's share of income equal to 0.36, along with a steady state output level of $Y = 1$. Combined with the US tax system of $(\tau_c, \tau_\ell, \tau_k) = (0.064, 0.234, 0.273)$ we obtain a transfer equal to 9.1 percent of GDP, quite close to the value estimated by Krusell and Ríos-Rull (1999). Table 1 presents the structural parameters that give rise to this calibration.

We set $\rho = 0.978$ and $\sigma = 0.0516$, consistent with the values from Floden and Lindé (2001). Thus, wage shocks are very persistent and volatile, leading to significant welfare losses associated with incomplete insurance. Finally, we set $\gamma = 2$.¹²

Our model matches reasonably well the inequality and mobility observed in the US data, but not perfectly. Figures 1a and 1b present the Lorenz curves for earnings and wealth

¹²Setting $\gamma = 1$ did not materially affect our results.

in the US and in the model; while we do not get enough concentration in either, we do relatively well. Tables 2 and 3 show mobility statistics from the model and the data over five-year horizons; again, we do surprisingly well, with clear deficiencies only in the extreme quintiles. In both cases, the model’s main failures involve the extremes of the distribution. Under the benchmark of equal-weighted voting, these failures will not matter significantly, since these extremes will have little mass; under wealth-weighted voting, however, they may play a more significant role.¹³

We solve our model using standard methods. Full details of the solution algorithm can be obtained upon request.

4 Voting over Taxation

Our main experiment is to consider what tax systems are selected by majority vote. Here, we call a tax system a vector $\tau = (\tau_c, \tau_\ell, \tau_k)$ along with a sequence of transfers $\{T_t\}_{t=0}^\infty$ that satisfy the government budget constraint period by period. We only allow tax systems that do not require lump-sum taxation in any period t , including the terminal steady state, so that $T_t \geq 0$ must hold; absent this restriction the decisive voter may select lump-sum taxes that exceed some agent’s ability to pay.¹⁴ Additionally, we also do not permit negative tax rates.¹⁵

4.1 The set of candidate tax policies

The space of candidate policies, \mathcal{P} , is constructed from a non-uniform grid consisting of 4,435 combinations of $(\tau_c, \tau_\ell, \tau_k)$ with τ_c between 0 and 190 percent, τ_ℓ between 0 and 90 percent, and τ_k between 0 and 70 percent. For each candidate, we solve for the terminal

¹³Carroll et al. (2016) explore the mobility implications in more detail.

¹⁴A utilitarian social planner would never select such a policy, but the decisive voter might.

¹⁵Both assumptions are restrictive, as both transfers and labor income are very close to zero in the voting equilibrium. Labor subsidies are the endogenous voting outcome in Azzimonti et al. (2008). We explore labor subsidies in an extension.

steady state and transition path starting from the initial distribution with fixed policy τ^0 . If there is a negative lump-sum transfer in the final steady state or in any period of the transition, then that policy is deemed infeasible and discarded from the policy set. The value functions obtained from solving each transition are used to construct the indirect utility function over tax policy described by equation (4).

4.2 Payoff structure

It is convenient to define the payoff function for a household in state (k, ε) under tax policy τ as

$$V(\tau; k, \varepsilon) = v(k, \varepsilon; \tau). \quad (4)$$

Note that we think of the payoff function as depending on taxes with (k, ε) as parameters, in contrast to the lifetime utility function v , which reverses these variables. We can then define the preference relation $\mathcal{P}(k, \varepsilon)$ by

$$\tau_i \mathcal{P}(k, \varepsilon) \tau_j \Leftrightarrow V(\tau_i; k, \varepsilon) \geq V(\tau_j; k, \varepsilon).$$

Ties are unlikely in our model due to numerical approximation, so we simply ignore them. It is a straightforward use of the Theorem of the Maximum to obtain that V is continuous in τ , which is important for our solution concepts.

Next we characterize the outcome of a “once-and-for-all” majority vote over future tax rates. We begin by initializing the model in the steady state under the tax policy $\tau^0 = (0.064, 0.234, 0.273)$; this vector is the US tax system as described by Carey and Rabesona (2003). A majority vote decides what taxes will be from period $t = 1$ onward. When evaluating the welfare consequences of each potential policy, households include the discounted utility experienced along the transition to the associated terminal steady state.

4.3 Political mechanism

In multidimensional voting games, the existence and uniqueness of equilibria can be problematic; the median voter, which delivers a unique outcome in one-dimensional policy

spaces, requires stringent symmetry conditions in multidimensional ones Plott (1967). We consider two possible mechanisms for resolving these problems. Probabilistic voting, which adds random non-economic utility terms, has the advantage of being intuitive and delivering a unique voting outcome; however, for quantitative models like this one, it has the drawback that the equilibrium outcome may be sensitive to assumptions about the distribution of those non-economic terms. For this reason, we also solve the Downsian electoral game directly, accepting the possibility of multiple equilibria. We implement a method that will uncover the set of all possible equilibria even in complicated environments like sophisticated voting and agenda setting. Nevertheless, in our experiment we find that this set is a singleton: there is a unique tax policy that defeats all others in pairwise competition. Furthermore, this policy is similar to that found under our benchmark parameterization of probabilistic voting. Thus, readers who are not interested in the details of the two solution concepts can safely skip to the discussion of the results.

4.3.1 Probabilistic Voting

Under probabilistic voting, a household’s return from any particular tax policy is a function of two components: an economic term $V(\tau; k, \varepsilon)$ and a “non-economic” one, η . As a result, given a distribution for non-economic preferences, the expected number of votes for each option is continuous. Supposing that the objective of the political candidates is to maximize the probability of winning, this continuity guarantees the existence of an equilibrium.

To implement probabilistic voting, we assume that agents receive an additive shock η_i to the utility of τ_i when voting; that is, the payoff from i is $V(\tau_i; k, \varepsilon) + \eta_i$. Household (k, ε) would vote for policy i over policy j if

$$V(\tau_i; k, \varepsilon) + \eta_i > V(\tau_j; k, \varepsilon) + \eta_j,$$

Supposing η has a logistic distribution with scale parameter ξ , i competing against j will receive an expected vote share equal to

$$2 \int_k \int_\varepsilon \frac{\exp(V(\tau_i; k, \varepsilon))}{\exp(V(\tau_i; k, \varepsilon)) + \exp(V(\tau_j; k, \varepsilon))} \Gamma_0(k, \varepsilon) - 1.$$

The preferred policy maximizes the expected number of votes, evaluated at a symmetric equilibrium $\tau_i = \tau_j$. When the distribution of η is independent of the household state (k, ε) , it can be shown that solving this problem is equivalent to maximizing a weighted utilitarian social welfare function where the weight on each household type is that type’s population share. Notice that the value of ξ does not appear in the vote share; however, ξ can play an important role if it takes different values across household types.

The greater the variance (higher ξ) for a particular household type, the less elastic is their vote share to deviations from their preferred tax policy. If variances differ across the wealth distribution, the weights on types in the welfare maximization objective function are the population weights adjusted downward proportional to the relative variance of each type. The intuition for this is straightforward. High-variance types have a relatively high mass of households that are essentially “locked in” to one of the candidates because their non-economic preference is large. In contrast, types with very low variance vote almost as a bloc. This biases policy toward low-variance types, since, at the margin, a relatively large share of low-variance types can be recruited by moving tax policy toward their ideal at the expense of losing only a small fraction of support from the high-variance types.¹⁶

Unfortunately, little data are available to discipline this parameter. In fact, identifying it in the data would be especially challenging since any approach to uncover non-economic voting preferences would necessarily rely upon the outcome of the vote itself. This instability of equilibria to different assumptions about the non-economic preference structure motivates our exploration of outcomes under Downsian voting.

4.4 Downsian voting

Under Downsian voting, we suppose that politics is a series of pairwise competitions between tax systems. With more than one dimension in the policy space, the median voter theorem generally does not apply.¹⁷ As a result, a Condorcet winner may not exist, and

¹⁶See Persson and Tabellini (2002) for a fuller treatment of probabilistic voting.

¹⁷Plott symmetry (Plott (1967)) is required to guarantee existence, which requires every hyperplane that divides the set of preferred points into equal-sized groups to pass through the same point. Since

therefore, the ordering of the competition may change the outcome (that is, agenda control has value).

To avoid taking a stand on the details of the agenda (in particular, who gets to decide what the agenda is), we use an object from political economy called the **uncovered set**, U . We formally define the uncovered set in Appendix B; however, intuitively a policy, τ , covers another policy, τ' under majority voting, if τ defeats τ' and τ defeats every policy that τ' defeats. The uncovered set is the collection of policies that are not covered.¹⁸ Importantly, the uncovered set contains all policies that are the outcome of some agenda even with sophisticated voting.¹⁹

Solving the multidimensional majority voting problem will reveal any collection of possible equilibria should they exist. Here we implement a method proposed by McKelvey (1986). We detail the computational method in Appendix B. A Condorcet winner is obviously uncovered and is easily seen to be the unique element of U . If instead, there are multiple tax policies that could win a head-to-head majority voting tournament through various strategic pairings or insincere voting, we can find all of them.

5 Voting Outcomes

Under probabilistic voting with identical variance across all (k, ε) , the equilibrium policy is $(\tau_c, \tau_\ell, \tau_k) = (0.18, 0.00, 0.14)$. This raises just enough revenue to pay for exogenous government spending, but leaves nothing for a transfer. Under Downsian voting we our preferences over taxes are derived from primitive preferences over consumption and leisure, we cannot simply assume they possess the required symmetry.

¹⁸See McKelvey (1986) or Miller (2007) for discussion. The uncovered set is a non-empty subset of the **dominating set** (Smith (1973)), in which all members of the set defeat all non-member policies in pairwise competition. In fact, the uncovered set is the smallest dominating set (Fishburn (1977)).

¹⁹Sophisticated voting means that agents may vote against their preferences in any particular round of pairwise voting in order to achieve a better outcome in the final round.

find a Condorcet winner.²⁰ We denote this policy τ^C (for “Condorcet winner”), and it is $(\tau_c, \tau_\ell, \tau_k) = (0.16, 0.00, 0.19)$. While the exact rates are slightly different, the policies are qualitatively the same: zero labor income tax rates, low rates on capital income and consumption, and almost no transfer. Now we will explain the mechanisms in the model that give rise to these policies. Because the policies from the probabilistic and the Downsian voting concepts are qualitatively identical, the same intuition applies to both. Therefore, for simplicity, we will subsequently only refer to the Condorcet winner.

Compared to τ^0 , the Condorcet winner places a much lower tax burden on labor and capital income taxes, and a significantly higher tax on consumption. The overall size of government is considerably smaller as well, as the transfer declines from 0.091 (9.10 percent of GDP) to 0.003 (0.27 percent of GDP).²¹ Capital and output increase by 21.6 percent and 10 percent, respectively.²²

5.1 Transition path

Figures 2 - 4 plot the transition paths of economy aggregates resulting from a change to the winning policy. There is a decline in most aggregates in the very early periods of transition. The capital stock declines for five periods before bottoming out at 2 percent below the initial steady state. Over time it rises, reaching a level 0.5 percent higher at the end of the transition. Effective labor input, hours, consumption, and output all fall sharply initially and never rise back to their initial levels. Despite considerable initial wealth and income inequality, majority voting in the model does not lead to much redistribution in the

²⁰To be clear, we find a Condorcet winner within the discrete set of tax policies P . While we cannot rule out that making the grid of policies more dense in the neighborhood of the Condorcet winner could result in a non-singleton uncovered set, agents would be effectively indifferent between the elements.

²¹We suspect that the transfer is actually zero in the terminal steady state, but it is prohibitively expensive to locate that point and check that it beats the Condorcet winner; obviously, it makes little difference.

²²We can show that the hyperplanes that divide the population evenly along each possible direction all intersect at the Condorcet winner; the graph, however, is three-dimensional and unreadable, so we omit it.

long run. The transfer falls from just over 9 percent of GDP in the initial steady state to 6 percent in the first period of transition, before declining further to nearly 0 and remaining there for the rest of the transition.²³

We compute the welfare gains for each household type from transitioning to the new tax policy. Figure 5 plots for each household the percentage of its initial steady state consumption that would need to be subtracted in every period of the transition and in the terminal steady state to make it indifferent between undergoing the transition and remaining in the initial steady state. All households experience a welfare gain, but they are substantially larger for the low-productivity poor. The maximum gain is 0.6 percent, which goes to a household with the lowest productivity and no initial wealth. Gains decline as wealth increases for all household types, and the ordering across productivity reverses. As wealth increases, low-productivity households stop working and thus benefit less from the elimination of the labor income tax, while households with high productivity continue to work at higher wealth levels.

6 Preferences over Tax Policies

Generally, a household favors tax policies that place a lower tax burden on its primary source of income. For example, households with high wealth (which work fewer hours all else equal) broadly favor labor income taxes, while asset-poor households prefer consumption and capital income taxes. In addition to this direct tax consideration, households also take into account how policies indirectly tax them through their effect on equilibrium prices. In general equilibrium, a higher τ_ℓ reduces labor supply and the equilibrium interest rate. Because the tax incidence of higher labor income taxes still falls on households without labor income, rich households do not want to institute an extremely high tax rate on labor income. Poor households likewise internalize the effects of higher capital income taxes on

²³Experimenting with capital adjustment costs led to no meaningful changes, only a correspondingly slower transition. Equilibrium tax policy remained the same.

the equilibrium wage. With these direct and indirect channels in mind, we now discuss each type of tax in turn and how households' preferences over each one differs across the wealth distribution.

6.1 Consumption taxes

Using (4), we hold fixed τ_ℓ and τ_k , vary the consumption tax rate, and plot the welfare gain (in utils) from electing alternative policies with higher consumption taxes than the winning tax policy. Specifically, for a household with initial wealth k and labor productivity ε , the welfare gain from enacting policy τ instead of τ' is $V(\tau; k, \varepsilon) - V(\tau'; k, \varepsilon)$. If the welfare gain is positive, then a household of type (k, ε) prefers τ to τ' .

In Figures 6a - 6c, the welfare gain is increasing in wealth, a reflection of the direct tax channel discussed above. Because the policy change is permanent, an increase in the consumption tax is equivalent to a positive tax on initial wealth. Households with high k prefer no consumption tax, while poor households support very high levels of τ_c .²⁴

For households supplying positive hours, there is a second form of direct taxation in that a consumption tax and a labor tax distort the same margin, causing them to shift their consumption from market to non-market consumption (i.e., leisure). Support for consumption taxes therefore naturally decreases in ε . Notice that the welfare gain curves converge as k increases and the curves of low ε types merge at lower wealth levels. As k increases, the wealth effect on leisure pushes households to the corner of their hours decision. Households with more labor productivity hit the lower bound on hours at a higher level of wealth because leisure is more expensive for them.

For households not supplying labor, the consumption tax/labor income tax equivalence matters only through the risk that the household will supply hours in the future. Typically

²⁴Poor, low-productivity households in particular favor extremely high consumption tax rates. This is driven by their desire for initial wealth redistribution. We have repeated our experiments with a fixed transfer when labor taxes are zero. Voters choose the capital income tax, and consumption taxes clear the government budget constraint. In this case, poor, low-productivity households prefer only moderate consumption tax rates.

in order for that to happen, the household must draw a sufficiently long string of below average productivity, the likelihood of which depends upon the persistence of the ε process. Consider a household with $\varepsilon = \varepsilon_{\min}$ and enough wealth so that the household does not work. First, the household will consume more than its after-tax capital income, so it will have less wealth next period. Second, because productivity shocks are serially correlated, the household will very likely draw another low ε tomorrow, causing its wealth to decline further toward a level where the household would work. Finally, because higher-productivity households exit the labor market at higher wealth levels, as the household reduces its wealth, the probability that it will supply positive hours due to a favorable ε shock rises.

6.2 Capital income taxes

Figures 7a - 7c plot the welfare gains associated with varying the capital income tax. Support for increasing capital taxes falls in k and in ε . Declining support in k is obvious, but not necessarily so for ε . Why do only a minority of households with zero wealth vote against raising capital income taxes even higher? There are two reasons. First, these households get most of their income from labor. Thus, the wage matters a lot to them, and high capital income taxes reduce the capital-labor ratio, driving down the wage; furthermore, wage increases benefit high ε types more than low ε types. Second, there is a lot of mobility in the model, meaning that households transition through the wealth distribution quickly relative to their discount factor. Simply put, even zero wealth households expect to have a lot more wealth in the “near” future, and so they share much of the same distaste for capital income taxes as their currently rich counterparts.

6.3 Labor income taxes

The model predicts zero labor income taxes. Preferences for increasing labor income taxes are monotonically decreasing in ε . Households that are more productive dislike labor taxes more, especially at low wealth levels where labor income is most important for consumption. However, labor income tax preferences over k are not monotonic. Instead each ε -curve is

U-shaped over k and divided into three regions (see Figures 8a-8c).

In the first region, households have low wealth and support low labor income taxes. As households gain wealth, they reduce their dislike of labor income taxes, with low ε households being the first to move into the second region and vote for increasing the tax. The downward slope is once again due to the wealth effect on hours. Each ε type curve bottoms out near the wealth level where it supplies 0 hours. Notice the same merging of curves from the bottom first, as the corner is hit at higher wealth levels for higher ε due to the substitution effect.

The reason that households eventually switch back to preferring lower labor income taxes is the effect of these taxes on the interest rate. Sufficiently rich households do not work and do not expect to work for a long time. The income and consumption of these types depend entirely upon the return to capital. Labor income taxes increase the capital-labor ratio and reduce r , so rich households oppose them. The fraction of households in the second and third regions is small, however, so the outcomes are primarily determined by the first region.

6.4 Most preferred tax policy by household type

By plotting (4), we can see the most preferred tax combination across wealth by productivity level. Figures 9a - 9c do this for the lowest productivity, the median productivity, and the highest productivity households. For the lowest- ε households, the ideal tax combination is high consumption taxes, moderate capital income taxes, and zero labor income taxes. As wealth increases, the preferred combination switches to zero consumption taxes, high labor income taxes, and slightly lower capital income taxes. The switch occurs around a wealth level at which the household earns a large fraction of its income from capital.

The picture is generally the same for all ε types. At low levels of k , consumption taxes are preferred to labor taxes with capital income somewhere in between. Then at a higher level of wealth, the ordering switches so labor income taxes become preferred to consumption taxes. The differences across types are mainly the degree to which they wish

to tax consumption when at low k levels. The least productive wealth-poor want very high consumption taxes, while their most productive counterparts want moderate levels. The k level at which the preferences switch increases with ε , since the substitution effect on hours is stronger, keeping high ε types working more, and thus more exposed to labor income taxation.

The figures also show the cumulative distribution of wealth. By taking the distribution of voters along with their preferences, we can understand the voting outcome. Labor income taxes are opposed by the majority voting system not because no one favors them, but because essentially no households reach the wealth levels at which they become preferred. We show in a later section that wealth-weighted voting changes equilibrium policy to taxing labor.

The equilibrium policy places no direct tax on labor and a mixture of taxes on consumption and capital income. It is natural to wonder why the winning policy features both of these taxes rather than a single tax on consumption. Voters balance the regressive nature of the consumption tax against the distortion on saving (and therefore on the wage) of the capital income tax.

In contrast, the capital income tax is progressive, but comes with a substantial cost in terms of aggregate wages. As seen in Figure 1 in Aiyagari and McGrattan (1998), the economy operates in general on the highly elastic portion of the capital supply curve, so that even small changes in after-tax returns will lead to large changes in aggregate capital and therefore wages. Thus, voters are reluctant to impose high capital taxes; the result is that they settle for a compromise that mixes the two types.

Voters then are roughly equating the marginal net gains from the two taxes. Lipsey and Lancaster (1956) note that, in general, second-best outcomes use multiple instruments a small amount rather than one instrument a lot; the intuition is that deadweight losses from taxation are typically convex in the tax rate. In this context, voters like consumption taxes because they act as a tax on initial wealth, but unfortunately it is a regressive tax: the poor suffer disproportionately more because their marginal propensity to consume is higher (see

Figure 10). Voters like capital income taxes because they tax the wealthy more heavily than the poor, but at a cost of permanently lower aggregate wages. Therefore, the voters compromise and use a little bit of both; using the welfare maximization interpretation, the mix of taxes equalizes the marginal gains net of costs.

We can see further how unpopular labor taxes are by considering what would happen if we forced capital and labor to be taxed at a uniform rate (an income tax). In that case the winning policy taxes consumption at a rate of 20 percent and income at zero. This result is consistent with other papers that show how desirable consumption taxation is, compared to income taxation; our results show that it is missing the key point that income taxation per se is not unpopular, only labor income taxation. If we remove consumption taxation as a policy instrument, forcing households to finance government expenditures with taxes on labor and capital income, they will tax labor but only because financing with capital income taxes alone requires an extremely high tax rate, which reduces aggregate capital too much.

6.5 Support for the winning policy

We now consider how strong the support is for the Condorcet winner. If one considers an alternative policy that deviates from the winning policy along a single dimension only, the share of votes going to that alternative declines in the size of the deviation. Figure 11a plots the fraction of households voting against the equilibrium tax policy for alternatives with higher consumption tax rates. Support for the alternative decreases sharply as τ_c increases. The equilibrium policy has a comfortable majority even against $\tau_c = 0.3$, with over 61 percent of the vote. Figure 11b illustrates that even small deviations from zero labor income taxation are met with little support. Figure 11c shows the same monotonic decline in support as policy moves away from the winning policy in the capital income tax direction. The vote share is especially sensitive in this dimension.

7 Extensions

7.1 Inequality and revoting

The winning policy gives rise to a long-run wealth distribution with more inequality than the initial distribution. This change can be seen from the Lorenz curves of wealth plotted in Figure 12. The initial distribution has a Gini coefficient of 0.60, while that of the final distribution is only slightly higher at 0.62. We interpret these small changes as evidence that our assumption of a once-and-for-all vote is unlikely to be restrictive; the agents will be in nearly the same distribution in each time period and therefore will not generate substantial support for alternative policies (particularly since the winner enjoys very strong support). To check this intuition, we repeat the vote using the wealth distribution at different points in the transition, namely, periods $t = 30$, $t = 60$, and the terminal steady state. In each case, the winning policy continued to exist and to enjoy strong support.²⁵

Because there are mixed effects on inequality from changing the various tax rates, we once again isolate tax changes along a single dimension and compare long-run wealth distributions. Figure 13 plots the CDF's of the steady state wealth distributions for alternative policies with much higher consumption taxes. As τ_c rises, long-run inequality is unambiguously reduced, which is the wealth tax equivalence of consumption taxation appearing again since higher consumption taxes redistribute initial wealth. Figure 14 plots CDF's for changes in capital income taxes. Just like consumption taxes, capital income taxes also unambiguously decrease long-run wealth inequality. Labor income taxes have a very small effect on the lower end of the wealth distribution, increasing inequality just slightly. At the middle and upper ends, however, labor income taxes have much stronger inequality-reducing effects. The CDF's are plotted in Figure 15.

²⁵This procedure assumes that agents do not anticipate an opportunity to revote. It is therefore not necessarily equivalent to assuming the vote occurs each period. Computing an equilibrium without commitment is complicated by the potential for multiple solutions, so we leave it for future work. One-dimensional models of voting without commitment in similar environments are studied in Bachmann and Bai (2013) and Corbae et al. (2009)), where a “Krusell-Smith”-style approximation is used to find approximate equilibria.

The reasons for the small effect on inequality can be traced back to the large amount of idiosyncratic risk faced by agents. If risk is small, changes in factor prices play a large role in determining inequality: in the limit, where risk is zero and households are frozen in their place in the wealth distribution, small changes in the interest rate lead to large changes in absolute wealth positions. But with idiosyncratic risk this effect gets swamped by precautionary motives, and changes in flat taxes simply do not materially affect this dimension.²⁶

7.2 Fragility of probabilistic voting

The model makes very different predictions for political equilibria depending on how ξ is distributed across the wealth distribution. To illustrate, suppose the ξ of any type is linearly related to the relative wealth of that group:

$$\xi(k) = 1 + \alpha_k(k - K)$$

where K is the average wealth in the economy.

If α_k is negative (positive), then the variance of non-economic preferences decreases (increases) with wealth.²⁷ By adjusting α_k , equilibrium policy can change from moderate consumption and capital income taxation with zero tax on labor income to relying solely on labor income taxes.

7.3 The role of mobility and patience

Our results depend critically on two aspects of our economy: households are mobile (they move around the (k, ε) space) and they are very patient. We illuminate the role of mobility by studying a version of our economy in which ε is fixed at the current value; as noted by Krusell and Ríos-Rull (1999) and Chatterjee (1994), the resulting economy has no

²⁶Carroll and Young (2018) discuss the connection between inequality and factor prices in a related environment, and show that idiosyncratic risk dominates any other factors once it is sufficiently important.

²⁷ $\alpha_k = 0$ corresponds to the benchmark case where ν_η is independent of wealth

mobility.²⁸ What we find is that the level of transfers is substantially higher, along with the levels of capital and consumption taxation, but labor income taxes remain zero. Mobility matters because agents expect to be “average” in the future; combined with a high β they become reluctant to impose high taxes, since they are committed to them for all time. Tables 2 and 3 show that our model actually overstates mobility for certain groups (based on mobility measures from Budría et al. (2002), namely, the very wealthy and the very poor; with less mobility we would find that support for higher transfers would increase.²⁹

To examine the role of patience (specifically, the forward-looking nature of voting), we consider a case where households evaluate the transition for the purposes of voting using a discount factor $\beta^* < \beta$; we call this “myopic voting.” That is, households make economic decisions using

$$v_t(k, \varepsilon; \tau) = \frac{c_t(k, \varepsilon)^{1-\gamma}}{1-\gamma} + \theta \log(1 - h_t(k, \varepsilon)) + \beta E[v_{t+1}(k_{t+1}(k, \varepsilon), \varepsilon'; \tau) | \varepsilon]$$

but vote using

$$\tilde{v}_t(k, \varepsilon; \tau) = \frac{c_t(k, \varepsilon)^{1-\gamma}}{1-\gamma} + \theta \log(1 - h_t(k, \varepsilon)) + \beta^* E[\tilde{v}_{t+1}(k_{t+1}(k, \varepsilon), \varepsilon'; \tau) | \varepsilon].$$

We find that the transfer again rises substantially, and both capital and consumption taxation increase. The reason is that now the future is discounted more, meaning that the currently “poor” are less affected by their transition to being average in the future. However, labor income taxes remain at zero. Depending on the degree of myopia in voting, we can generate very large transfers as a winning policy. A complete description of these experiments is available upon request.

7.4 Wealth-weighted voting

In the experiment above, voting is proportional: the vote share cast by households in state (k, ε) is equal to the population share at (k, ε) . Bachmann and Bai (2013) document that

²⁸Specifically, each household’s share of aggregate wealth remains equal over time: $\frac{k_t}{K_t} = \frac{k_0}{K_0}$. Note, however, that the decisive voter is still endogenously determined and could change over the transition.

²⁹Carroll et al. (2016) investigate the reasons why the model misses in the extreme quintiles.

political participation (in the form of campaign contributions) varies substantially across the wealth distribution, with participation rising in wealth. They propose a weighting function, k^χ , which multiplies the population weights, where χ captures the degree of “wealth bias” in the political process. There are multiple interpretations of this bias: ‘One-Dollar-of-Contribution-One-Vote’ implies that one dollar of contribution buys one de facto vote, while ‘One-Contributor-One-Vote’ means that each contributor (independent of dollar amounts) gets one de facto vote. Bachmann and Bai (2013) use data from the Cooperative Congressional Election Survey and the American National Election Studies to discipline their choices of χ ; when $\chi = 0.55$ they find that the model matches reasonably well the political bias generated by contributions and matches the low correlation between government spending and GDP.³⁰

We apply wealth-weighting to our model and find that it moves equilibrium tax policy away from capital income and consumption taxation and toward labor taxation. When $\chi = 0.3$, the winning policy is $(\tau_c, \tau_\ell, \tau_k) = (0.0, 0.20, 0.10)$; at $\chi = 0.5$ we obtain $(\tau_c, \tau_\ell, \tau_k) = (0.0, 0.30, 0.0)$. To get a better sense of how much wealth bias is implied by these χ values, Figure 16 plots the CDF’s of votes cast as a function of wealth under the two wealth-weighting rules and under proportional voting ($\chi = 0$). When votes are counted proportionally, the 50th percentile of votes occurs at the median wealth level, $k = 6.6$. In contrast, the 50th percentile of votes is at the 69th and 75th percentiles of the $\chi = 0.3$ and $\chi = 0.5$ wealth distributions, respectively.

It is easy to understand these changes: the rich like labor taxes, as shown above, and when they are sufficiently important politically, they impose this preference. The point

³⁰Bai and Lagunoff (2013) show formally the positive link between wealth inequality and political inequality for this weighting function. Note that the interpretation is a bit strained, since agents in the model don’t actually sacrifice any resources in order to gain voting power. An alternative interpretation of the weighting function is that captures empirically plausible (but unexplained) variation in voter turnout across the wealth distribution. While no studies, to our knowledge, correlate turnout and wealth, there is ample evidence of a positive correlation between turnout rates and correlates to wealth, such as income, age and educational attainment (Leighley and Nagler (2013), Smets and Van Ham (2013)).

we make here is that (i) it is easy and feasible to introduce aspects of voter participation and (ii) voter participation may play an important role in cross-country comparisons of tax systems.

7.5 Labor income subsidies

Because the labor income tax rate of the winning tax policy is at its lower bound, it may possibly be defeated by a policy with labor income subsidies if such a policy were permitted. To test this, we add to our original policy space, \mathcal{P} , a collection of 640 tax policy alternatives consisting of every combination of $\tau_c \in \{0.30, 0.40, 0.50, \dots, 1.20\}$, $\tau_\ell \in \{-0.10, -0.20, -0.30, \dots, -0.80\}$, and $\tau_k \in \{0.00, 0.10, 0.20, \dots, 0.70\}$. We then re-run our majority vote over this augmented policy space. Once again, the winner is $(\tau_c, \tau_\ell, \tau_k) = (1.10, -0.70, 0.10)$. Under this new policy, the long-run lump-sum transfer is 0.20 rather than zero. The ordering of the most preferred tax policy across (k, ε) is the same as that described in the baseline experiment extended to allow for labor subsidies. Labor subsidies are supported by low-wealth and middle-wealth households. Both groups favor relatively high consumption taxes, although the ideal rate for the poor is much higher (90 percent vs. 50 percent). Only poor, low-productivity households support positive capital income taxes. Rich households would rather tax labor income exclusively.

We recompute the welfare gains from transitioning to a policy with labor subsidies and plot them in Figure 17. In contrast to the case where negative labor taxes are prohibited, with subsidies some households experience welfare losses. Households that are initially rich would need to be compensated by as much as 0.3 percent to be made indifferent to the policy change. Welfare gains for the initial poor are much larger with subsidies. A low-productivity household with zero initial wealth would gain 1 percent. Not only is the variance of gains and losses across households increased by including labor subsidies, but the region of the wealth distribution where households switch to supporting positive labor income taxes is greater. The general equilibrium effect of labor subsidies produces a higher rate of return on capital, which compensates some middle-wealth working

households. Because of its support over a wide range of the wealth distribution, the policy with labor subsidies is robust to both the additive and multiplicative probabilistic voting cases as well as wealth-weighted voting under $\chi = 0.3$ and $\chi = 0.5$; to get a significant change, we would need to consider higher values of χ .

8 Conclusion

In our study of political mechanisms in the Aiyagari (1994) model, we found that majority voting was quite powerful at restricting outcomes: the Condorcet winner not only existed but enjoyed very strong support against alternatives. Compared to the data,³¹ however, the equilibrium tax system was far afield: although closest to the South Korean system of low labor income taxes and modest capital income and consumption taxes, a strong majority in the model would oppose shifting to South Korean taxes. The model gets even further away from reality if we permit labor income subsidies, as the voters select very large ones financed entirely out of consumption taxation. We choose to interpret our results positively: if we want to understand the political choices made by countries with respect to their tax systems, it seems more fruitful to look at how the countries are different in terms of their endowments, markets, and preferences rather than the intricate details of their political processes.

There are obviously many directions along which the calibration of the model could be improved in terms of earnings and wealth concentration, in particular, by being more careful about the idiosyncratic wage process. For example, Guvenen et al. (2015) find evidence that log labor income changes are highly non-Gaussian. Guvenen et al. (2015) model their process as a mixture of AR(1) processes, with mixture weights that depend on lagged income and heterogeneous variances; it would be a challenge to introduce the full scope of their process into our model (notwithstanding the problem that they estimate earnings rather than wages), but some features could perhaps be added that increase the

³¹See Carey and Rabesona (2003) for average tax rates by source in OECD countries.

amount of heterogeneity and introduce wealth concentration. As we have noted already, mobility is also a concern given its importance in determining the level of transfers. Human capital accumulation may also be important, although it seems likely that it would simply make labor taxation even more unattractive.

The machinery developed here can be used in a number of ways. Of particular interest to us would be the politics of progressive taxation, as the flexibility of a progressive tax system could allow the decisive bloc of poor and middle-class voters to tax the rich without also having to tax themselves. The diversity of progressive tax systems in the data is documented by Holter et al. (2014); we are exploring whether the model still predicts that only a small number of policies could survive and whether transfers are politically feasible. We could also study the importance of tax avoidance (deliberately shifting out of taxable activities like market consumption into untaxed home consumption) and tax evasion (choosing not to pay taxes that are owed) for the determination of equilibrium tax systems. Finally, there is a large literature on the implementation costs of different taxes (that dates back at least to Yitzhaki (1979)), and surely these costs play a role in the voting choices of agents. Our framework can easily accommodate such costs.

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A Probabilistic Voting

Under probabilistic voting, a household's return from any particular tax policy is a function of two elements: the deterministic economic component $V(\tau; k, \varepsilon)$ and a “non-economic,” policy-specific shock. As a result, given a distribution for those shocks the expected number of votes for each option is continuous. Supposing that the objective of the political candidates is to maximize the probability of winning, this continuity guarantees the existence of an equilibrium.

While the precise function for voter utility is arbitrary, in practice the distribution of shocks is logistic and enters utility either additively or multiplicatively; for these cases expected vote totals can be calculated analytically. Banks and Duggan (2005) show that for either assumption about the way shocks enter the payoff function, there is an equivalence between solving the probabilistic voting game and maximizing a social welfare function. When shocks enter additively, the social welfare function is the sum of households' utility (the utilitarian criterion). When the shocks enter multiplicatively, then the social welfare function is the sum of the logarithm of utility, leading to a social planner that displays constant relative inequality aversion (see Atkinson (1970)), meaning that low-utility types get disproportionate weight in the objective function.³²

To implement probabilistic voting, we assume that agents receive an additive shock η_i to the utility of τ_i when voting; that is, the payoff from i is $V(\tau_i; k, \varepsilon) + \eta_i$. Household (k, ε) would vote for policy i over policy j if

$$V(\tau_i; k, \varepsilon) + \eta_i > V(\tau_j; k, \varepsilon) + \eta_j,$$

which can be rearranged to obtain

$$V(\tau_i; k, \varepsilon) - V(\tau_j; k, \varepsilon) > \eta_j - \eta_i.$$

³²In general probabilistic voting and deterministic majority voting deliver different outcomes; see as a comparison case Hassler et al. (2003) vs. Hassler et al. (2005). Dolmas (2014) points out a potential pitfall from using probabilistic voting: in some environments, the outcome depends critically on whether the shocks are assumed to enter additively or multiplicatively.

Supposing η has a logistic distribution independent of (k, ε) , i competing against j will receive an expected vote share equal to

$$2 \int_k \int_\varepsilon \frac{\exp(V(\tau_i; k, \varepsilon))}{\exp(V(\tau_i; k, \varepsilon)) + \exp(V(\tau_j; k, \varepsilon))} \Gamma_0(k, \varepsilon) - 1.$$

Alternatively, we can assume that the shock is multiplicative, so that the payoff is

$$\exp(\eta_i) V(\tau_i; k, \varepsilon),$$

which leads to an expected vote share of

$$2 \int_k \int_\varepsilon \frac{V(\tau_i; k, \varepsilon)}{V(\tau_i; k, \varepsilon) + V(\tau_j; k, \varepsilon)} \Gamma_0(k, \varepsilon) - 1.$$

The preferred policy maximizes the expected number of votes, evaluated at a symmetric equilibrium $\tau_i = \tau_j$.

B Solving the Downsian Voting Game

We begin with a collection of indirect value functions of the tax policy space and the initial distribution of the population across (k, ε) . At this point, solving directly for U may be computationally infeasible if the policy space is large. Before computing the uncovered set, we reduce the policy space by removing any policies that are unanimously defeated by some other policy in the space, that is, those not in the *Pareto set*. Since the uncovered set is always a subset of the Pareto set, we are in no danger of discarding an equilibrium.

B.1 Finding the Pareto set

The Pareto set is defined as all tax systems that are not defeated unanimously by some other one in the policy space. That is,

$$P = \left\{ \tau_i : \int_k \int_\varepsilon \mathbf{1}(\tau_j \mathcal{P}(k, \varepsilon) \tau_i) \Gamma_0(k, \varepsilon) < 1 \text{ for every } \tau_j \right\};$$

it is easy to see that the Pareto set cannot be empty and that no policy outside the Pareto set would be proposed (note that policies in the Pareto set still may never win

under majority voting, and in pure redistribution games where total resources are fixed, the Pareto set is the entire policy space). In practice, due to the very small measure of some types, we compute an “approximate Pareto set” where we set the criterion that the policy is not defeated by a vote of at least 0.9999. In our model, when we allow for a wide range of tax rates, the cardinality of the Pareto set is typically much smaller than that of the entire policy space. This makes computing the uncovered set much easier.

Computationally, identifying the Pareto set consists of looping over the policy space, tallying up the fraction of households that support one policy over another, and throwing out any policies that fail the criterion.

B.2 Finding the uncovered set

To find the uncovered set, we begin with the Pareto set and then construct the **adjacency matrix** M with (i, j) element

$$m_{i,j} = \begin{cases} 1 & \text{if } i \neq j \text{ and } \int_k \int_\varepsilon \mathbf{1}(\tau_i \mathcal{P}(k, \varepsilon) \tau_j) \Gamma_0(k, \varepsilon) > \frac{1}{2} \\ 0 & \text{otherwise} \end{cases}.$$

We then compute the matrix

$$M^* = M^2 + M + I;$$

if $m_{i,j}^* = 0$, then i is covered by j .

Notice the quadratic structure of the calculation. This reflects a well-known property of policies outside the uncovered set, which states that for any covered policy, τ , there exists an agenda (i.e., sequence of pairwise votes) such that τ will be defeated within two rounds. Finding the uncovered set then merely amounts to computing M^* , and then removing all the policies associated with rows that have a zero element. If only one row remains, then this is the Condorcet winning policy.

It is helpful in practice to take an iterative approach to examining the policy space. Begin with a coarse grid of points, in order to identify regions in which equilibria may appear. Then add finer grids around those points *without discarding any points from the*

coarse grid. In this way, we strike a balance between completeness and precision. We allow voters to consider a very broad set of policies, but also identify policy outcomes to within one percentage point.

It may be the case, especially for a very fine grid, that the uncovered set contains many different policies. In this case there is a further refinement called the *essential set*, which contains every tax policy that is played in any mixed strategy Nash equilibrium of the voting game. See C for more detail.

C The Essential Set

The essential set is the set of all policies played with positive probability in some mixed strategy Nash equilibrium.³³

The essential set is a subset of the uncovered set. Thus it may deliver sharper predictions for some models. While this was not the case in our experiments, for the benefit of the reader we offer a discussion of how to compute the essential set.

C.1 Finding the essential set

To compute the essential set, we take all policies in the uncovered set. Let s_i denote the probability assigned to policy vector i , drawn from a set with $N < \infty$ possible policies. We construct the **dominance matrix**, with typical i, j element given by

$$d_{i,j} = \begin{cases} 1 & \text{if } i \neq j \text{ and } \int_k \int_\varepsilon \mathbf{1}(\tau_i \mathcal{P}(k, \varepsilon) \tau_j) \Gamma_0(k, \varepsilon) > \frac{1}{2} \\ 0 & \text{if } i = j \\ -1 & \text{if } i \neq j \text{ and } \int_k \int_\varepsilon \mathbf{1}(\tau_i \mathcal{P}(k, \varepsilon) \tau_j) \Gamma_0(k, \varepsilon) < \frac{1}{2} \end{cases},$$

³³The essential set is a generalization of the **bipartisan set** from Laffond et al. (1993); the bipartisan set is the mixed strategy support when the mixed strategy equilibrium is unique, whereas the essential set is the union of the strategy support for all mixed strategy equilibria. See Dutta and Laslier (1999) for discussion.

where $\Gamma_0(k, \varepsilon)$ is the initial distribution. We then solve the linear program

$$(s^*, e^*) = \operatorname{argmax}_{e, \{s_1, \dots, s_N\}} \{e\}$$

subject to

$$\begin{aligned} \sum_{j=1}^N d_{i,j} s_j &\leq 0 \quad \forall i \in \{1, \dots, N\} \\ s_i - \sum_{j=1}^N d_{i,j} s_j - e &\geq 0 \quad \forall i \in \{1, \dots, N\} \\ \sum_{i=1}^N s_i &= 1 \\ s_i &\geq 0 \quad \forall i \in \{1, \dots, N\} \\ e &\geq 0. \end{aligned}$$

The essential set then consists of the tax policies that are played with strictly positive probability:

$$E = \{\tau_i : s_i^* > 0\};$$

given the constraint set it is clear that E is non-empty. If there is a Condorcet winner, it will be the only member of the essential set.³⁴

D Dolmas (2008)

In this appendix we discuss how our results relate to Dolmas (2008). In that paper, majority voting was found to have limited predictive power: the uncovered set and the essential set both contained a large number of policies that were “spread out” across the policy space, so that the old adage that “in politics anything goes” held. We illustrate that this limited power was a result of one crucial assumption, namely, that the number of distinct types was small.

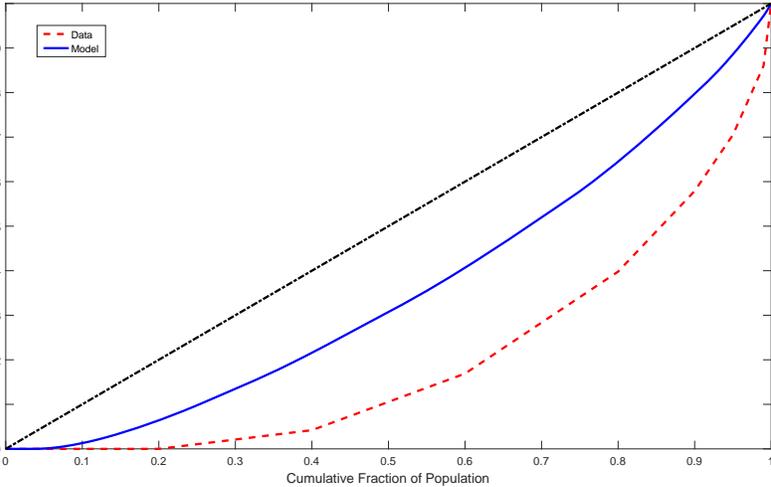
³⁴This linear program is discussed in Brandt and Fischer (2008).

The model of Dolmas (2008) is substantially different than ours, so we quickly describe the relevant ingredients. The economic model is taken from Rebelo (1991), and features endogenous growth and no transitional dynamics. Households are endowed with an initial wealth k_0 and productivity e_0 ; these values will remain fixed over time (in the case of wealth, fixed as a share of the aggregate to be more precise, but since the model is always on a balanced growth path, the distinction is irrelevant). Dolmas (2008) supposes there are two values for productivity and two for wealth, leading to four types, and calibrates their weights to roughly match some distributional facts from the US. The result is that no group is a majority, but each has substantial measure; in fact, one can assemble a majority in his model in eight different ways, most but not all of which include the ‘low e , low k ’ type that has measure just smaller than 0.5. Each of these types has very different preferred tax rates, which depend on where their primary source of income arises and how wealthy they are relative to the mean; however, most types are poorer than average so they desire positive transfers, and because there is no mobility they are not reluctant to impose high taxes to get them. Figure 18 presents the uncovered set from Dolmas (2008) for his benchmark model with four types; note that the range of taxes is very large in each dimension.³⁵ As a comparison we also present in Figure 18 the uncovered set when the number of types is extended to nine, using a similar calibration procedure that picks points from the Lorenz curves for earnings and wealth in the US; now the uncovered set has shrunk to a small number of points (6) and is confined to a region of zero labor income taxes, high capital and consumption taxes, and very large transfers, and the essential set contains only five points. The Pareto set, in comparison, remains large; the specifics of these calculations are available upon request. This experiment shows that again our zero labor income tax result is very robust and the importance of mobility for the level of transfers. Since the model is very different from ours, we do not explicitly compare the two.

³⁵A slight difference in the parameters accounts for the change in the location of the Pareto set relative to the graph in Dolmas (2008).

Figure 1: Lorenz curves

(a) Earnings



(b) Wealth

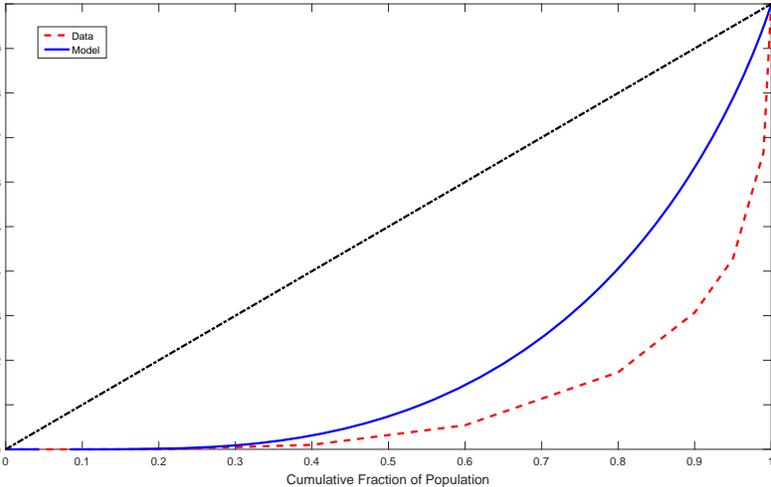


Figure 2: Transition path under Condorcet winner policy

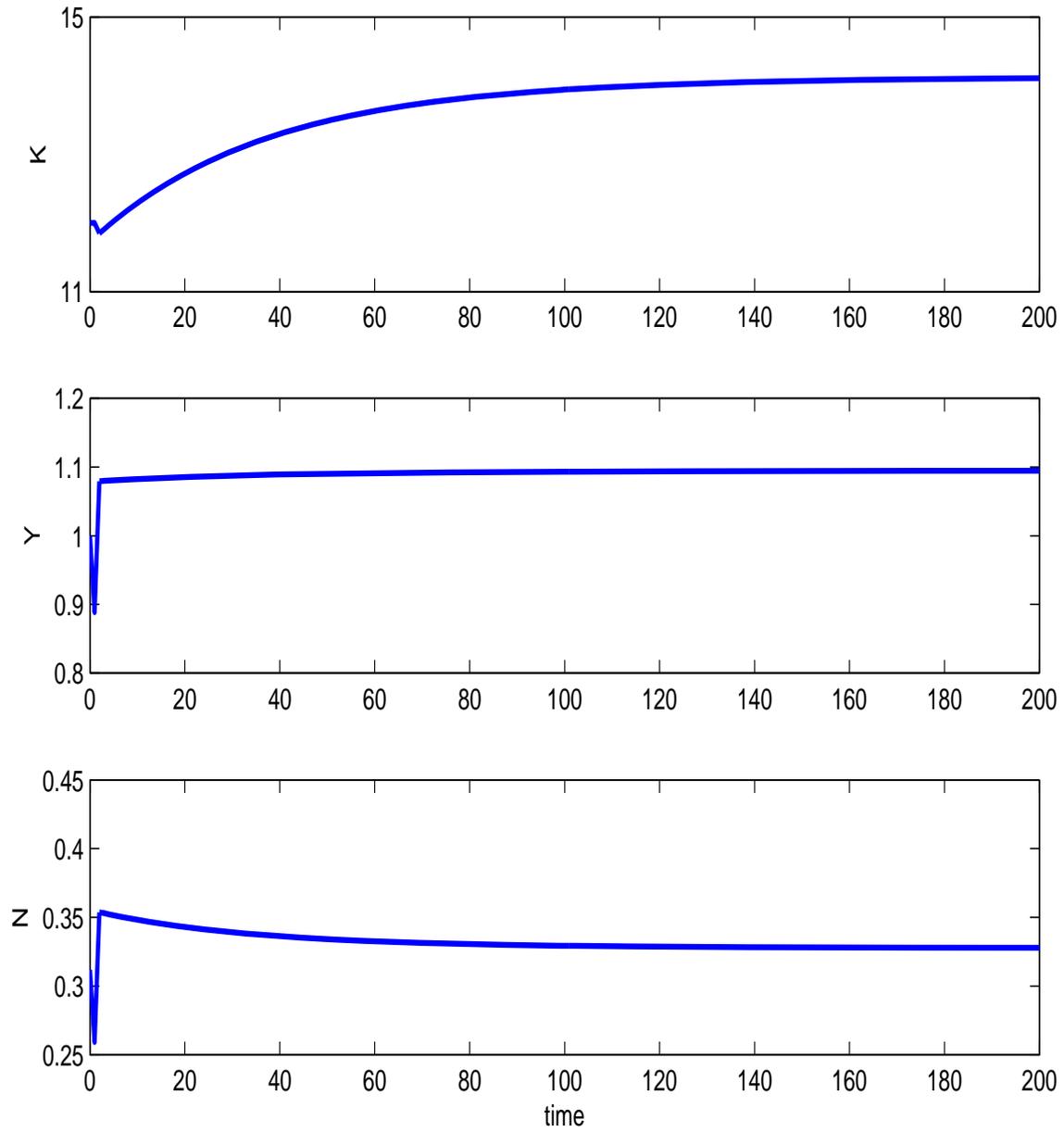


Figure 3: Transition path under Condorcet winner policy

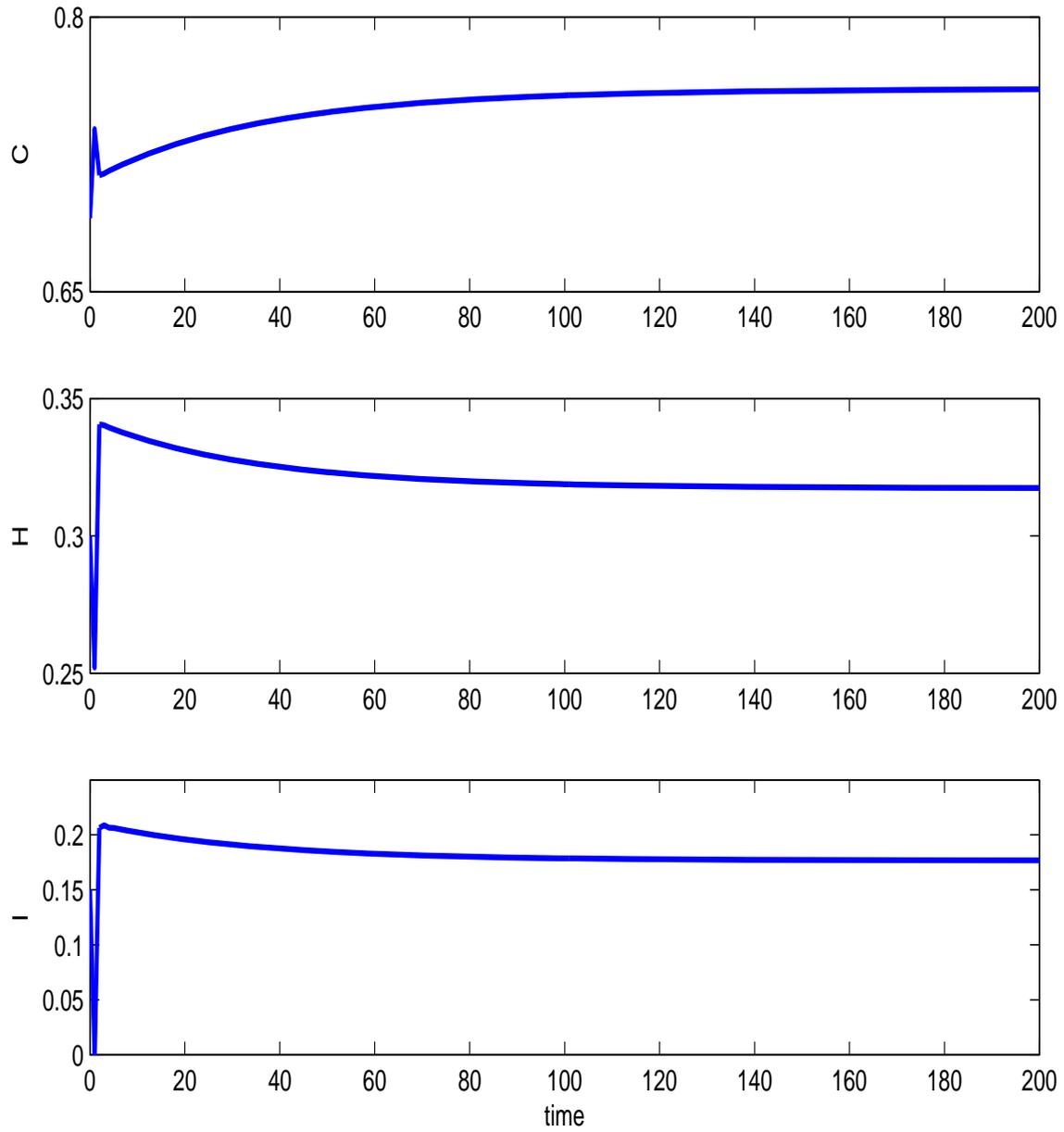


Figure 4: Transition path under Condorcet winner policy

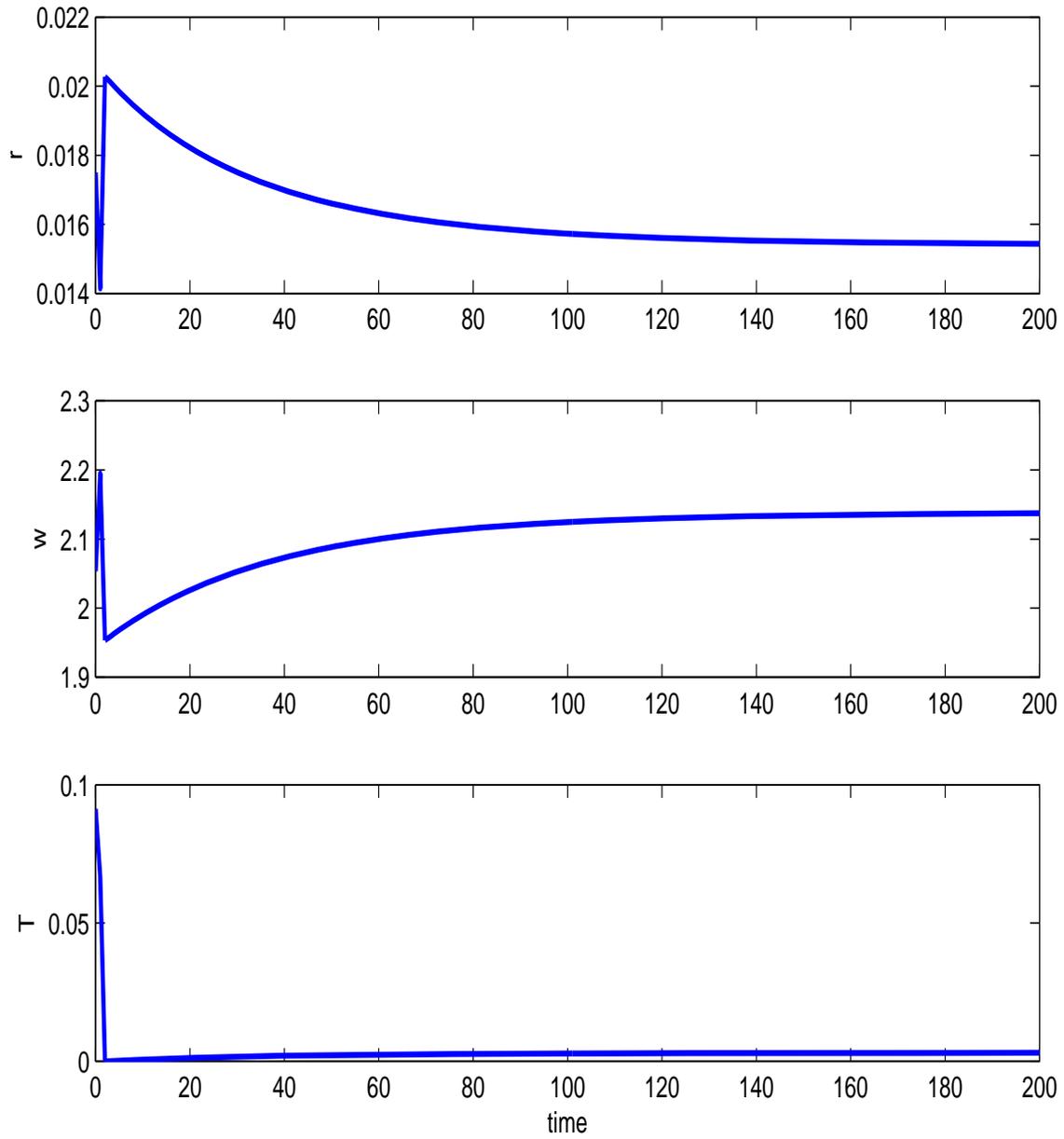


Figure 5: Welfare gain from transition to Condorcet winning policy

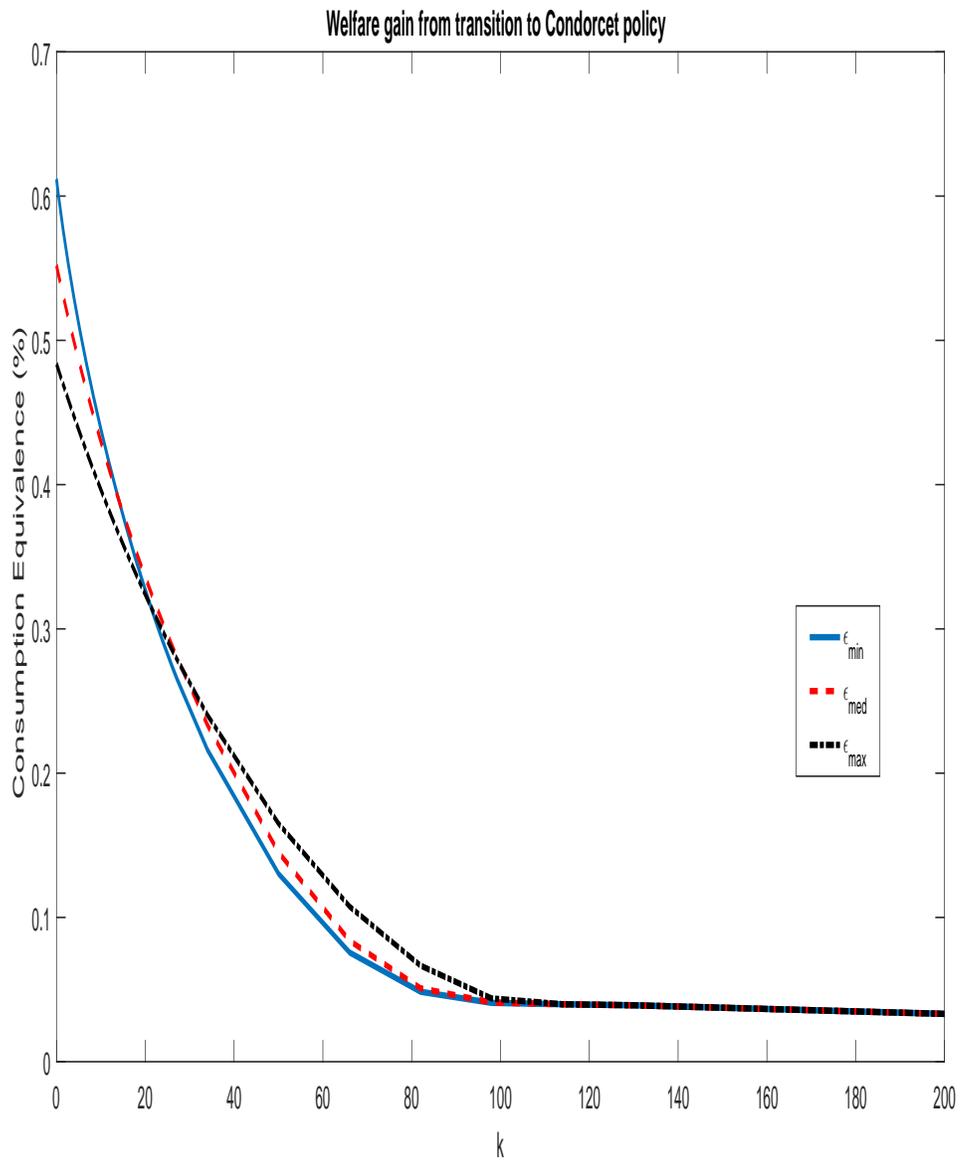


Figure 6: Preferences over consumption taxes

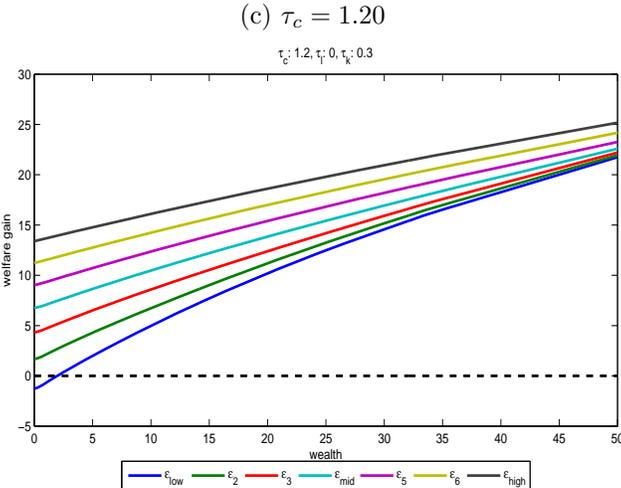
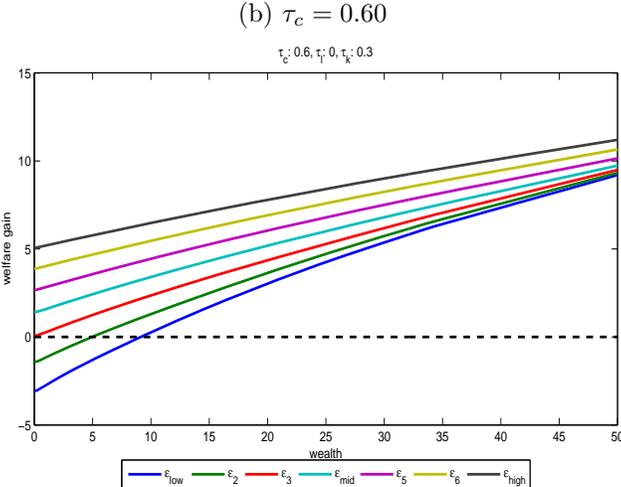
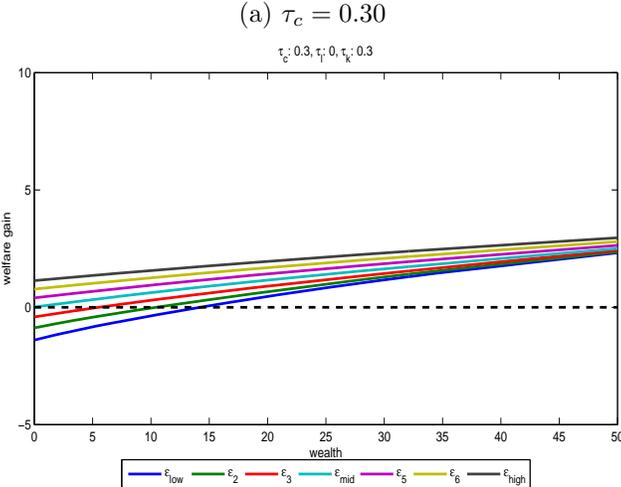


Figure 7: Preferences over capital income taxes

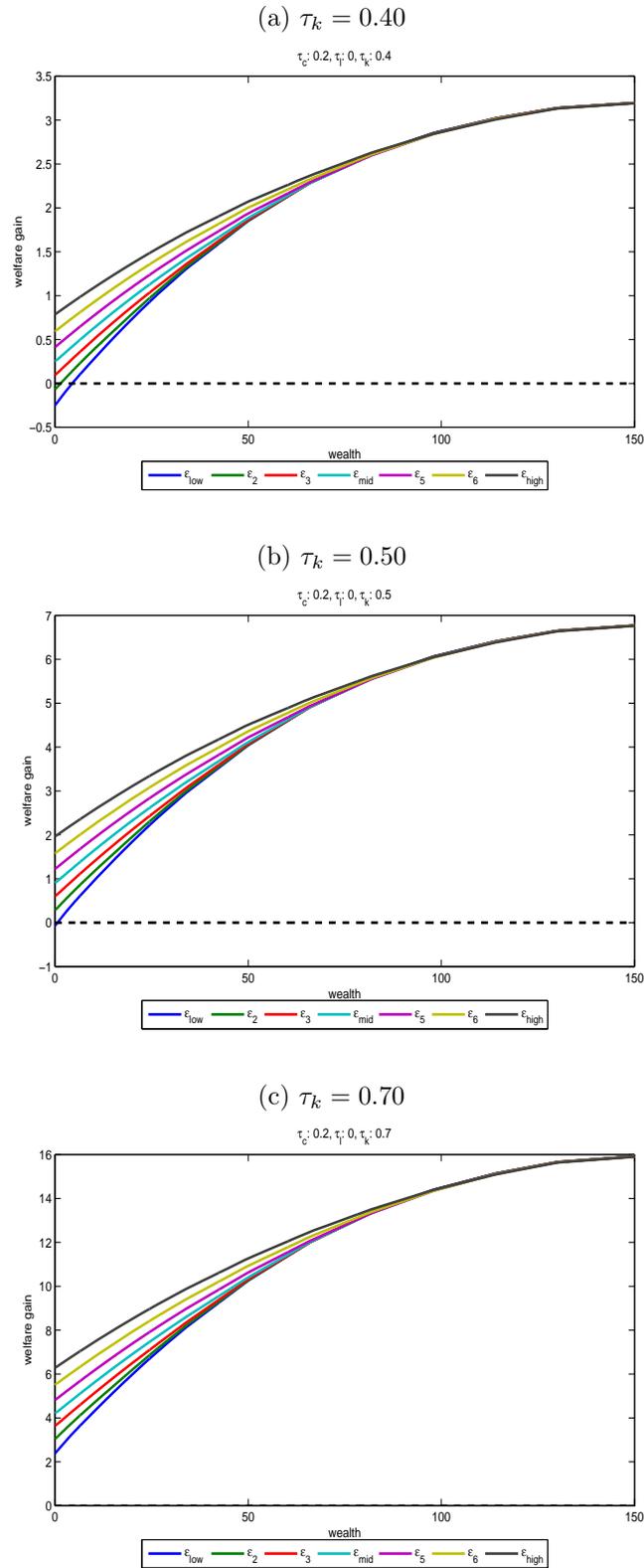


Figure 8: Preferences over labor income taxes

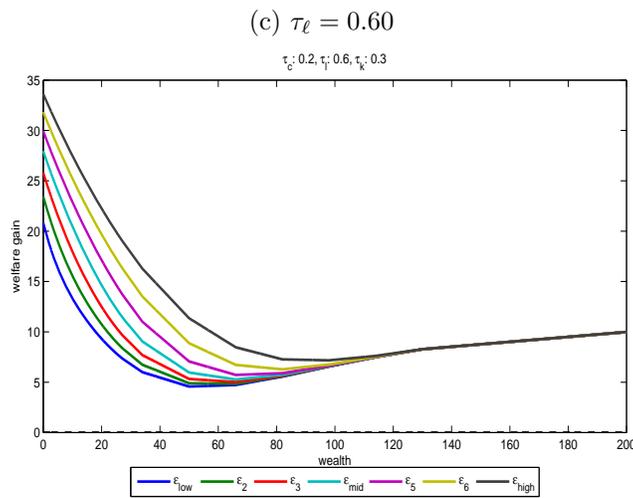
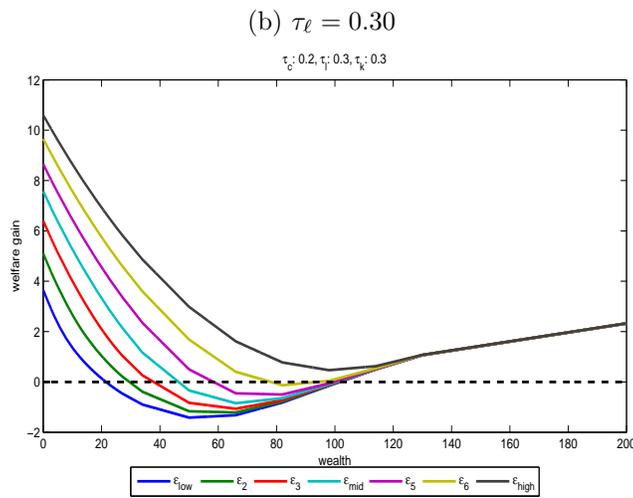
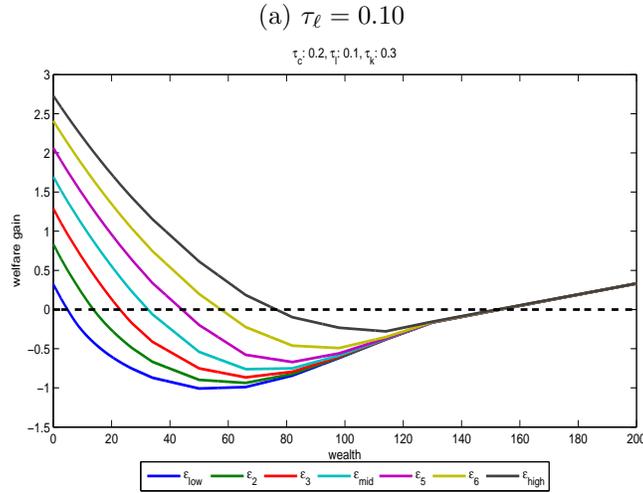
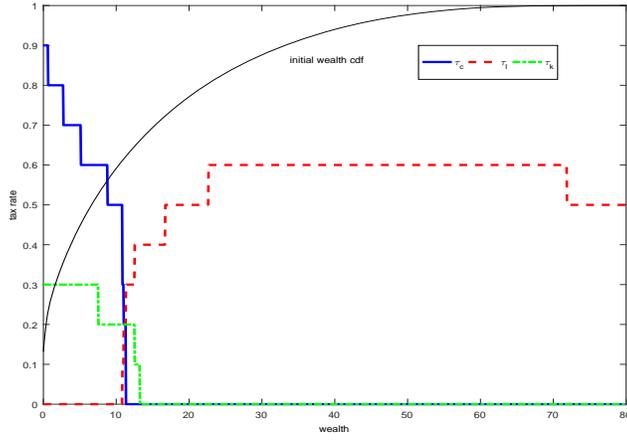
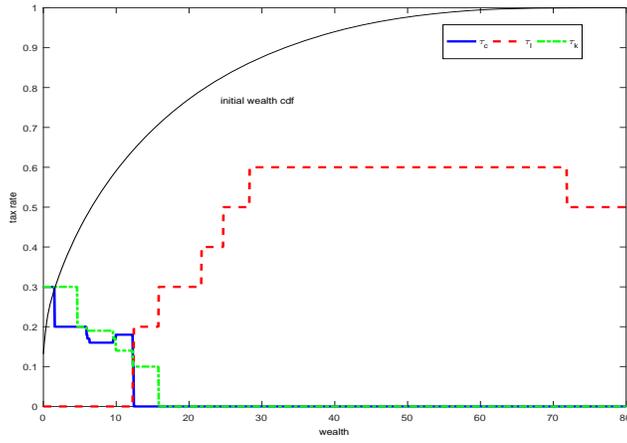


Figure 9: Most preferred tax combination by productivity and wealth

(a) Lowest ε



(b) Median ε



(c) Highest ε

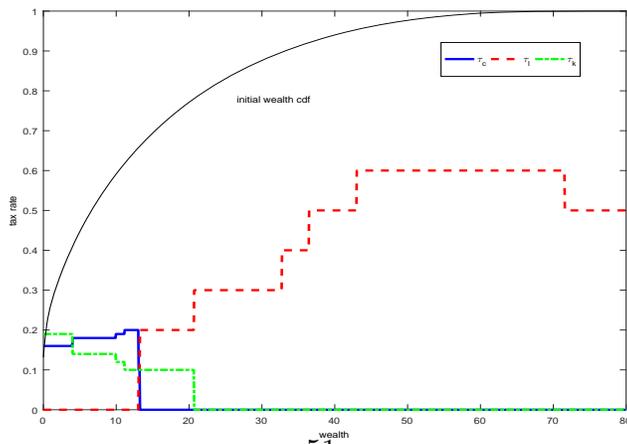


Figure 10: Marginal propensity to consume

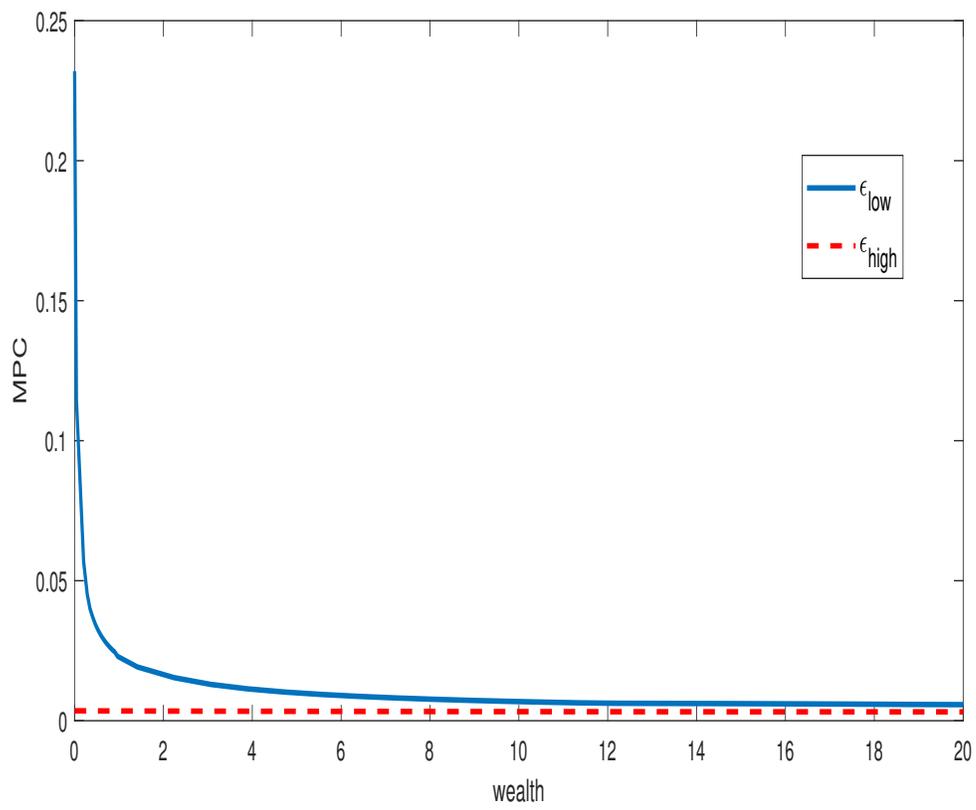
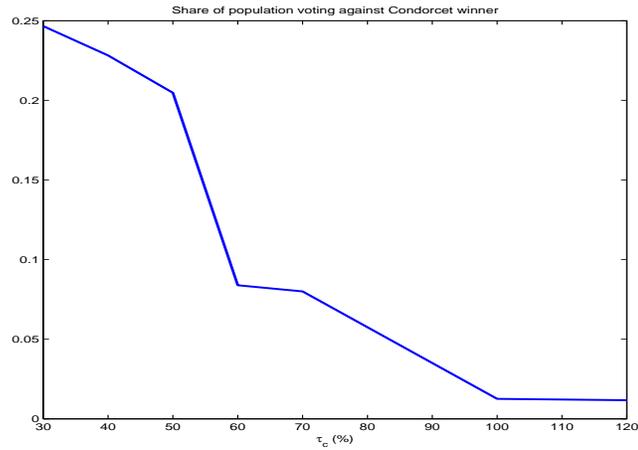
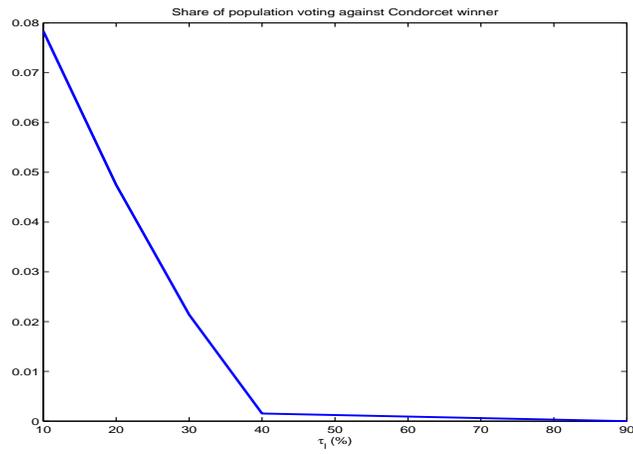


Figure 11: Share of votes for alternative policy with higher . . .

(a) consumption tax



(b) labor income tax



(c) capital income tax

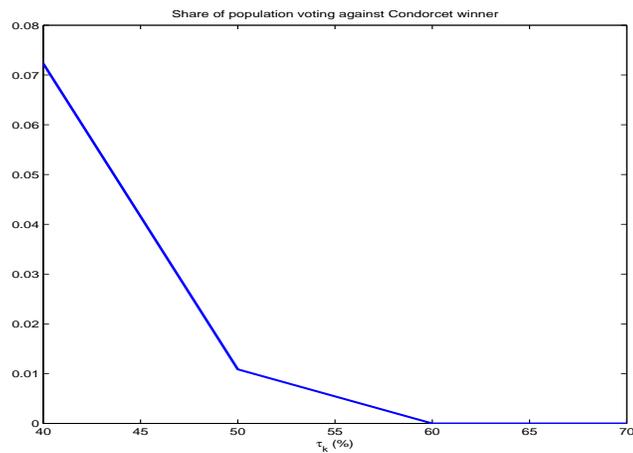


Figure 12: Wealth Lorenz curve

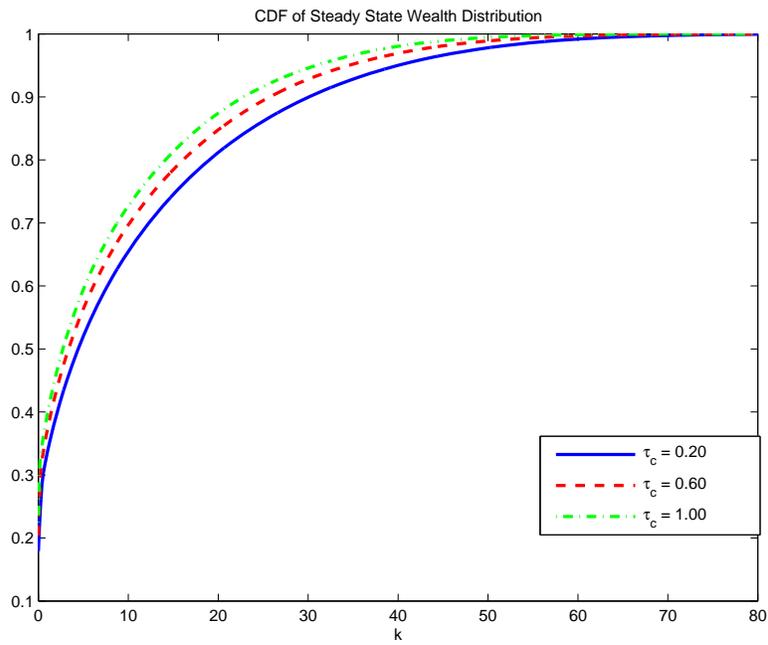
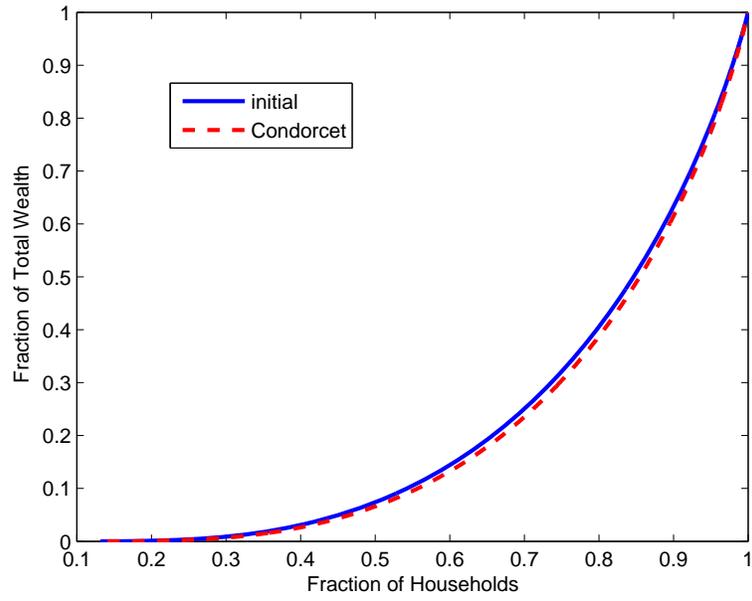


Figure 13: CDF of wealth by τ_c

Figure 14: CDF of wealth by τ_k

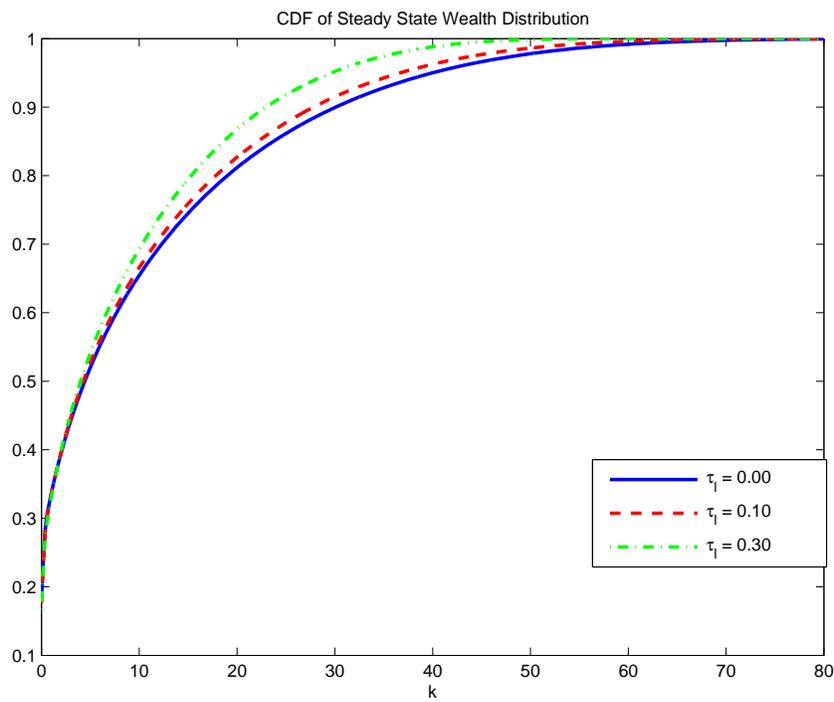
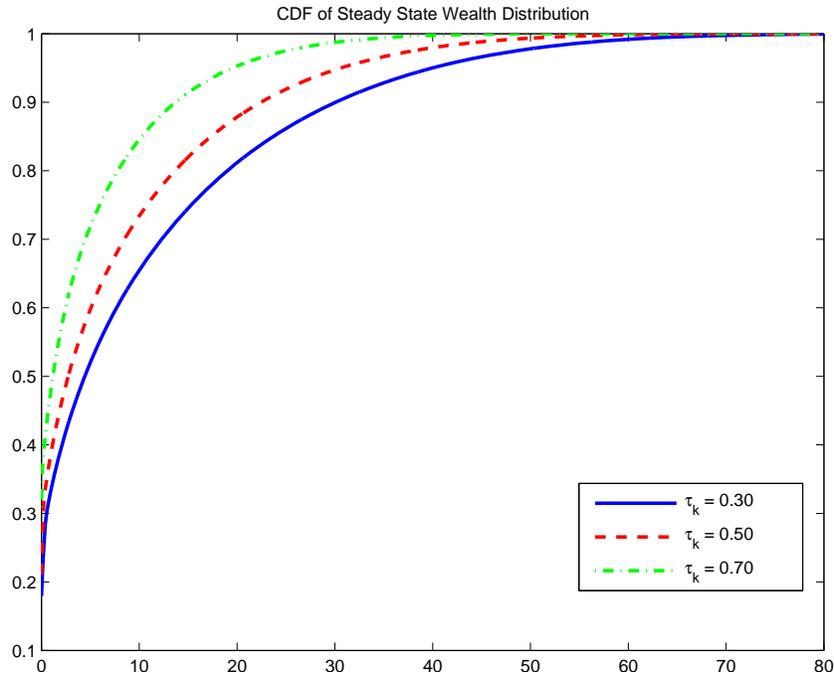


Figure 15: CDF of wealth by τ_l

Figure 16: CDF of votes under wealth-weighting

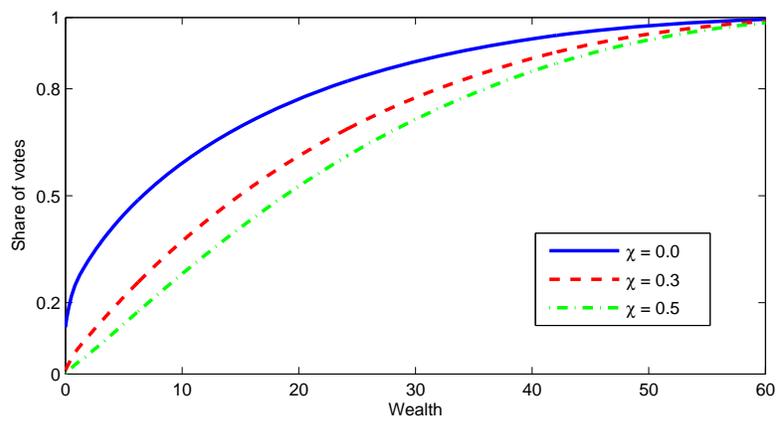
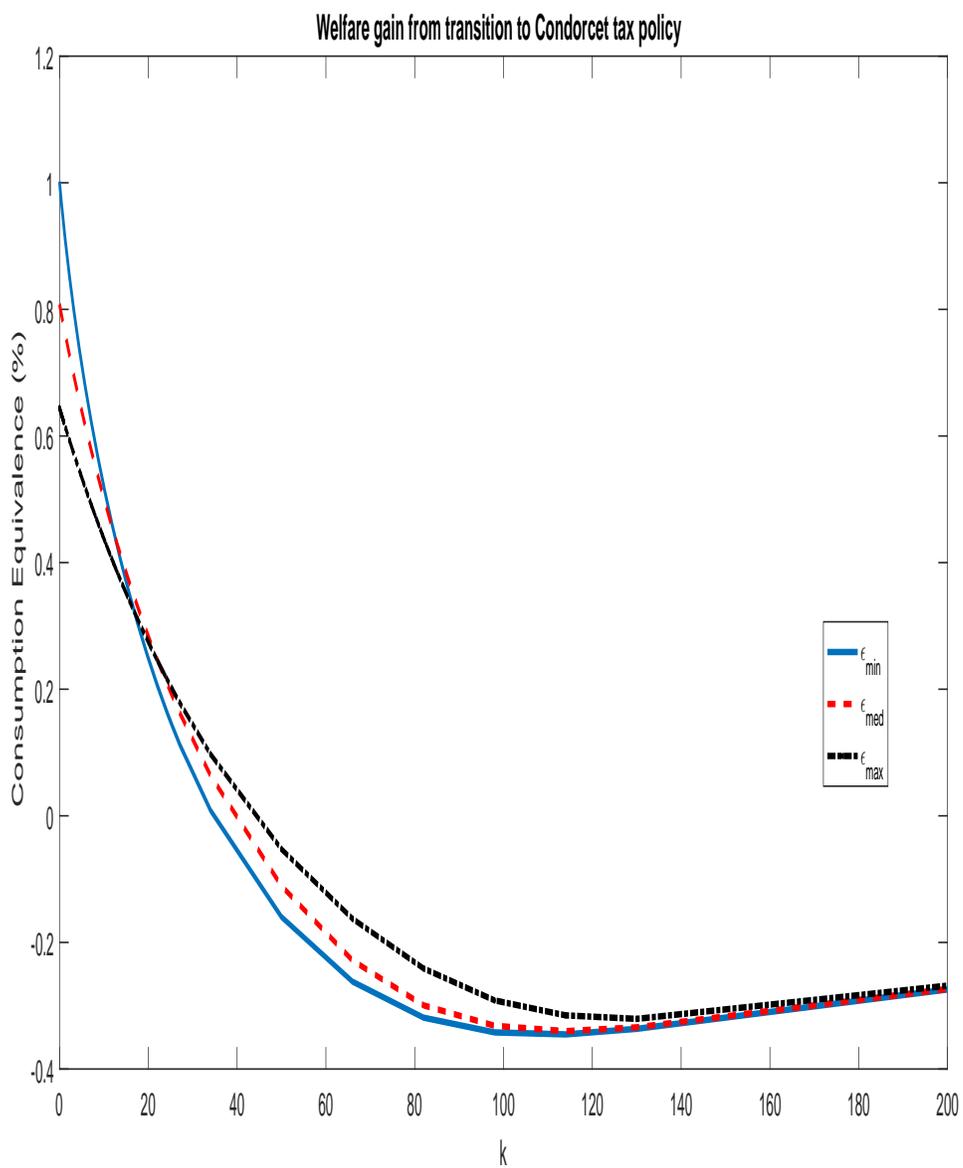


Figure 17: Welfare gain from transition to Condorcet winning policy (subsidies allowed)



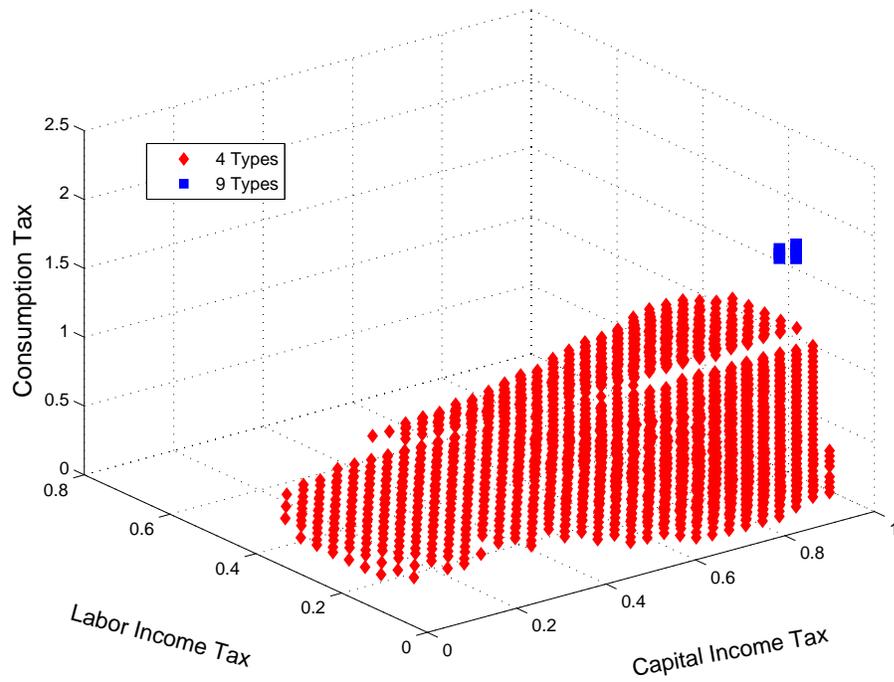


Figure 18: Uncovered set in Dolmas model

Table 1: Calibrated Parameters

Parameter	Value
β	0.986
Z	0.862
θ	2.203
T	0.091

Data	1	2	3	4	5
1	0.90	0.07	0.02	0.01	0.00
2	0.27	0.34	0.30	0.06	0.02
3	0.09	0.14	0.45	0.25	0.06
4	0.05	0.06	0.15	0.51	0.23
5	0.05	0.05	0.06	0.17	0.68
Model	1	2	3	4	5
1	0.58	0.20	0.13	0.06	0.03
2	0.16	0.35	0.21	0.20	0.07
3	0.11	0.15	0.39	0.16	0.18
4	0.08	0.19	0.09	0.41	0.22
5	0.07	0.09	0.18	0.17	0.49

Table 2: Earnings Mobility

Table 3: Wealth Mobility

Data	1	2	3	4	5
1	0.63	0.26	0.07	0.03	0.02
2	0.27	0.45	0.17	0.07	0.03
3	0.07	0.22	0.45	0.20	0.06
4	0.03	0.05	0.26	0.45	0.21
5	0.01	0.03	0.05	0.25	0.67
Model	1	2	3	4	5
1	0.76	0.23	0.01	0.00	0.00
2	0.24	0.55	0.21	0.01	0.00
3	0.00	0.22	0.61	0.17	0.00
4	0.00	0.00	0.17	0.72	0.11
5	0.00	0.00	0.00	0.11	0.89