Capital taxation, inequality and polarisation under lack of commitment*

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Abstract

Research from models allowing for heterogeneity in asset endowments and endogenously chosen fiscal policy suggests a positive link between income inequality and both capital taxes and polarisation. However, while the second prediction receives empirical support, capital tax rates are negatively related with inequality in the data for OECD democracies. Using the basic neoclassical model with capital asset inequality, we show that both stylised facts can be explained in a majority equilibrium with representative democracy and Markov perfect policy. This result is driven by the fact that the concentration of capital holdings and the capitalist bias associated with the politico-economy system work as substitutes in reducing the inefficiencies associated with lack of commitment.

Keywords: Markov-perfect policy; Representative democracy; Capital taxation

JEL Classification: E62, H21

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1 Introduction

An important issue for fiscal policy is the potential trade-off between efficiency and equality (see e.g. Atkinson and Stiglitz (1980), Drazen (2000) and Persson and Tabellini (2000)). A focal point of this research has been the choice of the capital tax, given the apparent inequalities in the distribution of wealth. This issue is typically examined in setups that allow for heterogeneity in asset ownership, so that agents can have different preferences over the mix of tax policy. A general prediction from these studies is that as underlying income inequality rises, redistributive policies in general, and the capital tax in particular, should also increase, since the median-voter in a democratic system prefers more redistribution. Moreover, higher inequality leads to greater polarisation, as the consensus between the different income groups over the choice of fiscal policy is reduced.

The empirical literature has generally not been able to provide robust support for the prediction that inequality is positively related to more redistributive policies (see e.g. Drazen (2000, ch. 11)). For instance, when we examine the relationship between the effective average capital tax rate and income inequality for high-income OECD democracies in Figure 1 below, we find a negative relationship.\footnote{The Gini index on income inequality is obtained from the World Development Indicators and the tax rate data are obtained from Martinez-Mongay (2000). We use the effective average tax rate on post-depreciation capital income that includes the income of the self-employed. Both variables are averaged over 1993-2000.} On the other hand, empirical studies have confirmed a positive relationship between income inequality and polarisation (see e.g. Drazen (2000, ch. 11)). Using a dataset on polarisation, which measures the lack of consensus between the different agents regarding economic policy, we also find in Figure 1 below a positive relationship between polarisation and income inequality for high-income OECD democracies.\footnote{The data on polarization are obtained from Lindqvist and Ostling (2010), who measure polarization using the standard deviation from survey responses about the role of the government in the years 1999-2000. The particular measure we use is SD\_GOV from their sub-sample of democratic countries. Also see Azzimonti (2011) who uses this measure to examine the relationship between polarisation and investment.}

[Figure 1 here]

In light of the above, this paper examines the trade-off between efficiency and redistribution in the choice of the capital tax and attempts to explain how capital asset inequality and endogenously chosen fiscal policy can be consistent with both empirical observations in Figure 1. To this end, we use the basic neoclassical dynamic general equilibrium model with asset inequality and solve for both utilitarian and political economy equilibria with and
without commitment. More specifically, we solve for Ramsey and Markov-perfect tax-spending policy in a setup with capitalists and workers. In our model, the government chooses both capital and labour tax rates to finance endogenous utility-enhancing public services. Following Krusell et al. (2002), Klein et al. (2008) and Azzimonti (2011), we focus on the steady-state of a differentiable Markov-perfect equilibrium, working with the generalized-Euler equation (GEE). To obtain the political economy equilibria, we follow e.g. Persson and Tabellini (1994, 2000) and assume that, in a democratic system, economic policy is chosen by the majority.

The type of heterogeneity and asset inequality that relies on the distinction between “capitalists” and “workers” has been popular in the literature on optimal taxation (see e.g. Judd (1985), Lansing (1999) and Krusell (2002)). Using this breakdown, Judd (1985) derived the striking result that a benevolent government under commitment should not impose any redistributive capital taxes in the long-run.\(^3\) This holds even from the perspective of those agents without capital income. Thus, there is no trade-off between efficiency and equity. However, the Judd (1985) results hold when the government can commit to future policies. In recent work, within the representative agent framework, Klein and Rios-Rull (2003), Ortigueira (2006), Klein et al. (2008) and Martin (2010) have also examined time-consistent optimal fiscal policy.\(^4\) The general message arising from this research is that Markov-perfect policy results in inefficiently high capital taxes in the long-run relative to Ramsey policy.\(^5\)

Our analysis shows the following. First, under time consistent policy, an increase in the concentration of capital holdings leads to an increase in income and welfare inequality. However, it also helps to partially correct the distortion introduced by lack of commitment through a reduction in the inefficiently high capital tax. This happens because as asset concentration and income inequality increase, the total supply of capital is reduced since

\(^3\)The robustness of this normative long-run result has been challenged (see e.g. Guo and Lansing (1999) and Lansing (1999), but it remains a point of reference in the modern theory of optimal taxation. As Mankiw et al. (2009, p. 167) point out, “perhaps the most predominant result from dynamic models of optimal taxation is that the taxation of capital ought to be avoided”.

\(^4\)Earlier work on time-consistent policy is reviewed in Krusell (2002) and Klein et al. (2008).

\(^5\)Martin (2010) further shows the circumstances under which the government would have an incentive to confiscate capital when both capital and labour taxes are optimally chosen. Krusell (2002) shows that, in a model with capitalists and workers, where a single production tax is used to finance lump-sum transfers to workers, the time-consistent tax in the long-run is generally non-zero and non-confiscatory as long as some weight is put on the utility of the capitalists.
a smaller segment of the population can accumulate capital. In turn, this implies that the incentive of the government to tax the capital base is reduced, given that, under diminishing returns, the efficiency losses arising from reducing a smaller capital stock are even higher. Therefore, tax policies that involve a relatively low capital tax can become credible and thus arise in equilibrium even under Markov policies. In contrast, under commitment, the above mechanism is absent as, consistent with the Judd-type literature, the government finds it optimal to commit to a zero capital tax irrespective of capital ownership and income inequality.

The intuition behind the above result is that a higher concentration of capital holdings effectively increases the preferences of the government for more "conservative" policies. This is consistent with e.g. the conservative central banker in Rogoff (1985), the conservative (or right-wing) fiscal authorities in Persson and Tabellini (1994) and the conservative robust decision maker in Dennis (2010)).

Second, we next show that, consistent with Person and Tabellini (1994), if policy is chosen by the majority in a representative democracy, the government finds it optimal to be biased in favor of capitalists and this allows for lower capital taxes and benefits for both workers and capitalists. Therefore, such a representative democracy equilibrium is Pareto superior to the commonly accepted social norm of Benthamite policy, despite leading to higher inequality. This finding suggests that there are areas of consensus between the two agents, which are captured by the degree of the capitalist bias in fiscal policy that the worker agrees with.

Third, we find that the representative democracy equilibrium is not Pareto dominated by the Ramsey equilibrium, given that the workers find it optimal to choose a non-zero capital tax. In other words, although the workers are willing to trade-off some equity for efficiency gains, the optimum for them includes some redistribution, in the form of a positive capital tax, despite the productivity losses caused by the latter. The capitalists, on the other hand, would prefer a higher capitalist bias than workers. Hence, despite areas of consensus regarding economic policy, there is also a conflict of interests behind the equilibria observed in representative democracies since the

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6Person and Tabellini (1994, 2000, ch. 12), suggest that the majority in a representative democracy will find it optimal to delegate fiscal policy to a conservative government that cares more about the agents with a higher capital endowment. This can allow the government to credibly commit to lower capital taxes, and the implied efficiency gains make up for the equity losses, at least for the majority.

7This possibility has also been discussed by Persson and Tabellini (1994) and further suggests that, basing normative analysis about optimal policy on commitment, might lead to erroneous recommendations.
"optimal" degree of capitalist bias differs between workers and capitalists.

Fourth, consistent with the stylised facts presented in Figure 1, we find that under a representative democracy, inequality is negatively related to capital taxation and positively related to polarisation. The latter can be measured by a fall in the degree of capitalist bias characterizing the preferences of the representative chosen by the worker. The intuition behind these two findings respectively is as follows. On the one hand, in a representative democracy, the higher the concentration of capital holdings, and so the scarcer the supply of capital, the stronger the incentive of the worker-voter to accept lower capital taxes to encourage capitalists to increase the capital stock. On the other hand, the benefits for the workers from a government that uses a higher capitalist bias are smaller under higher concentration of capital holdings, which leads to higher polarization.

Finally, a comparison of the representative democracy equilibrium to either the time consistent Benthamite equilibrium or the Ramsey equilibrium, suggests that the former’s predictions regarding capital and labour tax rates are more empirically relevant and closer to actual rates. This finding is encouraging given the well known gap between theory and practice in tax policy (see e.g. Mankiw et al. (2009)).

2 The economy

We next describe a deterministic version of the neoclassical growth model comprised of capitalists, workers, firms and a government. Time is discrete and infinite. In each time-period, the government acts as a Stackelberg leader, so that it moves first choosing its current tax-spending policy and, in turn, private agents move acting competitively. In each period, we first solve for the decentralized competitive equilibrium (DCE) given policy. Then, taking this DCE into account, the government chooses its tax-spending policy to maximize a weighted average of capitalists and workers’ welfare.

2.1 Economic agents and their roles

Capitalists consume, work and save in the form of capital. They also own the firms and receive profits which, for simplicity, are zero in equilibrium due to constant returns to scale. Workers in contrast do not have access to capital

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As in most of the related literature (see e.g. Judd (1985), Lansing (1999) and Krusell (2002)), we take agents’ roles as given and do not model their microfoundations. See e.g. Aghion and Howitt (2009, ch. 6) for a review of the literature on participation in capital markets and inequality.
markets and thus only consume and work. The government taxes income from capital and labour to finance utility-enhancing public spending.\(^9\)

### 2.2 Population composition

Total population size, \(N\), is exogenous and constant. Among \(N\), \(N^w < N\) are identical workers, while the rest \(N^k = N - N^w\) are identical capitalists. Workers are indexed by the subscript \(w = 1, 2, ..., N^w\) and capitalists by the subscript \(k = 1, 2, ..., N^k\). Private firms are indexed by the subscript \(f = 1, 2, ..., N^f\). We assume that the number of firms equals the number of capitalists, \(N^k = N^f\), or that each capitalist owns one firm.

### 2.3 Households

#### 2.3.1 Utility functions and budget constraints

We start by presenting the two types of households, capitalists, \(k\), and workers, \(w\). Each household \(h \equiv k, w\) maximises:

\[
U_h = \sum_{t=0}^{\infty} \beta^t u \left( C_{h,t}, z_{h,t}, \bar{G}_t \right)
\]

where \(C_{h,t}\) and \(z_{h,t}\) are household \(h\)’s consumption and leisure time at \(t\); \(\bar{G}_t\) is average government services (i.e. total public consumption services divided by total population, \(N\)) at \(t\); and \(0 < \beta < 1\) is the time preference rate. The period utility function, \(u_{h,t} \equiv u \left( C_{h,t}, z_{h,t}, \bar{G}_t \right)\), is increasing and concave in all arguments.

The within-period budget constraint of each capitalist (indexed by subscript \(k\)) is:

\[
C_{k,t} + K_{k,t+1} - (1 - \delta) K_{k,t} = r_t K_{k,t} + \pi_{k,t} - \tau^k_t \left( (r_t - \delta) K_{k,t} + \pi_{k,t} \right) + (1 - \tau^l_t) w_l l_{k,t}
\]

where \(K_{k,t+1}\) is the end-of-period capital stock held by each capitalist; \(r_t\) is the return to the beginning-of period capital stock; \(w_l\) is the wage rate; \(l_{k,t}\) is hours of work by each capitalist, where \(l_{k,t} + z_{k,t} = 1\) is the time constraint in each period; \(\pi_{k,t}\) is firms’ profit per capitalist; \(0 \leq \tau^l_t < 1\) is the tax rate on capital income\(^10\) and profits; \(0 \leq \tau^l_t < 1\) is the tax rate on labour income;

\(^9\)Krusell (2002) and Azzimonti et al. (2008) also study time-consistent policy and redistribution, using however a smaller set of policy instruments that includes lump-sum ones. Moreover, Azzimonti (2011) considers time-consistent policy with agents who differ in their preferences over the public good.

\(^{10}\)Following most of the literature on optimal policy, we assume capital taxes net of depreciation, see e.g. Chari et al. (1994) and Klein et al. (2008).
$0 < \delta < 1$ is the capital depreciation rate; and $K_{k,0} > 0$ is given. Each capitalist $k$ acts competitively choosing $(C_{k,t}, l_{k,t}, K_{k,t+1})_{t=0}^{\infty}$.

The budget constraint of each worker (indexed by subscript $w$) is:

$$C_{w,t} = (1 - \tau^1_t) w_t l_{w,t}. \quad (3)$$

Each worker $w$ acts competitively choosing $C_{w,t}$ and $l_{w,t}$ in each period, where the time constraint is $l_{w,t} + z_{w,t} = 1$.

### 2.4 Firms

Firm $f = 1, 2, ..., N^f$ profits are given by:

$$\pi_{f,t} = Y_{f,t} - r_t K_{f,t} - w_t l_{f,t} \quad (4)$$

where $Y_{f,t}$ is each firm’s output and $K_{f,t}$ and $l_{f,t}$ are respectively the inputs of capital and labour employed by the firm at $t$. The output technology is:

$$Y_{f,t} = f(K_{f,t}, l_{f,t}) \quad (5)$$

where the production function $f(.)$ is increasing and concave in both arguments, and, for simplicity, displays constant returns to scale in the two factors. Each firm $f$ acts competitively choosing $K_{f,t}$ and $l_{f,t}$ to maximize profits.

### 2.5 Government budget constraint

The government budget is balanced in each period. Thus, in aggregate terms, we have:

$$N^G_t = N^k [\tau^k_t (r_t - \delta) K_{k,t} + \pi_{k,t}] + \tau^1_t w_t l_{k,t} + N^w \tau^1_t w_t l_{w,t} \quad (6)$$

so that there are three policy instruments, $\tau^k_t$, $\tau^1_t$ and $G_t$, out of which only two can be independently set.

### 2.6 Decentralized competitive equilibrium (DCE)

We now present the DCE given policy. In this equilibrium, households maximize utility, firms maximize profits, the government budget constraint is satisfied and markets clear.\textsuperscript{11} It is convenient to: (i) define the population

\textsuperscript{11}The market-clearing conditions in the capital, labor, dividend and goods markets are respectively $N^f K_{f,t} = N^k K_{k,t}$, $N^f l_{f,t} = N^k l_{k,t} + N^w l_{w,t}$, $N^f \pi_{f,t} = N^k \pi_{k,t}$ and $N^k C_{k,t} + N^w C_{w,t} + N^k (K_{k,t+1} - (1 - \delta) K_{k,t}) + N^G_t = N^f Y_{f,t}$. 

7
shares, $n^w \equiv N^w / N$ and $n^k \equiv N^k / N = 1 - n^w$; and (ii) work with net factor returns, $R_t \equiv (1 - \tau^k_t) (r_t - \delta)$ and $W_t \equiv (1 - \tau^l_t) w_t$. Then, the DCE can be summarized by six equations, in \{\(C_{k,t}, C_{w,t}, l_{k,t}, l_{w,t}, K_{k,t+1}\}_{t=0}^{\infty}\} and the path of one of the three policy instruments that adjusts to satisfy the government budget constraint (see Appendix 8.1.1 for the DCE). It is convenient to treat \(G_t\) as the adjusting instrument, so that \(\tau^k_t\) and \(\tau^l_t\), or equivalently \(R_t\) and \(W_t\), are the independently chosen instruments.

As is well known, if the government chooses its policy subject to this form of the DCE, and if we do not assume commitment technologies, the solution is time inconsistent. We thus need to transform the DCE conditions into recursive form so that policy choices affect payoffs dated \(t\) and later but not earlier. To do so, we work as in Klein et al. (2008). Focusing on a Markov-perfect equilibrium, if such an equilibrium exists, equilibrium strategies will be functions of the current value of the economy’s state variable, \(K_{k,t}\). Specifically, in our model, after policy has been chosen, a Markov solution will include undetermined functions of the form \(K_{k,t+1} = h(K_{k,t})\), \(l_{k,t} = \lambda(K_{k,t}, W_t, R_t)\), \(l_{w,t} = \mu(K_{k,t}, W_t)\), \(W_t = \Phi(K_{k,t})\) and \(R_t = \Psi(K_{k,t})\). We can thus use \(h(K_{k,t+1}), \lambda(K_{k,t+1}), \mu(K_{k,t+1}), \Phi(K_{k,t+1})\) and \(\Psi(K_{k,t+1})\) to replace respectively \(K_{k,t+2}\), \(l_{k,t+1}\), \(l_{w,t+1}\), \(W_{t+1}\) and \(R_{t+1}\) in the DCE equations and, in particular, in the capitalist’s Euler-equation which includes \(t + 1\) variables. Then, the DCE equilibrium conditions become (see Appendix 8.1.2 for further details):

\[
\begin{align*}
C_{k,t} &= -K_{k,t+1} + (1 + R_t)K_{k,t} + W_t l_{k,t} \\
&\equiv C(K_{k,t}, W_t, R_t, l_{k,t}, K_{k,t+1}) \tag{7}
\end{align*}
\]

\[
\begin{align*}
l_{k,t} &= \Lambda(K_{k,t}, W_t, R_t) \tag{8}
\end{align*}
\]

\[
\begin{align*}
K_{k,t+1} &= H(K_{k,t}, W_t, R_t) \tag{9}
\end{align*}
\]

\[
\begin{align*}
C_{w,t} &= W_t l_{w,t} \tag{10}
\end{align*}
\]

\[
\begin{align*}
l_{w,t} &= M(K_{k,t}, W_t, R_t) \tag{11}
\end{align*}
\]

\[
\begin{align*}
\overline{G}_t &= n^k Y_{f,t} - \delta n^k K_{k,t} - R_t n^k K_{k,t} - W_t (n^k l_{k,t} + n^w l_{w,t}) \\
&\equiv \overline{G}(K_{k,t}, W_t, R_t, l_{k,t}, l_{w,t}) \tag{12}
\end{align*}
\]

where we use for output:

\[
\begin{align*}
Y_{f,t} = f \left( K_{k,t}, l_{k,t} + \frac{n^w}{n^k} l_{w,t} \right) \tag{13}
\end{align*}
\]

Equations (7), (10) and (12) are budget constraints, while the functions given in (8), (9) and (11) replace the private agents’ optimality conditions
for capital and labour. These three functions show the optimal response of private agents given the economy’s state, $K_{k,t}$, and the current values of the two independent policy instruments, $W_t$ and $R_t$, under the presumption that we will be in a Markov-perfect equilibrium in the future. The properties of these private reaction functions, $H(\cdot)$, $\Lambda(\cdot)$ and $M(\cdot)$, follow from the properties of the primitive functions (utility and production) and the properties of the undetermined Markov functions guessed above (see also Klein et al., 2008, p. 795).

3 Markov-perfect policy

Although below we solve for optimal (Markov) policy under various political economy scenaria, it is convenient to first present the general policy problem and then study special cases. In each time-period, the government chooses its current policy instruments to maximize a weighted average of capitalists and workers welfare subject to the recursive form of the DCE as shown in (7—13).

The government chooses $W_t$ and $R_t$ to solve the dynamic programming problem:

$$V(K_{k,t}) = \max[(1 - \gamma)u(C_{k,t}, 1 - l_{k,t}, \bar{G}_t) + \gamma u(C_{w,t}, 1 - l_{w,t}, \bar{G}_t) + \beta V(K_{k,t+1})]$$

where $V(K_{k,t})$ denotes the value function of the government at $t$; $\gamma$ and $(1 - \gamma)$ are the weights attached by the government to the utility of workers and capitalists respectively. For instance, if the government has a Benthamite utility function, $\gamma = n^w$ and $(1 - \gamma) = n^k$.

The optimality conditions include the first-order conditions for the two independent policy instruments, $W_t$ and $R_t$, and the envelope condition for the state variable, $K_{k,t}$. Working as in Klein et al. (2008), we use one of the optimality conditions to substitute out the government’s value function, $V_t = V(K_{k,t})$. In particular, we use the optimality condition for $W_t$ to find an expression for $\frac{dV_{t+1}}{dK_{k,t+1}}$ as well as its one-period lead to obtain a relation for $\frac{dV_{t+2}}{dK_{k,t+2}}$ and, in turn, we substitute these into the lead-once envelope condition yielding the so-called Generalized Euler-equation (GEE).

Therefore, the final system to solve consists of the government’s GEE, the government’s optimality condition for $R_t$, the Euler condition of capitalists, the labour supply condition of capitalists and the labour supply condition of

\footnote{Note that we derive the properties of the private reaction functions using specific functional forms in Appendix 8.2.}
workers. Namely, there are five equations in five functions, $K_{k,t+1} = h(K_{k,t})$, $l_{k,t} = \lambda(K_{k,t})$, $l_{w,t} = \mu(K_{k,t})$, $W_t = \Phi(K_{k,t})$ and $R_t = \Psi(K_{k,t})$.

### 3.1 Quantitative assumptions

To quantitatively address the key questions raised in the Introduction, we employ the numerical perturbation algorithm proposed by Krusell et al. (2002) and Klein et al. (2008) to solve the system of functional equations derived above at the steady-state. To facilitate comparability with the literature, we adopt the same functional forms for utility and production, as well as the same parameter values used by Klein et al. (2008). In particular, we use:

$$u(C_{h,t}, z_{h,t}, G_t) = \mu_1 \log(C_{h,t}) + \mu_2 \log(1 - l_{h,t}) + \mu_3 \log(G_t)$$

and $A = 1$, $\alpha = 0.36$, $\beta = 0.96$, $\delta = 0.08$, $\mu_1 = 0.261$, $\mu_2 = 0.609$, $\mu_3 = 1 - \mu_1 - \mu_2$. Since (15) applies to both capitalists and workers, the only additional parameters required by our setup include $n^k$ and $n^w = 1 - n^k$. In our baseline parameterization, we set $n^k = 0.25$.

Using these functional forms allows the final system of equations to be reduced from the five set out above to three, i.e. the government’s GEE, the government’s optimality condition for $R_t$ and the Euler condition of capitalists, which are solved for the following three undetermined functions, $K_{k,t+1} = h(K_{k,t})$, $R_t = \Psi(K_{k,t})$, $W_t = \Phi(K_{k,t})$.

### 4 Benthamite optimal policy

In this section, we study the case of a utilitarian or Benthamite government which attaches weights $\gamma$ and $(1 - \gamma)$ to the utility of workers and capitalists equal to their population shares, i.e. $\gamma = n^w$ and $(1 - \gamma) = n^k$. We characterise the solution of this government under lack of commitment as this serves to provide a useful normative benchmark for fiscal policy. We next examine the importance of the underlying population structure and, in particular, the inequality in asset holdings. Following the related literature, we focus on the long run. Finally, to contextualise the importance of lack of commitment, we also report results for the Ramsey equilibrium. In this case of second-best policy, the government chooses $\{W_t, R_t, G_t\}_{t=0}^{\infty}$ to maximise the weighted average of capitalists and workers welfare, as specified in (14), subject to the DCE in Appendix 8.1.1.

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13Note that Appendix 8.2 presents the final system using specific functional forms while Appendix 8.3 briefly describes the computational solution algorithm.
4.1 Markov versus Ramsey policy

Optimal allocations with and without commitment are shown in Table 1. As can be seen, a Ramsey government needs to take into account the distortions introduced by the tax system and does not find it optimal to equate the welfare of both agents, despite caring about them equally. Instead, it finds it best to support aggregate welfare by financing the public good in the least distorting way. Then, consistent with the results in Judd (1985), Chamley (1986) and Persson and Tabellini (1994), the optimal tax on capital in the long-run is zero under Ramsey policy, while the labour tax rate is positive. In other words, under commitment, the efficiency distortions of the tax system are minimized by choosing a zero capital and a positive labour tax in the long-run. This policy increases labour productivity and income through tax-induced increases in the capital stock.

In stark contrast, time-consistent Markov policy suggests that it is optimal for the Benthamite government to impose a very high capital tax and to reduce labour taxation to near zero. Naturally, these changes result in lower capital accumulation and higher labour supply in the Markov, relative to the Ramsey solution.\(^\text{14}\) Moreover, given that the tax system is more inefficient under lack of commitment, the optimal provision of the public good, \(G_t\), is reduced relative to Ramsey policy, as are total output and welfare (both at aggregate and individual levels). Therefore, our results under Benthamite policy suggest that lack of commitment has important effects on both the optimal choice and the efficiency of policy instruments on one hand and also on the welfare of both types of agents on the other.

It is a well-established finding in representative agent models that lack of commitment leads to inefficient increases in capital taxation (see e.g. Kydland and Prescott (1977) and Fischer (1980)). Time-consistent taxation in a differentiable subgame-perfect Markov equilibrium, within the context of a representative agent model, has been studied by Klein et al. (2008) and Martin (2010). The predictions regarding the effects of lack of commitment on the optimal choice and efficiency of the policy instruments obtained here under agent heterogeneity are consistent with the results from these models. For example, under both modeling assumptions, lack of commitment results in increases in capital taxes, reductions in the labour tax and a decrease in the overall efficiency of the tax system. Martin (2010) also allows the government to choose the capital and the labour tax rate simultaneously and shows

\(^\text{14}\)In particular, the fall in the labour tax increases the capitalist’s labour supply, but leaves the worker’s labour supply unaffected. This is because the worker’s labour supply is inelastic with respect to the labour tax since he does not save and has logarithmic preferences. These effects result in an increase in the aggregate labour supply.
that time-consistent policies generally result in confiscatory capital taxes and labour subsidies in the form of negative labour taxes. In particular, without commitment, although the government cannot undo the dynamic distortion in the form of high capital taxes, it can reduce the static distortion that the higher capital tax causes on the labour supply by reducing the labour tax.\textsuperscript{15}

The results in Table 1 are obtained for the same calibration used in Klein \textit{et al.} (2008) and for which Martin (2010) obtained confiscatory capital taxes. Therefore, we find that, for standard calibrations, a confiscatory capital tax does not generally follow in a capitalist-worker setup.\textsuperscript{16} The incentive to tax capital heavily in a Markov-perfect equilibrium and, at the same time, the incentive to subsidise labour, so as to undo the damage from high capital taxes, are weaker in our model. This is because capital taxation is more distortionary in a heterogeneous economy, since only a subset of the population can hold capital, which means that, \textit{ceteris paribus}, the supply of capital is lower relative to an economy where all agents have capital holdings. Hence, the incentive to tax capital is weaker, since the marginal efficiency losses arising from reducing a smaller capital stock are higher due to diminishing

\textsuperscript{15}The intuition behind the labour subsidy result is that since high future capital taxation discourages labour effort today, the government finds it optimal to subsidise labour. This, in turn, puts more pressure on the capital tax, so that for standard calibrations it becomes confiscatory.

\textsuperscript{16}Indeed, we find a robust range of interior solutions under heterogeneity based on changes in our base calibration over empirically relevant parameter ranges.
returns. In turn, the labour supply distortion, at the aggregate level, caused by future capital taxation is smaller relative to a single agent model. This follows, first because capital taxation is lower and second because the worker's optimal labour supply decision is not affected negatively by future capital taxation. As a result, the incentive for the government to subsidise labour is also weaker.\textsuperscript{17} Therefore, heterogeneity and, in particular, heterogeneous marginal propensities to save and labour supply elasticities, contribute to well-defined non-confiscatory tax rates on capital.

Regarding the welfare implications of the lack of commitment, we would expect that, under Ramsey policy, the capitalist should be better off, given the increases in efficiency under the zero capital tax. The results in Table 1 confirm that this is indeed the case. Does the increased productivity resulting from higher capital accumulation under Ramsey provide enough compensation in terms of private consumption for the worker? The findings in Table 1 suggest that consumption for the worker is higher in the Markov case, implying that the productivity gains are smaller than the income losses sustained by the increase in the labour tax. However, the increased efficiency of the tax system under commitment allows the government to provide much more of the public good and this more than compensates for the loss of private consumption, so that the worker is better off overall. Therefore, comparing Ramsey to Markov, we see that lack of commitment hurts all agents, at least under the assumption of a Benthamite government.

4.2 Asset concentration and the capital tax

The above discussion suggests that the degree of the heterogeneity in capital holdings between the two agents is important for the results obtained regarding the tax structure. The parameter that controls the extent of heterogeneity in this setup is the population share of capitalists, $n^k$. In particular, if $n^k = 1$, this model collapses to the representative agent model. As $n^k$ decreases, a larger share of the population is excluded from the capital markets, or, alternatively, a lower share of the population holds the capital stock. We would thus expect that income inequality would increase as $n^k$ decreases, since the proportion of high income agents in the economy becomes smaller.

We next examine the sensitivity of the solution obtained in Table 1 above, for changes in $n^k$ around the base value of 0.25 and present the results in Figure 2 below. We plot the long-run results for policy outcomes $(\tau^k, \tau^l, G/Y)$,  

\textsuperscript{17}The inelastic supply of labour for the worker creates the incentive for the government to positively tax this factor on efficiency grounds. However, since the same tax rate also applies to the labour supply of the capitalists, which is adversely affected by high future capital taxation, a labour tax would also have a negative effect on aggregate labour supply.
income inequality (Gini coefficient) and the welfare \( (u^k, u^w) \) against values of \( n^k \). Under commitment, changes in the concentration of capital holdings do not affect the utilitarian government’s policy and the equilibrium outcomes for the representative worker’s welfare. The representative capitalist, on the other hand, is able to increase his income and welfare as \( n^k \) falls.

The implications for government policy are different under lack of commitment. As can be seen, increases in \( n^k \) indeed make the results of the model more similar to those of the representative agent model analysed in e.g. Martin (2010). In particular, the capital tax rate quickly increases to near-confiscatory values, while the labour tax rapidly turns into a subsidy. As discussed above, a larger number of capitalists implies a higher supply of total capital, which in turn implies that the attractiveness of capital taxes increases. Therefore, the government cannot credibly commit to lower capital taxes. Instead, it tries to minimise the distortion in the labour market by subsidising the labour supply. Given the calibration of the remaining parameters, for values of \( n^k \) higher than 0.28, confiscatory capital taxes can arise.

\[ \text{[Figure 2 here]} \]

On the other hand, as \( n^k \) falls, the total capital stock tends, other things equal, to fall and thus the marginal costs of capital taxation rises. This implies that the government has a smaller incentive to tax capital and indeed the capital tax is reduced. In contrast, the labour tax has to be increased, which reduces labour supply. In fact, given the calibration of the remaining parameters, for \( n^k \) less than 22%, the distorting effects of the labour tax on the labour supply of the capitalist are so strong that the latter tends to become negative so that an interior solution cannot be obtained.

As expected in this neoclassical setup, the higher the capital tax, the more distorting the tax system, so that the available resources for the provision of the public good are reduced as well. Moreover, welfare of both agents is also reduced. Therefore, under lack of commitment in a Benthamite policy-regime, the welfare of both the workers and the capitalists is improved when the capital stock is held by fewer people since this allows the government to choose lower capital rates. This in turn brings the economy closer to the more efficient, second-best Ramsey solution. As we saw above, efficiency gains in this setup also imply Pareto gains.

The fact that everyone is better-off under a lower capital tax economy, does not also imply that the gains are the same for both agents. In particular, as the Gini coefficient plot in Figure 2 makes clear, capitalists increase their income more compared to the workers as the capital tax is reduced, following a fall in \( n^k \). This happens because in addition to the labour productivity
gains, the capitalists also benefit from the increase post-tax capital income. Therefore, despite the Pareto gains, increases in asset concentration lead to higher income and welfare inequality under a Benthamite government that cannot commit. The results in Figure 2 then suggest that higher asset concentration helps to correct the distortions caused by the lack of commitment by reducing the inefficiently high time-consistent capital tax.

5 Political preferences & majority equilibria

Our previous analysis assumed that policies are chosen by a utilitarian government, which uses weights $\gamma$ and $(1-\gamma)$ that equal the respective population shares in its objective function. However, policies in reality are chosen by governments that may have ideological preferences over specific groups or are preferred by the majority of voters. It is thus important to understand the consequences of non-Benthamite preferences for economic policy and equilibrium allocations. To this end, we next analyse in subsection 5.1, the importance of the weights $\gamma$ and $(1-\gamma)$ in the design of optimal tax policies and focus on the combination of these which leads to the highest welfare for the workers. Given that the workers constitute the majority in our model (i.e. $n^w > 0.5$), the policy preferred by them is also the one favoured by the median voter. Thus, in subsection 5.2, we also study below two such majority equilibria, the case of direct democracy and the case of representative democracy (see e.g. Persson and Tabellini (1994, 2000)). In the latter, the median voter delegates policy to a representative.

5.1 Political preferences and the capital tax

A striking result in Judd’s (1985) analysis of the neoclassical model with workers and capitalists is that the optimal allocations under commitment are independent of the weights, $\gamma$ and $(1-\gamma)$, that the government employs in its objective function, i.e. equation (14) in our setup. This result also holds for the variation of the neoclassical model under heterogeneity in asset holdings that we consider. To demonstrate this point, we next solve the model and evaluate welfare for a range of weights in the government’s objective function. For the base value of $n^k = 0.25$ reported above, Figure 3 below plots the steady-state values for the policy outcomes ($\tau^k$, $\tau^l$, $G/Y$), income inequality (Gini coefficient) and the welfare ($u^k$, $u^w$) for each agent against the weight attached to workers ($\gamma$) with and without commitment.

[Figure 3 here]
The results for a Ramsey government suggest that, for all agents, the zero capital taxation policy is the best policy to adopt and, as a consequence, there is no conflict of interests between agents. In contrast, the value of \( \gamma \) matters for allocations and welfare in the Markov equilibrium. This is consistent with Krusell (2002), who also considers a capitalist-worker setup and shows that the weight attached by the government to the utility of the worker is important for long-run optimal taxation. In particular, in Krusell (2002), when this weight is equal to 1, a confiscatory capital tax arises. An important result that appears in Figure 3 is that, for both types of agents, welfare can be greater for \( \gamma < n^w (= 0.75) \), which implies that caring more for the capitalist relative to the benevolent case, \( \gamma = n^w \), is Pareto improving. This finding coheres with Rogers’ (1986) and Persson and Tabellini’s (1994) discussion of a "more conservative" president in a representative democracy. We next examine the mechanism that leads to this outcome.

Starting from the Benthamite case for the base calibration, \( \gamma = n^w = 0.75 \), we first examine optimal allocations as \( \gamma \) increases, i.e. the government cares more (less) for the worker (capitalist). Lack of commitment and partisan preferences make high capital taxes unavoidable. The disincentive for the capitalist to accumulate capital reduces productivity and public goods provision. In turn this leads the government to compensate workers’ income by increasing the labour subsidy. The more the government cares about the worker, the higher the incentive to subsidise labour. This further implies that the need to generate tax revenue, and thus to tax capital, will be even higher. Therefore, the efficiency distortions introduced by the tax system become higher as \( \gamma \) rises. The outcome of all these changes is a fall in the welfare of all agents. For the worker, the adverse productivity effects from higher capital taxes exceed the increased income generated by labour subsidies, so that workers's welfare falls for \( \gamma > 0.75 \). Not surprisingly, the capitalist is also directly hurt by capital taxes that reduce his capital income. When the weight on the worker increases above a critical point, i.e. \( \gamma > 0.77 \) for this model/calibration, the incentive for the government to impose confiscatory capital taxes is so high that an interior solution cannot be obtained.\(^{18}\)

We next consider reductions in the weight for the worker. As \( \gamma \) falls from \( n^w = 0.75 \), the incentive for the government to tax capital and subsidise labour is reduced. Therefore, the capital tax is decreased and the labour tax increased. The government, by caring more about the capitalist, can use

\(^{18}\)Note that in the model without labour income taxation analysed in Krusell (2002), the capital taxes are not confiscatory when the weight attached to the worker is arbitrarily close to unity, but not equal to one. The introduction of labour taxation reduces the upper bound on the policymaker’s partisan preferences that can be consistent with an interior equilibrium.
labour to generate tax revenue and thus the need for capital tax revenue is reduced. In turn, this implies that a lower capital tax becomes a credible policy in this setup. As can be seen in Figure 3, such "capitalist biases" can take the tax rate to zero, which results in the same labour tax as in the Ramsey solution under commitment. Further increases in the capitalist bias result in capital subsidies and further increases in the labour tax, which, for this model/calibration, lead to non-positive labour supply choices for the capitalist and thus not well-defined interior solutions.

5.1.1 A "capitalist bias" can be Pareto improving

Figure 3 showed that for the range of $\gamma$ that implies interior solutions, an increase in the capitalist bias decreases the tax rate on capital. Given that the capital tax reduction increases the efficiency of the tax system, the provision of the public good is also increased. The worker faces a trade-off when capital taxes are reduced. On one hand, his labour income tends to be reduced, because of the higher labour tax. On the other hand, he benefits from the increased labour productivity, resulting from the increased capital accumulation, as well as from the higher quantity of the public good. Starting from the Benthamite case (i.e. $\gamma = 0.75$), the positive effects dominate for initial reductions in $\gamma$, so that the worker is better-off by a government that chooses capital taxes biased in favor of the capitalist. As a result, a capitalist bias can be Pareto improving.

Although Pareto improving, a capitalist bias increases income inequality and the welfare gains of the capitalist relative to the worker are larger. The income and welfare gains of the capitalist are higher under capitalist biases since the capitalist benefits directly from the increase in his capital income, in addition to the labour income and public good benefits accruing to both agents.

5.1.2 Commonality and conflicts of interest

Under lack of commitment, Figure 3 showed that, up to a point, it was in both agents' interests for the government to favour capitalists, i.e. $\gamma < n^w(= 0.75)$, when designing optimal policy. There is, thus, an area in which the interests of both agents are aligned, as the workers are happy to trade-off equity for efficiency. The extent of this area can be measured by the distance between the $\gamma$ associated with maximum welfare for the worker and $\gamma = n^w = 0.75$. However, although the capitalist’s welfare is always increasing while the capital tax is reduced, this is not the case for the worker. The trade-off in the amount of the capitalist bias discussed above suggests that there
is an optimal amount of capitalist bias, corresponding to a non-zero capital tax, for the worker, given by $\gamma = 0.606$ and $\tau^k = 0.319$ respectively in Figure 3. By contrast, the capitalist would prefer $\gamma = 0$ and $\tau^k = 0$.

In this class of neoclassical models with asset inequality, there is no conflict of interests under commitment, as the literature reviewed in the Introduction has extensively discussed. In particular, it is optimal for both the worker and for the capitalist to eliminate the capital tax. However, our analysis suggests that there will be conflict of interests between the workers and the capitalists under lack of commitment. In particular, the capitalist would prefer a capitalist bias sufficiently large to implement the zero-capital tax policy, while the worker would prefer a capitalist bias that would imply a policy with positive capital taxes and lower labour taxes. Therefore, although there is agreement that a capitalist bias is preferable to Benthamite preferences, there is disagreement over the degree of the capitalist bias, or the reduction of the capital tax relative to the Benthamite case.

5.1.3 Is commitment Pareto superior?

The results in Figure 3 suggest that, consistent with the analysis in Persson and Tabellini (1994), the "capitalist bias" mechanism can be a substitute for commitment technology and thus help to implement the Ramsey tax policy, which is obtained for a value of $\gamma = 0.555$ in Figure 3. However, the welfare of the worker is maximised for a lower capitalist bias and thus the elimination of the distortions introduced by the lack of commitment is not Pareto optimal. Persson and Tabellini (1994) also suggested that it might not be possible to Pareto rank commitment versus lack of commitment equilibria, because a segment of the population with smaller capital endowments might prefer the lack of commitment equilibria. Our results here confirm that this is indeed the case for a standard calibration of a differentiable subgame-perfect Markov equilibrium in an infinite-horizon model.

It is interesting to note that assuming Benthamite policy, as we did in the previous section, the Ramsey equilibrium is Pareto superior to the Markov outcomes. However, allowing for political economy considerations and, in particular, ideological preferences on the part of policymakers, has opened the door to potential non-Benthamite equilibria that might be welfare superior for a segment of the population to the commitment equilibrium. An important question that then arises is which of these equilibria is likely to be the outcome in a democratic society?

\footnote{This is of course not a general result. In static models (see e.g. Meltzer and Richard (1981)) and two-period models (see e.g. Persson and Tabellini (1994)), the agents have different preferences regarding taxation even under commitment.}
5.2 Direct and representative democracy

Our analysis and the results in Figure 3 suggest that a government that cared only about the capitalist (i.e. $\gamma = 0$) would lead to a zero capital tax, whereas a government that cared only about the worker (i.e. $\gamma = 1$) would lead to a confiscatory capital tax. This is consistent with Persson and Tabellini (1994), who also show that for agents above a specific threshold in the asset distribution, the optimal capital tax is zero, whereas, for those below the threshold, it is confiscatory. Since workers constitute the majority in our model, the median-voter equilibrium in a direct democracy is captured by simply setting $\gamma = 1$.

In practice, however, most democracies are not direct but, instead, policy is set by a representative who is chosen by the majority (see e.g. Persson and Tabellini (1994, 2000)). In our model, this is equivalent to choosing the value of $\gamma$ that maximises the welfare of the worker (recall that since $n^w > 1/2$, workers form the majority in our model). As we saw above, such an equilibrium is well-defined and given by $\gamma = 0.606$. A comparison of this equilibrium to the Benthamite one under lack of commitment, or the Ramsey one under commitment, suggests that the former’s predictions regarding tax policy are more empirically relevant. In particular the tax structure associated with the majority equilibrium, i.e. a capital tax of about 32% and a labour tax of around 31% is much closer to the data for a typical, advanced and democratic economy than either the Benthamite ($\tau^k = 80\%$, $\tau^l = 0\%$) or the the Ramsey ($\tau^k = 0\%$, $\tau^l = 40\%$). Moreover, as can be seen in Figure 3, the majority equilibrium is not Pareto dominated by either the Benthamite or Ramsey equilibria.

The above discussion suggests that a "capitalist bias" on the part of the worker/median voter can provide a means to reduce the inefficiently high capital taxation inherent in a Markov-perfect equilibrium. This finding is consistent with the results in the analysis of taxation in two-period economies under heterogeneity in capital and labour income with given government spending (see, e.g. Persson and Tabellini (1994, 2000)). In particular, Persson and Tabellini (1994, 2000) have shown that, in a representative democracy, a majority has the incentive to vote for a "more conservative" government, that has a higher stake in the interests of the capitalists, as a means to correct for the inefficiently high taxation that arises when the policymakers cannot commit to their tax choices. This effect of "more conservative" preferences is also similar to the findings in the literature on time-consistent monetary policy (see e.g. Rogoff (1985) and more recently Dennis (2010)).
6 Effects of asset concentration

In this section, we study the effects of the concentration of capital holdings on tax policy and polarization in a representative democracy. We focus our interest on whether higher asset concentration acts to control for inefficiently high capital taxation that arises without commitment and whether it increases polarization.

To answer these questions, we work as in the previous section and obtain, under the representative democracy equilibrium (RDE), the predictions of the model regarding the optimal choice of policy instruments and the associated inequality in income and welfare for each agent, when asset concentration, as controlled by \( n \), changes. We present results for three values of \( n \), the base of 0.25 and the higher and lower values of 0.28 and 0.22. For each case, we also report the value of \( \gamma \) that defines the RDE, i.e. the degree of capitalist bias preferred by the worker. The results are reported in Table 2 below. Moreover, to facilitate the discussion, we report in this Table the Benthamite equilibrium (BE) for each \( n \), as well as measures of "polarisation", denoted by \( \text{pol}(\cdot) \) that will be discussed below.

6.1 Inequality and the capital tax

As expected, as \( n \) falls, income and welfare inequality also increase under both the BE and the RDE. As discussed in Section 5, under the BE, this results in a reduction in the capital tax. Table 2 shows that this is also the case under the RDE. The logic is the same. When there are fewer agents who can invest in capital, the capital stock is scarcer and thus it has more value at the aggregate level, given the neoclassical production function and decreasing returns. In turn, this implies that the incentive for the government, as well as for the majority that elects it, to tax capital is smaller. Therefore, the model predicts that under a majority political equilibrium, inequality is negatively related with the capital tax.

Although this prediction is supported by the data, as discussed in the Introduction, it appears to be at odds with the prediction coming from the basic political economy models of redistribution, which suggest that as inequality increases, so does the capital tax under median-voter equilibria.\(^{20}\) Clearly, in static models, or under commitment, the effect of asset concentration on reducing the distortion introduced by the lack of commitment is missed. Moreover, the predictions in this literature are obtained for changes

in the asset or endowment distribution that result in a bigger gap between the median and the mean agent-voter, leaving the endowments of the mean agent unchanged. This would correspond to a case where, while the distribution of the capital stock changes, its aggregate supply remains unchanged. As noted above, the fall in the supply of total capital is important in generating the negative relationship between inequality and the capital tax.

Table 2: Benthamite and Representative Democracy Equilibria

<table>
<thead>
<tr>
<th></th>
<th>BE</th>
<th>RDE</th>
<th>BE</th>
<th>RDE</th>
<th>BE</th>
<th>RDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n^k = 0.22$</td>
<td></td>
<td></td>
<td>$n^k = 0.25$</td>
<td></td>
<td>$n^k = 0.28$</td>
<td></td>
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<tr>
<td>Policy</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.7800</td>
<td>0.6470</td>
<td>0.7500</td>
<td>0.6060</td>
<td>0.7200</td>
<td>0.5650</td>
</tr>
<tr>
<td>$\tau^k$</td>
<td>0.7722</td>
<td>0.3186</td>
<td>0.8025</td>
<td>0.3189</td>
<td>0.8337</td>
<td>0.3196</td>
</tr>
<tr>
<td>$\tau^l$</td>
<td>0.0418</td>
<td>0.3076</td>
<td>0.0087</td>
<td>0.3072</td>
<td>-0.0292</td>
<td>0.3066</td>
</tr>
<tr>
<td>$G/Y$</td>
<td>0.2202</td>
<td>0.2465</td>
<td>0.2150</td>
<td>0.2463</td>
<td>0.2088</td>
<td>0.2461</td>
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</table>

<table>
<thead>
<tr>
<th>Inequality and welfare</th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>$gini$</td>
<td>0.1085</td>
<td>0.2324</td>
<td>0.0927</td>
<td>0.2234</td>
<td>0.0769</td>
<td>0.2142</td>
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<tr>
<td>$u_k$</td>
<td>-0.8535</td>
<td>-0.6819</td>
<td>-0.8901</td>
<td>-0.7051</td>
<td>-0.9287</td>
<td>-0.7239</td>
</tr>
<tr>
<td>$u_w$</td>
<td>-0.9514</td>
<td>-0.8967</td>
<td>-0.9669</td>
<td>-0.8966</td>
<td>-0.9879</td>
<td>-0.8966</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Polarisation Indices</th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$pol(\gamma)$</td>
<td>0.867</td>
<td></td>
<td>0.856</td>
<td></td>
<td>0.845</td>
<td></td>
</tr>
<tr>
<td>$pol(\tau^k)$</td>
<td>0.546</td>
<td></td>
<td>0.516</td>
<td></td>
<td>0.486</td>
<td></td>
</tr>
<tr>
<td>$pol(\tau^l)$</td>
<td>0.734</td>
<td></td>
<td>0.701</td>
<td></td>
<td>0.664</td>
<td></td>
</tr>
<tr>
<td>$pol(G/Y)$</td>
<td>0.974</td>
<td></td>
<td>0.969</td>
<td></td>
<td>0.963</td>
<td></td>
</tr>
</tbody>
</table>

It is also interesting to note in Table 2 that, although the welfare of the capitalists clearly rises as $n^k$ falls, the welfare of the worker is not affected much by changes in $n^k$ in a RDE. This is because the "conservative" representative chosen by the worker, has already corrected for the efficiency losses due to lack of commitment, so that the benefits from lower capital taxes driven by a lower $n^k$ are very small. Indeed, the reduction in the capital tax is much bigger in the BE compared to the RDE as $n^k$ falls. Therefore, capitalist bias and increases in asset concentration work in a similar way in correcting for inefficiently high capital taxation under lack of commitment. In other words, they work as substitutes regarding the capital tax.

6.2 Inequality and polarisation

How does the change in asset concentration affect the extent of conflict of interests or polarisation? We can obtain a measure of polarisation in our
context as a negative function of the capitalist bias that the worker would choose in the majority equilibrium. Recall that, starting from the Benthamite equilibrium, there is an agreement between the agents regarding a capitalist bias. Thus, the higher the capitalist bias implemented under the majority equilibrium, the higher the area of agreement between the two agents with respect to the reduction in the capital tax. In contrast, if the difference between the Benthamite and the majority equilibrium is decreased, then polarisation increases, as the capitalists would prefer an even bigger bias and reduction in the capital tax. In other words, we assume that a utilitarian or Benthamite government, which cares equally about all, is the social norm and we define the area of agreement in the socio-political system as the distance between this norm and a political agreement that trades-off equity for efficiency. The key here is that all proposals for a capitalist bias up to the value of that maximises workers welfare would receive the support of everyone in the society and not just the majority. We thus define polarisation as a decreasing function of this area of agreement.

To operationalise this approach, we calculate a polarisation index defined as one minus the absolute value of the distance between the Benthamite and the majority equilibrium for each level of $n^k$. The results in Table 2 suggest that when income inequality increases, polarisation also increases. To understand this result, recall that when inequality is higher, the distortion from the lack of commitment has already been corrected at least partially under the norm of the Benthamite government. Therefore, the usefulness of the political mechanism, in the form of electing a conservative, capitalist-biased government, is reduced. In turn, the workers are not willing to have the capital tax rate reduced by the same amount from the Benthamite norm, so that the area of agreement shrinks.

7 Conclusions

In this paper, we solved for time-consistent (Markov-perfect) optimal fiscal policy in an economy with capitalists and workers when policy-makers are elected in a representative democracy. Our analysis showed that the model’s predictions are consistent with the stylised facts regarding inequality, capital

\footnote{Note that it is not practical to define polarisation by comparing the choices of government that cares only about the capitalist (i.e. $\gamma = 0$) to a government that cares only about the worker (i.e. $\gamma = 1$). As explained above, the first case always leads to a zero capital tax, while the second to a confiscatory capital tax.}

\footnote{This is done for those quantities associated with conflict of interests that are bounded between zero and unity, i.e. for $\gamma$, $r^k$, $r^l$ and $G/Y$.}
taxation and polarisation. These findings are driven by the fact that the concentration of capital holdings and the capitalist bias associated with the political economy system work as substitutes in reducing the inefficiencies associated with lack of commitment.

References


8 Appendix

8.1 Decentralized competitive equilibrium (DCE)

We first present the DCE conditions and then transform them to recursive form.

8.1.1 DCE

The DCE is given by the following six relations:

\[
\frac{\partial u(C_{k,t}, 1 - l_{k,t}, G_t)}{\partial C_{k,t}} = \beta \frac{\partial u(C_{k,t+1}, 1 - l_{k,t+1}, \overline{G}_{t+1})}{\partial C_{k,t+1}} (1 + R_{t+1})
\]

(17)

\[
\frac{\partial u(C_{k,t}, 1 - l_{k,t}, G_t)}{\partial (1 - l_{k,t})} = \frac{\partial u(C_{k,t}, 1 - l_{k,t}, G_t)}{\partial C_{k,t}} W_t
\]

(18)

\[
\frac{\partial u(C_{w,t}, 1 - l_{w,t}, G_t)}{\partial (1 - l_{w,t})} = \frac{\partial u(C_{w,t}, 1 - l_{w,t}, G_t)}{\partial C_{w,t}} W_t
\]

(19)

\[
C_{w,t} = W_t l_{w,t}
\]

(20)

\[
n^k Y_{f,t} = n^k C_{k,t} + n^w C_{w,t} + n^k [K_{k,t+1} - (1 - \delta) K_{k,t}] + \overline{G}_t
\]

(21)

\[
\overline{G}_t = n^k Y_{f,t} - \delta n^k K_{k,t} - R_t n^k K_{k,t} - W_t (n^k l_{k,t} + n^w l_{w,t})
\]

(22)

where we use:

\[
Y_{f,t} = f \left( K_{k,t} l_{k,t} + \frac{n^w}{n^k} l_{w,t} \right).
\]

(23)

which are solved for \(\{C_{k,t}, C_{w,t}, l_{k,t}, l_{w,t}, K_{k,t+1}\}_{t=0}^{\infty}\) and the path of one of the three policy instruments, say \(\{\overline{G}_t\}_{t=0}^{\infty}\). This is given \(\{R_t, W_t\}_{t=0}^{\infty}\).
8.1.2 Recursive DCE

To obtain the recursive form of the DCE, (7) – (12), in the main text, we work as follows. If we combine (20), (21) and (22), capitalists’ consumption is:

\[ C_{k,t} = -K_{k,t+1} + (1 + R_t)K_{k,t} + W_t l_{k,t} \]
\[ = C(K_{k,t}, W_t, R_t, l_{k,t}, K_{k,t+1}) \]  

which is (7) in the text, while (12) in the text follows simply from (22) and (23). Substituting the constraints (7), (9) and (11) into the three optimality conditions (17), (18) and (19), and using the guess Markov functions presented in the text to substitute out \( t + 1 \) variables, we obtain the three private reaction functions, \( l_{k,t} = A(K_{k,t}, W_t, R_t) \), \( K_{k,t+1} = H(K_{k,t}, W_t, R_t) \) and \( l_{w,t} = M(K_{k,t}, W_t, R_t) \), which are (8), (9) and (11) in the text.

8.2 Model solution using specific functional forms

We next set out the recursive DCE and Markov perfect equilibrium conditions using the specific functional forms assumed in subsection 3.1.

8.2.1 Recursive DCE and private reaction function

Equations (7), (10), (12) and (13) do not change, whereas equations (8) and (11) simplify to \( l_{k,t} = 1 - \frac{\mu_2 C_{k,t}}{\mu_1 W_t} \) and \( l_{w,t} = \frac{\mu_1}{\mu_1 + \mu_2} \), so that we need to specify only one private reaction function, \( K_{k,t+1} = H(K_{k,t}, W_t, R_t) \). Using (7), and having guessed \( K_{k,t+2} = h(K_{k,t+1}) \), \( W_{t+1} = \Phi(K_{k,t+1}) \) and \( R_{t+1} = \Psi(K_{k,t+1}) \) as defined the text, we have from the Euler-equation of capitalists in (17):

\[ \eta(K_{k,t}, W_t, R_t, K_{k,t+1}) \equiv \frac{1}{C(K_{k,t}, W_t, R_t, K_{k,t+1})} - \frac{\beta(1 + \Psi(K_{k,t+1}))}{C(K_{k,t+1}, \Phi(K_{k,t+1}), \Psi(K_{k,t+1}), h(K_{k,t+1}))} = 0 \]  

which confirms that, if there is a solution, this is of the form \( K_{k,t+1} = H(K_{k,t}, W_t, R_t) \).

We next specify the properties of the function \( H(.) \). Using \( H(K_{k,t}, W_t, R_t) \) for \( K_{k,t+1} \) into the LHS of (25), we have:

\[ \eta(K_{k,t}, W_t, R_t, H(K_{k,t}, W_t, R_t)) = 0 \]  

so that at the optimum:

\[ \eta_k(t) + \eta_k'(t)H_k(t) = 0 \text{ or } H_k(t) = \frac{-\eta_k(t)}{\eta_k'(t)} \]  

(27)
These three equations are respectively:

\[ \eta_w(t) + \eta_k'(t)H_w(t) = 0 \quad \text{or} \quad H_w(t) = \frac{-\eta_w(t)}{\eta_k'(t)} \quad (28) \]

\[ \eta_r(t) + \eta_k'(t)H_r(t) = 0 \quad \text{or} \quad H_r(t) = \frac{-\eta_r(t)}{\eta_k'(t)} \quad (29) \]

where \( \eta_k(t), \eta_w(t), \eta_r(t) \) and \( \eta_k'(t) \) denote the partials of \( \eta(K_{k,t}, W_t, R_t, K_{k,t+1}) \) and \( H_k(t), H_w(t) \) and \( H_r(t) \) denote the partials of \( H(K_{k,t}, W_t, R_t) \).

Then, given \( K_{k,t+1} \), we also have from (25):

\[ \eta_k(t) = -\frac{1}{(C_{k,t})^2}C_k(t) \quad (30) \]

\[ \eta_w(t) = -\frac{1}{(C_{k,t})^2}C_w(t) \quad (31) \]

\[ \eta_r(t) = -\frac{1}{(C_{k,t})^2}C_r(t) \quad (32) \]

\[ \eta_k'(t) = -\frac{1}{(C_{k,t})^2}C_k'(t) - \frac{\beta}{C_{k,t+1}}\Psi_k(K_{k,t+1}) + \frac{\beta(1 + \Psi(K_{k,t+1}))}{[C_{k,t+1}]^2} \times \]

\[ \times \{C_k(t + 1) + C_w(t + 1)\Phi_k(K_{k,t+1}) + C_r(t + 1)\Psi_k(K_{k,t+1}) + \]

\[ + C_k'(t + 1)h_k(K_{k,t+1}) \} \quad (33) \]

where \( C_k(t), C_w(t), C_r(t) \) and \( C_k'(t) \) denote the partials of \( C_{k,t} = C(K_{k,t}, W_t, R_t, K_{k,t+1}) \). This completes the properties of the single private reaction function, \( H(K_{k,t}, W_t, R_t) \).

8.2.2 Markov-perfect equilibrium conditions

As pointed out in the text, under the specification used, the final system is reduced to three equations only. Namely, the government’s GEE, the government’s optimality condition for \( R_t \), both as defined in section 3, and the Euler condition of capitalists. Thus, we have three equations in three unknown functions, \( K_{k,t+1} = h(K_{k,t}), W_t = \Phi(K_{k,t}) \) and \( R_t = \Psi(K_{k,t}) \). These three equations are respectively:

\[ \frac{dV_{t+1}}{dK_{k,t+1}} = (1 - \gamma)[\partial u_{k,t+1}/\partial C_{k,t+1} \partial C_{k,t+1} - \partial u_{k,t+1} \partial C_{k,t+1} \partial K_{k,t+1}] \]

\[ + \beta \frac{\partial G_{t+1}}{\partial C_{k,t+1} \partial K_{k,t+1}} + \gamma \frac{\partial u_{w,t+1}}{\partial C_{w,t+1} \partial C_{k,t+1}} \partial C_{w,t+1} - \partial u_{w,t+1} \partial C_{w,t+1} \partial K_{k,t+1} \]

\[ + \beta \frac{\partial G_{t+1}}{\partial C_{k,t+1} \partial K_{k,t+1}} + \beta \frac{dV_{t+2}}{dK_{k,t+2}}H_k(t + 1) \quad (34) \]
\begin{equation}
(1 - \gamma) \left[ \frac{\partial u_{k,t} \partial C_{k,t}}{\partial C_{k,t} \partial R_t} - \frac{\partial u_{k,t}}{\partial (1 - l_{k,t})} \frac{\partial l_{k,t}}{\partial R_t} + \frac{\partial u_{k,t \partial \overline{C}_t}}{\partial \overline{C}_t \partial R_t} \right] + \gamma \frac{\partial u_{w,t} \partial C_{w,t}}{\partial C_{w,t} \partial R_t} - \frac{\partial u_{w,t}}{\partial (1 - l_{w,t})} \frac{\partial l_{w,t}}{\partial R_t} + \frac{\partial u_{w,t \partial \overline{C}_t}}{\partial \overline{C}_t \partial R_t} + \beta \frac{dV_{t+1}}{dK_{k,t+1}} H_r(t) = 0 \tag{35}
\end{equation}

\begin{equation}
\frac{1}{C_{k,t}} = \frac{\beta(1 + R_{t+1})}{C_{k,t+1}} \tag{36}
\end{equation}

where \( C_{k,t} \), \( l_{k,t} \), \( K_{k,t+1} \), \( C_{w,t} \), \( l_{w,t} \), \( \overline{C}_t \) and \( Y_{f,t} \) are as in (7) – (13), \( \frac{dV_{t+1}}{dK_{k,t+1}} \) follows by using the optimality condition for \( W_t \) and, similarly, \( \frac{dV_{t+2}}{dK_{k,t+2}} \) follows from the same condition led-once. Any future values \( W_{t+i} \), \( R_{t+i} \) and \( K_{k,t+1+i} \), where \( i \geq 1 \), are expressed in terms of the current value of the state variable, \( K_{k,t} \), by repeated use of the equilibrium functions \( W_t = \Phi(K_{k,t}) \), \( R_t = \Psi(K_{k,t}) \) and \( K_{k,t+1} = h(K_{k,t}) \).

### 8.3 Numerical solution algorithm

To solve the system of functional equations in (34) – (36) for the steady-state, we follow the perturbation method proposed by Krusell et al. (2002) and Klein et al. (2008). In particular, we approximate the unknown functions, \( K_{k,t+1} = h(K_{k,t}) \), \( W_t = \Phi(K_{k,t}) \) and \( R_t = \Psi(K_{k,t}) \) in equilibrium by polynomials of some degree \( n \) and then iterate on \( n \) until the steady-state values for the endogenous variables do not change. When \( n = 0 \), the system in (34) – (36) can be solved for the three unknown constant-guess functions. For higher order approximations, this system also contains derivatives of the guessed policy functions and thus has more unknowns than equations. The methodology employed circumvents this problem by augmenting (34) – (36) to include the \( n^{th} \) derivatives of (34) – (36) with respect to \( K_t \) evaluated at the steady-state. All results reported in the paper are based on cubic polynomials, as this was sufficient to guarantee convergence of the endogenous variables at the steady-state.
Figure 1: Capital tax and polarisation on inequality
Figure 2: Benthamite policy ($\gamma=1-n^k$)

- **Capital tax rate**
  - $\kappa_k$

- **Labour tax rate**
  - $\tau_l$

- **Government consumption to output ratio**
  - $G/Y$

- **Income inequality**
  - Gini coefficient

- **Welfare of capitalist**
  - $u_k$

- **Welfare of worker**
  - $u_w$

Markov (-) left axis Ramsey (-.-) right axis
Figure 3: Partisan policy ($n^k=0.25$)

- **Capital tax rate**
  
- **Labour tax rate**

- **Government consumption to output ratio**

- **Income inequality**

- **Welfare of capitalist**

- **Welfare of worker**

Markov (-)     Ramsey (-.-)