Optimal Capital Income Taxation with Externality of Wealth*

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Abstract

This paper analyzes the optimal tax policy in a framework of dynamic general equilibrium, with the imperfection of negative wealth externality. We model this "keeping up with Joneses" effect by incorporating relative wealth status into the household utility function. Under the first-best and second-best rules, quite different from conventional conclusions of zero capital tax in the long-run, our results are that the optimal tax rates on capital are both positive and exactly the same, while the first-best optimal tax rate on labor income is zero and the second-best one is a constant.

Keywords: Fiscal Policy; Capital Income Taxation; Relative Wealth

JEL classification: E13, E62, H21, H31

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1 Introduction

Since the taxation of economic activities is distorting and the non-distorting lump-sum tax is hardly available, a basic problem of public finance is how to use such taxes to collect revenue in ways with the least distortion. A classic problem of this sort analyzes the optimal tax policy on labor income and capital income to finance an exogenous stream of government purchases in the general equilibrium framework with a representative infinitely-lived household. Chamley (1986) and Judd (1985) presented the result that the optimal tax rate on capital income is zero in the long run and the government collects tax revenue through a distortionary tax on labor income.

This paper is intended to derive both the first-best and second-best tax policies when relative wealth status influences household preferences and government expenditures are internalized, by involving themselves in utility determination. We compare the solution of the Ramsey problem (or the second-best tax policy) with the first-best policy that can be implemented when the government has access to lump-sum taxes. The main conclusion we obtained in this paper is that both the first-best and second-best tax policies include a positive proportional tax on capital income, while the first-best tax rate on labor income is zero and the second-best one is a constant.

Our conclusion about the capital tax is quite different from those of Chamley (1986) and Judd (1985) and some other researchers. Instead of being zero in the long run, the tax rate on capital income derived in our paper is strictly positive, even in steady state. This difference results mainly from our assumption about household utility, which describes the situation that people care about their relative wealth status compared to others. When relative wealth status affects household preferences through their utility function, marginal utility of wealth accumulation is positive, which is a distinctive feature from conventional models. This feature of utility function makes households to rebalance resources between consumption and investment, as well as bond purchasing, indicating that in equilibrium households would like to invest more than the level with Pareto efficiency, which induces the government to interfere by levying positive tax on capital income to cool down people's enthusiasm to saving.

There are alternative theoretical justifications for a non-zero limiting capital tax in dynamic general equilibrium models: private borrowing constraints [See Aiyagari (1995)], congestion externalities [See Judd (1999), Corsetti and Roubini (1996)], tax code restrictions

[See Stiglitz (1987), Jones et al. (1997)], untaxed factors of production [See Correia (1996)], imperfectly competitive product market [See Judd (1997), Guo and Lansing (1999)], permission for purchaser of capital to deduct capital expenditures from taxable capital income [See Abel (2006)], and negative externality of consumption [See Ljungqvist and Uhlig (2000), Guo (2005) and Abel (2005)]. What we introduce in this paper as possible justification for non-zero capital tax is the negative wealth externality, or interpersonal dependency of wealth preference.

David Hume, Adam Smith, J.S. Mill, Karl Marx et al. pointed out the existence of wealth preference, while Veblen (1922) proposed that relative wealth contributes to social status and that status matters for individual utility. Evidence suggests that individual decisions to accumulate wealth or get involved in income-generating activities are driven by status concerns [See Bakshi and Chen (1996), Clark and Oswald (1996), Neumark and Postlewaite (1998)]. Economists also analyze the implications of a concern for relative wealth in various growth models. Cole et al. (1992), Corneo and Jeanne (1997), Fershtman et al. (1996) and Zou (1994) have shown that when individuals care about their social status, optimal saving behavior is affected in systematic ways and the normative properties of the equilibrium path strongly differ from the conventional ones.

Concepts of wealth preference and interpersonal dependency of preference have been modeled in both static and dynamic frameworks [See Robson (1992) and Fershtman and Weiss (1993) for the studies in the static framework]. Ono (1994) emphasizes the importance of wealth preference and constructs a dynamic general equilibrium model with Keynesian feature. Ikeda (1993, 1995) constructs a dynamic general equilibrium model of interpersonal dependency of preference and analyzes the effects of the interpersonal dependency of preference on wealth distribution.

As many authors, including Marx, Hume and Thorstein Veblen, have implied, an agent's utility depends on its relative position in the society rather than the absolute level of its own wealth. Therefore, in this paper we construct our model with emphasis on the concept of interpersonal dependency of wealth preference. That is, we will incorporate an index of relative wealth into the household utility function to analyze the optimal tax policy with the existence of negative wealth externality.

Throughout the paper we restrict our discussion to proportional tax system, despite the fact that lump-sum tax is utilized in the Pareto efficient problem, which is intended to be replicated by the distorting tax policy in competitive equilibrium.

The remainder of this paper is organized as follows. Section 2 presents the model with households, firms and government. Section 3 derives and discusses the two kinds of fiscal policy. Section 4 constructs calibrations and computations on the second-best tax rates. Section 5 concludes.

2 Model

We assume an economy with identical firms and identical and infinitely-lived households, implying that the markets are perfectly competitive and we can choose a representative household in analyzing optimal tax policy. This economy involves government, households and firms. Firms employ labor and rent capital from households and pay wages and interests back, governments levy proportional tax on capital income and labor income, and debt trading occurs between government and households.

2.1 Firms

The economy has identical firms, producing exactly the same goods with the same technology. Both the factor market and goods market are perfectly competitive. We assume in this paper that the representing firm produces with the conventional Cobb-Douglas technology, which uses capital and labor as factors of production with the feature of constant return-to-scale and is described by

$$F(k_t, l_t) = A_t k_t^{\alpha} l_t^{1-\alpha},\ 0 < \alpha < 1, \tag{1}$$

where k_t and l_t denote the capital and labor utilized in producing goods, respectively, A_t is an aggregate technology shock, and α governs the relative contribution level of capital as a factor to output. The perfect competition condition leads to the following results, which is derived from the first-order condition of firm profit maximizing problem,

$$w_t = (1-\alpha) A_t k_t^{\alpha} l_t^{-\alpha} \tag{2}$$

and

$$r_t = \alpha A_t k_t^{\alpha-1} l_t^{1-\alpha} \tag{3}$$

where w_t and r_t are the equilibrium real wage and rental rate, derived by partially differentiating F with respect to l_t and k_t, respectively. Under this condition, the net profit of the representative firm is zero, which indicates

$$A_t k_t^{\alpha} l_t^{1-\alpha} = w_t l_t + r_t k_t \tag{4}$$

2.2 Households

In this section we introduce a household utility function with the feature of "keeping up with Joneses" on wealth. We use the term $s_t = W_t/\bar{W}_t$ to represent the relative wealth status of individuals compared with social average level. This term was used by Bakshi and Chen (1996) for the use of analyzing the externalities of wealth in pricing stocks. We modify their model by incorporating labor supply and government expenditure per capita into household utility function.

There may be other terms to describe the relative wealth status. For instance, $s_t = W_t - \kappa\bar{W}_t$ shares the property that increases with W_t and decreases with $\bar{W}_t$, just as $s_t = W_t/\bar{W}_t$ does. However, this model has a demanding restriction, $W_t - \kappa\bar{W}_t > 0$, which adds unnecessary difficulties in solving the optimization problem.

In our setup, the economy is populated by a large number of identical and infinitely-lived households. Therefore no one in the economy has effective influence on the level of social average wealth. Taking the level of average wealth in the economy as given, the representative household chooses consumption, labor and individual wealth to maximize

$$\sum_{t=0}^{\infty} \beta^t \left[\frac{c_t^{1-\gamma}}{1-\gamma} \left(\frac{W_t}{\bar{W}_t} \right)^{-\sigma} - \lambda \frac{l_t^{1+\rho}}{1+\rho} + B \log g_t \right] \tag{5}$$

$$\begin{aligned} 0 &< \beta < 1, \gamma > 0, \gamma \neq 1, \lambda > 0, \rho \geqq 0, B > 0, \\ \sigma &> 0 \text{ when } \gamma > 1 \text{ and } \sigma > 0 \text{ otherwise,} \end{aligned}$$

where β is the time preference parameter, γ is the coefficient of risk aversion, λ governs the contribution level of leisure to utility, ρ stands for the intertemporal elasticity of substitution in labor supply, and, B controlling the contribution level of public expenditure to utility.

In this paper we incorporate government expenditures into the household utility function. The term $B \log g_t$ represents the utility provided by per capita public consumption goods g_t which are determined beyond the household's control. Addictive separability in g_t indicates that government expenditure does not influence the marginal utility of private consumption or wealth, indicating that we do not have to deal with the term involving g_t when deriving the household optimization conditions.

The emphasis of this paper's formulation is the dependence of household utility on the ratio of the individual wealth (W) to the average level of wealth in the economy ($\bar{W}$). This term represents the agent's preference regarding relative wealth status. As mentioned in the introduction part, this formulation follows the spirit of studies by Hume, Marx, Veblen and other researchers. Here σ measures the extent to which households care about relative wealth status.

The utility function without relative wealth consideration corresponds to the case of $\sigma = 0$, when household preferences only depend on their own consumption and labor supply. When $\sigma > 0$, $\gamma > 1$ and $\sigma < 0$, $\gamma < 1$, individual utility increases with his relative wealth status. In this case, the household utility is said to exhibit the feature of "keeping up with the Joneses", not in the sense of consumption, but in the sense of wealth. This feature implies a negative wealth externality, because individual household fail to internalize that their wealth have negative effect on the utility of everyone else.

There remains a problem how to define individual wealth W_t. In an economy where capital is owned by households and can be rented by firms to produce goods, while debt can be traded between the government and households, in each period we can use the sum of capital and debt owned by representative household to describe the level of individual wealth. This definition is described as

$$W_t = k_t + b_t. \tag{6}$$

The budget constraint faced by the representative household is given by

$$c_t + k_{t+1} - (1-\delta)k_t + b_{t+1} - R_{bt}b_t = (1-\theta_t)w_t l_t + (1-\tau_t)r_t k_t + \tau_t \delta k_t, \tag{7}$$

where k_t is the household's capital stock, δ denotes the capital depreciation rate, b_t is the government debt hold by households and R_{bt} is the return on debt in period t. Households acquire their income by supplying labor and capital services to firms at rates w_t and r_t, and pay taxes on labor and capital income at rates θ_t and τ_t, respectively. One additional source of household income is the depreciation allowance $\tau_t \delta k_t$ that is built into the U.S. tax code. Here we implement the standard depreciation allowance, implying that the depreciation rate for tax purposes equals to the rate of economic depreciation.

In a competitive equilibrium, by choosing consumption, labor supply, capital and debt holding, each household maximizes (5) subject to its budget constraint (7) and the individual wealth definition (6), while taking factor prices, tax rates, average wealth, initial wealth and public expenditure as given. The first-order conditions for the household optimization problem and associated transversality conditions (TVCs) are

$$c_t : \xi_t = \left(\frac{W_t}{\bar{W}_t}\right)^{-\sigma} c_t^{-\gamma}, \tag{8}$$

$$l_t : \xi_t (1-\theta_t) w_t = \lambda l_t^{\rho}, \tag{9}$$

$$k_{t+1}: \xi_t = \beta \xi_{t+1} \left[1 + (1-\tau_{t+1})(r_{t+1} - \delta) - \frac{\sigma c_{t+1}}{(1-\gamma) W_{t+1}} \right], \tag{10}$$

$$b_{t+1}: \xi_t = \beta \xi_{t+1} \left[R_{bt+1} - \frac{\sigma c_{t+1}}{(1-\gamma) W_{t+1}} \right], \tag{11}$$

$$\lim \beta^t \xi_t k_{t+1} = 0, \tag{12}$$

and

$$\lim \beta^t \xi_t b_{t+1} = 0, \tag{13}$$

where ξ_t denotes the Lagrangian multiplier associated with the household's budget constraint (7). Equation (12) and (13) are transversality conditions to ensure equation (7) can be transformed into an infinite-horizon, present-value budget constraint. From (10) and (11), the bond's gross interest rate can be expressed as

$$R_{bt+1} = 1 + (1-\tau_{t+1})(r_{t+1} - \delta) \tag{14}$$

For the convenience of explaining the economic meaning of these first-order conditions, we denote

$$u(c_t, l_t, k_t, b_t, g_t) = \frac{c_t^{1-\gamma}}{1-\gamma} \left(\frac{W_t}{\bar{W}_t} \right)^{-\sigma} - \lambda \frac{l_t^{1+\rho}}{1+\rho} + B \log g_t \tag{15}$$

and u_{ct}, u_{lt}, u_{kt} and u_{bt} as the partial differentiation of u with respect to c, l, k and b, respectively. The next step is to eliminate ξ_t from the system of four equations (8) to (11) to obtain the following three equations (16) to (18),

$$u_{ct}(1-\theta_t) w_t = -u_{lt}, \tag{16}$$

$$k_{t+1}: \left[\frac{\beta \left(u_{ct+1} + u_{kt+1}/R_{kt+1} \right)}{u_{ct}} \right] R_{kt+1} = 1, \tag{17}$$

$$b_{t+1}: \left[\frac{\beta \left(u_{ct+1} + u_{bt+1}/R_{bt+1} \right)}{u_{ct}} \right] R_{kt+1} = 1, \tag{18}$$

where

$$R_{kt+1} = 1 + (1-\tau_{t+1})(r_{t+1} - \delta) \tag{19}$$

as the gross rate of return on capital.

Equation (16) equates the loss in utility from reducing leisure by an hour in period t to the increase in utility that can be achieved by working an additional hour – earning an additional after-tax income of $(1-\theta_t)w_t$, and using this income to increase consumption in period t. Equations (17) and (18) are both analogous illustrations of the standard conditions that requires the product of the intertemporal marginal rate of substitution and the gross rate of return on an asset to be equal to one. If households do not care about relative wealth status and thus $\sigma = 0$, indicating that $u_{bt+1} = u_{kt+1} = 0$, then (17) and (18) collapse to the standard conditions. Since in period $t+1$, both capital and debt, as well as consumption, will increase household utility, people should take into account capital and debt when defining the intertemporal marginal rate of substitution. That is, if households reduce consumption in period t, in addition to consuming more in period $t+1$, they can gain more capital and hold more debt as well , which as well contributes to their utility in period $t+1$.

2.3 Government

Discussion in this section is the preparation work for deriving the second-best tax policy. In the dynamic version of the second-best tax problem (or the Ramsey problem), the government chooses a series of distortionary taxes, debt, and public expenditures to optimize the utility of the representative household.

There exists a problem when we try to achieve the second-best policy. In solving the Ramsey problem, the first-order condition of c_0 is different from those of c_t $(t \geq 1)$, and k_0 and b_0 are given exogenously instead of determined by first-order condition, leading to the problem of time inconsistency for government.

To deal with the problem of time inconsistency, we suppose here that the government, at $t = 0$[1], has to commit itself to a certain sequence of tax policies for now and thereafter. We model this rule by having the government choose a policy π at the beginning of time and then having consumers choose their allocations. Formally, allocation rules are sequences of functions $x(\pi)$ that map policies π into allocation x, where is defined as $x = (c, l, b, k)$. Price rules are sequences of functions $w(\pi)$ and $r(\pi)$ that map policies into price systems. That is, we have the requirement of optimality by households and firms for all tax policies that the government might choose, which is analogous to the requirement of subgame perfection in a game.

Closely following the approach of Chari et al. (1994), we further assume that τ_0 and R_{b0} are specified exogenously such that tax revenue collected at $t = 0$ cannot finance all future expenditures. Otherwise, an initial levy on household assets may allow the government to eventually replicate the "first-best" outcome that is obtained with the availability of lump-sum taxes (The solution to the first best problem is considered independent of this section, but separately discussed in section 3.1).

[1] See Benhabib and Rustichini (1997) for an analysis of the "third best" tax policy without commitment.

The government budget constraint in per capita terms is

$$g_t = T_t + b_{t+1} - b_t R_{bt}, \tag{20}$$

where $T_t = \theta_t w_t l_t + \tau_t (r_t - \delta) k_t$. Summing up the household budget constraint (7) and government budget constraint (20), and substituting the firm zero-profit feature (4) into the derived equation, we obtain the resource constraint for the economy,

$$F(k_t, l_t) = g_t + c_t + k_{t+1} - (1 - \delta)k_t. \tag{21}$$

Since the resource constraint (21) and the government budget constraint (20) are related to each other with the linkage of household budget constraint (7), we will use Eq. (21) rather than Eq. (20) as the resource constraint to restrict the government allocation problem.

So far, a competitive equilibrium for this economy consists of a policy $\{\theta_t, \tau_t, b_{t+1}\}_{t=0}^{\infty}$, an allocation $\{c_t, l_t, g_t, k_{t+1}\}_{t=0}^{\infty}$, and a price system $\{w_t, r_t, R_{bt+1}\}_{t=0}^{\infty}$ such that given the policy and the price system, the resulting allocation satisfies the representative consumer's optimal conditions (8)-(13), the price system satisfies (2), (3) and (14), and the government's budget constraint (20). Notice that in equilibrium $\bar{W}_t = W_t = k_t + b_t$, because households are identical in each period. Substituting the aggregate consistency condition $\bar{W}_t = W_t = k_t + b_t$ into (8) yields the following expression for ξ_t in equilibrium,

$$\xi_t = c_t^{-\gamma} \tag{8'}$$

3 Fiscal Policy

Two policy rules are often used in analyzing optimal taxing, which are described as the first-best and the second-best. The first-best policy involves replicating a Pareto efficient economy with lump-sum tax, using an economy of competitive equilibrium in which only distortionary taxes on capital income and labor income are available. The second-best policy is achieved by solving the Ramsey problem. The Ramsey problem is a utility maximizing problem with resource constraint and implementability constraint. Implementability constraint can be viewed as the budget constraint of either households or government, in which both firm and household first-order conditions are utilized to substitute out factor prices and tax rates. Therefore, both constraints in the Ramsey problem only involve allocations, indicating that the Ramsey problem is reduced to a simple programming problem to maximize utility by choosing allocations.

3.1 First-Best Tax Policy

We start our discussions on optimal tax by considering the first-best tax policy, for the purpose of providing a benchmark for the following results. In this case, the equilibrium allocations coincide with those chosen by a social planner who maximizes (5) subject to (21) and (1). The planner's allocations must also satisfy the transversality condition (12) and (13). Due to the availability of lump-sum taxes, government borrowing has no effect on the equilibrium allocations. Therefore, we set $b_t = 0$ for all t and ignore equation (11). The planner's allocation problem is achieving the Pareto optimum.

At the Pareto optimum, the social planner internalizes the wealth externality by setting $\bar{W}_t = W_t$ in the utility function (5). We assume that $\theta_t = \tau_t = 0$ and in each time period there is a lump-sum tax T_t levied on the representative household (When $T_t < 0$, it means there is a lump-sum subsidy offered to households). With this assumption, the social planner can achieve the Pareto optimum without levying distorting tax on wage or capital income.

Substituting (1) into (21) gives the budget constraint of social planner,

$$A_t k_t^{\alpha} l_t^{1-\alpha} = g_t + c_t + k_{t+1} - (1-\delta)k_t. \tag{22}$$

The Lagrangian form of the planner's optimizing problem is the following:

$$\begin{aligned} L &= \sum_{t=0}^{\infty} \beta^t \left[\frac{c_t^{1-\gamma}}{1-\gamma} - \lambda \frac{l_t^{1+\rho}}{1+\rho} + B \log g_t \right] && (23) \\ &\quad + \sum_{t=0}^{\infty} \beta^t \mu_t \left[A_t k_t^{\alpha} l_t^{1-\alpha} - g_t - c_t - k_{t+1} + (1-\delta)k_t \right], && (1) \end{aligned}$$

where μ_t is the Lagrangian multiplier associated with the budget constraint (22). The first-order conditions for this maximizing problem and associated transversality condition (TVC) imply

$$c_t : \mu_t = c_t^{-\gamma}, \tag{24}$$

$$l_t : \mu_t (1-\alpha) A_t k_t^{\alpha} l_t^{-\alpha} = \lambda l_t^{\rho}, \tag{25}$$

$$k_{t+1} : \mu_t = \beta \mu_{t+1} \left[1 + \alpha A_{t+1} k_{t+1}^{\alpha-1} l_{t+1}^{1-\alpha} - \delta \right], \tag{26}$$

$$b_{t+1} : \xi_t = \beta \xi_{t+1} \left[R_{bt+1} - \frac{\sigma c_{t+1}}{(1-\gamma) W_{t+1}} \right], \tag{27}$$

$$\lim \beta^t \mu_t k_{t+1} = 0. \tag{28}$$

Substituting (24) into (25), we find that equation (25) equates the loss in utility from reducing leisure by an hour in period t to the increase in utility that can be achieved by working an additional hour, and using this income to increase consumption in period t. Substituting (24) into (26), we obtain the standard condition that requires the product of the intertemporal marginal rate of substitution and the gross rate of return on capital to be equal to one, where the gross rate of return on capital is $1+\alpha A_{t+1}k_{t+1}^{\alpha-1}l_{t+1}^{1-\alpha}-\delta$ simply due to the abortion of proportional tax. Equation (27) denotes the first-order condition for public expenditure. Substituting (24) into (27) yields the condition that the marginal utility of consumption and government expenditure equals to one another, indicating that in equilibrium it will not increase utility by removing produced goods from individual consumption to public expenditures or vise versa. Equation (28) is the transversality condition. Notice that since the utility function (5) and the aggregate production function (1) both are strictly concave, equation (24)-(28) are necessary and sufficient conditions for characterizing the unique Pareto optimal allocation.

In our model, there is an imperfection due to the negative externality of wealth. This imperfection may lead to higher level of accumulating of capital and holding of debt for households compared with the level at the Pareto optimum. Therefore, this situation provides the government with an incentive to interfere because competitive equilibrium derived by the market itself does not yield an efficient (in terms of first-best) allocation.

Proposition 1 *The first-best fiscal policy that implements the planner's allocation as a decentralized equilibrium is,*

$$\tau_t^{*1st} = -\frac{\sigma}{(1-\gamma)(r_t-\delta)}\frac{c_t}{W_t} > 0, \tag{29}$$

$$\theta_t^{*1st} = 0. \tag{30}$$

Total revenues from taxation is

$$T^* = -\frac{\sigma k_t}{(1-\gamma)}\frac{c_t}{W_t}, \tag{31}$$

and the optimal debt is

$$b_{t+1}-b_t = \frac{1}{B}c_t^{\gamma} + \frac{\sigma}{(1-\gamma)}c_t + (r_t-\delta)b_t, \tag{32}$$

where is r_t given by (5) and $W_t = k_t + b_t$.

Proof. Notice that equations (8)-(13) are necessary and sufficient conditions for a competitive equilibrium. On the other hand, as mentioned earlier, equation (24)-(28) are necessary and sufficient conditions for the Pareto optimum.

To derive the first-best fiscal policy, we have to prove that when the tax policy rules (29) and (30) are implemented, the resulting equilibrium allocations, characterized by (8)-(13), satisfy the Pareto optimality conditions as in (24)-(28), which indicates that the equilibrium allocation under the proposed τ_t^{*1st} and θ_t^{*1st} can be fully replicated by the non-distortion allocation satisfying Pareto optimum where only lump-sum tax (or subsidy) exists.

Comparing (8') and (24), we find that the marginal utility of consumption in equilibrium is equal to its counterpart in efficiency,

$$\xi_t = \mu_t \tag{33}$$

Substituting (33), together with the equilibrium wage rate (2) and the proposed $\theta_t^{*1st} = 0$, into (9) shows that the social planner's first-order condition for labor hours (25) is satisfied.

Similarly, substituting (33) and the proposed $\tau_t^{*1st} = -\frac{\sigma}{(1-\gamma)(r_t-\delta)}\frac{c_t}{W_t}$ into (10) shows that the social planner's consumption Euler equation (26) is satisfied.

The expression for the optimal bonds is obtained by substituting optimal lump-sum taxes (31) and equation (14), into the government budget constraint (20). ■

According to the pre-assumption about σ, which indicates that utility increases with the relative wealth status, $\tau_t^{*1st} = -\frac{\sigma}{(1-\gamma)(r_t-\delta)}\frac{c_t}{W_t}$ is positive with the assumption $r_t - \delta > 0$. This assumption is reasonable since there is no incentive to invest at all if return on capital is lower than its depreciation rate.

Therefore, the first-best tax on capital income is bigger than zero. The intuition for this result can be straightforward. Since the "keeping up with the Joneses" effect of wealth will induce households to invest more and hold more debt compared to the level with Pareto efficiency. The government should implement the tax rules to adjust this distorting equilibrium back to efficient condition. Therefore, there should be a positive tax rate on capital income to cool down people's intention to invest more than that under Pareto efficiency.

Notice that if $\sigma = 0$, then $\tau_t^{*1st} = 0$. Since σ describes the extent to which people care about their relative wealth status, this result corresponds to the situation when households do not care about their relative wealth compared to their peers, which collapses to Chamley's theory that tax rate on capital income falls zero after period 0 using certain forms of utility functions. Furthermore, τ_t^{*1st} increases with the absolute value of σ, which governs the household's degree of caring about the relative wealth status, indicating that the more households care about their relative level of wealth, the more distortionary tax on capital income should be levied to fix this imperfection.

We find that the optimal lump-sum tax is also bigger than zero, implying that the social planner chooses to levy positive lump-sum tax on households. This result is intuitively understandable, since we are using the distortionary tax policy to replicate this lump-sum tax/subsidy, and the distortionary tax on capital income is strictly positive, indicating the corresponding lump-sum tax should be positive in order to levy the same amount of tax.

3.2 Second-Best Fiscal Policy

To achieve the second-best fiscal policy, we build our framework on the primal approach to optimal taxation. [See, for example, Atkinson and Stiglitz (1980) and Lucas and Stokey (1983).] This primal approach characterizes the set of allocations that can be implemented as a competitive equilibrium with distorting taxes by two restrictions: (i) resource constraint and (ii) implementability constraint.

To achieve the optimal fiscal policy, the government should take into account the rational responses of the private agents to any possible policies and market condition, as summarized by equation (2), (3), (7), and equation (8)-(13). Using these constraints, we can substitute out some variables so that the government's optimization problem is simplified as an allocation problem in which the government directly chooses a sequence of optimal allocations, $\{c_t, l_t, g_t, k_{t+1}\}_{t=0}^{\infty}$. These derived allocations can then be used to recover a sequence of factor prices $\{r_t, w_t, R_{bt+1}\}_{t=0}^{\infty}$ and policy variables $\{\theta_t, \tau_t, b_{t+1}\}_{t=0}^{\infty}$ that will support the allocations as a decentralized equilibrium, with the initial conditions $\{\tau_0, R_{b0}, b_0, k_0\}$ given. We derive the following implementability constraint that incorporates the private-sector equilibrium conditions into one equation [See Appendix],

$$\left(c_0^{1-\gamma} - \lambda l_0^{1+\rho}\right) + \sum_{t=1}^{\infty} \beta^t \left[\left(1 - \frac{\sigma}{1-\gamma}\right) c_t^{1-\gamma} - \lambda l_t^{1+\rho}\right] = c_0^{-\gamma}(R_{k0}k_0 + R_{b0}b_0), \tag{35}$$

where $R_{k0} = 1 + (1 - \tau_0)(r_0 - \delta)$. This implementability constraint can be considered as an infinite horizon version of the budget constraint of either the consumer of government, where the household and firm first-order conditions are utilized to substitute out factor prices and tax policies (which are implemented in the form of proportional tax on capital income and labor income in our model). Since τ_0 and R_{b0} are specified exogenously, the government's problem amounts to choosing a sequence of allocations $\{c_t, l_t, g_t, k_{t+1}\}_{t=0}^{\infty}$ to maximize household utility (5) subject to the resource constraint (21), and the implementability constraint (35). Both constraints only involve allocations, implying that we only have to solve a simple programming problem to achieve the second-best tax policy. After making some substitutions, the government's decision problem can be written in the Lagrangian form as

$$
\begin{aligned}
&\max_{\{c_t,l_t,g_t,k_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \left[\frac{c_t^{1-\gamma}}{1-\gamma} - \lambda \frac{l_t^{1+\rho}}{1+\rho} + B \log g_t \mu_t\right] \\
&+ \sum_{t=0}^{\infty} \beta^t \eta_t \left[A_t k_t^{\alpha} l_t^{1-\alpha} - g_t - c_t - k_{t+1} + (1-\delta) k_t\right] \\
&- \varsigma \left\{ \left(c_0^{1-\gamma} - \lambda l_0^{1+\rho}\right) + \sum_{t=1}^{\infty} \beta^t \left[\left(1 - \frac{\sigma}{1-\gamma}\right) c_t^{1-\gamma} - \lambda l_t^{1+\rho}\right] \right\} \\
&+ \varsigma c_0^{-\gamma} (R_{k0} k_0 + R_{b0} b_0)
\end{aligned}
\tag{36}
$$

with $\{\tau_0, R_{b0}, b_0, k_0\}$ given. Here η_t is the Lagrange multiplier on the resource constraint (21). The Lagrange multiplier ς associated with Eq. (35) measures the marginal excess burden of distortionary taxation, which is negative. The interpretation of ς is the amount that households would like to pay (in units of time zero consumption) to have one dollar of distortionary tax revenue replaced by one dollar of lump-sum tax revenue. Notice that when $\varsigma = 0$, the government's problem (36) collapses to the social planner's problem of maximizing household utility (5) subject to the social technology (1) and the resource constraint (21), as described in section 3.1.

Notice that in this optimization problem the first-order condition of consumption is different for the case $t = 0$ and $t > 0$. We derive government's first-order condition of the optimization problem (36) for the case $t > 0$:

$$c_t : \eta_t = [1 - \varsigma(1-\gamma-\sigma)] c_t^{-\gamma}, \tag{37}$$

$$l_t : \eta_t (1-\alpha) A_t k_t^{\alpha} l_t^{-\alpha} = [1 - \varsigma(1+\rho)] \lambda l_t^{\rho}, \tag{38}$$

$$k_{t+1} : \eta_t = \beta \eta_{t+1} \left[1 + \alpha A_t k_t^{\alpha-1} l_t^{1-\alpha} - \delta\right], \tag{39}$$

$$g_t : \eta_t = B g_t^{-1} \tag{40}$$

$$\lim \beta^t \eta_t k_{t+1} = 0, \tag{41}$$

For $t > 0$, the solution to the above system (37)-(41) can be characterized by a set of stationary allocation rules: $c_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$, $l_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$, $g_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$, and $k_{t+1}(k_t, c_{t-1}, l_{t-1}, \varsigma)$. Given these allocation rules, Equations (8)-(13) can be used to compute a set of stationary rules for the factor prices and tax rates: $r_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$, $w_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$, $\tau_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$ and $\theta_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$ for $t > 0$. A stationary allocation rule for government borrowing $b_{t+1}(k_t, c_{t-1}, l_{t-1}, \varsigma)$ can be computed by using the following recursive equation,

$$c_t^{-\gamma}(k_{t+1} + b_{t+1}) = \beta c_{t+1}^{-\gamma}(k_{t+2} + b_{t+2}) + \beta c_{t+1}^{-\gamma} \left[\left(1 - \frac{\sigma}{1-\gamma}\right) c_{t+1} - \frac{\lambda l_t^{1+\rho}}{c_{t+1}^{-\gamma}}\right]. \tag{42}$$

This equation is the household budget constraint at $t+1$ after substituting in the first-order conditions of the household and the firm.

Equations (37)-(41), (42) and (8) –(13) form the basis of the following propositions.

Proposition 2 *The second-best fiscal policy based on the Ramsey allocation problem implements the following tax rate in the case $t > 0$,*

$$\tau_t^{*2nd} = -\frac{\sigma}{(1-\gamma)(r_t-\delta)}\frac{c_t}{W_t} > 0, \tag{43}$$

$$\theta_t^{*2nd} = \frac{1+\rho+\sigma}{1+\rho-\varsigma^{-1}} > 0, \tag{44}$$

indicating that the optimal tax rate on capital income in the second-best standard is exactly the same as that in the first-best standard and the optimal tax rate on labor income is a constant.

Proof. Comparing (37) and (8) gives the relationship between ξ_t and η_t:

$$\eta_t = [1-\varsigma(1-\gamma-\sigma)]\xi_t \tag{45}$$

Substituting (45) into (39) yields

$$\xi_t = \beta\xi_{t+1}\left[1+\alpha A_t k_t^{\alpha-1} l_t^{1-\alpha} - \delta\right] \tag{46}$$

Comparing (46) with (10) and using the expression for real interest rate (3), yields expression of in τ_t^{*2nd} (43).

Substituting (45) and (3) into (38), then comparing the derived equation with (9), we find the expression of θ_t^{*2nd} with the Lagrange multiplier as a parameter. ■

Notice that the second-best tax rule we have discussed so far is only about the time period 1 and thereafter. Now we will turn to the first-order condition of consumption and capital in period 0. For $t = 0$, the optimal allocations are determined using the government's first-order conditions with respect to c_0 and k_1.

The first-order condition of 0-period labor supply is exactly the same as that in period t ($t > 1$). The first-order condition of c_0 is

$$c_0 : \eta_0 = c_0^{-\gamma}\left[1-\varsigma(1-\gamma-\sigma) - \varsigma\gamma\frac{R_{k0}k_0 + R_{b0}b_0}{c_0}\right] \tag{47}$$

Substituting (8) into (47) gives

$$\eta_0 = \xi_0\left[1-\varsigma(1-\gamma-\sigma) - \varsigma\gamma\frac{R_{k0}k_0 + R_{b0}b_0}{c_0}\right] \tag{48}$$

Substituting (48) into (38) and comparing it with (9), we obtain

$$\theta_0^{*2nd} = \frac{\rho + \sigma + \gamma[1 - (R_{k0}k_0 + R_{b0}b_0)\, c_0^{-1}]}{1 + \rho - \varsigma^{-1}}, \tag{49}$$

The computation works backwards in time starting for initial time and imposes the stationary rules for $t > 1$ as boundary conditions. The entire sequence of allocations, together with the initial conditions, determines ς such that implementability constraint (35) is satisfied.

4 Calibration and Computation

In this section, we construct a quantitative assessment of the second-best optimal tax policy in a calibrated version of our model, given the inconclusive nature of the theory. We assume that the postwar U.S. economy represents a stationary equilibrium and parameters are chosen in such a way that the steady-state conditions of our model match the long-run features identified from U.S. economic data. This provides a framework for measuring whether observed U.S. tax rates are consistent with the actions of an optimizing government. Since we do not observe lump-sum taxes actually being implemented, our quantitative analysis focuses exclusively on the second-best policy.

Not losing generality, we implement the special case of $\gamma = 1$ for the convenience of solving and computing, implying that the household coefficient of risk aversion is 1. Therefore, the simplified utility function used in the remaining of this paper is described as

$$\sum_{t=0}^{\infty} \beta^t \left[\left(\frac{W_t}{\bar{W}_t} \right)^{-\sigma} \log c_t - \lambda \frac{l_t^{1+\rho}}{1+\rho} + B \log g_t \right]. \tag{5'}$$

Notice that the restrictions for σ change when we set $\gamma = 1$. That is, we have to restrict $\sigma \log c_t < 0$ for the purpose of describing the "keeping up with the Joneses" effect.

For the convenience of derivation, in this section, we set the intertemporal elasticity of substitution in labor income, denoted as ρ, to be zero. Therefore, the household single-period utility function is simplified as

$$\left(\frac{W_t}{\bar{W}_t} \right)^{-\sigma} \log c_t - \lambda l_t + B \log g_t. \tag{50}$$

This utility is separable in c_t, l_t, and g_t. The linearity in hours worked implies that all movements in total labor hours are due to changes in the number of workers employed, as opposed to changes in hours per worker.

The equilibrium conditions in a steady state are described by a system determining the values of c, k, l, and g. These equilibrium conditions are achieved by removing all the subscript notation of t from dynamic equilibrium conditions.

Table 1 provides base-line values of some parameters in the above system. Using the steady-state equilibrium conditions and applying the base-line parameters in Table 1 to this system, we can solve for the remaining parameters.

Table 1 Base-line Parameter Values		
Output	y	1.00
Private consumption	c	0.57
Government consumption	g	0.21
Capital stock	k	2.61
Labor supply	l	0.30
Discount rate	β	0.94
Capital income tax rate	τ	0.43
Labor income tax rate	θ	0.25
Government debt	b	0.49

We choose $\beta = 0.94$, which is regularly used in other research papers. Guo and Lansing (1999) used long-run U.S. data to estimate the value of steady-state l, k/y, b/y, i/y, and g/y. The results of their computation are $l = 0.3$, $k/y = 2.61$, $b/y = 0.49$, $i/y = 0.21$ and $g/y = 0.21$. Since in this paper we discuss about a closed economy, further assumption can be made that the net export/import in steady state is zero. Therefore, by setting output as a unit, we obtain $l = 0.3$, $k = 2.61$, $b = 0.49$, $c = 0.57$ and $g = 0.21$. These base-line values conform to the long-run U.S. data.

Mendoza, Razin and Tesar (1994) deliverd a method for computing tax rates using national accounts and revenue statistics and used this method they obtained estimates of effective tax rates on factor incomes and consumption consistent with the tax distortions faced by a representative agent in a general equilibrium framework. For instance, they estimated average tax rates on consumption and factor incomes of the U.S. as the following: capital tax rate 0.43, consumption tax rate 0.06 and labor tax rate 0.25. Therefore, we set our base-line values of capital income tax rate as 0.43 and labor income tax rate as 0.25.

We obtain the base-line values of other unknown parameters by solving the system, using data in Table 1. The results are

$$\delta = 0.0843, \alpha = 0.4255, \sigma = 0.1833, B = 0.3684, \lambda = 2.5197, A = 1.3277.$$

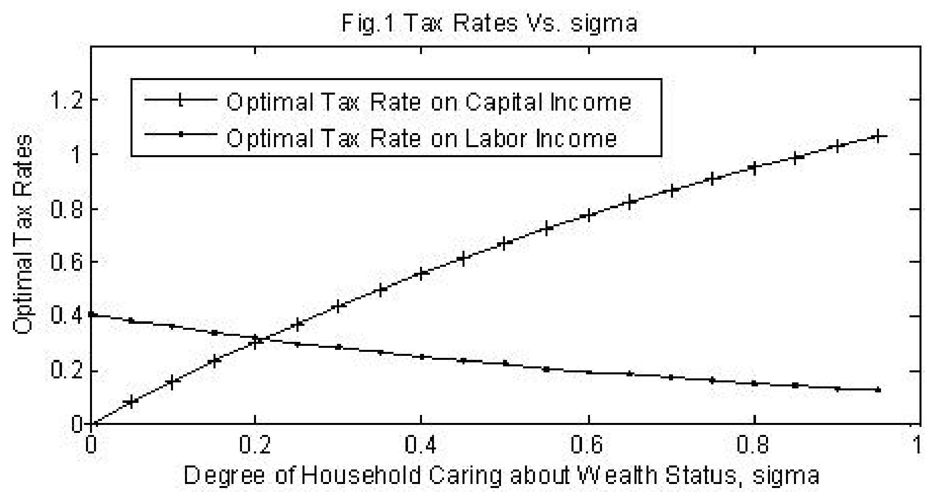
Using these derived base-line parameters, we can do simulations on the optimal tax policy of second-best. By solving dynamic equilibrium conditions, we can achieve the dynamic expressions of consumption, public expenditure, labor supply and capital, denoted as $c_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$, $l_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$, $g_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$, and $k_{t+1}(k_t, c_{t-1}, l_{t-1}, \varsigma)$.. Using these denotations, we can obtain $r_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$, $w_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$, $\tau_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$ and $\theta_t(k_t, c_{t-1}, l_{t-1}, \varsigma)$ for $t > 0$ under the second-best tax policy. Therefore, there only remains one sequence of endogenous variables in this economy unsolved, government debt. However, we can use (42) to achieve the optimal debt route. Actually, equation (42) is equivalent to the implementability constraint, and they are both derived from the household budget constraint, optimal conditions and Euler equation.

So far, we have completed the general equilibrium discussion of this economy. The problem of doing this, however, is complicatedness. This method relies on the initial setting of b_0, k_0, τ_0 and R_{b0}, and we have to offer the exact level of initial consumption. Therefore, in the following discussion we focus on the optimal tax policy in the steady state, rather than the dynamic transition.

When the economy comes into a steady state, due to the pre-assumption in our model that there are no drivers, like technology development, for sustainable economic growth, all endogenous variables are constant. Therefore, it is possible for us to remove all the subscript notations in dynamic equilibrium conditions and solve for optimal tax rate. We chose a value of b that achieves a target level for the steady-state government debt ratio b/y as a short cut to computing the transition path. This procedure implies a required set of initial conditions such that the implementability constraint is satisfied. Generally speaking, we consider the post-war U.S. economy as in a steady state and in this economy, the U.S. government debt ratio to aggregate output is about 0.49.

Using the method described above, we obtained the simulated optimal tax policy, which is described as $\tau^{*2nd} = 0.2806$ and $\theta^{*2nd} = 0.3252$. It is interesting to compare our results to some estimated tax rates for the postwar American economy. As mentioned before, Mendoza et al. (1994) estimate the average capital tax rate on capital income for the period 1965 to 1988 in U.S to be 0.43. Auerbach (1996) estimates the effective marginal tax rate on capital income under the current U.S tax code, with an estimate of 0.26 for nonresidential capital and 0.06 for residential capital. Our outcome using the baseline parameters is well between these two results.

It is natural for us to consider the sensitivity of optimal tax rates on capital income and labor income to various parameter changes. Therefore, we provide a series of figures describing this sensitivity. In constructing each figure, we vary a single parameter while

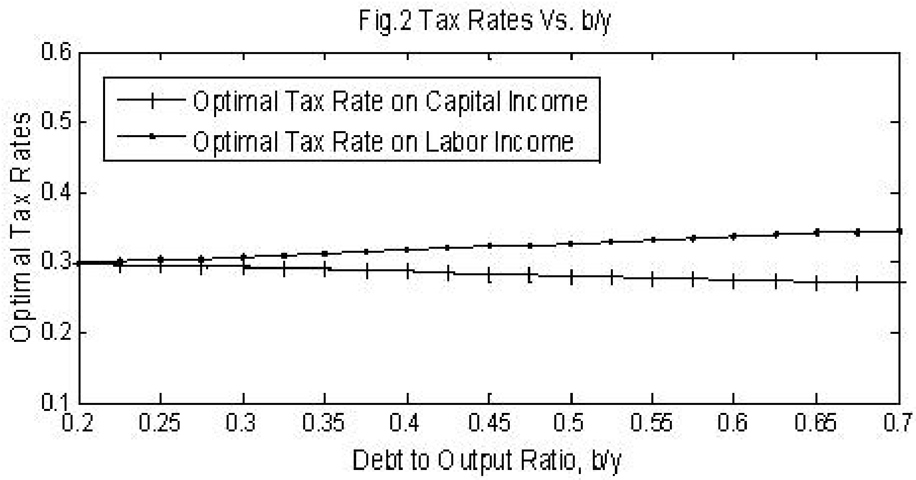


simultaneously recalibrating the other parameters to match the optimal conditions described above.

Figure 1 shows the sensitivity of optimal tax rates to the degree of household caring about their relative social status, σ. Capital tax rate increases and labor tax rate decreases with σ, indicating the existence of relative wealth status will boom up investment and induce government to levy higher tax on capital income and lower the tax rate on labor income to maintain government expenditures. The slope of tax rate on capital income is sharper than its counterpart of labor income tax. Parameter σ affects the capital tax rate in two ways. Firstly, when σ increases, people tend to hold more capital and thus reduce consumption, due to their caring for wealth, which decreases capital tax rate. Secondly, σ may increases capital tax by multiplying itself into the expression of capital tax rate. These two conflicting effects compete with each other, and in our model, the second effect seems to dominate the first one, since figure 1 shows that the tax rate on capital income has an almost linear relationship with σ when $\sigma < 0.5$.

Fig. 2 describes the sensitivity of the optimal tax rates to the target value of the government debt ratio b/y. The quantitative impact of the debt ratio on the optimal tax rates is very small. With the debt ratio significantly changing from 0.2 to 0.7, tax rate on capital income decreases from 0.30 to 0.27 and tax rate on labor income increases from 0.30 to 0.33, very slightly. Therefore, we know that the target value of b/y hardly influence our simulation results.

Fig. 3 exhibits the effect of varying the public spending ratio g/y, which is achieved by changing the value of parameter B in the household utility function. When the government

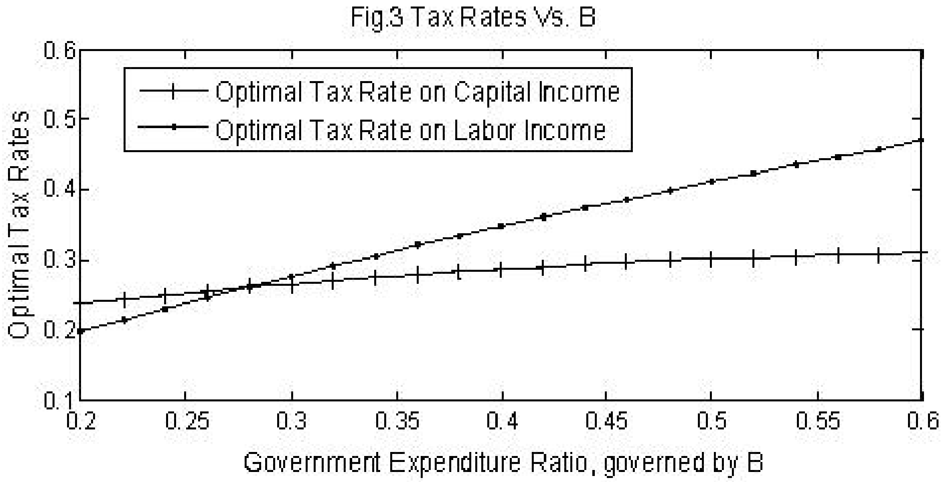


spending ratio increases, both optimal tax rates increase. As the government expenditure increases, the absolute value of marginal excess of burden $|\varsigma|$ rises, leading to the increase of tax rate on labor income with B. The optimal tax rate on capital income, however, increases slightly from 0.24 to 0.31, while the parameter B rises from 0.2 to 0.6, exhibiting the feature that government expenditures have little effect on the determination of optimal tax rate on capital income.

5 Conclusion

Traditionally, wealth is only viewed as the source or limit of consumption, which hardly influences consumers' utility. However, according to the theory of capitalism, in reality people often consider wealth more than that. They obtain wealth not only for consume more, but also for increasing their social status and self-satisfaction. Otherwise, it may be impossible to explain the incentives of those millionaires who still work hard and make fortune everyday. Therefore, people are happier if they have relatively more wealth than their peers, and they are "jealous" when finding their relative wealth status is low. In this paper, we model this "keeping up with Joneses" effect by incorporating relative wealth status into the household utility function.

Our main conclusions are that under the first-best and second-best policy, the optimal tax rates on capital are both positive and exactly the same, while the first-best optimal tax rate on labor income is zero and the second-best one is a constant with undetermined sign. The positive tax rate on capital is intuitively understandable, since the "keeping up with



Joneses" effect induces people to invest more than efficiency and levying a positive tax on capital can pull back this intention. This result is quite different those derived by Chamley (1986) and Judd (1985) and other researchers, due to the introduction of negative externality of wealth introduced to our model.

Further extensions of our study can be extending this deterministic analysis to stochastic situation, adding imperfection into market by introducing some kind of monopoly, changing this model of infinitely-lived households to the model of over-lapping generations, or adding negative externality of consumption by incorporating average consumption level into household utility function.

APPENDIX

We will show in Appendix that the implementability constraint for Ramsey problem is described as

$$\left(c_0^{1-\gamma} - \lambda l_0^{1+\rho}\right) + \sum_{t=1}^{\infty} \beta^t \left[\left(1 - \frac{\sigma}{1-\gamma}\right) c_t^{1-\gamma} - \lambda l_t^{1+\rho}\right] = c_0^{-\gamma}(R_{k0}k_0 + R_{b0}b_0)$$

Proof. Substituting $R_{kt+1} = 1 + (1 - \tau_{t+1})(r_{t+1} - \delta)$ into the household budget constraint in time period $t+1$ gives

$$R_{kt+1}k_{t+1} + R_{bt+1}b_{t+1} = c_{t+1} - (1 - \theta_{t+1})w_{t+1}l_{t+1} + k_{t+2} + b_{t+2}. \tag{A1}$$

Comparing the first-order condition of government debt in the household optimization problem with the denotation of R_{kt+1}, we obtain

$$R_{kt+1} = R_{bt+1} \tag{A2}$$

Substituting (A2) into (A1) and multiplying both sides of (A1) by $\beta\xi_{t+1}$ give

$$\beta\xi_{t+1}R_{kt+1}(k_{t+1}+b_{t+1}) = \beta\xi_{t+1}c_{t+1} - \beta\xi_{t+1}(1-\theta_{t+1})w_{t+1}l_{t+1} + \beta\xi_{t+1}(k_{t+2}+b_{t+2}). \tag{A3}$$

Notice that in equilibrium, $\xi_{t+1} = c_{t+1}^{-\gamma}$. Substituting this term and the optimal condition of consumption and labor into (A3), we obtain

$$\beta\xi_{t+1}R_{kt+1}(k_{t+1}+b_{t+1}) = \beta\left[c_{t+1}^{1-\gamma} - \lambda l_{t+1}^{\rho+1} + c_{t+1}^{-\gamma}(k_{t+2}+b_{t+2})\right] \tag{A4}$$

Recalling the Euler equation

$$\xi_t = \beta\xi_{t+1}\left[R_{kt+1} - \frac{\sigma c_{t+1}}{(1-\gamma)W_{t+1}}\right] \tag{A5}$$

we substitute (A5) into (A4) to eliminate the term of and obtain

$$c_t^{-\gamma}(k_{t+1}+b_{t+1}) = \beta c_{t+1}^{-\gamma}(k_{t+2}+b_{t+2}) + \beta c_{t+1}^{-\gamma}\left[\left(1-\frac{\sigma}{1-\gamma}\right)c_{t+1} - \frac{\lambda l_{t+1}^{\rho+1}}{c_{t+1}^{-\gamma}}\right], t \geq 0 \tag{A6}$$

Multiplying both sides of (A6) by β^t and summing them up for $t \geq 0$ and use the TVC condition, we obtain

$$\left(c_0^{1-\gamma} - \lambda l_0^{1+\rho}\right) + \sum_{t=1}^{\infty}\beta^t\left[\left(1-\frac{\sigma}{1-\gamma}\right)c_t^{1-\gamma} - \lambda l_t^{1+\rho}\right] = c_0^{-\gamma}(R_{k0}k_0 + R_{b0}b_0)$$

■

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