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Abstract

We develop a two-period, three-class of income model where low-income agents are borrowing constrained because of capital market imperfections, and where redistributive expenditure is financed by tax and government debt. When the degree of capital market imperfection is high, there is an ends-against-the-middle equilibrium where the constrained low-income and the unconstrained high-income agents favor low levels of government debt and redistributive expenditure; these agents form a coalition against the middle. In this equilibrium, the levels of government debt and expenditure might be below the efficient levels, and the spread of income distribution results in a lower debt-to-GDP ratio.

Keywords: Government debt; Borrowing constraints; Voting; Structure-induced equilibrium; Income inequality.

JEL Classification: D72, H52, H60.

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1 Introduction

The conventional wisdom is that a higher inequality of income results in a larger redistributive public expenditure and that it results in a greater issue of government debt that finances redistribution. This theoretical prediction builds on a median-voter framework, in which a higher level of inequality translates into a poorer decisive agent in the political arena, who will then demand more redistribution (Romer, 1975; Roberts, 1977; Meltzer and Richard, 1981; Krusell and Rios-Rull, 1999) and, thus, more government debt issue for financing redistribution (Cukierman and Meltzer, 1989).

The empirical evidence, however, does not necessarily support the above-mentioned theoretical predictions. OECD cross-country data show that the volume of redistribution is negatively correlated with income inequality (for example, Gottschalk and Smeeding, 1997; Chen and Song, 2009). The theoretical prediction of inequality and government debt is also controversial. For instance, Belgium, France and Germany, located in the Continental Europe, show low Gini coefficients and high debt-to-GDP ratios, whereas the United Kingdom and the United States, included in the Anglo-Saxon group, show high Gini coefficients and low debt-to-GDP ratios.[1] A negative correlation between inequality and debt-to-GDP ratio is observed for some OECD countries. This indicates that the relationship between inequality and the size of government is not as simple as the standard theory might expect.

Several theories have been provided to make sense of the above-mentioned puzzles. Examples include political bias toward the rich (Benabou, 2000), the prospect of upward mobility by low-income agents (Quadrini, 1999; Benabou and Ok, 2001; Alesina and La Ferrara, 2005; Arawatari and Ono, 2009), lobbying and campaign contributions by the rich (Rodriguez, 2004; Campante, 2010), voters' preferences for redistribution (Creedy and Moslehi, 2009; Creedy, Li and Moslehi, 2010), and borrowing constraints that hit low-income agents (Casamatta, Cremer and Pestieau, 2000; Bellettini and Berti Ceroni, 2007; Cremer et al., 2007). These studies, however, assume that redistributive expenditure is financed only via income tax. In other words, they abstract away government debt as an additional option for financing redistributive expenditure even though government debt is one of the major sources of government revenue in OECD countries.

The purpose of this paper is to consider the relationship between inequality and the size of government debt when voting results in a negative correlation between inequality and redistributive expenditure. In particular, we focus on the role of borrowing constraints

[1] Gini coefficients in Belgium, France and Germany in the mid-2000s were 0.271, 0.270 and 0.298, respectively; debt-to-GDP ratios in those countries in 2005 were 0.957, 0.760 and 0.711, respectively. In contrast, Gini coefficients in the United Kingdom and the United States in the mid-2000s were 0.335 and 0.381, respectively; debt-to-GDP ratios in these countries in 2005 were 0.461 and 0.623, respectively. The source of the Gini coefficients is OECD (2008), and the source of the debt-to-GDP ratio is OECD (2009).

(or, equivalently, capital market imperfection) as a source of the negative correlation, and examine how politically determined government debt and expenditure are affected by the degree of capital market imperfection. In addition, we consider the spread of income distribution and examine its impact on the debt-to-GDP ratio in relation to the degree of capital market imperfection.

For the purpose of analysis, we utilize the two-period, three-class of income model of Bellettini and Berti Ceroni (2007). In their framework, redistributive expenditures, such as publicly provided education and investment in infrastructure such as schools, libraries and research institutes are financed through the first-period income tax; the expenditures improve the productivity of all agents in the second period. We introduce government debt as an additional policy option for financing redistributive expenditure into their framework. That is, the redistributive expenditure is financed by the first-period income tax as well as by government debt issue. The debt repayment is financed by the second-period income tax.

Under this extended framework, voters cast a ballot over the first-period income tax, and also over government debt issue. Under this type of voting game, the existence of a Condorcet winner of the majority voting game is not necessarily guaranteed because of the multidimensionality of the issue space (see, for example, Persson and Tabellini, 2000, Chapter 2). To deal with this problem, we utilize the concept of a structure-induced equilibrium (Shepsle, 1979). We determine the decisive voter over one issue given the other issue and derive his/her reaction function for each policy issue. We then find the point where the two reaction functions cross; this point corresponds to the structure-induced outcome of the majority voting game.

Our model demonstrates that voting over policy produces two opposing effects on agents via the government expenditure: a negative effect that results in a greater tax burden for financing expenditure and, thus, the utility loss today; and a positive effect that results in an improvement of labor productivity in the second period and, thus, the utility gain in the future. When agents are borrowing unconstrained, they prefer a higher level of government expenditure and, thus, a higher first-period tax and government debt as their first-period income becomes lower. Because of the borrowing, unconstrained agents can reallocate resources freely from the second period to the first period, and they can compensate the utility loss today by the utility gain tomorrow. Therefore, they want to increase government expenditure in order to get the benefit of the second-period labor productivity improvement.

However, the opposite result holds when agents are borrowing constrained. Borrowing-constrained agents prefer lower government debt and expenditure as their first-period income becomes lower. Borrowing-constrained agents are unable to reallocate resources freely from the second period to the first period. Because of this constraint, the utility gain from government expenditure in the future is valued less than the utility loss from government expenditure today for the borrowing-constrained agents. Therefore, they prefer less government expenditure and, thus, lower first-period income tax and debt as their first-period income becomes lower.

Given the above-mentioned feature of the model, we obtain the following three results. First, the type of decisive voter depends on the degree of capital market imperfection. The decisive voter is the middle-income, borrowing-unconstrained agent when the degree of capital market imperfection is low. However, the decisive voter becomes the low-income, borrowing-constrained agent when the degree is high. That is, the economy displays the ends-against-the-middle equilibrium, as in Epple and Romano (1996), where the high- and low-income agents, who favor low government expenditure and debt, form a coalition against the middle who favor high government expenditure and debt.

The second result is that the political equilibrium generally fails to attain the efficient allocation. That is, first-period tax, government debt and expenditure in the political equilibrium are higher or lower than the efficient levels depending on either the income level of a decisive voter or the degree of capital market imperfection. In particular, under a certain condition, there exists a critical level of capital market imperfection such that the political equilibrium levels of first-period tax, government debt and expenditure are lower than the efficient levels when the degree of capital market imperfection is above the critical level. This result implies that countries with less access to capital markets are more likely to attain lower levels of first-period tax, government debt and expenditure than the efficient levels.

The third result is that the effect of income distribution on the debt-to-GDP ratio depends on the degree of capital market imperfection. In particular, there exists a critical level of capital market imperfection, which is different from that described in the last paragraph, such that the income distribution results in a higher debt-to-GDP ratio when the degree of capital market imperfection is below the critical level, and the standard result a la Cukierman and Meltzer (1989) holds. However, when the degree is above the critical level, the opposite result holds because the decisive voter, who is a borrowing-constrained low-income agent, wants to choose lower government expenditure and debt. That is, there is a negative correlation between inequality and debt-to-GDP ratio when the degree of capital market imperfection is high.

Our analysis and results contribute to the following three strands of literature. The first strand is the literature on inequality and redistribution in the presence of borrowing constraints. Examples are Casamatta, Cremer and Pestieau (2000), Bellettini and Berti Ceroni (2007), Cremer et al. (2007) and Arawatari and Ono (2011). These studies demonstrate that the decisive voter prefers a lower income tax as his/her income is decreased when he/she is borrowing constrained. Thus, they clarify the role of borrowing constraint in presenting the negative correlation between inequality and the preferred tax for redistribution. However, government debt is abstracted away in these studies. The current paper contributes to the literature by demonstrating how the politically determined size of government debt is affected by income distribution in the presence of borrowing constraints.

The second strand is the literature on tax smoothing and government debt (for example, Barro, 1979; Lucas and Stokey, 1983; Aiyagari et al., 2002). Our model demonstrates that, in an efficient allocation, the tax rates should be equal between two periods, and the size of government debt is adjusted to smooth tax rates across periods. However, the model demonstrates that, in political equilibrium, the first-period tax rate becomes lower or higher than the efficient rate depending on either the income level of a decisive voter or the degree of capital market imperfection. The result suggests that the presence of borrowing constraint might prevent the realization of tax smoothing in the political economy.

The third strand is the literature on the politics of government debt. Although there are many studies that consider how the size of government debt is determined via politics, most of them abstract away the role of income inequality among voters in the determination of government debt. Previous studies instead have focused on the roles of common pool problems (for example, Tabellini, 1986; Velasco, 1999), political instability (for example, Persson and Svensson, 1989; Aghion and Bolton, 1990; Alesina and Tabellini, 1990; Tabellini and Alesina, 1990), altruistic and selfish agents (de Walque and Gevers, 2001) and intergenerational conflict (for example, Song, Storesletten and Zilibotti, 2012).

An exception is the study of Cukierman and Meltzer (1989), which demonstrates the positive correlation between inequality and government debt: a higher level of inequality results in a greater issue of government debt. However, as mentioned above, empirical evidence suggests that the relationship is not so straightforward: some countries are featured by low inequality and high debt-to-GDP ratio, whereas others are characterized by high inequality and low debt-to-GDP ratio. The current paper demonstrates that there is a negative correlation between inequality and debt-to-GDP ratio when the degree of capital market imperfection is high. The result could provide one possible explanation for the empirical evidence among some OECD countries.

The organization of this paper is as follows. Section 2 introduces the model. Section 3 characterizes political equilibrium. Section 4 compares the political equilibrium with the efficient allocation. Section 5 examines the effect of income inequality on the debt-to-GDP ratio. Section 6 provides concluding remarks. Proofs of Propositions are given in the Appendix.

2 The Model

We consider a small open economy model that is based on Bellettini and Berti Ceroni (2007). Agents live in two periods; they are indexed by their first-period labor productivity e_1^i, which is also equal to their income. They belong to three income classes (low, middle and high classes) in terms of their first-period labor productivity, denoted by $e_1^i(i = l, m, h) : e_1^l < e_1^m < e_1^h$. The fraction of people in each class is given by ϕ^i with $\phi^i \in (0, 0.5)$ and $\sum_{i\in\{l,m,h\}} \phi^i = 1$. The average first-period income, $E_1 \equiv \sum_{i\in\{l,m,h\}} \phi^i e_1^i$, which is equal to aggregate labor income, is assumed to satisfy $e_1^m < E_1 < e_1^h$; the distribution of the first-period income is right-skewed.

In their first period of life, agents allocate their labor income between consumption and saving. Because of the assumption of a small open economy, the aggregate return on saving is exogenous and equal to $R(> 1)$. Following De Gregorio (1996) and Bellettini and Berti Ceroni (2007), we assume that, in the first period, agents cannot borrow more than $\psi - 1$ times their after-tax income to finance current consumption. When $\psi = 1$, agents cannot borrow at all; when $\psi \to +\infty$, agents can borrow as much as they want. Therefore, the index $\psi \in [1, +\infty)$ represents the degree of capital market imperfection. A lower ψ implies a higher degree of capital market imperfection.

Preferences are specified by the following intertemporal utility function:

$$U^i = \log c_1^i + \beta \log c_2^i,$$

where c_1^i and c_2^i represent consumption of a type- i agent in periods 1 and 2, respectively, and $\beta \in (0, 1)$ denotes the discount factor. We employ the above-mentioned specification for the tractability of analysis. The role of this assumption will be discussed later.

Labor income in the second period is equal to his/her labor productivity in that period. Following Bellettini and Berti Ceroni (2007), we assume that a type-i's productivity in the second period, defined by e_2^i, depends on the public expenditure in the first period. In particular, we assume $e_2^i = A(e_1^i)^\mu G$, where $A(> 0)$ is an exogenous parameter, $\mu \in (0, 1)$ is a coefficient of labor productivity depreciation and G is public expenditure in the first period. The expenditure G increases the productivity of labor of all agents in the second period. Examples of the public expenditure are publicly financed education and public investment in infrastructure such as schools, universities, research institutions and libraries.

The public expenditure in the first period is financed through linear income taxation and government debt issue. We assume convex costs of collecting taxes in order to avoid corner solutions for the endogenous tax rate. In particular, if τ_t is the tax rate in the tth period, the actual tax revenue in that period is $\tau_t(1-\tau_t)E_t$, where $E_t \equiv \sum_{i\in\{l,m,h\}} \phi^i e_t^i$ is the aggregate labor income (i.e., GDP) in the tth period.[2]

The government budget constraints in the first and the second periods, respectively, are given by:

$$G = \tau_1(1-\tau_1)E_1 + B, \tag{1}$$

$$RB = \tau_2(1-\tau_2)E_2, \tag{2}$$

where B denotes government debt issue. In the first period, the revenue from tax and debt issue is used for public expenditure G. In the second period, government debt is paid off by the second-period tax revenue. We assume that the government is not allowed to default.

3 The Political Equilibrium

At the beginning of period 1, each agent votes over τ_1 and B to maximize his/her indirect utility subject to the government budget constraints. The corresponding level of government expenditure is determined via the first-period government budget constraint (1). After that, given policies, each agent chooses consumption c_1^i and c_2^i to maximize his/her utility subject to individual budget constraints. At the beginning of period 2, the government imposes the tax τ_2 to finance the repayment of government debt.

The tax revenue in the second period is solely used to finance debt repayment. This implies that setting B is equivalent to setting τ_2. Given this property, we hereafter focus on the political determination of τ_1 and τ_2, rather than τ_1 and B, and consider the following two-stage maximization problem. In the first stage, agents vote over policies to maximize their indirect utility subject to the government budget constraints (1) and (2). In the second stage, given policies, agents choose consumption to maximize their utility subject to individual budget constraints.

In what follows, we induce the political equilibrium by backward induction. First, we solve the utility maximization problems of agents (Subsection 3.1). Then, we define the political institution and describe policy preferences of agents (Subsection 3.2). Finally, we characterize political equilibrium of the voting game (Subsection 3.3).

[2] The assumption of convex costs could be viewed as the reduced form of distortion in the labor market produced by labor–leisure choice (see, for example, Casamatta, Cremer and Pestieau, 2000; Bellettini and Berti Ceroni, 2007; Cremer et al., 2007). The assumption of distortionary taxation is solely to ensure an interior solution to preferred tax rates and otherwise plays no role.

3.1 Economic Decisions

The utility maximization problem of a type-i agent is as follows:

$$\begin{aligned} \max_{c_1^i, c_2^i} \quad & U^i = \log c_1^i + \beta \log c_2^i, \\ \text{s.t.} \quad & c_1^i = (1-\tau_1)e_1^i - s^i, \\ & c_2^i = (1-\tau_2)e_2^i + Rs^i, \\ & s^i \geq (1-\psi)(1-\tau_1)e_1^i, \end{aligned} \tag{3}$$

where s^i denotes the saving of a type-i agent. The first and the second constraints are individual i's budget constraints in the first and the second periods, respectively. The third constraint is the borrowing constraint.

In order to solve the problem, suppose first that the borrowing constraint is not binding. The solution to the utility maximization problem yields:

$$c_1^{iu} = \frac{1}{1+\beta} \cdot \left[(1-\tau_1)e_1^i + \frac{(1-\tau_2)e_2^i}{R}\right], \tag{4}$$

$$c_2^{iu} = \frac{\beta R}{1+\beta} \cdot \left[(1-\tau_1)e_1^i + \frac{(1-\tau_2)e_2^i}{R}\right], \tag{5}$$

$$s^{iu} = \frac{\beta}{1+\beta}(1-\tau_1)e_1^i - \frac{1}{(1+\beta)R}(1-\tau_2)e_2^i, \tag{6}$$

where the superscript u denotes "unconstrained".

We substitute the saving function into the borrowing constraint (3) to obtain the condition where a type-i agent is actually unconstrained in terms of the tax rates τ_1 and τ_2:

$$R\{(1+\beta)\psi - 1\} > \frac{(1-\tau_2)e_2^i}{(1-\tau_1)e_1^i}. \tag{7}$$

This condition states that the borrowing constraint of a type-i agent does not bind when his/her after-tax income is high in the first period and is low in the second period.

Alternatively, suppose that the borrowing constraint is binding; that is, (7) fails to hold. The solution to the utility maximization problem yields:

$$c_1^{ic} = \psi(1-\tau_1)e_1^i, \tag{8}$$

$$c_2^{ic} = R(1-\psi)(1-\tau_1)e_1^i + (1-\tau_2)e_2^i = R \cdot \left\{(1-\psi)(1-\tau_1)e_1^i + \frac{(1-\tau_2)e_2^i}{R}\right\}, \tag{9}$$

$$s^{ic} = (1-\psi)(1-\tau_1)e_1^i, \tag{10}$$

where the superscript c denotes "constrained".

3.2 Policy Preferences, the Political Institution and Voting

In the voting stage, agents vote over policies to maximize their indirect utility. In order to set up this maximization problem, we first derive the indirect utility functions in terms of tax rates. For this purpose, we substitute the consumption functions derived in the previous subsection into the utility function U^i and obtain the following:

$$U^i = \begin{cases} \log\left(\frac{1}{1+\beta}\cdot[(1-\tau_1)e_1^i + (1-\tau_2)e_2^i/R]\right) & \\ \quad + \beta \cdot \log\left(\frac{\beta R}{1+\beta}\cdot[(1-\tau_1)e_1^i + (1-\tau_2)e_2^i/R]\right) & \text{if } R\{(1+\beta)\psi - 1\} > \frac{(1-\tau_2)e_2^i}{(1-\tau_1)e_1^i}, \\ \log(\psi(1-\tau_1)e_1^i) & \\ \quad + \beta\cdot\log[(1-\tau_2)e_2^i + R(1-\psi)(1-\tau_1)e_1^i] & \text{if } R\{(1+\beta)\psi - 1\} \leq \frac{(1-\tau_2)e_2^i}{(1-\tau_1)e_1^i}. \end{cases}$$

The productivity in the second stage, e_2^i, depends on the government expenditure G and, thus, on the tax rates τ_1 and τ_2. In order to write e_2^i as a function of τ_1 and τ_2, we define:

$$\widetilde{E}_1 \equiv A\sum_i \phi^i (e_1^i)^\mu$$

and rewrite E_2 as a function of $\widetilde{E}_1$:

$$E_2 \equiv \sum_i \phi^i e_2^i = G\widetilde{E}_1.$$

The variable $\widetilde{E}_1$ shows the marginal effect of public expenditure G on the second-period GDP, denoted by E_2.

We utilize $\widetilde{E}_1 \equiv A\sum_i \phi^i(e_1^i)^\mu$ and $E_2 = G\widetilde{E}_1$ to rewrite two government budget constraints (1) and (2) as follows:

$$G = \frac{\tau_1(1-\tau_1)E_1}{1-\gamma^2\tau_2(1-\tau_2)}, \tag{11}$$

$$B = \gamma^2\tau_2(1-\tau_2)\cdot\frac{\tau_1(1-\tau_1)E_1}{1-\gamma^2\tau_2(1-\tau_2)}, \tag{12}$$

where

$$\gamma \equiv \sqrt{\widetilde{E}_1/R}.$$

We impose the following assumption:

Assumption 1: $\gamma \in (1, 2)$.

The inequality condition of $1 < \gamma$ ensures that the tax rate in the second period is set within the range $(0, 1/2)$ in equilibrium. Given $\tau \in (0, 1/2)$, the term appeared in (11) and (12) is positive as long as $\gamma < 2$. Therefore, the condition of $\gamma < 2$ ensures that $B > 0$ and $G > 0$ hold in equilibrium; otherwise the economy experiences (a) international lending of assets rather than borrowing and (b) no government expenditure, both of which are not considered in this paper. The inequality condition of $\gamma < 2$ also guarantees the single-peakedness of preferences over τ_1 and τ_2. These roles of Assumption 1 are found in the following analysis.

By the use of (11), we can present the lifetime income of a type-i agent as a function of tax rates:

$$(1-\tau_1)e_1^i + \frac{(1-\tau_2)e_2^i}{R} = (1-\tau_1)e_1^i + \frac{(1-\tau_2)}{R} \cdot A(e_1^i)^\mu \cdot \frac{\tau_1(1-\tau_1)E_1}{1-\gamma^2\tau_2(1-\tau_2)}.$$

With the above-mentioned lifetime income, the indirect utility function of a type-i agent becomes:

$$V^i(\tau_1,\tau_2) = \begin{cases} V^{iu} \equiv \beta \cdot \log(\beta R) - (1+\beta)\cdot \log(1+\beta) \\ \quad + (1+\beta)\cdot \log\left[(1-\tau_1)e_1^i + \frac{(1-\tau_2)}{R} \cdot A(e_1^i)^\mu \cdot \frac{\tau_1(1-\tau_1)E_1}{1-\gamma^2\cdot\tau_2(1-\tau_2)}\right] \\ \qquad\qquad\qquad \text{if } R\left\{(1+\beta)\psi - 1\right\} > \frac{(1-\tau_2)e_2^i}{(1-\tau_1)e_1^i}, \\ V^{ic} \equiv \log(\psi e_1^i) + \log(1-\tau_1) + \beta\cdot\log(R) \\ \quad + \beta \cdot \log\left[(1-\psi)(1-\tau_1)e_1^i + \frac{(1-\tau_2)}{R}\cdot A(e_1^i)^\mu \cdot \frac{\tau_1(1-\tau_1)E_1}{1-\gamma^2\cdot\tau_2(1-\tau_2)}\right] \\ \qquad\qquad\qquad \text{if } R\left\{(1+\beta)\psi - 1\right\} \le \frac{(1-\tau_2)e_2^i}{(1-\tau_1)e_1^i}. \end{cases} \tag{13}$$

The tax rates τ_1 and τ_2 are determined by individuals through a political process of majoritarian voting. Because the issue space is bidimensional, the Nash equilibrium of a majoritarian voting game may fail to exist. To deal with this feature, we use the concept of issue-by-issue voting, or structure-induced equilibrium, as formalized by Shepsle (1979). In particular, if preferences are single peaked for each policy issue, a sufficient condition for (τ_1^*, τ_2^*) to be an equilibrium of the voting game is that τ_1^* represents the outcome of majority voting over τ_1 when the other dimension is fixed at τ_2^*, and vice versa. In Appendix A.1, it is shown that preferences are indeed single peaked along every dimension of the issue space.

We can now solve the problem in the voting stage. A type-i agent chooses τ_1 to maximize his/her indirect utility given τ_2; and he/she chooses τ_2 to maximize his/her indirect utility given τ_1. The threshold level of capital market imperfection for a type-i agent, denoted by ψ^i, is derived by substituting his/her preferred pair of tax rates into the condition (7). The following proposition states policy preferences of agents.

Proposition 1. *The most preferred policy by a type-i agent satisfies:*

$$(\tau_1^i)^* = \begin{cases} \tau_1^{iu} \equiv \frac{1}{2} - \frac{R\gamma(2-\gamma)}{2AE_1}\cdot (e_1^i)^{1-\mu} < \frac{1}{2} & \text{if } \psi > \psi^i, \\ \tau_1^{ic} \equiv \frac{\beta}{1+2\beta} + \frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{(1+2\beta)AE_1}\cdot (e_1^i)^{1-\mu} & \text{if } \psi \le \psi^i, \end{cases}$$

$$(\tau_2^i)^* = 1 - \frac{1}{\gamma} \in \left(0, \frac{1}{2}\right) \quad \forall \psi \ge 1, \quad \forall i \in \{l, m, h\},$$

$$(G^i)^* = \begin{cases} G^{iu} \equiv \frac{E_1}{4(2-\gamma)}\left[1 - \left(\frac{R\gamma(2-\gamma)}{AE_1}\right)^2 \cdot (e_1^i)^{2(1-\mu)}\right] & \text{if } \psi > \psi^i, \\ G^{ic} \equiv \frac{E_1}{(2-\gamma)(1+2\beta)^2}\left[\beta(1+\beta) + \frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{AE_1} \cdot (e_1^i)^{1-\mu}\right. & \\ \qquad\qquad \left. - \left(\frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{AE_1}\right)^2 \cdot (e_1^i)^{2(1-\mu)}\right] & \text{if } \psi \leq \psi^i, \end{cases}$$

$$(B^i)^* = \begin{cases} B^{iu} = (\gamma - 1) \cdot G^{iu} & \text{if } \psi > \psi^i, \\ B^{ic} = (\gamma - 1) \cdot G^{ic} & \text{if } \psi \leq \psi^i, \end{cases} \tag{14}$$

where ψ^i is given by:

$$\psi^i \equiv \frac{1}{2(1+\beta)} + \frac{AE_1}{2R(1+\beta)\gamma(2-\gamma)} \cdot (e_1^i)^{\mu-1}.$$

Proof. See Appendix A.2.

For each type of i, there is a threshold level of capital market imperfection, denoted by ψ^i. When the degree of imperfection is higher, such that $\psi \leq \psi^i$, any agent belonging to class i is borrowing constrained. The threshold level ψ^i becomes higher as the productivity in the first period becomes lower: $\psi^l > \psi^m > \psi^h$. That is, an agent belonging to a lower class is more likely to be borrowing constrained.

The degree of capital market imperfection critically affects the preferences over policy. In order to understand the role of capital market imperfection, we first consider its impact on the preference over the government expenditure financed by the first-period tax and debt. On the one hand, raising the government expenditure decreases the utility today through an increase in the first-period tax burden. On the other hand, raising the government expenditure, financed by an increase in the first-period tax and debt issue, increases the utility in the future through an improvement in labor productivity. Therefore, the most preferred first-period tax and debt are determined to equate negative and positive effects at a margin.

When a type-i agent is borrowing unconstrained, he/she can choose τ_1^i and B^i that attain the maximum of utility. His/her preferences over τ_1^i and B^i follow the standard result in the literature of the political economy of redistribution (Romer, 1975; Roberts, 1977; Meltzer and Richard, 1981; Cukierman and Meltzer, 1989): a richer agent prefers lower tax and debt issue. However, when he/she is borrowing constrained, he/she cannot reallocate income freely from the second period to the first period. Given this limitation, the utility gain in the future is less valued than the utility loss today. Therefore, a constrained agent prefers a lower level of government expenditure and, thus, lower first-period tax and debt as he/she becomes poorer.

Voters' preferences over the second-period tax rate are unaffected by types and capital market imperfection. This property depends on the specification of the second-period productivity, $e_2^i = A(e_1^i)^\mu G$. The second-period productivity e_2^i is linearly related to government expenditure G. This implies that maximizing V^i with respect to τ_2^i is equivalent to maximizing G with respect to τ_2^i. Because G is unaffected by types and capital market imperfection, as shown in (11), the choice of τ_2^i is independent of them. This result also holds true as long as preferences are characterized by a constant intertemporal elasticity of substitution (see Appendix A.3).

The most preferred levels of government expenditure and public debt by a type-i agent are derived by substituting $(\tau_1^i)^*$ and $(\tau_2^i)^*$ into the government budget constraints (11) and (12). The preferred levels satisfy the following properties. First, $(G^i)^*$ and $(B^i)^*$ are affected by the degree of capital market imperfection when a type-i agent is borrowing constrained. Second, $(B^i)^*$ is linearly related to $(G^i)^*$ because $(B^i)^* = (\gamma)^2\tau_2(1-\tau_2)(G^i)^*$ holds from (11) and (12), and $(\tau_2^i)^*$ is independent of the type of an agent and is simply given by $1 - 1/\gamma$.

The following corollary states how policy preferences of agents are affected by capital market imperfection when agents are borrowing constrained.

Corollary 1

(i) $\partial\tau_1^{ic}/\partial\psi > 0$, $\partial G^{ic}/\partial\psi > 0$, *and* $\partial B^{ic}/\partial\psi > 0$.

(ii) $\tau_1^{iu} = \tau_1^{ic}$, $G^{iu} = G^{ic}$, *and* $B^{iu} = B^{ic}$*at* $\psi = \psi^i$.

Proof. See Appendix A.4.

[Figure 1 about here.]

Figure 1 illustrates how voters' preferences over policies (τ_1, G, B) are affected by the degree of capital market imperfection, denoted by ψ. When they are borrowing unconstrained, their choice of τ_1, G and B is independent of capital market imperfection. However, when they are borrowing constrained, their choice depends on the degree of capital market imperfection. A lower ψ implies that they are more constrained. In order to relax the constraint, they prefer a lower first-period tax rate and, thus, prefer a lower level of government expenditure.

3.3 Political Equilibrium

Based on the characterization of voting behavior of each type of an agent, we now consider the determination of structure-induced equilibrium policies via majority voting. The second-period tax rate is given by $\tau_2 = 1 - 1/\gamma$ because all types of agents prefer this rate. Given $\tau_2 = 1 - 1/\gamma$, the equilibrium first-period tax rate is given by the most preferred τ_1 by the median voter. The equilibrium levels of government expenditure and debt are then given by the preferred levels by the median voter over τ_1.

In order to determine the median voter over τ_1, we introduce the critical level of the first-period income, $\widetilde{e}_1$, defined by:

$$\widetilde{e}_1 \equiv \left[AE_1/((1+2\beta)R\gamma(2-\gamma))\right]^{\frac{1}{1-\mu}}.$$

Direct calculation leads to:

$$e_1^i \gtreqless \widetilde{e}_1 \Leftrightarrow \psi^i \lesseqgtr 1.$$

When the first-period productivity of a type-i agent is high such that $e_1^i > \widetilde{e}_1$, $\psi^i < 1$ always holds for a type-i agent. In other words, he/she is borrowing unconstrained for any degree of capital market imperfection of $\psi \in [1, +\infty)$. He/she has enough income in the first period that is beyond the critical level $\widetilde{e}_1$ and, thus, can choose a combination of consumption and saving that does not hit the borrowing constraint from the viewpoint of utility maximization. In contrast, an agent might be borrowing constrained for a low ψ if $e_1^i \leq \widetilde{e}_1$ holds. In order to reduce a set of possible political equilibria, we impose the following assumption with respect to $\widetilde{e}_1$.

Assumption 2. $e_1^l < e_1^m < \widetilde{e}_1 < e_1^h$.

Assumption 2 ensures that type-h agents are never borrowing constrained. Therefore, given the properties of preferred first-period tax rate, demonstrated in Proposition 1 and Corollary 1, the decisive voter will be a type-l or a type-m agent. The following proposition determines the decisive voter, contingent on the degree of capital market imperfection.

Proposition 2 *The decisive voter over τ_1 is a borrowing-constrained type-l agent if $\psi \in [1, \widehat{\psi}]$, and a borrowing-unconstrained type-m agent if $\psi \in (\widehat{\psi}, \infty)$ where:*

$$\widehat{\psi} \equiv \frac{AE_1 + R\gamma(2-\gamma) \cdot \left[2(1+\beta) \cdot (e_1^l)^{1-\mu} - (1+2\beta) \cdot (e_1^m)^{1-\mu}\right]}{2(1+\beta)R\gamma(2-\gamma) \cdot (e_1^l)^{1-\mu}} \in (\psi^m, \psi^l).$$

Political equilibrium policies, $\{\tau_1^*,\ \tau_2^*,\ G^*,\ B^*\}$, are given by:

$$\tau_1^* = \begin{cases} \tau_1^{lc} & \text{if } \psi \in [1, \widehat{\psi}] \\ \tau_1^{mu} & \text{if } \psi \in (\widehat{\psi}, \infty) \end{cases},$$

$$\tau_2^* = 1 - \frac{1}{\gamma} \quad \forall \psi \geq 1,$$

$$G^* = \begin{cases} G^{lc} & \text{if } \psi \in [1, \widehat{\psi}] \\ G^{mu} & \text{if } \psi \in (\widehat{\psi}, \infty) \end{cases},$$

$$B^* = \begin{cases} B^{lc} & \text{if } \psi \in [1, \widehat{\psi}] \\ B^{mu} & \text{if } \psi \in (\widehat{\psi}, \infty) \end{cases}.$$

Proof. See Appendix A.5.

Figure 2 illustrates the political equilibrium policies τ_1^*, G^* and B^*. As demonstrated in the figure, the identity of the median voter depends on the degree of capital market imperfection, denoted by ψ: a higher ψ means a lower degree of capital market imperfection. When an agent is less likely to be borrowing constrained, such that $\psi > \widehat{\psi}$, the decisive voter becomes the type-m agent who is borrowing unconstrained. Their preferred policies lie between those by type-l and type-h agents. However, when an agent is more likely to be borrowing constrained, such that $\psi < \widehat{\psi}$, there is an ends-against-the-middle equilibrium: the decisive voter is the borrowing-constrained, type-l agent. He/she prefers a lower tax rate and, thus, lower levels of government expenditure and debt than the type-m agent because of the strict financial constraint. The policies preferred by the borrowing-constrained type-l agent lie between those by type-m and type-h agents.

[Figure 2 about here.]

4 Welfare Implication

In this section, we evaluate the political equilibrium in terms of efficiency. Following Bellettini and Berti Ceroni (2007), we focus on the set of policy variables that maximize the present discounted value (PDV) of aggregate disposable income. We compare it with the political equilibrium policies and investigate under what condition the political equilibrium results in an excess burden of tax and debt.

The PDV of aggregate disposable income, denoted by I, is given by:

$$I \equiv \sum_{i\in\{l,m,h\}} \phi^i(1-\tau_1)e_1^i + \frac{1}{R}\sum_{i\in\{l,m,h\}} \phi^i(1-\tau_2)e_2^i,$$

that is,

$$I = (1-\tau_1)E_1 + \frac{(1-\tau_2)A\tau_1(1-\tau_1)E_1}{R\{1-(\gamma)^2\tau_2(1-\tau_2)\}}\cdot \widetilde{E}_1.$$

The first term on the right-hand side is the aggregate disposable income in the first period, and the second term is the present value of the aggregate disposable income in the second period.

The first-period tax rate τ_1 has two competing effects on PDV of aggregate disposable income. An increase in τ_1 creates a negative effect via a decrease in the first-period after-tax income, and a positive effect via an increase in the government expenditure devoted to education. A social planner chooses τ_1 to equate these two competing effects at a margin. The second-period tax τ_2 also has two competing effects via the second-period after-tax income and government expenditure. The planner chooses τ_2 to equate these two competing effects at a margin.

Let $\{\tau_1^e,\ \tau_2^e\}$ denote the efficient tax rates that maximize the PDV of aggregate disposable income, and $\{G^e,\ B^e\}$ denote the corresponding levels of government expenditure and debt, respectively. The efficient tax rates τ_1^e and τ_2^e are derived by setting $\partial I/\partial \tau_1 = 0$ and $\partial I/\partial \tau_2 = 0$, respectively:

$$\tau_1^e = \tau_2^e = 1 - \frac{1}{\gamma}.$$

The planner chooses the same tax rates between the two periods in order to smooth tax burdens over periods. The corresponding levels of government expenditure and debt are calculated by substituting τ_1^e and τ_2^e into the government budget constraints:

$$G^e = \frac{(\gamma-1)\cdot E_1}{\gamma^2(2-\gamma)};\ B^e = \frac{(\gamma-1)^2\cdot E_1}{\gamma^2(2-\gamma)} = (\gamma-1)\cdot G^e.$$

A noteworthy feature is that the second-period tax rate in the political equilibrium is efficient: $\tau_2^e = \tau_2^*$. In order to understand the mechanism behind this result, we focus on the term related to τ_2. In the political equilibrium, the decisive voter j chooses τ_2 to maximize his/her second-period after-tax income, given by:

$$(1-\tau_2)A(e_1^i)^\mu G = (1-\tau_2)A(e_1^i)^\mu . \frac{\tau_1(1-\tau_1)E_1}{1-\gamma^2\tau_2(1-\tau_2)}.$$

In contrast, in the efficient allocation, the planner chooses τ_2 to maximize the aggregate second-period after-tax income given by:

$$\sum_{i\in\{l,m,h\}} \phi^i(1-\tau_2)A(e_1^i)^\mu G = \sum_{i\in\{l,m,h\}} \phi^i(1-\tau_2)A(e_1^i)^\mu . \frac{\tau_1(1-\tau_1)E_1}{1-\gamma^2\tau_2(1-\tau_2)}$$

The objective functions are different between the two problems. However, the terms related to τ_2 are equivalent between the two problems; both are given by $(1-\tau_2)/\{1-\gamma^2\tau_2(1-\tau_2)\}$. This is because the government expenditure G, given in (1), enters into these two objective functions in a linear fashion. Therefore, we can obtain the efficient second-period tax rate in the political equilibrium.

The efficiency generally fails to hold as regards τ_1, G and B. The following proposition demonstrates the conditions for which the political equilibrium levels of τ_1, G and B are higher or lower than the efficient levels.

Proposition 3.

(i) *Suppose that* $e_1^m > \left(\frac{AE_1}{R\gamma^2}\right)^{\frac{1}{1-\mu}}$ *holds. Then,*

$$\tau_1^e > \tau_1^*, \quad G^e > G^*, \quad B^e > B^*, \quad \forall\psi \geq 1.$$

(ii) *Suppose that* $\gamma < \frac{1+2\beta}{1+\beta}$ *holds. Then,*

$$\tau_1^e \leq \tau_1^*, \quad G^e \leq G^*, \quad B^e \leq B^*, \quad \forall \psi \geq 1.$$

(iii) *Suppose that* $e_1^m \leq \left(\frac{AE_1}{R\gamma^2}\right)^{\frac{1}{1-\mu}}$ *and* $\gamma \geq \frac{1+2\beta}{1+\beta}$ *hold. Then,*

$$\begin{cases} \tau_1^e > \tau_1^*, \quad G^e > G^*, \quad B^e > B^*, \quad \text{if } \psi \in [1, \psi^*), \\ \tau_1^e \leq \tau_1^*, \quad G^e \leq G^*, \quad B^e \leq B^*, \quad \text{if } \psi \in [\psi^*, \infty), \end{cases}$$

where:

$$\psi^* \equiv 1 + \frac{(1+2\beta)AE_1}{(1+\beta)R\gamma(2-\gamma)} \cdot \left[\frac{1+\beta}{1+2\beta} - \frac{1}{\gamma}\right] \cdot (e_1^l)^{\mu-1} \in [1, \widehat{\psi}].$$

Proof. See Appendix A.6.

Figure 3 illustrates the result in Proposition 3. In order to provide the interpretation of the result in Proposition 3, we focus on the first-period tax rate because the properties of government expenditure and debt are qualitatively similar to those of the first-period tax rate. After describing the efficiency of the first-period tax rate, we discuss the efficiency of debt issue in relation to the previous studies.

[Figure 3 about here.]

In the current framework, efficiency requires the same tax rates between the two periods in order to smooth the tax burden across periods. However, the political equilibrium realizes a lower or a higher first-period tax rate than the efficient one depending on either the income level of a decisive voter or the degree of capital market imperfection.

To confirm this argument, consider first the case of a low degree of capital market imperfection such that $\psi > \hat{\psi}$: an unconstrained middle-income agent becomes the decisive voter. He/she prefers a lower first-period tax rate than the efficient one when his/her income is high such that $e_1^m > (AE_1/R\gamma^2)^{\frac{1}{1-\mu}}$; otherwise, he/she prefers a higher tax rate. Therefore, the decisive voter's income level affects the efficiency of the political-equilibrium first-period tax rate when he/she is borrowing unconstrained.

Next, consider the case of a high degree of capital market imperfection such that $\psi < \hat{\psi}$: the decisive voter is the constrained low-income agent. As demonstrated in Subsection 3.2, a constrained agent prefers a lower tax rate as the degree of imperfection is increased. This implies that a further imperfection improves tax smoothing when the preferred tax rate by the decisive voter is initially higher than the efficient one, while it prevents tax smoothing when the preferred tax rate is initially lower than the efficient level. Therefore, the degree of capital market imperfection determines the degree of difference from the efficient rate when the decisive voter is borrowing constrained.

Given the discussion so far, we can now state that the political equilibrium does not necessarily result in an overissue of public debt in the current framework. Previous studies, in general, show that the politics results in an overissue of public debt because of common-pool problems (Tabellini, 1986; Velasco, 1999) and political instability (Persson and Svensson, 1989; Aghion and Bolton, 1990; Alesina and Tabellini, 1990). In the real world, however, some countries, such as Australia, Korea and New Zealand, do control successfully the issue of public debt (OECD, 2009). These countries could be viewed as issuing public debt below the efficient level. The result of underissue of public debt in the current framework may provide one possible explanation for these countries.

5 Income Inequality and Borrowing Constraint

The analysis so far has demonstrated the political equilibrium policy given the distribution of income. This section takes a step toward changing a situation. In particular, we consider an increase in the initial income of the high type, e_1^h, coupled with a decrease in the initial income of the low type, e_1^l.[3] We focus on the term $\widetilde{E}_1 \equiv A\sum_i \phi^i(e_1^i)^\mu$, which represents the marginal impact of government expenditure on the second-period GDP. Then, we consider the spread of income distribution, keeping $\widetilde{E}_1$ unchanged. Under the $\widetilde{E}_1$-preserving spread of income distribution, the second-period tax rate is unchanged because it is given by $\tau_2 = 1 - 1/\sqrt{\widetilde{E}_1/R}$. Thus, the specification enables us to concentrate on the decisive voter's choice over the first-period tax τ_1 and the government debt B.

Proposition 4. *Suppose that the first-period income of the high type, e_1^h, increases and the first-period income of the low type, e_1^l, decreases, leaving $\widetilde{E}_1$ unchanged. Then, there exists a critical level of ψ, denoted by $\widetilde{\psi}^l (> \widehat{\psi})$, such that the equilibrium debt-to-GDP ratio decreases if $\psi \leq \widetilde{\psi}^l$; the equilibrium debt-to-GDP ratio increases if $\psi > \widetilde{\psi}^l$.*

Proof. See Appendix A.7.

The result in Proposition 4 states that the effect of income inequality on the debt-to-GDP ratio depends heavily on the degree of capital market imperfection, denoted by ψ. The spread of income distribution results in a lower debt-to-GDP ratio when the degree of capital market imperfection is high such that $\psi \in [1, \widetilde{\psi}^l]$. However, it results in a higher debt-to-GDP ratio when the degree is low such that $\psi \in (\widetilde{\psi}^l, \infty)$. In order to understand the mechanism behind this result, we present three key results about agents' preferences

[3] Assuming a decrease in e_1^m instead of a decrease in e_1^l does not qualitatively affect the result shown below.

being affected by the spread of income distribution. Based on the results, we demonstrate illustratively the effect of income distribution on the debt-to-GDP ratio.

First, recall the threshold level of capital market imperfection for a type-j agent ($j = l, m$), denoted by ψ^j (Proposition 1):

$$\psi^j \equiv \frac{1}{2(1+\beta)} + \frac{AE_1}{2R(1+\beta)\gamma(2-\gamma)}(e_1^j)^{\mu-1}.$$

The threshold level is increased by the spread of income distribution in the following two ways. Given ψ, the spread of income distribution decreases type-l's labor earnings and, thus, decreases his/her after-tax income. In addition, a decrease in the type-l's income induces him/her to choose a higher first-period tax rate, which results in a lower after-tax income for every agent as long as the type-l agent is a decisive voter. Because of these two negative effects on the after-tax income, the type-j ($j = l, m$) agent, who is initially borrowing unconstrained, could become borrowing constrained. This implies that the range of ψ that makes the type-j agent ($j = l, m$) free from borrowing constraint, (ψ^j, ∞), becomes narrower as the income inequality becomes higher.

Second, the spread of income distribution produces positive and negative effects on the preferred debt-to-GDP ratio by each agent. The $\widetilde{E}_1$-preserving spread of income distribution increases the first-period GDP, E_1, implying an expansion of the tax base in the first period. This gives the decisive voter an incentive to increase the government spending and, thus, to issue more public debt. In addition, the type-l agent chooses higher government spending and, thus, a higher level of public debt when he/she is a decisive voter because his/her income is decreased by the spread of income distribution. These are positive effects on the debt-to-GDP ratio. In contrast, an increase in the first-period GDP, E_1, makes the debt-to-GDP ratio lower for a given B; this is a negative effect.

When the type-j ($= l$ or m) agent is borrowing constrained, the positive effect becomes smaller than the negative effect because he/she is unable to freely reallocate resources between the two periods. His/her policy choice results in a lower debt-to-GDP ratio in response to the spread of income distribution. In contrast, the positive effect overcomes the negative effect when he/she is borrowing unconstrained.

Third, under Assumption 2, a type-h agent is always borrowing unconstrained and, thus, prefers a higher B/E_1 in response to the spread of income distribution. However, the preferred level of B/E_1 by a type-h agent is always lower than that by the other two types of agents under Assumption 2. Therefore, the decisive voter is a type-l or type-m agent who prefers a lower B/E_1 between them (Proposition 2).

Based on the above-mentioned three results, we now illustrate changes in preferences over B/E_1 for each type of agent as in Figure 4. The dotted and solid curves in panel (a) depict the type-j's choices over B/E_1 before and after the spread of income distribution, respectively. The spread of income distribution increases the threshold level of ψ that distinguishes the type of decisive voter from $\widehat{\psi}$ to $\widehat{\psi}'$. The bold dotted and solid curves in panel (b) depict the decisive voter's choices over B/E_1 before and after the spread of income distribution, respectively. There exists a unique level of ψ, denoted by $\widetilde{\psi}^l \in (\widehat{\psi}, \widehat{\psi}')$ such that the bold dotted and solid curves cross at this level. Therefore, the range of ψ is divided into four subranges of ψ, as illustrated in Figure 4: $[1, \widehat{\psi}], (\widehat{\psi}, \widetilde{\psi}^l], (\widetilde{\psi}^l, \widehat{\psi}']$ and $(\widehat{\psi}', +\infty)$.

[Figure 4 about here.]

For $\psi \in [1, \widehat{\psi}]$, the initial decisive voter is a borrowing-constrained, type-l agent, and he/she still remains the decisive voter after the spread of income distribution. His/her choice over policies results in a lower level of B/E_1 in response to the decrease in his/her income. In contrast, for $\psi \in (\widehat{\psi}, \widetilde{\psi}^l]$, the initial decisive voter is a borrowing-unconstrained type-m agent. Because of the spread of income distribution, the decisive voter changes from a borrowing-unconstrained type-m agent to a borrowing-constrained type-l agent. The policy choice by the latter results in a lower level of B/E_1 than that by the former, as demonstrated in Figure 4.

For $\psi \in (\widetilde{\psi}^l, \widehat{\psi}']$, the initial decisive voter is a borrowing-unconstrained type-m agent. The decisive voter changes from a borrowing-unconstrained type-m agent to a borrowing-constrained type-l agent. The policy choice by the latter results in a higher level of B/E_1 than that by the former as demonstrated in Figure 4. Finally, for $\psi \in (\widehat{\psi}', +\infty)$, the initial decisive voter is a borrowing-unconstrained type-m agent, and he/she still remains the decisive voter after the spread of income distribution. His/her choice over policies results in a higher level of B/E_1 in response to the spread of income distribution.

6 Conclusion

This paper developed the two-period, three-class of income model with borrowing constraints (i.e., capital market imperfection), and studied the politics of redistributive expenditure financed by tax and government debt. In our framework, a borrowing-unconstrained agent prefers higher government expenditure and debt as his/her first-period income becomes lower because he/she wants to compensate his/her income loss today by redistributive expenditure in the future. However, an opposite result holds for a borrowing-constrained agent: he/she prefers lower government expenditure and debt because his/her income becomes lower because he/she is unable to make such compensation under borrowing constraints.

We showed the following three results. First, the type of a decisive voter depends on the degree of capital market imperfection. In particular, the decisive voter becomes the low-income, borrowing-constrained agent, rather than the middle, when the degree of capital market imperfection is high. The economy displays the ends-against-the-middle equilibrium. Second, the political equilibrium generally fails to attain the efficient allocation. In particular, under a certain condition, the political equilibrium attains an underissue of government debt when the degree of capital market imperfection is high.

Third, the spread of income distribution results in a lower debt-to-GDP ratio when the degree of capital market imperfection is high. This is because the decisive voter, who is a borrowing-constrained, low-income agent, wants to choose lower government expenditure and debt. The result implies that there is a negative correlation between inequality and debt-to-GDP ratio when the degree of capital market imperfection is low.

The standard result in the literature of politics and government debt is that (i) the political economy displays an overissue of government debt, and (ii) the spread of income distribution results in a greater issue of government debt. Our analysis and results, therefore, show that the standard result does not hold when the borrowing constraint is considered. More importantly, the result of the negative correlation between inequality and debt-to-GDP ratio could provide one possible explanation for the cross-country evidence among OECD countries.

Several research directions for future research are highlighted by our results in this paper. First, we characterized the structure-induced equilibrium of the voting game where agents simultaneously vote over tax and government debt. An interesting question is whether the current result is still true when an alternative concept of equilibrium is adopted. For example, one may study sequential voting or probabilistic voting. Second, we assumed a small open economy where the interest rate is exogenous. This simplifies the analysis and guarantees the analytical treatment of our political game but at the cost of abstracting general equilibrium effects. Third, the default of government debt was not considered in our analysis. Relaxing these assumptions are interesting areas for future research.

A Appendix

A.1 Single-peakedness of Preferences

A.1.1 Single-peakedness of preferences over τ_1 given τ_2

Given τ_2, let $\hat{\tau}_1(\tau_2, e_1^i)$ denote the first-period tax rate satisfying

$$R\{(1+\beta)\psi - 1\} = \frac{(1-\tau_2)e_2^i}{(1-\tau_1)e_1^i}. \tag{15}$$

Then, the preferences of a type-i agent over τ_1 are:

$$V^i(\tau_1, \tau_2) = \begin{cases} V^{iu} \text{ if } \tau_1 < \hat{\tau}_1(\tau_2, e_1^i), \\ V^{ic} \text{ if } \tau_1 \geq \hat{\tau}_1(\tau_2, e_1^i), \end{cases}$$

where V^{iu} and V^{ic} are defined in (13). In what follows, we first show that both V^{iu} and V^{ic} are singled peaked over τ_1. Then, we demonstrate that $V^{iu} = V^{ic}$ and $\partial V^{iu}/\partial \tau_1 = \partial V^{ic}/\partial \tau_1$ hold at $\tau_1 = \hat{\tau}_1(\tau_2, e_1^i)$, implying that V^i has a unique local maximum over the whole range of τ_1 and, thus, V^i is single peaked.

In order to show that V^{iu} and V^{ic} are single peaked over τ_1, we take the first derivatives of V^{iu} and V^{ic} with respect to τ_1, and obtain:

$$\begin{aligned}
\frac{\partial V^{iu}(\tau_1,\tau_2)}{\partial \tau_1} \gtreqless 0 &\Leftrightarrow -(1+\beta)\cdot\frac{1}{1-\tau_1} + (1+\beta)\cdot\frac{\frac{(1-\tau_2)}{R}\cdot A(e_1^i)^\mu\cdot\frac{E_1}{1-\gamma^2\cdot\tau_2(1-\tau_2)}}{e_1^i + \frac{(1-\tau_2)}{R}\cdot A(e_1^i)^\mu\cdot\frac{\tau_1 E_1}{1-\gamma^2\cdot\tau_2(1-\tau_2)}} \gtreqless 0 \\
&\Leftrightarrow \frac{(1-\tau_2)}{R}\cdot A(e_1^i)^\mu\cdot\frac{(1-2\tau_1)E_1}{1-\gamma^2\cdot\tau_2(1-\tau_2)} \gtreqless e_1^i \\
&\Leftrightarrow 1-2\tau_1 \gtreqless \frac{R\cdot\{1-\gamma^2\cdot\tau_2(1-\tau_2)\}}{AE_1(1-\tau_2)}\cdot(e_1^i)^{1-\mu} \\
&\Leftrightarrow \tau_1 \lesseqgtr \tau_1^{iu}(\tau_2; e_1^i) \equiv \frac{1}{2} - \frac{R\cdot\{1-\gamma^2\cdot\tau_2(1-\tau_2)\}}{2AE_1(1-\tau_2)}\cdot(e_1^i)^{1-\mu},
\end{aligned} \tag{16}$$

and

$$\begin{aligned}
\frac{\partial V^{ic}(\tau_1,\tau_2)}{\partial \tau_1} \gtreqless 0 &\Leftrightarrow -(1+\beta)\cdot\frac{1}{1-\tau_1} + \beta\cdot\frac{(1-\tau_2)A(e_1^i)^\mu\cdot\frac{E_1}{1-\gamma^2\tau_2(1-\tau_2)}}{(1-\tau_2)A(e_1^i)^\mu\cdot\frac{\tau_1 E_1}{1-\gamma^2\tau_2(1-\tau_2)} + R(1-\psi)e_1^i} \gtreqless 0 \\
&\Leftrightarrow (1-\tau_2)A(e_1^i)^\mu\cdot\frac{\{\beta-(1+2\beta)\tau_1\}E_1}{1-\gamma^2\tau_2(1-\tau_2)} \gtreqless (1+\beta)R(1-\psi)e_1^i \\
&\Leftrightarrow \tau_1 \lesseqgtr \tau_1^{ic}(\tau_2; e_1^i) \equiv \frac{\beta}{1+2\beta} + \frac{(1+\beta)R(\psi-1)\cdot\{1-\gamma^2\cdot\tau_2(1-\tau_2)\}}{(1+2\beta)AE_1(1-\tau_2)}\cdot(e_1^i)^{1-\mu},
\end{aligned} \tag{17}$$

where the second lines for both calculations come from the fact that $1-\gamma^2\cdot\tau_2(1-\tau_2) > 0$.[4] These results state that V^iu and V^ic have a unique local maximum at $\tau_1 = \tau_1^iu(\tau_2; e_1^i)$ and $\tau_1 = \tau_1^ic(\tau_2; e_1^i)$, respectively, and, thus, are single-peaked.

[4]The condition $1-\gamma^2\cdot\tau_2(1-\tau_2) > 0$ always holds because γ is set within the range $(1, 2)$ under Assumption 1, and τ_2 is set within the range $(0, 1/2)$ under Assumption 1 and the convex costs of collecting taxes.

Next, we show that $V^{iu} = V^{ic}$ and $\partial V^{iu}/\partial\tau_1 = \partial V^{ic}/\partial\tau_1$ hold at $\tau_1 = \hat{\tau}_1(\tau_2, e_1^i)$. From (11) and (15), we have:

$$(1-\hat{\tau}_1) = \frac{(1-\tau_2)}{e_1^i R\{(1+\beta)\psi - 1\}} \cdot A(e_1^i)^{\mu} \cdot \frac{\hat{\tau}_1(1-\hat{\tau}_1)E_1}{1-\gamma^2\tau_2(1-\tau_2)}$$

$$\Leftrightarrow \ \hat{\tau}_1(\tau_2, e_1^i) = \frac{R\{(1+\beta)\psi - 1\} \cdot \{1-\gamma^2\tau_2(1-\tau_2)\} \cdot (e_1^i)^{1-\mu}}{AE_1(1-\tau_2)}. \tag{18}$$

By direct calculation, we have:

$$V^{iu}\Big|_{\tau_1=\hat{\tau}_1(\tau_2,e_1^i)} = V^{ic}\Big|_{\tau_1=\hat{\tau}_1(\tau_2,e_1^i)} = \beta\log(\beta R) + (1+\beta)\cdot\log(\psi e_1^i) + (1+\beta)\cdot\log(1-\hat{\tau}_1(\tau_2, e_1^i)),$$

$$\begin{aligned}\frac{\partial V^{iu}}{\partial\tau_1}\bigg|_{\tau_1=\hat{\tau}_1(\tau_2,e_1^i)} &= \frac{\partial V^{ic}}{\partial\tau_1}\bigg|_{\tau_1=\hat{\tau}_1(\tau_2,e_1^i)} \\ &= -(1+\beta)\cdot\frac{1}{1-\hat{\tau}_1(\tau_2,e_1^i)} + \frac{1-\tau_2}{\psi R}\cdot A(e_1^i)^{\mu-1}\cdot\frac{E_1}{1-\gamma^2\cdot\tau_2(1-\tau_2)}.\end{aligned}$$

In words, V^i is continuous at $\tau_1 = \hat{\tau}_1(\tau_2, e_1^i)$, and V^{iu} and V^{ic} have the same slope at $\tau_1 = \hat{\tau}_1(\tau_2, e_1^i)$. Given these results with the single peakedness of V^{iu} and V^{ic}, it can be concluded that V^i has a unique local Maximum, as demonstrated in Figure 5. In particular, V^i is maximized at $\tau_1 = \tau_1^{iu}(\tau_2; e_1^i)$ if $\tau_1^{iu}(\tau_2; e_1^i) < \hat{\tau}_1(\tau_2, e_1^i)$; it is maximized at $\tau_1 = \tau_1^{ic}(\tau_2; e_1^i)$ otherwise.

[Figure 5 about here.]

A.1.2 Single-peakedness of preferences over τ_2 given τ_1

Given τ_1, let $\hat{\tau}_2(\tau_1; e_1^i)$ denote the second-period tax rate satisfying

$$R\{(1+\beta)\psi - 1\} = \frac{(1-\tau_2)e_2^i}{(1-\tau_1)e_1^i}.$$

From (13), the preferences of a type-i agent over τ_1 are:

$$V^i(\tau_1,\tau_2) = \begin{cases} V^{iu} \text{ if } \tau_2 > \hat{\tau}_2(\tau_1; e_1^i), \\ V^{ic} \text{ if } \tau_2 \leq \hat{\tau}_2(\tau_1; e_1^i). \end{cases}$$

We take the first derivatives of V^{iu} and V^{ic} with respect to τ_2 and obtain:

$$\begin{aligned}\frac{\partial V^{iu}(\tau_1,\tau_2)}{\partial\tau_2} \gtreqless 0 &\Leftrightarrow -\left\{1-\gamma^2\tau_2(1-\tau_2)\right\} + (1-\tau_2)\gamma^2(1-2\tau_2) \gtreqless 0 \\ &\Leftrightarrow \tau_2 \lesseqgtr 1 - \frac{1}{\gamma},\end{aligned} \tag{19}$$

and

$$\frac{\partial V^{ic}(\tau_1, \tau_2)}{\partial \tau_2} \gtreqless 0 \Leftrightarrow -\left\{1 - \gamma^2 \tau_2 (1 - \tau_2)\right\} + (1 - \tau_2)\gamma^2(1 - 2\tau_2) \gtreqless 0$$
$$\Leftrightarrow \tau_2 \lesseqgtr 1 - \frac{1}{\gamma}. \tag{20}$$

V^{iu} and V^{ic} are maximized at the same tax rate $\tau_2 = 1 - 1/\gamma$. Thus, we can conclude that V^i has a unique local maximum at $\tau_2 = 1 - 1/\gamma$; that is, V^i is single peaked over τ_2.

A.2 Proof of Proposition 1

From (19) and (20), the most preferred second-period tax rate by a type-i agent is given by:

$$(\tau_2^i)^* = 1 - \frac{1}{\gamma}, \tag{21}$$

where $(\tau_2^i)^* \in (0, 1/2)$ holds under Assumption 1. We substitute $\tau_2 = (\tau_2^i)^*$ into (16) and (17) and obtain the following most preferred first-period tax rates by a type-i agent when he/she is unconstrained and constrained, respectively:

$$\tau_1^{iu} \equiv \frac{1}{2} - \frac{R\gamma(2-\gamma)}{2AE_1} \cdot (e_1^i)^{1-\mu}, \tag{22}$$

$$\tau_1^{ic} \equiv \frac{\beta}{1+2\beta} + \frac{(1+\beta)R(\psi - 1)\gamma(2-\gamma)}{(1+2\beta)AE_1} \cdot (e_1^i)^{1-\mu}. \tag{23}$$

Next, we derive $(G^i)^*$ and $(B^i)^*$. We substitute (21) and (22) into (11) and (12) to obtain G^{iu} and B^{iu} :

$$\begin{aligned} G^{iu} &= \frac{E_1}{2-\gamma} \cdot \left[\frac{1}{2} - \frac{R\gamma(2-\gamma)}{2AE_1} \cdot (e_1^i)^{1-\mu}\right] \cdot \left[\frac{1}{2} + \frac{R\gamma(2-\gamma)}{2AE_1} \cdot (e_1^i)^{1-\mu}\right] \\ &= \frac{E_1}{4(2-\gamma)} \left[1 - \left(\frac{R\gamma(2-\gamma)}{AE_1}\right)^2 \cdot (e_1^i)^{2(1-\mu)}\right], \end{aligned}$$

$$\begin{aligned} B^{iu} &= \gamma(\tau_2^i)^*(1 - (\tau_2^i)^*) \cdot G^{iu} \\ &= (\gamma - 1) \cdot G^{iu} \\ &= \frac{(\gamma-1) \cdot E_1}{4(2-\gamma)} \left[1 - \left(\frac{R\gamma(2-\gamma)}{AE_1}\right)^2 \cdot (e_1^i)^{2(1-\mu)}\right]; \end{aligned}$$

and we substitute (21) and (23) into (11) and (12) to obtain G^{ic} and B^{ic} :

$$\begin{aligned}
G^{ic} &= \frac{E_1}{2-\gamma}\left[\frac{\beta}{1+2\beta}+\frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{(1+2\beta)AE_1}\cdot(e_1^i)^{1-\mu}\right] \\
&\qquad\qquad\qquad\qquad \times\left[\frac{1+\beta}{1+2\beta}-\frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{(1+2\beta)AE_1}\cdot(e_1^i)^{1-\mu}\right] \\
&= \frac{E_1}{(2-\gamma)(1+2\beta)^2}\left[\beta(1+\beta)+\frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{AE_1}\cdot(e_1^i)^{1-\mu}\right. \\
&\qquad\qquad\qquad\qquad \left.-\left(\frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{AE_1}\right)^2\cdot(e_1^i)^{2(1-\mu)}\right], \\
B^{ic} &= \gamma(\tau_2^i)^*(1-(\tau_2^i)^*)\cdot G^{ic} \\
&= (\gamma-1)\cdot G^{ic} \\
&= \frac{(\gamma-1)\cdot E_1}{(2-\gamma)(1+2\beta)^2}\left[\beta(1+\beta)+\frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{AE_1}\cdot(e_1^i)^{1-\mu}\right. \\
&\qquad\qquad\qquad\qquad \left.-\left(\frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{AE_1}\right)^2\cdot(e_1^i)^{2(1-\mu)}\right].
\end{aligned}$$

Finally, we substitute τ_1^{iu}, $(\tau_2^i)^*$ and G^{iu} into the condition (7) to find the threshold level of capital market imperfection for a type-i agent:

$$\psi^i \equiv \frac{1}{2(1+\beta)}+\frac{AE_1}{2R(1+\beta)\cdot\gamma(2-\gamma)}\cdot(e_1^i)^{\mu-1}.$$

■

A.3 Voting Over τ_2 When Preferences Are Characterized by a Constant Intertemporal Elasticity of Substitution

Proposition 1 demonstrates that the second-period tax rate is independent of types and capital market imperfections under a logarithmic utility function. Here, we show that the result also holds true as long as the preferences are characterized by a constant intertemporal elasticity of substitution (CIES). For the purpose of analysis, we consider the following utility function:

$$U^i = \frac{(c_1^i)^{1-\sigma}}{1-\sigma}+\beta\cdot\frac{(c_2^i)^{1-\sigma}}{1-\sigma}, \quad \sigma\neq 1, \sigma>0,$$

where σ represents the inverse of the intertemporal elasticity of substitution.

In order to solve the problem, suppose that the borrowing constraint is not binding.

The solution to the utility maximization problem yields:

$$c_1^{iu} = \frac{1}{R + (\beta R)^{\frac{1}{\sigma}}} \cdot \left[(1-\tau_1)e_1^i + \frac{(1-\tau_2)e_2^i}{R} \right], \tag{24}$$

$$c_2^{iu} = \frac{R(\beta R)^{\frac{1}{\sigma}}}{R + (\beta R)^{\frac{1}{\sigma}}} \cdot \left[(1-\tau_1)e_1^i + \frac{(1-\tau_2)e_2^i}{R} \right], \tag{25}$$

$$s^{iu} = \frac{R}{R + (\beta R)^{\frac{1}{\sigma}}} \cdot \left[\frac{(\beta R)^{\frac{1}{\sigma}}}{R} \cdot (1-\tau_1)e_1^i - \frac{(1-\tau_2)e_2^i}{R} \right]. \tag{26}$$

We substitute (26) into the borrowing constraint (3) to obtain the condition where a type-i agent is actually unconstrained in terms of the tax rates τ_1 and τ_2:

$$\left[\left\{ R + (\beta R)^{\frac{1}{\sigma}} \right\} \cdot \psi - R \right] > \frac{(1-\tau_2)e_2^i}{(1-\tau_1)e_1^i}. \tag{27}$$

This condition states that the borrowing constraint of a type-i agent does not bind when his/her after-tax income is high in the first period and is low in the second period. Alternatively, suppose that the borrowing constraint is binding; that is, (27) fails to hold. The solution to the utility maximization problem is given by (8), (9) and (10).

We substitute the consumption functions and the first-period government budget constraint (11) into the utility function U^i, and obtain the following indirect utility function of a type-i agent:

$$V^i(\tau_1,\tau_2) = \begin{cases} V^{iu} \equiv \left(\frac{R}{R+(\beta R)^{\frac{1}{\sigma}}} \right)^{1-\sigma} \cdot \left\{ 1 + \beta (\beta R)^{\frac{1-\sigma}{\sigma}} \right\} \cdot \frac{1}{1-\sigma} \\ \qquad \times \left[(1-\tau_1)e_1^i + \frac{(1-\tau_2)}{R} \cdot A(e_1^i)^{\mu} \cdot \frac{\tau_1(1-\tau_1)E_1}{1-\gamma^2 \cdot \tau_2(1-\tau_2)} \right]^{1-\sigma} + (const) \\ \qquad\qquad\qquad \text{if } \left[\left\{ R + (\beta R)^{\frac{1}{\sigma}} \right\} \cdot \psi - R \right] > \frac{(1-\tau_2)e_2^i}{(1-\tau_1)e_1^i}, \\ V^{ic} \equiv \frac{1}{1-\sigma} \left\{ \psi (1-\tau_1) e_1^i \right\}^{1-\sigma} \\ \qquad + \beta \cdot \frac{R}{1-\sigma} \cdot \left[(1-\psi)(1-\tau_1)e_1^i + \frac{(1-\tau_2)}{R} \cdot A(e_1^i)^{\mu} \cdot \frac{\tau_1(1-\tau_1)E_1}{1-\gamma^2 \cdot \tau_2(1-\tau_2)} \right]^{1-\sigma} \\ \qquad\qquad\qquad \text{if } \left[\left\{ R + (\beta R)^{\frac{1}{\sigma}} \right\} \cdot \psi - R \right] \leq \frac{(1-\tau_2)e_2^i}{(1-\tau_1)e_1^i}. \end{cases} \tag{28}$$

We take the first derivative of V^{iu} and V^{ic} with respect to τ_2 and obtain:

$$\begin{aligned} \frac{\partial V^{iu}(\tau_1,\tau_2)}{\partial \tau_2} \gtrless 0 \Leftrightarrow \frac{\partial}{\partial \tau_2} \left[\frac{(1-\tau_2)}{1-\gamma^2 \cdot \tau_2(1-\tau_2)} \right] \gtrless 0 \\ \Leftrightarrow \tau_2 \lesseqgtr 1 - \frac{1}{\gamma}, \end{aligned}$$

and

$$\begin{aligned} \frac{\partial V^{ic}(\tau_1,\tau_2)}{\partial \tau_2} \gtrless 0 \Leftrightarrow \frac{\partial}{\partial \tau_2} \left[\frac{(1-\tau_2)}{1-\gamma^2 \cdot \tau_2(1-\tau_2)} \right] \gtrless 0 \\ \Leftrightarrow \tau_2 \lesseqgtr 1 - \frac{1}{\gamma}. \end{aligned}$$

The result implies that voter's preferences over τ_2 are unaffected by types and capital market imperfections as long as the utility function is characterized by CIES.

The intuition behind the result is as follows. An agent chooses τ_2 to maximize his/her second-period after-tax income given by:

$$\begin{aligned}(1-\tau_2)e_2^i &= (1-\tau_2)\cdot A(e_1^i)^\mu \cdot G \\ &= (1-\tau_2)\cdot A(e_1^i)^\mu \cdot \frac{\tau_1(1-\tau_1)E_1}{1-\gamma^2\cdot\tau_2(1-\tau_2)},\end{aligned}$$

regardless of whether he/she is borrowing constrained or not; and whether his/her utility function is characterized by a logarithmic function or CIES. The first line comes from the assumption of $e_2^i = A(e_1^i)^\mu \cdot G$; and the second line comes from the government budget constraints (1) and (2). Thus, maximizing $(1-\tau_2)e_2^i$ with respect to τ_2 is equivalent to maximizing $(1-\tau_2)/\{1-\gamma^2\cdot\tau_2(1-\tau_2)\}$ that is independent of types and capital market imperfections.

A.4 Proof of Corollary 1

(i) The differentiation of τ_1^{ic} with respect to ψ leads to:

$$\frac{\partial\tau^{ic}}{\partial\psi} = \frac{(1+\beta)R\gamma(2-\gamma)}{(1+2\beta)AE_1} > 0.$$

Next, we differentiate G^{ic} with respect to ψ and derive the condition for which $\partial G^{ic}/\partial\psi > 0$ holds:

$$\begin{aligned}\frac{\partial G^{ic}}{\partial\psi} > 0 \;\Leftrightarrow\; & \frac{(1+\beta)R\gamma(2-\gamma)}{AE_1}\cdot(e_1^i)^{1-\mu} \\ & -2\cdot\frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{AE_1}\cdot\frac{(1+\beta)R\gamma(2-\gamma)}{AE_1}\cdot(e_1^i)^{2(1-\mu)} > 0 \\ \Leftrightarrow\; & 1-2\cdot\frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{AE_1}\cdot(e_1^i)^{1-\mu} > 0 \\ \Leftrightarrow\; & \psi < 1+\frac{AE_1}{2R(1+\beta)\gamma(2-\gamma)}\cdot(e_1^i)^{\mu-1}. \end{aligned} \tag{29}$$

Based on the result in Proposition 1, the following condition holds when a type-i agent is borrowing constrained:

$$\psi < \psi^i \equiv \frac{1}{2(1+\beta)} + \frac{AE_1}{2R(1+\beta)\gamma(2-\gamma)}\cdot(e_1^i)^{\mu-1}.$$

Because the right-hand side of (29) is greater than ψ^i, we obtain:

$$\psi < \psi^i < 1+\frac{AE_1}{2R(1+\beta)\gamma(2-\gamma)}\cdot(e_1^i)^{\mu-1},$$

implying that $\partial G^{ic}/\partial\psi > 0$ actually holds. Finally, given $B^{ic} = (\gamma-1)\cdot G^{ic}$, $\partial B^{ic}/\partial\psi > 0$ also holds in equilibrium.

(ii) From the result in Proposition 1, we obtain:

$$\begin{aligned}
\tau_1^{ic}\big|_{\psi=\psi^i} &= \frac{\beta}{1+2\beta} + \frac{(1+\beta)R\gamma(2-\gamma)}{(1+2\beta)AE_1}\cdot\left[-\frac{1+2\beta}{2(1+\beta)} + \frac{AE_1}{2R(1+\beta)\gamma(2-\gamma)}\cdot(e_1^i)^{\mu-1}\right]\cdot(e_1^i)^{1-\mu} \\
&= \frac{\beta}{1+2\beta} - \frac{R\gamma(2-\gamma)}{2AE_1}\cdot(e_1^i)^{1-\mu} + \frac{1}{2(1+2\beta)} \\
&= \frac{1}{2} - \frac{R\gamma(2-\gamma)}{2AE_1}\cdot(e_1^i)^{1-\mu} \\
&= \tau_1^{iu}. \qquad (30)
\end{aligned}$$

From (11), we also obtain:

$$\begin{aligned}
G^{iu} = G^{ic} \;&\Leftrightarrow\; \frac{\tau_1^{iu}(1-\tau_1^{iu})E_1}{2-\gamma} = \frac{\tau_1^{ic}(1-\tau_1^{ic})E_1}{2-\gamma} \\
&\Leftrightarrow\; \tau_1^{iu} = \tau_1^{ic},
\end{aligned}$$

which implies

$$\psi = \psi^i.$$

Finally, we obtain:

$$\begin{aligned}
B^{ic}\big|_{\psi=\psi^i} &= (\gamma-1)\cdot G^{ic}\big|_{\psi=\psi^i} \\
&= (\gamma-1)\cdot G^{iu} \\
&= B^{iu}.
\end{aligned}$$

■

A.5 Proof of Proposition 2

Consider first the political determination of the second-period tax rate. As demonstrated in Proposition 1, all agents choose the same second-period tax rate, given by $\tau_2^* = 1-1/\gamma$. This is the equilibrium tax rate in majority voting.

Next, consider the political determination of the first-period tax rate. As demonstrated in Proposition 1, the preferred tax rate by a type-i agent, $(\tau_1^i)^*$, is:

$$(\tau_1^i)^* = \begin{cases} \tau_1^{ic} & \text{for } \psi \le \psi^i, \\ \tau_1^{iu} & \text{for } \psi > \psi^i. \end{cases}$$

Under Assumption 2, the critical degrees of the three types of agents, ψ^l, ψ^m, and ψ^h are ordered as:

$$\psi^h < 1 < \psi^m < \psi^l.$$

Given this order, a type-h agent is borrowing unconstrained and chooses $(\tau_1^h)^* = \tau_1^{hu}\ \forall\psi \in [1,\infty)$. In contrast, a type-$i$ ($i = l, m$) agent is borrowing constrained and chooses $(\tau_1^i)^* = \tau_1^{ic}$ for $\psi \leq \psi^i$; he/she is borrowing unconstrained and chooses $(\tau_1^i)^* = \tau_1^{iu}$ for $\psi > \psi^i$.

Preferred first-period tax rates by the three types of agents are illustrated in Panel (a) of Figure 2. Because $(\tau_1^l)^* < (\tau_1^m)^*$ holds for $\psi \in [1, \psi^l]$ and $(\tau_1^l)^* > (\tau_1^m)^*$ holds for $\psi \in [\psi^m, \infty)$, there exists a critical degree of ψ, denoted by $\hat{\psi}$, such that $(\tau_1^l)^* = (\tau_1^m)^*$ holds. We solve $(\tau_1^l)^* = (\tau_1^m)^*$ for ψ and obtain the following critical degree that changes the order of preferred first-period tax rates by types l and m agents:

$$\widehat{\psi} = \frac{AE_1 + R\gamma(2-\gamma)\cdot\left[2(1+\beta)\cdot(e_1^l)^{1-\mu} - (1+2\beta)\cdot(e_1^m)^{1-\mu}\right]}{2(1+\beta)R\gamma(2-\gamma)\cdot(e_1^l)^{1-\mu}} \in (\psi^m, \psi^l).$$

Given the definition of ψ^i and $\widehat{\psi}$, we now divide the range of ψ into the following four subranges: $[1, \psi^m), [\psi^m, \widehat{\psi}), [\widehat{\psi}, \psi^l)$, and $[\psi^l, \infty)$. As illustrated in Panel (a) of Figure 2, preferred tax rates by the three types of agents and their order are:

$$\begin{cases} (\tau_1^h)^* = \tau_1^{hu} & < & (\tau_1^l)^* = \tau_1^{lc} & < & (\tau_1^m)^* = \tau_1^{mc} & \text{for } \psi \in [1, \psi^m] \\ (\tau_1^h)^* = \tau_1^{hu} & < & (\tau_1^l)^* = \tau_1^{lc} & < & (\tau_1^m)^* = \tau_1^{mu} & \text{for } \psi \in (\psi^m, \widehat{\psi}] \\ (\tau_1^h)^* = \tau_1^{hu} & < & (\tau_1^m)^* = \tau_1^{mu} & < & (\tau_1^l)^* = \tau_1^{lc} & \text{for } \psi \in (\widehat{\psi}, \psi^l] \\ (\tau_1^h)^* = \tau_1^{hu} & < & (\tau_1^m)^* = \tau_1^{mu} & < & (\tau_1^l)^* = \tau_1^{lu} & \text{for } \psi \in (\psi^l, \infty). \end{cases}$$

Under the assumption of distribution of three types of agents, a type ranked in the middle of preferred tax rates becomes the decisive voter. That is, the decisive voter is a borrowing-constrained type-l agent for $\psi \in [1, \widehat{\psi})$; it is a borrowing-unconstrained type-m agent for $\psi \in [\widehat{\psi}, \infty)$. Thus, the equilibrium tax rate determined in majority voting is:

$$(\tau_1)^* = \begin{cases} \tau_1^{lc} & \text{for } \psi \in [1, \widehat{\psi}] \\ \tau_1^{mu} & \text{for } \psi \in (\widehat{\psi}, \infty). \end{cases}$$

The corresponding levels of G and B are:

$$G^* = \begin{cases} G^{lc} & \text{for } \psi \in [1, \widehat{\psi}] \\ G^{mu} & \text{for } \psi \in (\widehat{\psi}, \infty) \end{cases}$$

$$B^* = \begin{cases} B^{lc} & \text{for } \psi \in [1, \widehat{\psi}] \\ B^{mu} & \text{for } \psi \in (\widehat{\psi}, \infty). \end{cases}$$

These are calculated based on the result in Proposition 1.

■

A.6 Proof of Proposition 3

As demonstrated in Proposition 2, τ_1^* is equal to τ_1^{lc} and is increasing in ψ for $\psi \in [1, \hat{\psi})$; τ_1^* is equal to τ_1^{mu} and is constant for $\psi \in [\hat{\psi}, \infty)$. That is, τ_1^* attains the lowest value

$\beta/(1+2\beta)$ at $\psi = 1$ and the highest value at $\psi \in [\hat{\psi}, \infty)$. Thus, $\tau_1^e > \tau_1^*$ holds $\forall\psi \geq 1$ if $\tau_1^e > \tau_1^{mu}$; and $\tau_1^e < \tau_1^*$ holds $\forall\psi \geq 1$ if $\tau_1^e < \beta/(1+2\beta)$. That is,

$$\tau_1^e > \tau_1^* \ \forall\psi \geq 1 \text{ if } \ e_1^m > \left(\frac{AE_1}{R\gamma^2}\right)^{\frac{1}{1-\mu}},$$
$$\tau_1^e < \tau_1^* \ \forall\psi \geq 1 \text{ if } \ \gamma < \frac{1+2\beta}{1+\beta}.$$

Suppose that the above-mentioned two conditions fail to hold; that is, $e_1^m \leq (AE_1/R\gamma^2)^{\frac{1}{1-\mu}}$ and $\gamma \geq (1+2\beta)/(1+\beta)$ hold. Because of the continuity of τ_1^{lc} with respect to ψ, there exists a critical level of ψ, denoted by ψ^*, such that $\tau_1^e = \tau_1^{lc}$ holds. Solving $\tau_1^e = \tau_1^{lc}$ for ψ leads to:

$$\psi = \psi^* \equiv 1 + \frac{(1+2\beta)AE_1}{(1+\beta)R\gamma(2-\gamma)}\left[\frac{1+\beta}{1+2\beta} - \frac{1}{\gamma}\right] \cdot (e_1^l)^{\mu-1}.$$

Thus, we obtain $\tau_1^e \gtreqless \tau_1^*$ if $\psi \lesseqgtr \psi^*$.

The same argument holds for G^* and B^* because they have the same property as τ_1^* with respect to ψ, as demonstrated in Proposition 2.

■

A.7 Proof of Proposition 4

Consider an increase in the initial income of the high type, e_1^h, coupled with a decrease in the initial income of the type-l, keeping $\widetilde{E}_1$ unchanged. Given the definition of $\widetilde{E}_1 \equiv A\sum_i \phi^i (e_1^i)^\mu$, the $\widetilde{E}_1$-preserving spread of income distribution results in:

$$\mathrm{d}\widetilde{E}_1 = 0 \Leftrightarrow \mathrm{d}e_1^h = (-1)\,\frac{\phi^l}{\phi^h} \cdot \frac{(e_1^h)^{1-\mu}}{(e_1^l)^{1-\mu}} \cdot \mathrm{d}e_1^l. \tag{31}$$

Under this spread of income distribution, the first-period GDP, given by $E_1 = \sum_i \phi^i e_1^i$, changes as follows:

$$\begin{aligned}\mathrm{d}E_1 &= \phi^l \cdot \mathrm{d}e_1^l + \phi^h \cdot \mathrm{d}e_1^h \\ &= \left[1 - \frac{(e_1^h)^{1-\mu}}{(e_1^l)^{1-\mu}}\right] \cdot \phi^l \cdot \mathrm{d}e_1^l \\ &> 0.\end{aligned} \tag{32}$$

where the equality in the second line comes from (31).

By the use of the result in (32), we hereafter investigate how the type-j's ($j = l, m, h$) preference over B/E_1 changes in response to the $\widetilde{E}_1$-preserving spread of income distribution. We first consider borrowing-unconstrained and borrowing-constrained cases separately. Then, we unify the two cases to determine the decisive voter for each level of

ψ before and after the $\widetilde{E}_1$-preserving spread of income distribution, and demonstrate the effect of this distribution spread on the decisive voter's choice over B/E_1.

Under Assumption 2, a type-h agent is always borrowing unconstrained. The preferred level of B/E_1 by a type-h agent is always lower than that by the other two types of agents, under Assumption 2. The decisive voter is a type-l or type-m agent who prefers a lower B/E_1(Proposition 1) between them. Therefore, we hereafter focus on types-l and m agents.

A.7.1 An unconstrained type-j's ($j = l, m$) preference over B/E_1

We consider how the type-j's ($j = l, m$) preference over B/E_1 is affected by the $\widetilde{E}_1$-preserving spread of income distribution when he/she is borrowing unconstrained. From (14) in Proposition 1, the preferred debt-to-GDP ratio by an unconstrained type-j's individual is given by:

$$\frac{B^{ju}}{E_1} = \frac{\gamma - 1}{4(2-\gamma)} \cdot \left[1 - \left(\frac{R\gamma(2-\gamma)}{AE_1}\right)^2 \cdot (e_1^j)^{2(1-\mu)}\right], \quad j = l,\ m.$$

Differentiation of the above equation with respect to $B^{ju}/E_1, E_1$ and e_1^j leads to:

$$\begin{aligned}\frac{4(2-\gamma)}{\gamma-1} \cdot \mathrm{d}\left(\frac{B^{ju}}{E_1}\right) &= 2\left(\frac{R\gamma(2-\gamma)}{A}\right)^2 \cdot \left(\frac{1}{E_1}\right)^3 \cdot (e_1^j)^{2(1-\mu)} \cdot \mathrm{d}E_1 \\ &\quad - 2(1-\mu) \cdot \left(\frac{R\gamma(2-\gamma)}{AE_1}\right)^2 \cdot (e_1^j)^{1-2\mu} \cdot \mathrm{d}e_1^j \\ &= 2\left(\frac{R\gamma(2-\gamma)}{AE_1}\right)^2 \cdot (e_1^j)^{1-2\mu} \cdot \left\{\frac{e_1^j}{E_1} \cdot \mathrm{d}E_1 - (1-\mu) \cdot \mathrm{d}e_1^j\right\}. \end{aligned} \tag{33}$$

(33) indicates that $\mathrm{d}\left(B^{lu}/E_1\right) > 0$ always holds because $\mathrm{d}E_1 > 0$ as shown in (32) and $\mathrm{d}e_1^j \leq 0$ ($j = l,\ m$), under the current assumption.

A.7.2 A constrained type-j's ($j = l, m$) preference over B/E_1

Next, we consider how the type-j's ($j = l, m$) preference over B/E_1 is affected by the $\widetilde{E}_1$-preserving spread of income distribution when he/she is borrowing constrained. From (14) in Proposition 1, the preferred debt-to-GDP ratio by a constrained type-j's individual is given by:

$$\frac{B^{jc}}{E_1} = \frac{\gamma - 1}{(2-\gamma)(1+2\beta)^2}\left[\beta(1+\beta) + \Gamma \cdot \left\{\frac{(e_1^j)^{1-\mu}}{E_1} - \Gamma \cdot \frac{(e_1^j)^{2(1-\mu)}}{(E_1)^2}\right\}\right], \quad j = l,\ m; \tag{34}$$

where

$$\Gamma \equiv \frac{(1+\beta)R(\psi-1)\gamma(2-\gamma)}{A}.$$

Differentiation of the above equation with respect to $B^{jc}/E_1, E_1$ and e_1^j leads to:

$$\begin{aligned}
\frac{(2-\gamma)(1+2\beta)^2}{\gamma-1}\cdot \mathrm{d}\left(\frac{B^{jc}}{E_1}\right) &= \Gamma\cdot\left\{\frac{1-\mu}{E_1}(e_1^j)^{-\mu} - \Gamma\cdot\frac{2(1-\mu)}{(E_1)^2}\cdot(e_1^j)^{1-2\mu}\right\}\cdot \mathrm{d}e_1^j \\
&\quad + \Gamma\cdot\left\{-\frac{(e_1^j)^{1-\mu}}{(E_1)^2} + 2\Gamma\cdot\frac{(e_1^j)^{2(1-\mu)}}{(E_1)^3}\right\}\cdot \mathrm{d}E_1 \\
&= \frac{(1-\mu)\Gamma(e_1^j)^{-\mu}}{E_1}\cdot\left\{1-\frac{2\Gamma(e_1^j)^{1-\mu}}{E_1}\right\}\cdot \mathrm{d}e_1^j \\
&\quad - \frac{\Gamma(e_1^j)^{1-\mu}}{(E_1)^2}\cdot\left\{1-\frac{2\Gamma(e_1^j)^{1-\mu}}{E_1}\right\}\cdot \mathrm{d}E_1 \\
&= \frac{\Gamma(e_1^j)^{-\mu}}{E_1}\cdot\left\{1-\frac{2\Gamma(e_1^j)^{1-\mu}}{E_1}\right\}\cdot\left[(1-\mu)\cdot \mathrm{d}e_1^j - \frac{e_1^j}{E_1}\cdot \mathrm{d}E_1\right],
\end{aligned} \tag{35}$$

where the sign of the term $\{1-2\Gamma(e_1^j)^{1-\mu}/E_1\}$ in the last line is positive under the assumption that the type-j agent is borrowing constrained.[5] (35) indicates that $\mathrm{d}\left(B^{lc}/E_1\right) > 0$ always holds because $dE_1 > 0$ as shown in (32) and $\mathrm{d}e_1^j \leq 0$ ($j = l, m$), under the current assumption.

A.7.3 Decisive voter's choice over B/E_1

Based on the results established so far, we can illustrate changes in preferences over B/E_1 by three types of agents, as in Figure 4.

The bold dotted and solid curves depict the decisive voter's choices over B/E_1 before and after the spread of income distribution, respectively. The spread of income distribution increases the threshold level of ψ that distinguishes the type of a decisive voter,

[5] The parameter ψ included in Γ satisfy $\psi \leq \psi^j$ because we assume that the type-j agent ($j = l, m$) is now borrowing constrained (Proposition 1). By the use of the definition of ψ^j in Proposition 1, we can write:

$$\begin{aligned}
1-\frac{2\Gamma(e_1^j)^{1-\mu}}{E_1} &= 1-\frac{2(1+\beta)R(\psi-1)\gamma(2-\gamma)\cdot(e_1^j)^{1-\mu}}{AE_1} \\
&\geq 1-\frac{2(1+\beta)R(\psi^j-1)\gamma(2-\gamma)\cdot(e_1^j)^{1-\mu}}{AE_1} \\
&= 1-\frac{2(1+\beta)R\gamma(2-\gamma)\cdot(e_1^j)^{1-\mu}}{AE_1}\cdot\frac{AE_1-(1+2\beta)R\gamma(2-\gamma)\cdot(e_1^j)^{1-\mu}}{2(1+\beta)R\gamma(2-\gamma)\cdot(e_1^j)^{1-\mu}} \\
&= 1-\frac{AE_1-(1+2\beta)R\gamma(2-\gamma)\cdot(e_1^j)^{1-\mu}}{AE_1} \\
&= \frac{(1+2\beta)R\gamma(2-\gamma)\cdot(e_1^j)^{1-\mu}}{AE_1} \\
&> 0,
\end{aligned}$$

where the inequality in the second line comes from $\psi \leq \psi^j$, and the inequality in the last line comes from Assumption 1.

denoted by $\hat{\psi}$, from $\widehat{\psi}$ to $\widehat{\psi}'$. There exists a unique level of ψ, denoted by $\widetilde{\psi}^l \in (\widehat{\psi}, \widehat{\psi}')$ such that the bold dotted and solid curves cross at this level. Therefore, there are four subranges of ψ, as illustrated in Figure 4: $[1, \widehat{\psi}], (\widehat{\psi}, \widetilde{\psi}^l], (\widetilde{\psi}^l, \widehat{\psi}']$ and $(\widehat{\psi}', +\infty)$.

For $\psi \in [1, \widehat{\psi}]$, the initial decisive voter is a borrowing-constrained, type-l agent, and he/she still remains the decisive voter after the spread of income distribution. His/her choice over policies results in a lower level of B/E_1 in response to the spread of income distribution, as demonstrated in Subsection A.7.2. Thus, the $\widetilde{E}_1$-preserving spread of income distribution leads to a lower level of B/E_1.

For $\psi \in (\widehat{\psi}, \widetilde{\psi}^l]$, the initial decisive voter is a borrowing-unconstrained type-m agent. Because of the spread of income distribution, the decisive voter changes from a borrowing-unconstrained type-m agent to a borrowing-constrained type-l agent. The policy choice by the latter results in a lower level of B/E_1 than that by the former, as demonstrated in Figure 4.

For $\psi \in (\widetilde{\psi}^l, \widehat{\psi}']$, the initial decisive voter is a borrowing-unconstrained type-m agent. The decisive voter changes from a borrowing-unconstrained type-m agent to a borrowing-unconstrained type-l agent. The policy choice by the latter results in a higher level of B/E_1 than that by the former, as demonstrated in Figure 4.

Finally, for $\psi \in (\widehat{\psi}', +\infty)$, the initial decisive voter is a borrowing-unconstrained type-m agent, and he/she still remains the decisive voter after the spread of income distribution. His/her choice over policies results in a higher level of B/E_1 in response to the spread of income distribution, as shown in Subsection A.7.1. Thus, the $\widetilde{E}_1$-preserving spread of income distribution leads to a higher level of B/E_1.

■

References

[1] Aghion, P. and Bolton, P., 1990. Government domestic debt and the risk of default: a political-economic model of the strategic role of debt. In: Dornbusch, R. and Draghi, M., (eds.), *Public Debt Management: Theory and History*, (pp. 315–344). Cambridge University Press: Cambridge, UK.

[2] Aiyagari, S.R., Marcet, A., Sargent, T.J., and Seppala, J., 2002. Optimal taxation without state-contingent debt. *Journal of Political Economy* 110, 1220–1254.

[3] Alesina, A., and La Ferrara, E., 2005. Preferences for redistribution in the land of opportunities. *Journal of Public Economics* 89, 897–931.

[4] Alesina, A., and Tabellini, G., 1990. A positive theory of fiscal deficits and government debt. *Review of Economic Studies* 57, 403–414.

[5] Arawatari, R., and Ono, T., 2009. A second chance at success: a political economy perspective. *Journal of Economic Theory* 144, 1249–1277.

[6] Arawatari, R., and Ono, T., 2011. The political economy of social security in a borrowing-constrained economy. *Journal of Public Economic Theory*, forthcoming.

[7] Barro, R.J., 1979. On the determination of the public debt. *Journal of Political Economy* 87, 940–971.

[8] Bellettini, G., and Berti Ceroni, C., 2007. Income distribution, borrowing constraints and redistributive policies. *European Economic Review* 51, 625–645.

[9] Benabou, R., 2000. Unequal societies: income distribution and the social contract. *American Economic Review* 90, 96–129.

[10] Benabou, R., and Ok, E.A., 2001. Social mobility and the demand for redistribution: the POUM hypothesis. *Quarterly Journal of Economics* 116, 447–487.

[11] Campante, F.R., 2010. Redistribution in a model of voting and campaign contributions. *Journal of Public Economics* doi:10.1016/j.jpubeco.2010.11.013

[12] Casamatta, G., Cremer, H., and Pestieau, P., 2000. The political economy of social security. *Scandinavian Journal of Economics* 102, 503–522.

[13] Chen, K., and Song, Z., 2009. Markovian social security in unequal societies. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1367476

[14] Creedy, J., and Moslehi, S., 2009. Modelling the composition of government expenditure in democracies. *European Journal of Political Economy* 25, 42–55.

[15] Creedy, J., Li, S.M., and Moslehi, S., 2010. The composition of government expenditure: economic conditions and preferences. *Economic Inquiry* 49, 94–107.

[16] Cremer, H., De Donder, P., Maldonado, D., and Pestieau, P., 2007. Voting over type and generosity of a pension system when some individuals are myopic. *Journal of Public Economics* 91, 2041–2061.

[17] Cukierman, A., and Meltzer, A. H., 1989. A political theory of government debt and deficits in a neo-Ricardian framework. *American Economic Review* 79, 713–732.

[18] De Gregorio, J., 1996. Borrowing constraints, human capital accumulation, and growth. *Journal of Monetary Economics* 37, 49–71.

[19] de Walque, G., and Gevers, L., 2001. Heterogeneous dynasties and the political economy of public debt. *Scandinavian Journal of Economics* 103, 369–389.

[20] Epple, D., and Romano, R.E., 1996. Ends against the middle: determining public services provision when there are private alternatives. *Journal of Public Economics* 62, 297–325.

[21] Gottschalk, P., and Smeeding, T.M., 1997. Cross-national comparisons of earnings and income inequality. *Journal of Economic Literature* 35, 633–687.

[22] Krusell, P., and Rios-Rull, J-V., 1999. On the size of U.S. government: political economy in the neoclassical growth model. *American Economic Review* 89, 1156–1181.

[23] Lucas, R.E., and Stokey, N.L., 1983. Optimal fiscal and monetary policy in an economy without capital. *Journal of Monetary Economics* 12, 55–93.

[24] Meltzer, A., and Richard, S., 1981. A rational theory of the size of government. *Journal of Political Economy* 89, 914–927.

[25] OECD, 2008. *Growing unequal? Income distribution and poverty in OECD countries.* Paris, OECD.

[26] OECD, 2009. *OECD Factbook 2009.* Paris, OECD.

[27] Persson, T., and Svensson, L.E.O., 1989. Why a stubborn conservative would run a deficit: policy with time-inconsistent preferences. *Quarterly Journal of Economics* 104, 325–345.

[28] Persson, T., and Tabellini, G., 2000. *Political Economics: Explaining Economic Policy.* MIT Press, Cambridge, Massachusetts.

[29] Quadrini, V., 1999. Growth, learning and redistributive policies. *Journal of Public Economics* 74, 263–297.

[30] Roberts, K.W.S., 1977. Voting over income tax schedules. *Journal of Public Economics* 8, 329–340.

[31] Rodriguez, F., 2004. Inequality, redistribution, and rent-seeking. *Economics and Politics* 16, 287–320.

[32] Romer, T., 1975. Individual welfare, majority voting, and the properties of a linear income tax. *Journal of Public Economics* 4, 163–185.

[33] Shepsle, K.A., 1979. Institutional arrangements and equilibrium in multidimensional voting models. *American Journal of Political Science* 23, 27–59.

[34] Song, Z., Storesletten, K., and Zilibotti, F., 2012. Rotten parents and disciplined children: a politico-economic theory of public expenditure and debt. http://folk.uio.no/kjstore/papers/ssz_fiscal_discipline.pdf

[35] Tabellini, G., 1986. Money, debt and deficits in a dynamic game. *Journal of Economic Dynamics and Control* 10, 427–442.

[36] Tabellini, G., and Alesina, A., 1990. Voting on the budget deficit. *American Economic Review* 80, 37–49.

[37] Velasco, A., 1999. A model of endogenous fiscal deficits and delayed fiscal reforms, In: Poterba, J., and von Hagen, J. (eds.), *Fiscal Institutions and Fiscal Performance*, University of Chicago Press.

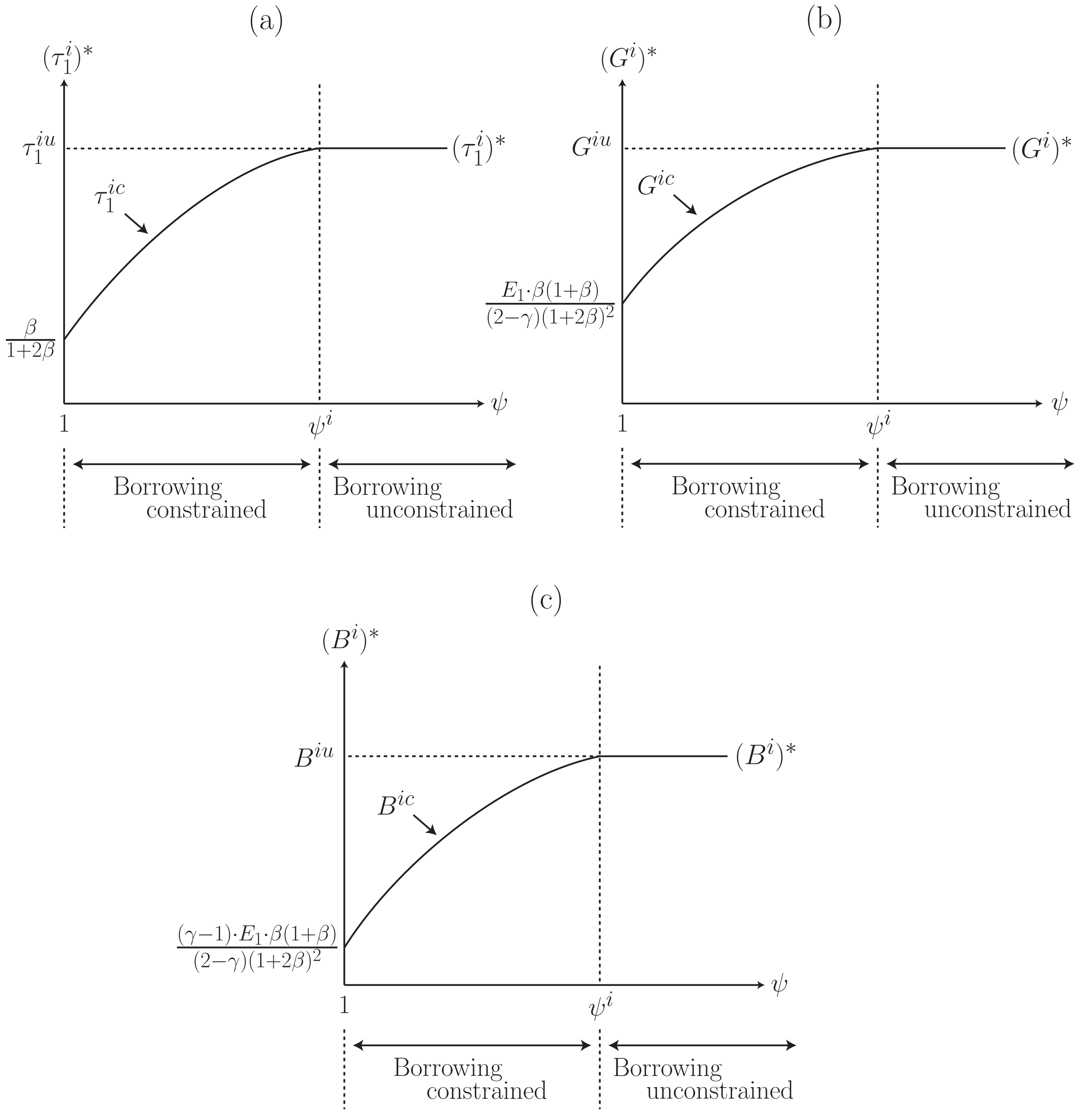

Figure 1: The most preferred policies for a type-i agent.

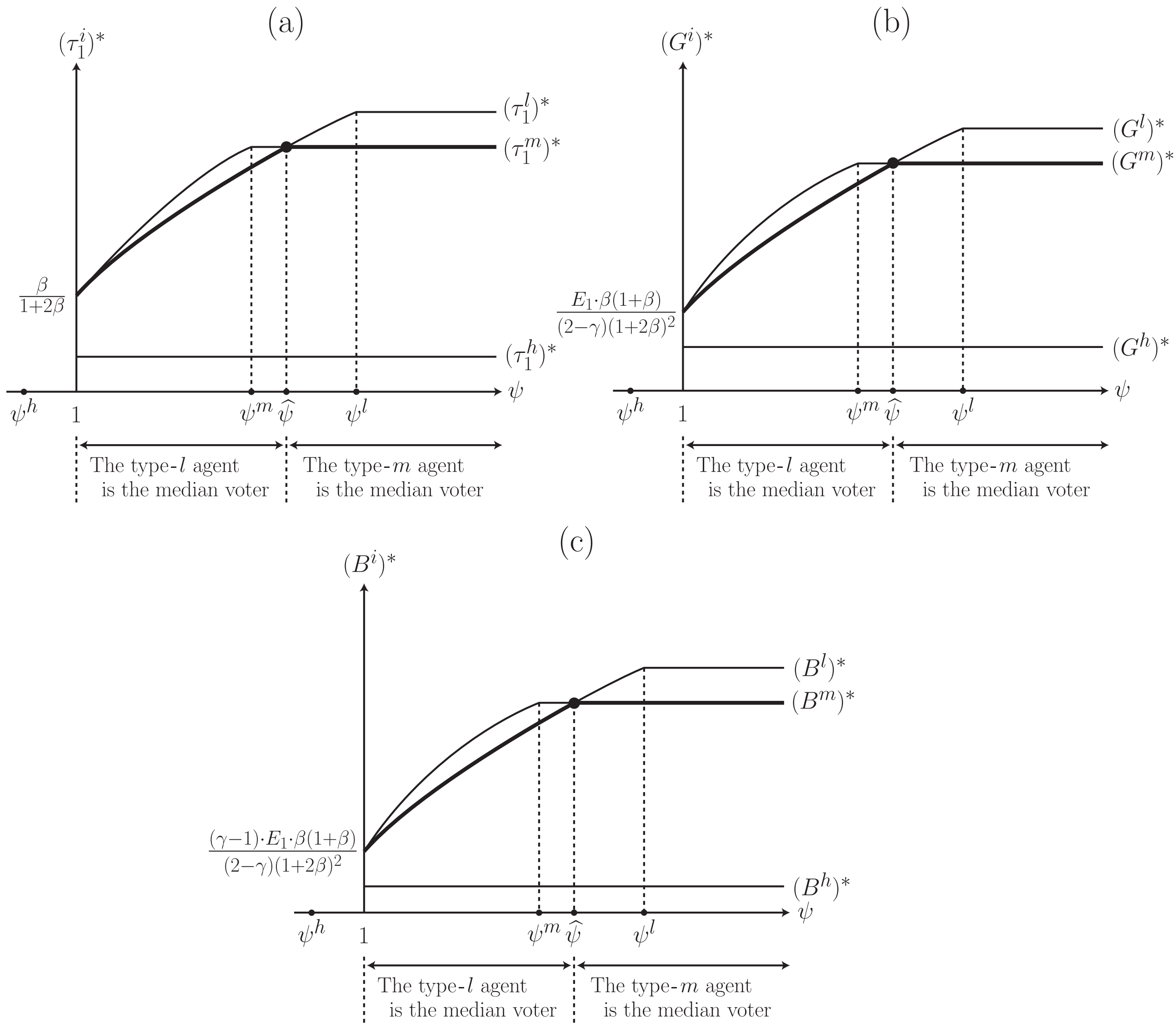

Figure 2: The bold curves show equilibrium policies.

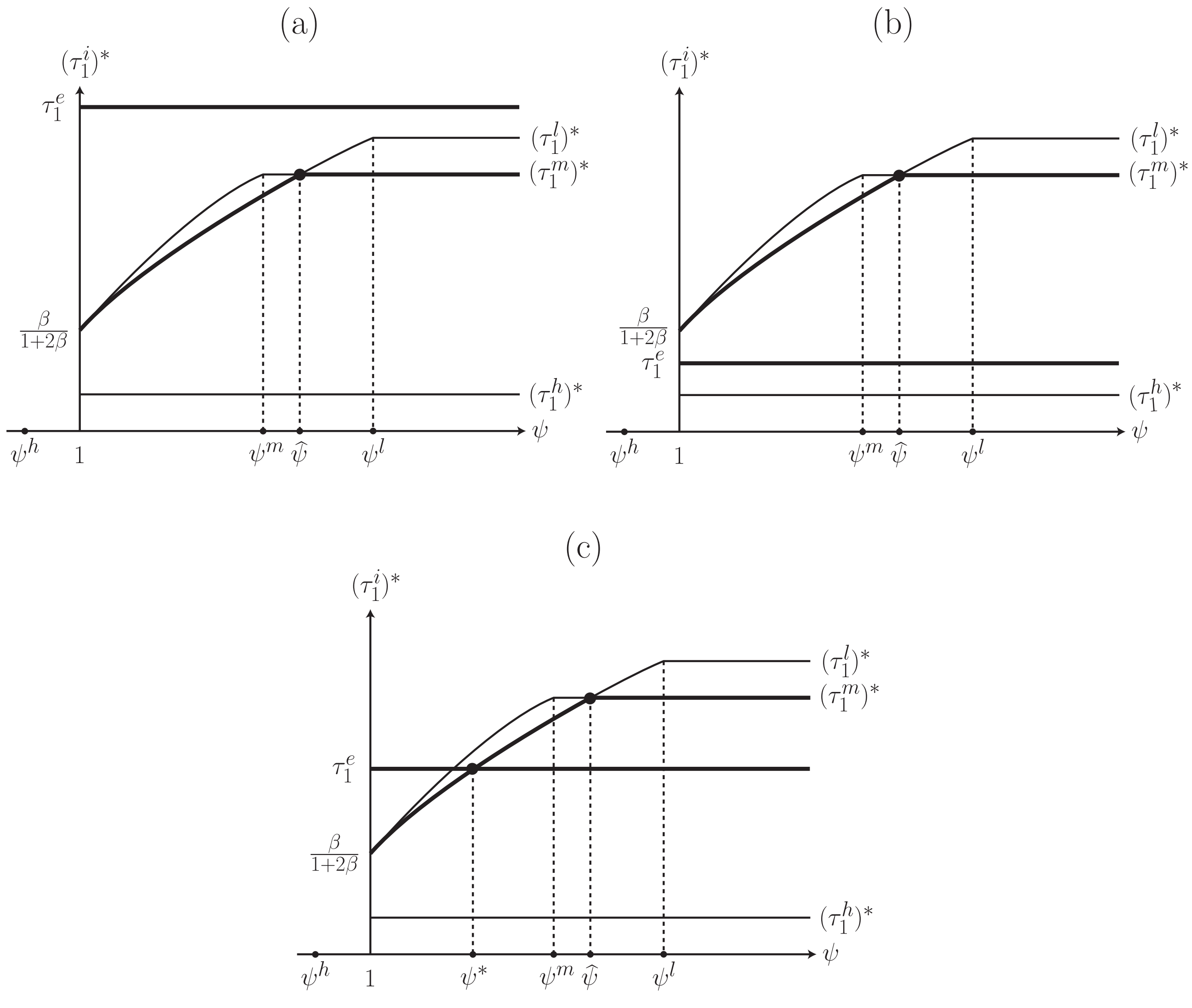

Figure 3: Panel (a) is the case of $e_1^m > \left(\frac{AE_1}{R\gamma^2}\right)^{\frac{1}{1-\mu}}$; panel (b) is the case of $\gamma < \frac{1+2\beta}{1+\beta}$; and panel (c) is the case of $e_1^m \leq \left(\frac{AE_1}{R\gamma^2}\right)^{\frac{1}{1-\mu}}$ and $\gamma \geq \frac{1+2\beta}{1+\beta}$.

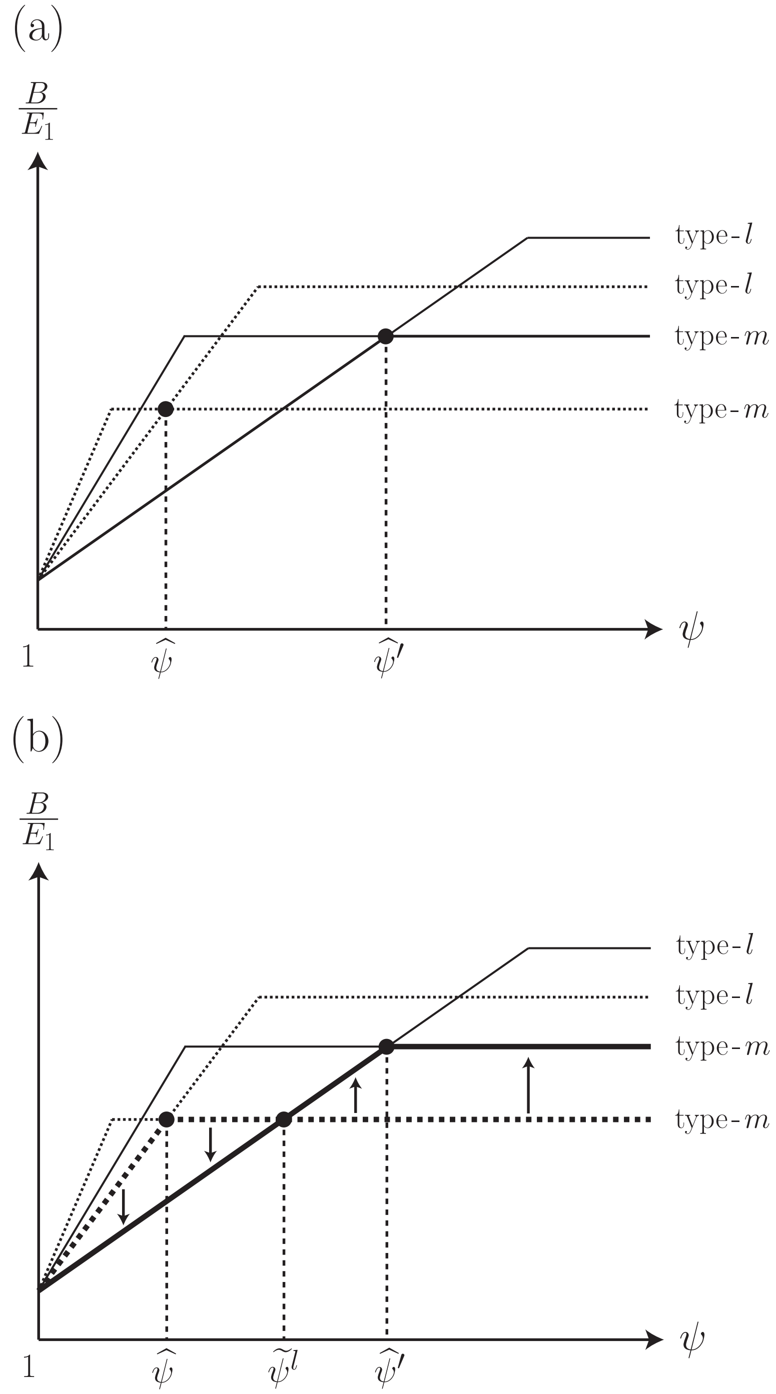

Figure 4: In panel (a), the dotted and solid curves depict the choice of a type-$j(= l, m)$ agent over B/E_1 before and after the spread of income distribution, respectively. In panel (b), the bold dotted and solid curves depict the choice of the decisive voter over B/E_1 before and after the spread of income distribution, respectively.

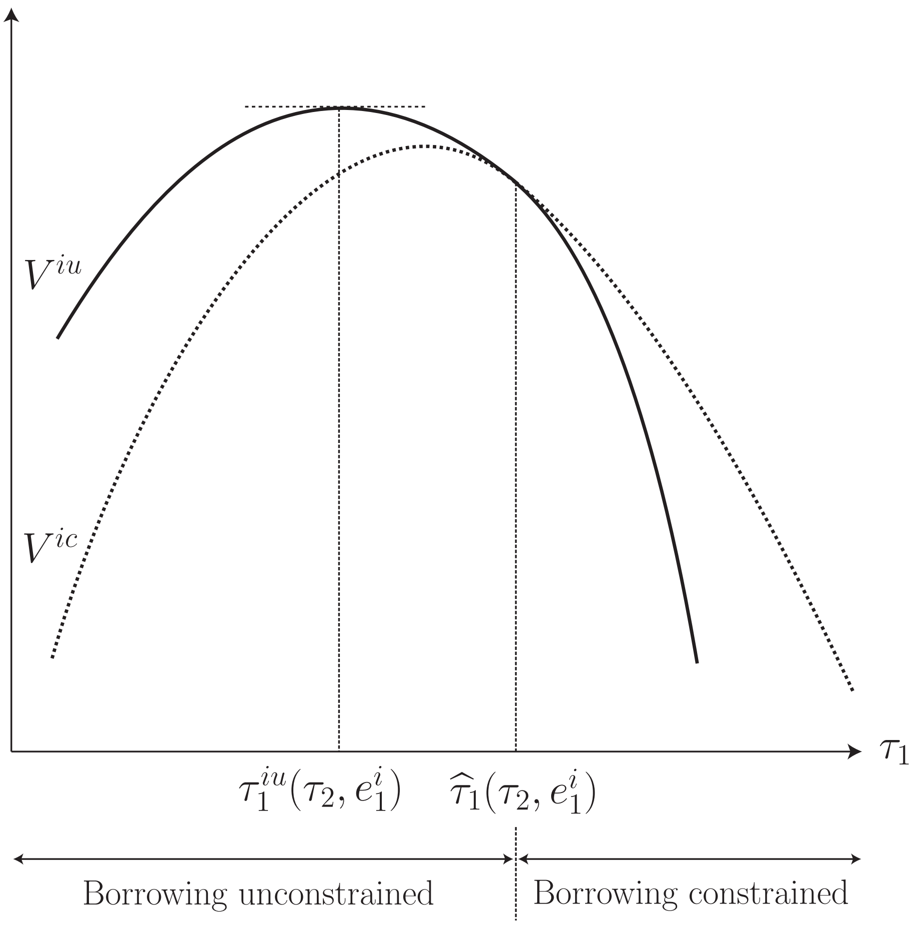

Figure 5: The bold curve illustrates the type-i's indirect utility as a function of τ_1 given τ_2. The figure is the case of $\tau_1^{iu}(\tau_2, e_1^i) < \widehat{\tau}_1(\tau_2, e_1^i)$.