Income Inequality And Political Inequality In The U.S.

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Abstract

The median voter theorem is one of the most celebrated results in the public choice theory. However, existing structural models predict too high income redistribution for the U.S. economy if the tax rate is chosen by the median voter. One potential explanation is that the political process in the U.S. is biased towards wealthier agents. In this case, the decisive agent is richer than the standard median voter and therefore prefers lower redistribution. In this paper I ask the following question: Can the wealth bias in the political process rationalize a significant drop in progressiveness of the income tax system induced by the Economic and Recovery Tax Act of 1981. I introduce wealth-weighted majoritarian voting over progressive income taxation into a heterogeneous agent model with incomplete financial markets. I show that the model can significantly better explain the dynamics of income redistribution in the U.S. since 1980s than a model, in which the standard median voter is decisive.

Key words: median voter theorem, income tax, wealth bias, heterogeneous agents.

JEL: E62, H24, H31.

In a political system where nearly every adult may vote but where knowledge, wealth, social position, access to officials, and other resources are unequally distributed, who actually governs?

Robert Dahl (1961)

1 Introduction

The median voter theorem is one of the most celebrated results in public choice theory. A vast body of research has applied the median voter theorem to explain income redistribution through fiscal policy. In their seminal paper, Meltzer & Richard (1981) show that rising inequality in income before taxes and transfers leads to a higher level of redistribution. Intuitively, higher

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levels of market income inequality – measured by the distance between the median and the mean market income – translate into a poorer decisive agent, who then sets a higher rate of taxation and demands more redistribution.[1]

However, the theoretical prediction of the model by Meltzer & Richard (1981) finds little empirical support in the literature.[2] For example, the general equilibrium models by Krusell & Rios-Rull (1999), Klein, Krusell & Rios-Rull (2008), Corbae, D'Erasmo & Kuruscu (2009) predict for the U.S. economy a way too high equilibrium level of redistribution, when the tax rate is allowed to be chosen by the median voter.

To account for empirical evidence, researchers introduced different extensions of the baseline version of the median voter theorem. Benabou (2000) develops *analytically* one such extension. He departs from the assumption of equal voting rights. Instead, he assumes that the political process is biased towards richer agents. More specifically, he uses a simple functional relationship between private wealth holdings and agent's voting share. As a result, the pivotal agent has income larger than that of the median voter. In this case the distance between the income of the pivotal agent and the mean income reduces, and the pivotal agent prefers a lower level of redistribution.

To the best of my knowledge, my paper is the first *empirical* paper, which explains the observed dynamics of income redistribution in the U.S. using a macroeconomic model with wealth-weighted majoritarian voting over income redistribution. I use the same functional relationship between private wealth holdings and agent's voting share as in Benabou (2000) (and later in Lagunoff & Bai (2013), and Bachmann & Bai (2013)). I quantify the degree of political inequality in the U.S. by estimating a parameter of this function. Then I show that the model can significantly better explain the dynamics of income redistribution in the U.S. since 1980s than a model, in which the standard median voter is decisive.

There are at least three explanations for why rich people have stronger power in politics than the poor. The first explanation is that rich people tend to vote more often than the poor. Rosenstone & Hansen (1993) and Page, Bartels & Seawright (2013) find that propensity to participate in voting in the U.S. rises with income and wealth. The second explanation is that rich people are able to make higher campaign contributions and potentially affect the election outcome or to obtain influence over legislative decision-making by the successful candidate. Rosenstone & Hansen (1993) and Campante (2011) find that propensity to make contributions rises with income. The third explanation is that rich people tend to meet public officials more often than the poor. About half of respondents in Page et al. (2013) reported contacting at least one highly ranked official

[1] Throughout this paper I assume that the mean income is larger than the median income, as it is the case in the U.S.

[2] This literature can be divided into two strands. One strand is solely empirical and uses econometric tools, such as a linear regression. Benabou (1997, Table 2) reviews the key studies and concludes that the effect of inequality on redistribution is rarely significant, and its sign varies from one study or even one specification to the other. Another strand of literature is based on structural heterogeneous agents models. I consider the latter only.

within a half year, a much higher proportion than among the general public.[3]

This paper examines the dynamics of income redistribution in the period 1980-1990 in the U.S. The market income inequality started to rise substantially since 1980. For example, while the Gini index for market income was 0.479 in 1979, it grew up to 0.525 in 1990. Notably, this increase in income inequality has been mainly driven by an increased concentration of labor income, which accounted for more than 90 percent of the overall increase. (Congressional Budget Office (2011)) In order to explain the dynamics of income redistribution, I use a heterogeneous agents model with incomplete financial markets by Aiyagari (1994) because the main source of income inequality in this model are uninsurable idiosyncratic shocks to wages.

While market income inequality was rising, the progressiveness of the income tax schedule was declining during the same period, mostly due to adoption of the Economic and Recovery Tax Act of 1981. For example, the top marginal income tax rate was cut from 70 to 50 percent. In order to capture the progressiveness of the income tax system, I introduce progressive income taxation into the model. I borrow the functional form for the effective tax function from Gouveia & Strauss (1994), who estimated the parameters of this function using the U.S. data in the same period as the one I am focussing on. A key progressivity parameter of this income tax schedule is endogenously determined in my model through a majoritarian voting system.

Redistribution in the U.S. takes various forms such as progressive income taxation, targeted transfers, etc. In order to summarize the redistributive effect of transfers and taxes, I use a measure of redistribution widely used by OECD and CBO. This measure compares the Gini index for market income with the Gini index for after-tax and after-transfer income. The larger is the difference, the larger is income redistribution.

I set up a benchmark model economy, which matches the observed levels of wage and income inequality in the U.S. in 1979-1980. In particular, the wage process is calibrated to match relatively low dispersion of wages and relatively low mobility across wage groups in the data at that time. For the quantitative exercise, I modify the environment of the benchmark model economy in two ways. First, I change the specification of the wage process; this change is meant to account for a significant rise in wage dispersion in the U.S. during 1981-1990. Second, I endogenize the progressivity of the tax schedule: in 1980 agents vote once-and-for-all on it. This modification imitates the adoption of the Economic and Recovery Tax Act of 1981. I introduce a wealth bias in the political decision making process by assuming the same functional relationship between private wealth holdings and agent's voting share as in Benabou (2000). Before agents vote, they anticipate the occurred changes in the employment process.

Then I simulate counterfactual dynamics of income redistribution when the standard median voter is decisive and compare them with the data and the dynamics of income redistribution when the weighted median voter is decisive. I disentangle the overall redistributive effect of taxes and

[3]The study by Rosenstone & Hansen (1993) is based on National Election Studies in the U.S. in 1952-1988. Page et al. (2013) interview 83 top wealthy households in Chicago area and find that 99 percent of the respondents participate in voting. Campante (2011) uses the data on contributions given to presidential candidate committees and to party committees from the Federal Election Commission and the 2006 Cooperative Congressional Survey. He finds in a probit regression that individuals with a higher income have a higher probability to make campaign contributions and that, conditional on contributing, income increases the value that is donated. Data show that fewer than 25 percent made contacts (in a broader sense) within a year.

transfers into the redistributive effect of taxes and the redistributive effect of transfers for each simulation. I show that a model, in which the standard median voter is decisive, predicts a jump in both effects. On the contrary, a model, in which the weighted median voter is decisive, predicts a fall in both effects consistent with the data.

Afterwards, I compute the degree of political inequality in the economy, which rationalizes the drop in the progressiveness of the income tax schedule observed in the data in 1981-1990. In particular, I find that the standard median voter was located in the 2nd quintile of the equilibrium wealth distribution of 1980 and in the 1st quintile of the equilibrium income distribution of 1980, while the weighted median voter was a household in the top decile of the wealth distribution and second highest decile of the income distribution. In order to understand the differences between the voting outcomes under the standard and the weighted median voters, I quantify the effect of rising dispersion of wages and rising mobility across wage groups since 1980 on the most preferred tax rate of the standard and the weighted median voters. I show that agent's expectations about the future wage inequality are crucial in understanding the differences between the two equilibrium voting outcomes.

I proceed as follows. Section 2 emphasizes the contribution of this paper relative to the existing literature. In section 3 I set up the model and define a politico-economic recursive competitive equilibrium. The parameters of the model are estimated in section 4. The quantitative exercise is done in section 5. Challenging tasks for future research are discussed in section 6.

2 Literature review

The current paper contributes to a vast strand of literature which attempts to explain the economic size of the government. In their seminal paper, Meltzer & Richard (1981) apply the standard median voter theorem to study the relationship between rising inequality and the resulting redistribution. Krusell & Rios-Rull (1999) show that the model by Meltzer & Richard (1981) considerably overestimates the amount of redistribution in the U.S. This is because the only distortionary effect of taxation comes from the endogenously supplied labor. Krusell & Rios-Rull (1999) extend this framework to a dynamic setup and add endogenous savings decisions. When agents vote, they internalize the distortionary effect of income taxation on the savings decision. Thanks to a stronger distortionary effect of taxation, the model explains better the amount of redistribution in the U.S. in 1995 but still overestimates it.

An important feature of the model by Krusell & Rios-Rull (1999) is that agents face no uncertainty and therefore agents have permanent differences in individual productivities. Benabou & Ok (2001) are the first to formalize an additional effect, which determines the voter's preferences over redistribution: the mobility across the earnings groups.[4] The authors introduce idiosyncratic shocks to income and show that the longer the duration of the proposed tax reform, the less support for redistribution there will be. This is because the "prospect of upper mobility" makes some of the poor voters prefer low income taxation. However, the authors don't show empirically if mobility helps better understand the observed dynamics of redistribution in the U.S.

[4]Throughout this paper earnings are defined as income from labor supply.

Corbae et al. (2009) are the first to do this. They introduce idiosyncratic productivity risk into the model by Krusell & Rios-Rull (1999). The authors ask what impact the increased mobility and the increased dispersion of earnings since 1980s in the U.S. had on redistribution. The authors find that all considered models, including the model with commitment and once-and-for-all voting by a median voter, overestimate the amount of redistribution. In this paper I show that a model, which accounts for the wealth bias, has considerably stronger predictive power.

Benabou (2000) models the idea of a wealth bias in the political system. He associates the wealth bias with a wealth-weighted voting by introducing a simple functional relationship between private wealth holdings and the vote share. He shows analytically that high inequality can be consistent with low redistribution. However, he doesn't estimate the model to study the dynamics of redistribution in the U.S. Lagunoff & Bai (2013) adopt a "revealed preference" approach to the question of what can be inferred about the bias in a political system when an outside observer only observers a sequence of taxation policies but doesn't observe the underlying distribution of political power. They establish a Universal Bias Principle that says that if agent's indirect utility function is single-peaked in the tax rate, *any* level of the wealth bias can rationalize *any* observed level of taxation. To ensure uniqueness of the wealth bias, information on agent's preferences from the polling data is needed. I generate such information from the model and pin down uniquely the degree of political inequality in the U.S.

Bachmann & Bai (2013) are the first to introduce the wealth bias into a structural model, which they then estimate. They show that the observed contemporaneous correlation between output and government purchases in the U.S. can be better explained in a model, which accounts for the wealth bias in the political process. In their model the government spending is utility enhancing, and wealthier individuals desire higher levels of government spending. During economic booms agents with lower wealth gain political power, which dampens the co-movement of government spending and the output. Since the authors abstract from any redistribution, their model cannot be used to study the impact of the wealth bias on after-tax income inequality. Besides, the authors consider a government, which chooses the amount of government spending so as to maximize a weighted social welfare function, with weights dependent on the wealth of the households. I do not use this type of social choice institutions, since it leads to a bad fit in the data as shown by Corbae et al. (2009). Instead, I assume majoritarian voting.

2.1 Data facts: Dynamics of income redistribution

The central goal of this paper is to explain the dynamics of redistribution. Redistribution in the U.S. takes many forms. In order to summarize the overall redistributive effect of transfers and taxes, the established practice (by OECD, CBO, etc.) is to compare the Gini index for market income with the Gini index for after-tax and after-transfer income. The larger the difference between the two indices, the stronger is the redistributive effect.

The overall redistributive effect (RE) of taxes and transfers can be further decomposed into the redistributive effect of taxes and the redistributive effect of transfers. For the discussion to follow it is important to keep in mind these definitions, so I write them out:

Overall R.E. = Gini index for market income – Gini index for income after taxes and after transfers.

R.E. of transfers = Gini index for market income – Gini index for income after transfers but before taxes.
R.E. of taxes = Gini index for market income – Gini index for income after taxes but before transfers.

In figure 1 I plot the dynamics of the Gini coefficient for income and in figure 2 I show the dynamics of the redistributive effect of taxes and transfers in 1979-1990 in the U.S. It can be seen that the inequality in market income had been increasing since 1979. Surprisingly, however, redistribution had been declining on average in 1980-1990. One reason for the falling redistribution was a fall in the redistributive effect of taxes. In fact, the Economic and Recovery Tax Act of 1981 reduced the progressivity of the income tax system at the upper tail of the income distribution. For example, the top marginal income tax rate was cut from 70 to 50 percent.

To account for the redistributive effect of taxes, I introduce progressive income taxation into the model. A proportional income tax system would leave the Gini index for after-tax income and therefore redistribution unchanged, which is at odds with the data. As can be seen from figure 2, transfers are also progressive in the U.S. since they reduce the Gini index. This is because transfers are a decreasing percentage of market income as income rises. In my model transfers are progressive because they are assumed to be lump-sum.[5]

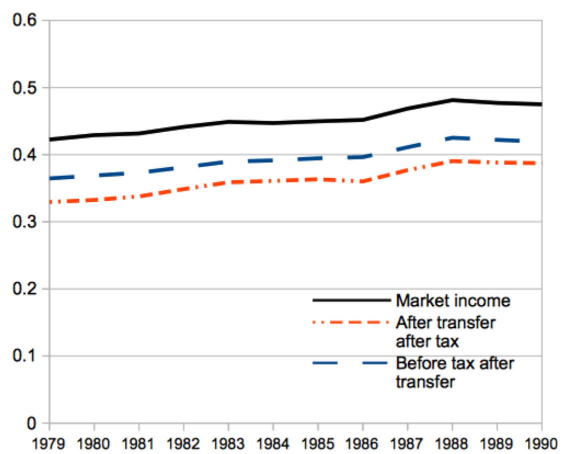


Figure 1: Dynamics of the Gini coefficient for income in the U.S.

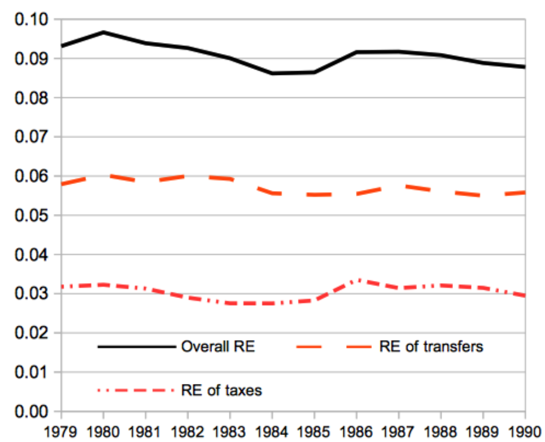


Figure 2: Redistributive effects of taxes and transfers in the U.S.

[5]Following Congressional Budget Office (2011), throughout this paper I define market income as a sum of wages, proprietors' and other business income, interest and dividends, and imputed taxes. I exclude capital gains from the definition of market income as they will not be part of my model. I define transfers as cash transfers and in-kind benefits. I exclude pensions from the definition of transfers since my model abstracts from retirement. I define taxes as individual federal income taxes. Social security taxes are not part of individual income taxes. CBO combines information from the Census Bureau's Current Population Survey and the Statistics of Income data compiled by the Internal Revenue Service. These estimates have relatively detailed information about very high-income households and taxes paid. I construct income series using Table 5 of the "Historical effective tax rates, 1979 to 2005", which can be downloaded at `www.cbo.gov/publication/20374`. The data is available for each quintile of income distribution (and for different percentiles for the top quintile) which allows me to construct the time series of Gini indices.

3 The model

3.1 Endowments and preferences

There is a unit measure of infinitely lived households. In each period households are endowed with one unit of productive time. They spend this time supplying labor to a competitive labor market or consuming leisure. Households are ex-ante identical. The only source of ex-post heterogeneity is exogenous idiosyncratic labor productivity shocks. At any date t agent's productivity, denoted by $\epsilon \in E = \{\epsilon_1, \ldots, \epsilon_z\}$, follows a first-order Markov process with a $z \times z$ transition matrix $\Pi(\epsilon' \mid \epsilon)$, which gives the probability of moving from the state ϵ to the state ϵ'. All agents face the same stochastic process for productivity. Agents know the law of motion for the productivity process.

There are no insurance markets against the idiosyncratic risk. In order to self-insure against the risk of low labor productivity in the future, agents can save in capital. Individual capital holdings are denoted a.[6] Self-insurance is limited by the assumption that the households can not borrow, i.e. $a \geq 0$.[7] Therefore, the individual state space consists of the sets $(a, \epsilon) \in [0, \infty) \times E$. Let $F_t(a, \epsilon)$ denote the cumulative density function of the assets and productivities in the economy at date t. The corresponding density function is denoted by $f_t(a, \epsilon)$.

The instantaneous utility function of the agent reads:

$$u(c, n) = \frac{[c^\gamma (1-n)^{1-\gamma}]^{1-\sigma}}{1-\sigma}, \tag{1}$$

where c is agent's consumption and n is agent's labor supply. The parameter γ measures the importance of consumption relative to leisure, and σ controls the degree of relative risk aversion.[8] This specification of the period utility function is widely used in the applied macro literature. This specification has the property that the optimal labor supply n is a decreasing function of agent's wealth a. This property is discussed in the quantitative exercise.

3.2 Technology

The aggregate technology is represented by a standard Cobb-Douglas production function $K_t^\theta N_t^{1-\theta}$, where K_t, N_t denote the aggregate capital stock and the aggregate efficient labor input, respectively, and θ is the capital share in production. The capital stock depreciates at the rate δ. As standard with a constant returns to scale technology and perfect competition, I assume the existence of a representative firm operating this technology.

[6] Since I consider only one type of asset, I refer to a as capital, wealth and assets interchangeably.

[7] This is a common assumption in the related literature, see Domeij & Heathcote (2004), Conesa & Krueger (2006).

[8] The coefficient of risk aversion is then given by: $-cu_{cc}/u_c = \sigma\gamma + 1 - \gamma$.

3.3 Government policy

Define

$$y_t(a, \epsilon) = \epsilon w_t n_t + r_t a_t, \tag{2}$$

the pre-tax income of the agent in the state (a, ϵ) at time t, where r_t is the risk-free interest rate and w_t is the wage per efficiency unit of labor.

In every period the government taxes each agent's market income. Among a large set of different specifications for the taxation rule, I choose the progressive taxation rule by Gouveia & Strauss (1994). The authors derived the rule from the theory and estimated its parameters for the U.S. for the period 1979-1989. This progressive taxation rule reads:

$$M(y; \tau) = \tau[y - (y^{-m_1} + m_2)^{-1/m_1}], \tag{3}$$

where $M(y)$ is the amount of taxes the agent has to pay if her pre-tax income equals y. The marginal tax rate is given by $M'(y)$ and the average tax rate is given by $M(y)/y$. Parameters τ and m_1 set the type and the magnitude of taxation, figures (3)-(4).

Parameter τ is the marginal (and average) tax rate as income goes to infinity, i.e. $\tau = \lim_{y\to\infty} M'(y) = \lim_{y\to\infty} M(y)/y$. The economically meaningful parameter space for τ is the interval $[0, 1]$.[9] Parameter m_1 determines the curvature of the marginal tax function $M'(y)$. This parameter has a meaningful economic interpretation on the whole set $[-1, \infty)$: if $m_1 = -1$, taxes are independent of income and equal τm_2; with $m_1 \to 0$ one obtains a proportional taxation rule $M(y) = \tau y$; for $m_1 > 0$, there is a progressive taxation of incomes. Parameter m_2 is a scaling parameter. When I change the units of measurement for income in the model, I can no longer use the estimates for τ and m_1 from the data, since the whole taxation rule changes. For the tax system to be unaffected by the change in the units of measurement, one has to adjust the parameter m_2 appropriately.

I choose the taxation rule by Gouveia & Strauss (1994) for three reasons. First, it defines a progressive taxation schedule, and as I showed in section 2.1 redistribution through the progressive tax system is important for the U.S. economy. Second, it is a commonly used specification in the empirical macroeconomic literature.[10] Finally, as compared to alternative specifications, this rule has a relatively small number of parameters, which will become important when it comes to the description of the political process (see below).[11]

In every period the government provides lump-sum transfers T_t.[12] The government runs a

[9] $\tau < 0$ implies negative marginal tax rates, while $\tau > 1$ implies that the marginal tax rate is above 1 for infinitely large incomes.

[10] See Castaneda, Diaz-Gimenez & Rios-Rull (2003), Kitao (2010), Conesa & Krueger (2006).

[11] I considered alternative specifications of progressive taxation. These specifications are either too simple to replicate the U.S. taxation system or they include a too large number of parameters.

[12] I don't include government consumption (defense, etc.) into the government budget constraint. The data don't allow me to say which fraction of individual federal income taxes was spent on issues other than transfers. Nevertheless, the amount of aggregate federal income taxes and the amount of aggregate transfers are very close in the data (Congressional Budget Office (2011)). For example, in 1979 individual income taxes amounted to 533.3 billion of 2005 U.S. Dollars, while transfers (cash transfers and in-kind income) were 539.3 billion of 2005 U.S. Dollars. This gives justification for neglecting government consumption from the government budget constraint.

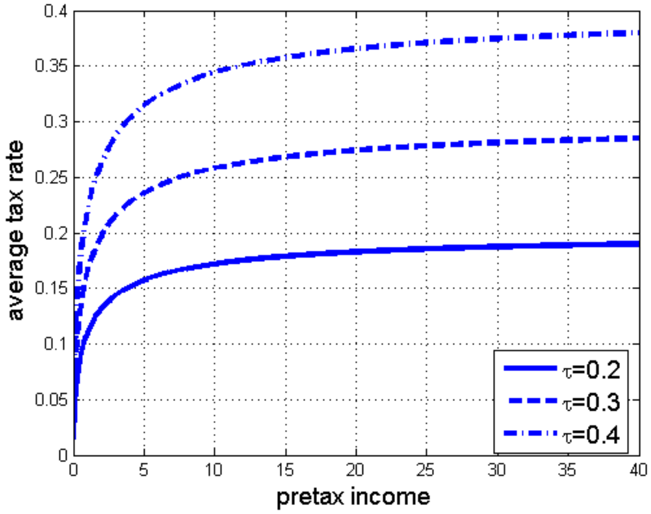


Figure 3: Average tax rates for different τ (with $m_1 = 0.768$ and $m_2 = 0.55$)

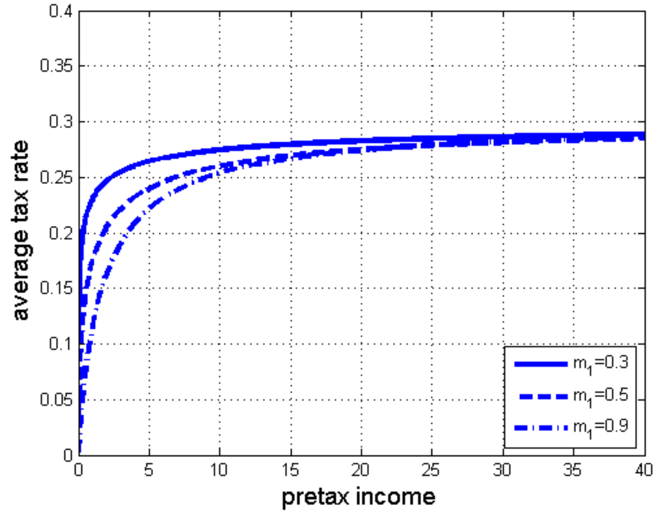


Figure 4: Average tax rates for different m_1 (with $\tau = 0.3$ and $m_2 = 0.55$)

balanced budget, so that the following equality holds:

$$T_t = \sum_{\epsilon} \int M(y_t(a,\epsilon);\tau_t) f_t(a,\epsilon)\mathrm{d}a. \tag{4}$$

3.4 Social choice mechanism

I assume a particular form of the social choice institutions – a majority voting system. Agents vote on the design of the progressive taxation schedule specified in (3). I assume that agents vote on the parameter τ, only. There are two reasons for this assumption. The first reason is that the parameter τ affects progressivity of the taxation schedule. From figure (3) one sees that an increase in the parameter τ raises the average tax rate for a given income and thus increases the progressivity of taxes. The second reason is that I am able to show that the key assumption of the median voter theorem (single peakedness of the indirect utility function) is satisfied if the voting is on the parameter τ.[13]

At $t = 0$ the rate of taxation, τ_0, and the capital stock, K_0, are given. In the same period agents vote on the future permanent rate of taxation $\tau^\star$, which becomes effective from $t = 1$ onwards. The implied implementation lag for the tax rate is important. Intuitively, if voting were on the same period's tax rate, taxation would be less distortionary because the initial capital stock is given and completely inelastic. Finally, I assume that the government can fully commit to keep the chosen tax rate constant. This is a restrictive assumption but relaxing it complicates the computational procedure considerably. Since this paper is the first attempt to explain the dynamics of redistribution when political power is unequally redistributed, it seems appropriate

[13]See more on this issue below. Note that the parameter m_1 also affects the progressivity of the taxation schedule, see figure (4). However, I couldn't show the single peakedness of the indirect utility function over m_1 for none of the typical specifications of the instantaneous utility function.

to start with a simpler case of full commitment.

3.5 Recursive competitive equilibrium

I define the politico-economic recursive competitive equilibrium in two steps. In the first step I set up a recursive competitive equilibrium, when agents take the tax rate $\tau^\star$ as given. In the second step I make $\tau^\star$ consistent with the political process.

Given a rate of taxation $\tau^\star$ and initial conditions τ_0, K_0 and F_0, a **recursive competitive equilibrium** is a sequence of household functions $\{c_t, n_t, a'_t\}_{t=0}^{\infty}$, production plans $\{K_t, N_t\}_{t=0}^{\infty}$, transfers $\{T_t\}_{t=0}^{\infty}$, prices $\{w_t, r_t\}_{t=0}^{\infty}$ and cumulative distribution functions $\{F_t\}_{t=0}^{\infty}$, such that for all $t = 0, 1, ...$ the following statements hold:

- Given the tax rate, prices, transfers and household policy functions, v solves the Bellman equation:

$$\begin{aligned} v(a, \epsilon, F_t; \tau_0, \tau^\star) &= \max_{c,a',n} \left\{ u(c,n) + \beta \sum_{\epsilon'} \Pi(\epsilon' \mid \epsilon) v(a', \epsilon', F_{t+1}; \tau_0, \tau^\star) \right\} \\ \text{subject to:} & \\ a' &= [\epsilon w_t n + (1+r_t)a] + T_t - M(y_t(a,\epsilon); \tau_t) - c, \\ a', c &\geq 0,\ 0 \leq n \leq 1, \qquad (5) \\ \tau_0 \text{ given}, \tau_{t+1} &= \tau^\star \text{ for all } t \geq 1, \qquad (6) \end{aligned}$$

  where $u(c, n)$, y_t and $M(\cdot)$ are defined in (1), (2) and (3), respectively. The parameter β is the subjective discount factor. A prime denotes tomorrow's realization of the related variable. The object $v(a, \epsilon, F_t; \tau_0, \tau^\star)$ denotes the discounted life-time indirect utility of a household in the state (a, ϵ) at time t, when the aggregate distribution of agents is F_t, the initial tax rate is τ_0 and the permanent tax rate is $\tau^\star$.[14] The fact that I rule out borrowing can be seen from the constraint $a' > 0$.

- The pricing functions satisfy: $r_t = \theta K_t^{\theta-1} N_t^{1-\theta} - \delta$ and $w_t = (1-\theta) K_t^{\theta} N_t^{-\theta}$.

- The distribution of agents across productivity levels and assets evolves according to

$$F_{t+1}(\epsilon_{t+1}, a_{t+1}) = \sum_{\epsilon_t} \Pi(\epsilon_{t+1} \mid \epsilon_t) F_t(\epsilon_t, a_{t+1}^{-1}(\epsilon_t, a_{t+1})),$$

  where $a_{t+1}^{-1}(\epsilon_t, a_{t+1})$ is the inverse of the optimal policy $a_{t+1} = a_{t+1}(\epsilon, a)$ with regard to current period wealth a.[15]

- The government runs a balanced budget according to (4).

[14] The distribution function $F_t(a, \epsilon)$ is an argument of the function $v(\cdot)$ in the maximization problem of the agent. In order to predict tomorrow's prices, the agent needs to know how much all other agents in the economy save today. Therefore, the agent needs to know the distribution of the individual states and to sum over the next period assets over all households.

[15] I assume that $a_{t+1}(\cdot)$ is invertible, which will be the case in my example economy.

- The markets clear. On the labor market it holds: $N_t = \sum_\epsilon \int \epsilon n_t(a,\epsilon) f_t(a,\epsilon)\mathrm{d}a$; on the asset market it holds: $K_{t+1} = \sum_\epsilon \int a'_t(a,\epsilon) f_t(a,\epsilon)\mathrm{d}a$; on the goods market it holds: $K_t^\theta N_t^{1-\theta} = \sum_\epsilon \int c_t(a,\epsilon) f_t(a,\epsilon)\mathrm{d}a + K_{t+1} - (1-\delta)K_t$.

A **stationary recursive competitive equilibrium** is a competitive equilibrium, in which household functions, production plans, transfers, prices and the distribution of agents are constant.[16]

3.6 Politico-economic recursive competitive equilibrium

I assume that the weight attached to the agent's vote depends on agent's capital holdings. More specifically, the vote allocation to the single agent in the state (a,ϵ) is given by a^α, with $\alpha > 0$ governing the strength of the wealth bias. Then the weight attached to all agents in the state (a,ϵ) at the time of voting, $t = 0$, is the product of the mass of agents in this state and the weight attached to each agent in this state, $f_0(a,\epsilon) \times a^\alpha$.

I find the most preferred tax rate of each agent type: among all possible $\tau \in [0,1]$, the agent in the state (a,ϵ) prefers the tax rate $\hat{\tau}$, which maximizes her ex ante life-time utility at $t = 0$ given by $v(a,\epsilon,F_0;\tau_0,\hat{\tau})$. Then I rank obtained tax rates $\hat{\tau}$ in ascending order and attach to each of it the weight $f_0(a,\epsilon)a^\alpha$. The median voter is then the agent type, whose most preferred tax rate is the weighted median of the ranked most preferred tax rates. Below I refer to this agent type as the weighted median voter and denote her most preferred tax rate $\tau^\star$.

The **politico-economic recursive competitive equilibrium** is:

- A sequence of household functions $\{c_t, n_t, a'_t\}_{t=0}^\infty$, production plans $\{K_t, N_t\}_{t=0}^\infty$, transfers $\{T_t\}_{t=0}^\infty$, prices $\{w_t, r_t\}_{t=0}^\infty$ and distributions $\{F_t\}_{t=0}^\infty$ that satisfy the definition of a recursive competitive equilibrium above.

- The most preferred tax rate of an agent in the state (a,ϵ) at date $t = 0$ satisfies:

$$\hat{\tau}(a,\epsilon) = \arg\max_{\tau\in[0,1]} v(a,\epsilon,F_0;\tau_0,\tau). \tag{7}$$

- The policy outcome $\tau^\star$ satisfies:

$$\frac{\int \mathcal{I}_{\{(a,\epsilon):\hat{\tau}(a,\epsilon)\geq\tau^\star\}} a^\alpha f_0(a,\epsilon)\mathrm{d}a}{\int a^\alpha f_0(a,\epsilon)\mathrm{d}a} \geq \frac{1}{2} \text{ and } \frac{\int \mathcal{I}_{\{(a,\epsilon):\hat{\tau}(a,\epsilon)\leq\tau^\star\}} a^\alpha f_0(a,\epsilon)}{\int a^\alpha f_0(a,\epsilon)\mathrm{d}a} \geq \frac{1}{2}, \tag{8}$$

  where $\mathcal{I}$ is an indicator function. This condition just determines the weighted median of the ranked most preferred tax rates, as I explained above. It is convenient to re-scale each weight $a^\alpha f_0(a,\epsilon)$, so that all the weights sum up to one. This explains the term $\int a^\alpha f_0(a,\epsilon)\mathrm{d}a$ in the denominator.

[16] Huggett (1993, pp. 960-961) provides conditions for the existence and the uniqueness of the stationary equilibrium in a similar model. He also describes the procedure to find the stationary equilibrium on a computer.

The median voter exists if each agent's indirect utility $v(a, \epsilon, F_0; \tau_0, \tau)$ is single-peaked in τ. Single-peakedness ensures that the median ranked preferred tax rate beats any other tax rate in pairwise comparison. I do not have a proof of existence of the voting equilibrium. Neither am I aware of any existence results for the incomplete market literature. However, I verify numerically that in every simulation at $t = 0$ the indirect utility function satisfies single peakedness for every (a, ϵ).[17]

3.7 Agent's most preferred tax rate

When choosing the tax rate, agents think through the equilibrium effects of each tax policy, and these effects extend into the infinite future. There are several effects which are internalized by the decisive agent. I describe them verbally below:[18]

1. *Distortionary effects*: Higher taxes distort agent's individual as well as aggregate labor supply and saving and therefore reduce the amount of redistribution.

2. *Redistribution effect*: If the agent is very poor in terms of wealth holdings or earnings, she has stronger incentives to set higher rate of taxation, since she receives a positive net transfer.

3. *Price effects*: Due to the distortionary effects, taxation affects the relative price of labor and capital. This affects the amount of taxes paid by each individual and thus the amount of transfers received.

4. *Income decomposition effect*: If agent's income has a large earnings share in relative terms, the agent would like to see a higher wage relative to the interest rate. As a consequence, the agent prefers tax policies which discourage the others from working.

5. *Mobility effect*: This effect relates to the persistence of idiosyncratic shocks. With idiosyncratic uncertainty what matters is agent's future productivity, not agent's current productivity. If mobility is high (i.e persistence is low), the agent who has currently low productivity expects higher productivity and therefore higher earnings in the future. Thus, higher mobility increases the cost of taxation and leads to lower tax rates.

6. *Insurance effect*: This effect relates to insurance that taxes provide against the idiosyncratic shocks. The higher the concavity of the utility function, the higher are equilibrium tax rates.

While the first four effects have been discussed extensively in the literature, the last two effects have drawn less attention. In section 5 I study in detail the contribution of these two effects to the equilibrium voting outcome.

[17] Krusell & Rios-Rull (1999), Corbae et al. (2009) and Bachmann & Bai (2013) use this procedure. Azzimonti, de Francisco & Krusell (2006) show analytically the existence of the median voter for a complete market model with a proportional income tax rate.

[18] Azzimonti et al. (2006) show analytically how the first four effects influence the voting decision in a non-stochastic environment with infinite horizon. Quadrini (2009) shows analytically the mechanism behind the last two effects in a two-period model.

4 Benchmark model economy

I assume that the model economy is in a steady state that matches key observations of the U.S. economy in 1979-1980.[19]

The parameters of the model can be summarized in three different sets: (*i*) preferences and technology $\{\beta, \gamma, \sigma, \theta, \delta\}$; (*ii*) government parameters $\{\tau, m_1, m_2\}$; and (*iii*) employment process $\{E, \Pi\}$. I take some of these parameter values from the data and the related studies, whereas some of the parameters are found by moment matching. The values for all the parameters of the benchmark model are summarized in table 3. The model period is one year.

4.1 Preferences and technology

The discount factor $\beta = 0.95$ is chosen so that the equilibrium of the benchmark economy implies a capital-output ratio of 3.13 as in Castaneda et al. (2003). I fix the parameter σ, which controls the degree of relative risk aversion, to 1.2 and estimate the importance of consumption in the utility function γ below.[20] Following Conesa & Krueger (2006), I set the labor's share of income equal to 64 percent (which implies $\theta = 0.36$) and the rate of depreciation δ to 6 percent.

4.2 Government parameters

The political element of the model is not exploited at this stage, since I treat the rate of taxation τ (and the potential bias in the political process) as exogenously given during the whole calibration exercise. Using the estimates by Gouveia & Strauss (1994), I set τ to 0.467 and the curvature of marginal taxes m_1 to 0.823, which are averages of the corresponding estimates for 1979-1980.[21] Below I estimate the scaling parameter m_2.

4.3 Employment process

The employment process is at the core of my analysis. I need to parameterize the transition matrix Π as well as the vector of employment shocks E. The starting point is the annual mobility matrix from 1978 to 1979 estimated by Corbae et al. (2009) based on the Panel Study of Income Dynamics (PSID). The PSID is a longitudinal data set particularly useful for measuring the evolution of earnings over time but earning are top coded. As a result of top coding, a model based on these

[19]The assumption that the benchmark model economy is in the steady state during 1979-1980 is not without concerns. In 1979 the second oil crisis took place, while the Iran-Iraq War started in 1980. Nevertheless, I choose this period because the key objects of my analysis – earnings and income inequality – were relatively low during this period (the dynamics of wages is plotted in figure 5 on page 20).

[20]Conesa, Kitao & Krueger (2009) set the parameter σ arbitrarily to 4.

[21]Gouveia & Strauss (1994) use individual income and tax data by the Internal Revenue Service. Their definition of market income deviates from mine (see footnote 5), since the authors additionally include pensions and capital gains.

data doesn't match the upper tail of the wealth distribution and therefore underestimates the wealth inequality. More precisely, Juster, Smith & Stafford (1999) argue that PSID does a poor job in representing the household wealth for the top 1 percent of wealth distribution.

There are two reasons why it is important to have an accurate measure of the top tail of the wealth distribution in my model. First, wealthier agents gain disproportionately more political power; therefore, existence of the very wealthy agents is important for the voting outcome. Second, below I have to resort to the data from the Survey of Consumer Finances (SCF) and the data by the Internal Revenue Service (IRS). As opposed to the PSID, these two data sources account sufficiently well for the extreme wealth inequality, so that combining these data with the PSID data might lead to wrong results.

In order to account for the extreme wealth inequality, I use an approach similar to Domeij & Heathcote (2004), Castaneda et al. (2003) and Diaz & Luengo-Prado (2010). I divide the households into two wage groups: super-rich and regular households. For regular households, the idiosyncratic productivities follow an autoregressive process $\log(\epsilon_{t+1}) = \rho \log(\epsilon_t) + u_{t+1}$. The shock u_{t+1} is iid with mean zero and variance given by $(1-\rho^2)\bar{\sigma}^2$, where $\bar{\sigma}^2 = var(\log(\epsilon_{t+1}))$. In the discussion to follow, I associate the parameter $\bar{\sigma}^2$ with the dispersion of idiosyncratic shocks and the parameter ρ with the mobility across productivity levels with higher ρ meaning lower mobility.

I set the persistence coefficient ρ to 0.77 and the dispersion of productivities $\bar{\sigma}^2$ to 0.75, which are the estimates obtained by Corbae et al. (2009) from the PSID data for 1979-1980. I approximate this autoregressive process by a 6-point Markov chain using the procedure by Tauchen (1986). This gives me a vector of discrete productivity levels $\{\epsilon_1, ..., \epsilon_6\}$ and a 6×6 transition matrix. The productivities ϵ are normalized, so that $\epsilon_1 = 1$. In the approximated process, the dispersion of productivities is reflected by the variance of the discrete values of ϵ, while the mobility across the productivity levels is reflected by the diagonal elements of the transition matrix with higher probabilities meaning lower mobility.

To account for the super-rich, I add to the obtained transition matrix the 7th row and the 7th column. Following Diaz & Luengo-Prado (2010), I assume that each regular household has an equal probability of 0.0005 of becoming a super-rich, and the probability that a super-rich becomes a regular household is 0.00825 and is the same for every type of regular households. These values imply that in the long run the super-rich represent 1 percent of the total population. I add to the vector of productivities $\{\epsilon_1, ..., \epsilon_6\}$ the shock for the super-rich, ϵ_7, which I estimate.

The resulting 7×7 transition matrix Π together with the vector of productivities $E = \{\epsilon_1, ..., \epsilon_7\}$ are given in table 1. To quantify the degree of mobility, I compute the expected durations of each shock ϵ_n, which is a reciprocal of $1 - \Pi(\epsilon_n \mid \epsilon_n)$. The expected duration of the highest shock is 20.2 years. Apart from the super-rich, the least mobile groups are the households facing the lowest and the second highest shocks: the expected duration of these two shocks is 1.89 years.

4.4 Remaining parameters

Finally, I jointly estimate the importance of consumption in the utility function γ, the productivity of a super-rich agent ϵ_7 and the scaling parameter in the progressive taxation schedule m_2. I

Productivity shocks ϵ						
1	1.68	2.83	4.75	7.99	13.44	33.60
Transition matrix Π						
0.4717	0.3358	0.1570	0.0321	0.0029	0.0001	0.0005
0.2133	0.3444	0.3032	0.1173	0.0198	0.0015	0.0005
0.0644	0.2170	0.3596	0.2621	0.0839	0.0124	0.0005
0.0124	0.0839	0.2621	0.3596	0.2170	0.0644	0.0005
0.0015	0.0198	0.1173	0.3032	0.3444	0.2133	0.0005
0.0001	0.0029	0.0321	0.1570	0.3358	0.4717	0.0005
0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.9505
Stationary distribution, %						
10	16	23	23	16	10	1
Expected duration, years						
1.89	1.52	1.56	1.56	1.52	1.89	20.20

Table 1: Transition matrix for 1978–1979

Productivity shocks ϵ						
1.00	1.82	3.34	6.10	11.15	20.38	50.95
Transition matrix Π						
0.4546	0.3313	0.1691	0.0399	0.0043	0.0002	0.0005
0.2136	0.3313	0.3010	0.1267	0.0246	0.0023	0.0005
0.0702	0.2150	0.3476	0.2606	0.0905	0.0156	0.0005
0.0156	0.0905	0.2606	0.3476	0.2150	0.0702	0.0005
0.0023	0.0246	0.1267	0.3010	0.3313	0.2136	0.0005
0.0002	0.0043	0.0399	0.1691	0.3313	0.4546	0.0005
0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.9505
Stationary distribution, %						
10	16	23	23	16	10	1
Expected duration, years						
1.83	1.49	1.53	1.53	1.49	1.83	20.20

Table 2: Transition matrix for 1995–1996

estimate these parameters using the simulated method of moments. My estimation strategy is to choose such a combination of the parameters, for which the model economy reproduces the key moments observed in the U.S. data in 1979-1980.

One requirement imposed on the moments is that they be informative about the parameters to be estimated: slight variations in the values of the parameters should result in different values of the moments. This requirement provides identification. The four conditions I impose on the model are:

1. A Gini coefficient for after-tax and after-transfer income inequality of 0.33.

2. A share of transfers in output of 13.6 percent.

3. Average labor supply of 30 percent.

4. A share of total wealth held by the 8th decile of the wealth distribution of 13 percent.[22]

I target the first two moments in order to obtain a realistic measure of redistribution in the model. These moments together turn out to be most informative about the scaling parameter m_2. Average labor supply, which is the third moment, pins down the importance of consumption in the utility function γ. I target the share of total wealth held by the 8th decile of the wealth distribution because the model needs to generate sufficient inequality of wealth at the upper tail of the wealth distribution. This moment is most informative about the relative productivity of the super-rich agents ϵ_7.

The combination of the described moments provides sufficient variation in the objective along the dimensions of the three parameters. The objective reads:

$$\text{Objective}(\gamma, m_2, \epsilon_7) = \sum_{i=1}^{3} [\text{data-implied moment}_i \text{–model-implied moment}_i(\gamma, m_2, \epsilon_7)].$$

The parameters of interest are identified by minimizing the objective:

$$\{\gamma^\star, m_2^\star, \epsilon_7^\star\} = \arg \min_{\{\gamma, m_2, \epsilon_7\}} [\text{Objective}(\gamma, m_2, \epsilon_7)],$$

where $(\gamma, m_2, \epsilon_7)$ are varied on a predetermined grid.[23] The objective function has a global minimum, so that identification is achieved. These resulting estimates are $\gamma^\star = 0.55$, $m_2 = 0.075$ and $\epsilon_7 = 2.5 \times \epsilon_6$. The estimate for γ implies a coefficient of risk aversion of $\sigma\gamma + 1 - \gamma = 1.11$. The estimate for ϵ_7 means that the super-rich face a productivity level, which is 2.5 times larger than

[22]Throughout this paper, wealth is measured as net worth as defined in Wolff (2004). More specifically, net worth is the difference in value between total assets and total liabilities or debt. Total assets are composed of financial and non-financial assets. Financial assets do not include future social security benefits. Non-financial wealth includes (among others) housing. Total liabilities include (among others) mortgage debt. I choose net worth and not financial wealth because net worth reflects wealth as a store of value and therefore a source of potential consumption. Thus, net worth is of higher importance to households than financial wealth when it comes to voting over the future permanent income tax rate (this will be the quantitative exercise below).

[23]Due to the computational intensity, I create a grid for the parameters and evaluate the objective function at each combination of the grid points. I vary γ between 0 and 1 and m_2 between 0 and 1.5 with a step of 0.05. For ϵ_7, I use the multiples 2,2.5,3,3.5,...,10 of ϵ_6.

Parameter	Description	Value	Source
Preferences:			
β	discount factor	0.95	Castaneda et al. (2003)
σ	degree of risk aversion	1.2	fixed
γ	rel. weight on consumption	0.55	estimated
$\sigma\gamma + 1 - \gamma$	rel. risk aversion	1.11	
Technology:			
θ	capital share	0.36	Conesa & Krueger (2006)
δ	depreciation	6 %	Conesa & Krueger (2006)
Productivity process for regular households:			
ρ	persistence	0.77	Corbae et al. (2009)
$\bar{\sigma}$	variance	0.75	Corbae et al. (2009)
Productivity process for super-rich:			
$\pi(\epsilon_7 \mid \epsilon), \epsilon = \epsilon_1, ..., \epsilon_6$	prob. of becoming super-rich	0.0005	Diaz & Luengo-Prado (2010)
$\pi(\epsilon \mid \epsilon_7), \epsilon = \epsilon_1, ..., \epsilon_6$	prob. of becoming regular	0.00825	Diaz & Luengo-Prado (2010)
ϵ_7	productivity of super-rich	40.32	estimated
Government policy:			
τ	marginal tax for ∞ income	0.467	Gouveia & Strauss (1994)
m_1	curvature	0.823	Gouveia & Strauss (1994)
m_2	scaling parameter	0.075	estimated

Table 3: Parameters of the benchmark model

that of the most productive regular household.

Table 4 evaluates the performance of the calibrated benchmark model economy.[24] First, the model matches the inequality in earnings relatively well. Specifically, the model performs well in replicating the average effective wage of the agents in the top 1 percentile relative to the average effective wage of the agents in the 0-90th percentiles of the income distribution. Second, the model achieves a very good fit of the redistributive effect of taxes and the redistributive effect of transfers even though these moments were not targeted during the estimation stage. Furthermore, the benchmark model economy does a relatively good job of accounting for the shares of wealth owned by the households in the 8th decile. Introducing the super-rich agents into the model improves the Gini coefficient for wealth, but nevertheless the model underestimates the share of wealth held by the top decile.[25]

[24] The data on wealth inequality are taken from Wolff (2004). The data on income distribution, earnings, wages and equalization effects are taken from Congressional Budget Office (2011) (see footnote 5 for the data file). The data on other moments displayed in the table are from Castaneda et al. (2003). The numbers in the table might not add up to corresponding aggregates because of rounding errors.

[25] Related literature had trouble in jointly matching the distribution of wealth, earnings and income. Domeij & Heathcote (2004, Table 2) achieve a relatively good fit of the distribution of wealth but significantly underestimate the earnings inequality; estimation results regarding the distribution of income are not reported. Castaneda et al. (2003, Table 7) achieve an excellent fit of the distribution of wealth and earnings without reporting results about the income distribution. In the current paper I care both about wealth inequality (because of the wealth bias) and income inequality (because of income redistribution). Thus, my estimation strategy is to reach a compromise in matching these two distributions. Below I discuss how the results of the paper depend on the achieved match of the distribution of wealth.

Moment	Benchmark	U.S.	Moment	Benchmark	U.S.
Wealth distribution:			**Income distribution:**		
-Gini coefficient	0.52	0.80	-Gini market income	0.53	0.43
-Percentiles :			-Gini after-tax after-transfer (*)	0.42	0.33
$0-80$	47	19	**Earnings:**		
$80-90$ (*)	18	13	-Gini pre-tax	0.62	0.61
$90-100$	35	68	-Earnings ratio P99-100/P0-90	13.99	15.91
Equalization effects:			**Other moments**:		
-overall	0.11	0.10	-average labor supply (*)	0.33	0.30
-transfers	0.07	0.06	-capital-to-output	3.66	3.13
-taxes	0.03	0.03	-transfers-to-output(*)	0.12	0.14

Table 4: Comparing the calibrated benchmark model economy with the data in 1979-1980
(*) denotes the target moments in the grid search procedure

5 Quantitative exercise

5.1 Overview

In the quantitative exercise I simulate the dynamics of income inequality since 1981. Before doing so, I modify the environment of the benchmark model economy in two ways. First, I change the specification of the idiosyncratic employment process (section 5.2). This change is meant to account for a significant rise in wage dispersion in the U.S. during 1981-1990. Second, I endogenize the progressivity of the tax schedule: in 1980 agents vote once-and-for-all on it (section 5.3). This modification imitates the adoption of the Economic and Recovery Tax Act of 1981. Before agents vote, they anticipate the changes in the employment process.

In order to understand the voting decision in 1980, I discuss agent's most preferred tax rate as a function of agent's asset holdings and productivity (section 5.5.1). Then I simulate the dynamics of income redistribution when the standard median voter and when the weighted median voter are decisive (section 5.5.2). Afterwards, I compute the strength of the wealth bias, which rationalizes the tax rate observed in the data in 1981-1990 (section 5.5.3). In order to understand the differences between the voting outcomes under the standard and the weighted median voters, I quantify the effect of rising dispersion of wages and rising mobility across wage groups since 1980 on the most preferred tax rate of the standard and the weighted median voters (section 5.5.4).

5.2 Changes in employment process

Since 1981 the variation in wages in the U.S. started to increase dramatically. In figure 5 I plot the variance of log (male) hourly wages using the data from Heathcote, Perri & Violante (2010). Different explanations have been proposed to explain this increased wage dispersion, such as globalization, decline of union strength, skill-biased technological change, executive compensation practices in the financial sector, etc. Since the rising wage dispersion itself is not the topic of this paper, I account for it by appropriately adjusting the parameters of the employment process.

In 1980 agents learn that the idiosyncratic employment process for *regular* agents changes as follows. The dispersion of productivities, measured by $\bar{\sigma}^2$ in the autoregressive representation, increases from 0.75 to 1.01. Second, the mobility across employment states rises: the persistence of shocks, measured by the autocorrelation coefficient ρ, decreases from 0.77 to 0.75. These numbers are the estimates obtained by Corbae et al. (2009) from the PSID data for 1995-1996.

I assume that a regular household has the same probability of becoming super-rich, and a super-rich agent has the same probability of becoming a regular household as in the benchmark model economy. As a result, the long-run share of the super-rich in the total population doesn't change. Furthermore, I assume – as in the benchmark model – that the productivity level of the super-rich agent is 2.5 times higher than the productivity of the most productive regular agent.[26]

The resulting transition matrix is in table 2 on p. 15. Larger dispersion in wages comes from the fact that now the 6 highest productivities are approximately 1.8, 3.3, 6.1, 11.1, 20.4 and 51.0 times larger than the lowest one (they were 1.7, 2.8, 4.7, 8.0, 13.4 and 33.6 times larger, respectively). Higher mobility comes from the fact that expected durations of the shocks for regular households are now 1.8, 1.5, 1.5, 1.5, 1.5, 1.8 years, which is slightly shorter than in the initial steady state (1.9, 1.5, 1.6, 1.6, 1.5, 1.9 years, respectively).

5.3 Once-and-for-all voting

In 1980 agents vote on the rate of taxation τ, which becomes effective from 1981 onwards. Voting takes place only once, and the chosen tax rate remains constant forever.

The assumption of once-and-for-all voting is not as restrictive as it may appear first. In figure 6 I plot the annual estimates of the parameter τ.[27] The shaded region in the figure corresponds to the pre-voting period, in which the economy is assumed to be in the steady state. It can be seen that in the period 1979-1989 there was only one significant drop in the progressivity of the income tax rates (i.e. drop in the value of the parameter τ). This drop took place in 1981. Historically, this time corresponds to the adoption of the Economic and Recovery Tax Act, which, for example, reduced the top marginal income tax rate from 70 to 50 percent. Later no changes in the progressiveness of the same significance occurred. This is why I assume that agents vote only once in the period 1980, choosing the tax rate which would be effective from 1981 onwards.[28]

[26] This is a somewhat arbitrary assumption. However, I find ex-post that the ratio of the average effective wage of agents in the top 1 percent to the average effective wage of agents in the 0-90th percentiles of the income distribution during 1981-1989 in the simulated model economy is ca. 7.70, which is close to 9.75 in the data by Piketty & Saez (2007).

[27] The estimates are taken from Gouveia & Strauss (1994). The authors estimated the tax schedule in (3) for the U.S. economy using individual level income tax data.

[28] The second, less significant, decline in the progressiveness took place in 1986, when The Tax Reform Act was adopted. The Act reduced the top marginal tax rates further down to 28 percent in 1988. At the same time, the same Tax Act eliminated the preferential tax treatment of capital gains, which explains a slight increase in progressiveness in 1987. The Tax Reform Act of 1986 seems to have had only short-terms effects in increasing the progressiveness, since the estimate for τ soon returns to its pre-reform levels. Note that during the whole period the estimates for the parameters m_1 and m_2, which also affect progressiveness, didn't change significantly, see Gouveia & Strauss (1994). This allows me to evaluate the progressiveness by only looking at the estimates for τ.

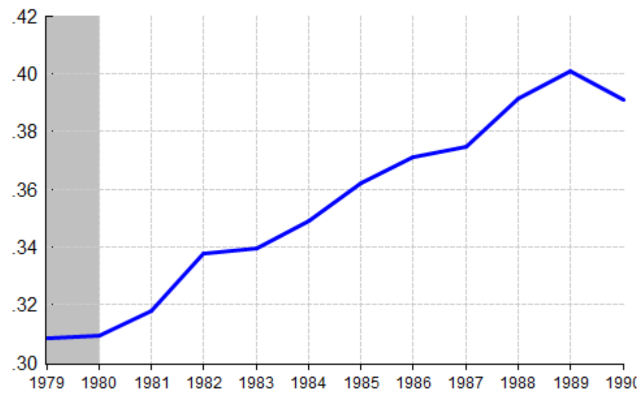


Figure 5: Variance of log (male) hourly wages

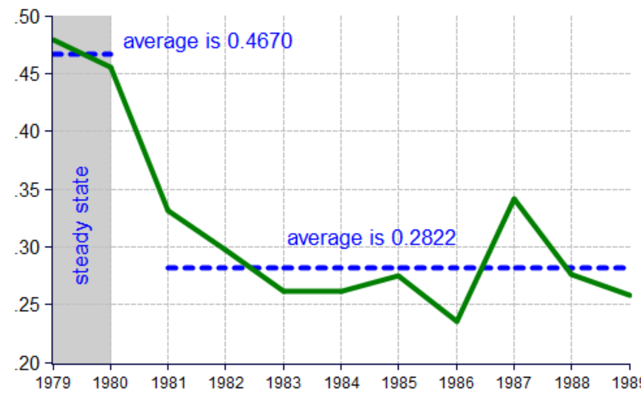


Figure 6: Estimates of the parameter τ

5.4 Strategy

My strategy for the quantitative exercise is as follows:

0. I solve for the benchmark model in 1980 using the old employment process from table 1 and the model parameters from table 3. I obtain the stationary distribution of agents over the states $(a, \epsilon) \in \Gamma_1$ at $t = 0$, $f_0(a, \epsilon)$.[29] This step was done in the previous section.

1. I feed into the model the parameters of the new employment process from table 2. All the remaining parameters (except for τ) remain constant. For every $\tau \in \Gamma_2$, I compute the corresponding steady state.[30]

2. I solve for transitional dynamics of the economy from the initial steady state computed in step 0 to each of the new steady states computed in step 1.[31] For each transition, I compute the corresponding function $v(a, \epsilon; F_0, \tau_0, \tau)$. I verify numerically that the function $v(a, \epsilon; F_0, \tau_0, \tau)$ is single peaked in τ for every $(a, \epsilon) \in \Gamma_1$. For every (a, ϵ), I find the most preferred tax rate $\hat{\tau}(a, \epsilon)$ according to (7).

3. Given the objects $\hat{\tau}(a, \epsilon)$ from the previous step and $f_0(a, \epsilon)$ from step 1, I find the equilibrium tax rate for the case of unbiased political process using (8) and setting $\alpha = 0$. The resulting tax rate, $\tau_U^\star$, is the tax rate preferred by the standard median voter. The tax rate preferred by the weighted median voter, $\tau_B^\star$, is simply the average of the estimates for τ in the period 1981-1989 computed by Gouveia & Strauss (1994) and plotted in figure 6. From all the transitions computed in step 2, I plot the transition associated with $\tau_U^\star$ and the transition associated with $\tau_B^\star$.

[29] The set Γ_1 is a discretized version of the set $[0, \infty) \times E$.
[30] The set Γ_2 is a discretized version of the set $[0, 1]$.
[31] I use the guess and verify technique. It starts with an initial guess for the time path of the factor prices. Given this guess, the decision functions of the agent along the transition are computed. The initial distribution and the computed decision functions imply a new path for the factor prices. If the initial guess of the factor prices is different from this new path, the guess is updated accordingly. Domeij & Heathcote (2004) describe the procedure in detail.

5.5 Main findings

5.5.1 Agent's most preferred tax rate

Agent's voting decision in 1980 can be better understood from figure 7, where I plot agent's most preferred tax rate as a function of agent's asset holdings and productivity (ignore for a moment the vertical and horizontal lines). Two observations are worth noting. First, for a given level of asset holdings, households facing a lower employment shock prefer a higher tax rate. Agents anticipate that the employment process in the future is going to be persistent (recall table 2), so that low productivity agents today expect to face low productivity in the future.

Second, the preferred tax rate is a weakly decreasing function of private wealth. Note that the most preferred tax rate of the super-rich is zero for all levels of assets.

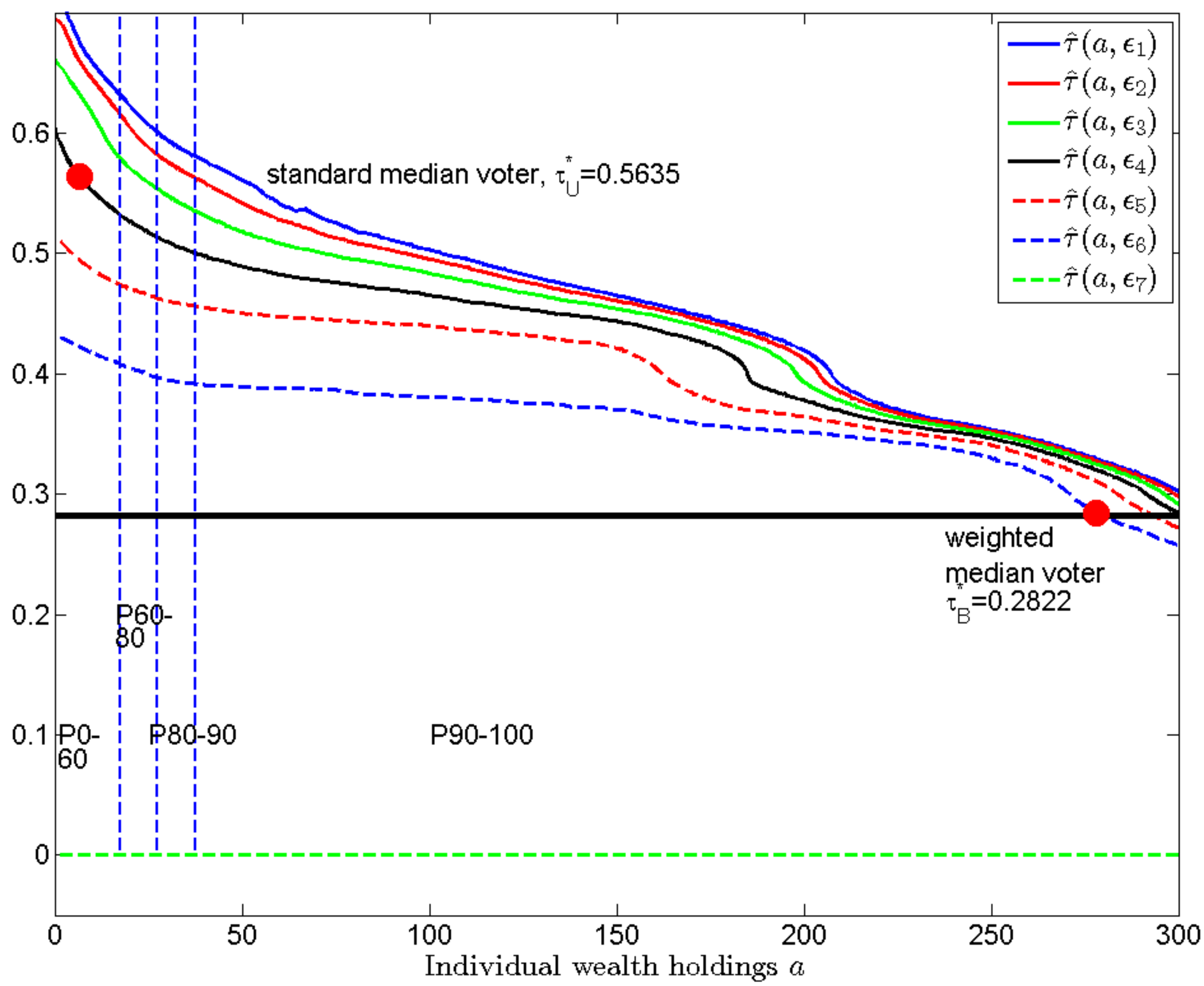


Figure 7: Most preferred tax rate $\hat{\tau}(a, \epsilon)$

5.5.2 Dynamics of redistribution

Using the function of most preferred tax rates $\hat{\tau}(a,\epsilon)$ and the initial distribution of agents $f_0(a,\epsilon)$, I can immediately find the equilibrium tax rate for the case of unbiased political process. It turns out to be $\tau_U^\star = 0.5635$. In figure 8 I contrast the data with the dynamics of income redistribution for the case of the weighted median voter ($\tau_B^\star = 0.2822$) and the standard median voter. Additionally, I decompose income redistribution into the redistributive effect of taxes and transfers and then plot their dynamics.[32]

It can be seen from the figure that a model, in which the standard median voter is decisive, predicts a rise in redistribution since 1981. The overall redistributive effect jumps from 0.10 to 0.16. This higher redistribution is brought about by both a more progressive tax system and more progressive transfers. In particular, the redistributive effect of transfers rises from 0.06 to 0.10, while the redistributive effect of taxes increases from 0.030 to 0.045.

On the contrary, a model which accounts for the wealth bias in the political process predicts a drop in redistribution consistent with the data. This drop results mainly from a lower redistributive effect of taxes which is also in line with the data.

5.5.3 Revealed political power

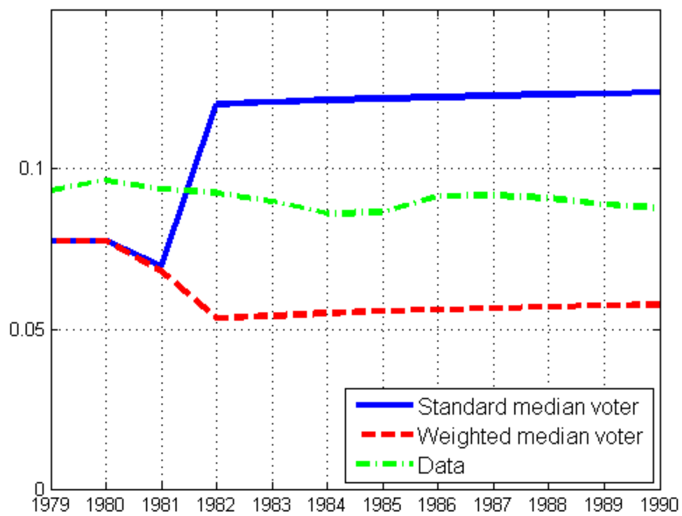
In the next step I find the strength of the wealth bias, which rationalizes the tax rate observed in the data in 1981-1990. The strength of the wealth bias is measured by the parameter α in (8). Thus, I find the value of $\alpha^\star$, such that given this value as well as the distribution of wealth $f_0(a,\epsilon)$ and the function of most preferred tax rates $\hat{\tau}(a,\epsilon)$, the weighted median of the ranked most preferred tax rates equals $\tau_B^\star = 0.2822$.[33]

The identified value of the parameter α allows me to uniquely pin down the state, in which the weighted median voter is located in the model in 1980 (I use this information for counterfactual experiments in the following section). Both the standard and the weighted median voters are marked by circles in figure 7; the dashed vertical lines refer to different percentiles of the wealth distribution and the solid horizontal line refers to $\tau_B^\star = 0.2822$. Whereas the standard median voter is located in the 2nd quintile of the equilibrium wealth distribution of 1980 and faces the 4th lowest employment shock, the weighted median voter is the agent in the top decile of the wealth distribution and faces the second largest employment shock. [34] Furthermore, I find that the

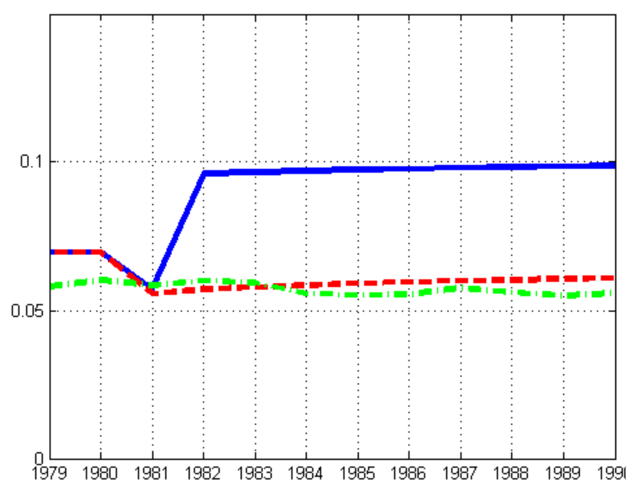
[32] The dynamics are plotted until 1990 only because in the model the impact of voting on redistribution dies out by that time.

[33] This analysis follows closely the reverse engineering approach discussed by Lagunoff & Bai (2013), who have the same specification for the wealth bias as in this paper. Their *Universal Bias Principle* ensures that if agent's indirect utility function $v(\cdot)$ is single-peaked in τ, then in principle *any* level of the wealth bias can rationalize *any* observed level of taxation $\tau^\star$. To guarantee the uniqueness of the wealth bias for a given equilibrium level of taxation, information on agent's preferences from the polling data is needed. In my model the function of most preferred tax rates $\hat{\tau}(a,\epsilon)$ delivers such information.

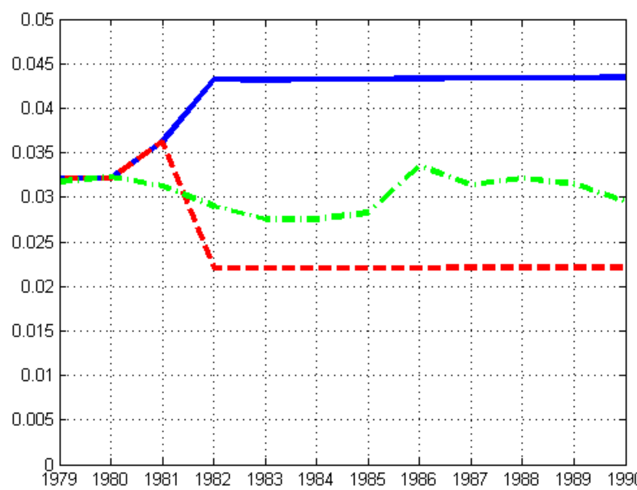
[34] As can be seen from figure 7, apart from the weighted median voter, there are agents in other states whose most preferred tax rate is $\tau_B^\star = 0.2822$. However, no value of α is consistent with the fact that these agents are pivotal in equilibrium given the initial distribution of agents $f_0(a,\epsilon)$ and the function of most preferred tax rates $\hat{\tau}(a,\epsilon)$.



Reduction in Gini index



Reduction in Gini index (transfers)



Reduction in Gini index (taxes)

Figure 8: Dynamics of redistribution

standard median voter is located in the 1st quintile of the equilibrium (market) income distribution of 1980, while the weighted median voter is in the second highest decile of the income distribution.

The obtained value for the strength of the wealth bias $\alpha^\star$ has no direct economic interpretation. This is why I construct a political Lorenz curve implied by $\alpha^\star$, since it gives a simple measure of political inequality. More precisely, it describes the proportion of political power held by the poorest fraction of population sorted by market income.[35] The Lorenz curve is plotted as a solid line in figure 9. The line of complete political equality (the 45 degree solid line) corresponds to the case of one agent-one vote.

[35] I sort agents by market income in order to allow for a comparison with the data (see footnote 36).

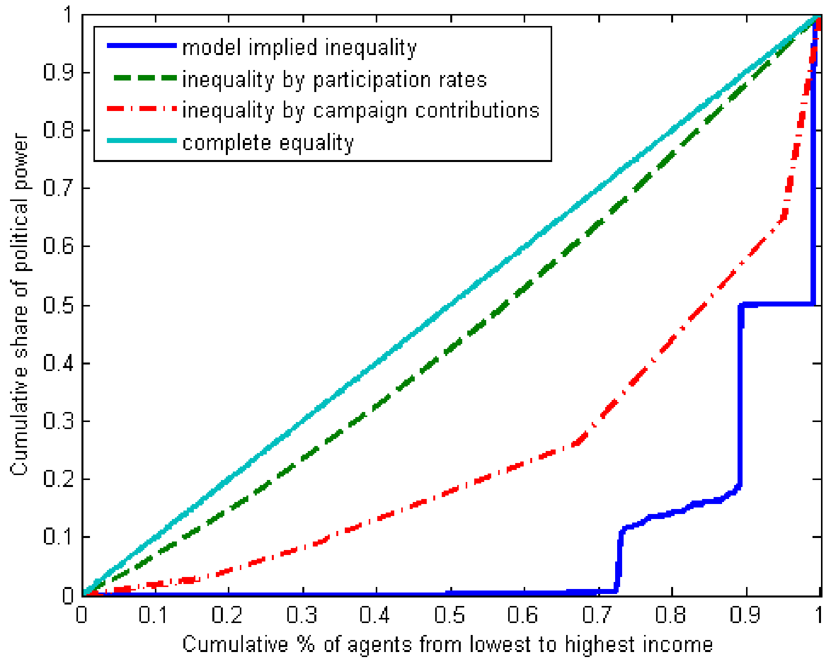


Figure 9: Political Lorenz curve

It is interesting to contrast the model results regarding political inequality with the data. In the data, though, we lack direct measures of political inequality. We could instead use some indirect measures. Recall from the introduction that there are different explanations for why rich people have stronger power in politics than the poor in the U.S. The first explanation is that rich people tend to vote more often than the poor. Thus, we could use participation rates in elections as a measure of political inequality. The resulting political Lorenz curve is represented by a dashed line in figure 9.[36]

It can be seen from the figure that the degree of political inequality implied by the participation rates is too weak as compared to the degree of inequality implied by the model. This is not surprising, since the political power in the real world stretches far beyond pure participation in elections. Recall that the second explanation for why rich people have stronger political power is that rich people are able to make higher campaign contributions and potentially affect the election outcome or to obtain influence over legislative decision-making by the successful candidate. Following Bachmann & Bai (2013), I assume that one dollar of campaign contributions buys one vote and that the mapping between agent's wealth a and her campaign contributions (and therefore, de facto votes) is given by the function a^{α}. Then I use the data on campaign contributions to compute the political Lorenz curve, which is represented by a dot-dashed line in figure 9.[37]

[36]To construct this political Lorenz curve, I use the Census data on voting in federal elections from Table 13 "Reported voting and registration of primary family members by race, Spanish origin, age, and family income" available at `https://www.census.gov/hhes/www/socdemo/voting/publications/p20/1980/tab13.pdf`. Households are sorted by market income in the Census data; this is why I also sort agents by income in the model.

[37]To construct this political Lorenz curve, I use campaign contributions shares along income groups from the Cooperative Congressional Election Survey from the years 2006 and 2008 (no data are available for 1980). These shares are computed by Bachmann & Bai (2013, Table 1, Scenario II.).

Figure 9 suggests that de facto political inequality implied by an unequal distribution of campaign contributions is not strong enough as compared to the degree of political inequality, which – in the context of the model – is needed to rationalize the voting outcome. One potential explanation could be that there are other sources of the wealth bias in the U.S., which are not captured by differential participation rates or campaign contributions.

5.5.4 Relative importance of mobility and inequality

In this section I discuss why the equilibrium tax rate in case of a political bias, $\tau_B^\star = 0.2822$, differs from the equilibrium tax rate in case of equal voting rights, $\tau_U^\star = 0.5635$. In particular, I show how the rising dispersion of wages as well as the rising mobility across wage groups contributed to this difference. For this exercise I need to know the state of the weighted median voter in the benchmark model economy, which I found in the previous section.

Recall the five effects from section 3.7, which are internalized by the decisive agent when choosing her most preferred tax rate. The mobility effect and the insurance effect are the key here in this section. This is because the only source of uncertainty stems from the employment process in the model and the employment process is subject to changes at the time of voting.

I conduct the following counterfactual experiments:

1. In 1980 agents vote on the future rate of taxation anticipating that the dispersion and the mobility remain unchanged (i.e. the levels of efficiency shocks and the transition matrix Π correspond to the calibration in 1978, table 1 on p. 15). This experiment is referred to as *Status-quo* below.

2. In 1980 agents vote on the future rate of taxation anticipating that the dispersion remains unchanged, while the mobility increases (i.e. the levels of efficiency shocks correspond to the calibration in 1978 but the transition matrix corresponds to the calibration in 1995, table 2 on p. 15).

3. In 1980 agents vote on the future rate of taxation anticipating that the mobility remains unchanged, while the dispersion increases (i.e. the transition matrix corresponds to the calibration in 1978 but the levels of efficiency shocks correspond to the calibration in 1995).[38]

The results of the experiments are presented in table 5. Without any changes in the mobility and the dispersion of the employment process, the standard median voter chooses the tax rate of 0.5635, while the weighted median voter prefers the tax rate of 0.3805.

Consider now a rise in the dispersion of productivities, which can be interpreted as a rise in cross-sectional wage inequality. It has an opposite effect on the voting decision of both agents. The most preferred tax rate of the standard median voter increases by 0.0120 relative to the Status-quo equilibrium. By the time of voting, this agent has accumulated a small amount of asset holdings and thus has built up a relatively low puffer against fluctuations in wages. The rising dispersion

[38]To conduct the experiments, I repeat steps 1-3 described in section 5.4. However, when computing the counterfactual tax rate in case of the bias (step 3), the strength of the political inequality in all the experiments is fixed at $\alpha^\star$, which I found in section 5.5.3.

	Status Quo	△ from mobility	△ from inequality	Total
Standard median voter	0.5635	-0.0075	+0.0120	=0.5645
Weighted median voter	0.3805	-0.0135	-0.0783	= 0.2882

Table 5: Changes in the tax rate τ attributable to changes in mobility and dispersion

in wages increases the risk for this agent. The insurance effect pushes agent's most preferred tax rate up.

The effect of rising dispersion is opposite for the weighted median voter, whose most preferred tax rate drops significantly by 0.0783. This agent faces the second largest productivity shock and has asset holdings, which put her to the top decile of the steady state wealth distribution. Due to the wealth effects, implied by the period utility function in (1), with this level of wealth holdings agents supply zero labor for any of the lowest 6 shocks. Thus, employment risk is not a concern for the weighted median voter. On the contrary, she favors the rising dispersion, as she is more likely to draw the largest employment shock which makes working attractive. This explains the drop in the most preferred tax rate.[39]

6 Outlook

This paper is the first step towards understanding whether a wealth bias in the political process can improve on the result of the standard median voter in explaining the dynamics of redistribution in the U.S. But a lot more work needs to be done in the future.

First, we need a better understanding of the nature of the bias in the political process. In this paper the bias is associated with agent's wealth according to an exogenously imposed rule. In the future, however, we need to provide micro-theoretical foundations for this link. One step towards accomplishing this task is to relax the assumption of direct democracy. In this paper I assume that there is a referendum over the tax rate, since each agent votes directly on her most preferred policy outcome. In the U.S., however, households elect Congressmen, who then vote on the federal tax rate. Modeling explicitly the interaction between agents and politicians makes it possible to study how turnout rates, campaign contributions and direct contact with politicians affect the voting outcome.

Second, as emphasized by Dahl (1961) in the epigraph of this paper, there might be other sources of the bias in the political process, such as knowledge (or human wealth). In fact, recall the finding by Rosenstone & Hansen (1993): propensity to participate in voting and to make campaign contributions rises with income. Therefore, we need to account for the fact that agents with large

[39]The wealth effects implied by the period utility function in (1) are crucial for this result. I considered a utility specification without wealth effects. For example, Corbae et al. (2009) use the specification by Greenwood, Hercowitz & Huffman (1988). In general, for this specification the optimal labor supply is a function of agent's productivity and the marginal tax rate, only. In case of a proportional income tax rate, as in Corbae et al. (2009), the marginal tax rate is just a constant, so that there are no wealth effects. However, with the progressive income taxation in (3), the marginal tax rate is a function of agent's income and therefore a function of agent's wealth. Therefore, this specification would not eliminate the wealth effects in my case.

human wealth (and thus high earnings) might be as politically active as those with large financial wealth holdings.

Third, we need to understand whether the bias in the political process can explain the dynamics of redistribution in the U.S. at longer time horizons. In this paper I consider the period 1981-1989. I argue that the most significant drop in progressiveness of the income tax code happened in 1981, which justifies the assumption of once-and-for-all voting. In order to increase the explanatory power of the model at longer time horizons, we need to introduce sequential voting to account for significant income tax reforms in 1991, 1993, 2001 and 2003. Also, in this paper I argue that within 1981-1989 rising wage dispersion accounted for more than 90 percent of the overall increase in the market income inequality. However, this is no longer true after 1989. Capital income became increasingly concentrated beginning in the early 1990s. The same is true about the capital gains (profits realized from the sale of assets). Thus, a good model has to account for the rising dispersion of these sources of income, as well.

Fourth, once we extend the time horizon of the model, it is natural to move toward sequential voting over income taxation. This assumption of sequential voting has at least two important implications. First, agent's most preferred tax rate is likely to change as compared to the case of once-and-for-all voting. For example, those agents, who are poor at the time of voting, are more likely to demand higher redistribution: if they happen to draw a high productivity shock tomorrow, they will be able to cast a vote for lower redistribution during the next elections. The opposite is true for those, who are rich at the time of voting. Second, with sequential voting changes over time in the wealth distribution affect the distribution of de facto political power, even if the strength of the wealth bias stays constant over time. In this case, rising wealth inequality implies a more skewed distribution of voting rights and therefore a more wealthy decisive agent. The decisive agent sets a lower level of redistribution than her predecessor, which leads to a more skewed distribution of wealth. Using a version of the current paper, extended for sequential voting, we can study whether this "inequality trap" is what drives political and income inequality in the U.S. data.

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