Journal of Urban Economics 71 (2012) 177–188

Contents lists available at SciVerse ScienceDirect

Journal of Urban Economics

www.elsevier.com/locate/jue

Fiscal centralization versus decentralization: Growth and welfare effects of spillovers, Leviathan taxation, and capital mobility

Angus C. Chu [a,b], C.C. Yang [c,d,e,*]

[a] Durham Business School, Durham University, Durham, United Kingdom
[b] School of Economics, Shanghai University of Finance and Economics, Shanghai, China
[c] Institute of Economics, Academia Sinica, Taipei, Taiwan
[d] Department of Public Finance, National Chengchi University, Taipei, Taiwan
[e] Department of Public Finance, Feng Chia University, Taichung, Taiwan

ARTICLE INFO

Article history:
Received 14 September 2010
Revised 18 October 2011
Available online 29 October 2011

JEL classification:
D72
H20
O41
O43

Keywords:
Fiscal decentralization
Spillovers of public goods
Tax competition
Leviathan taxation

ABSTRACT

This paper develops an endogenous growth model with spillovers of public goods, Leviathan taxation, and mobile capital to examine the relative merits of centralized and decentralized fiscal systems for economic growth and social welfare. We show that a decentralized system dominates a centralized system in terms of economic growth; however, the difference in social welfare between a decentralized and a centralized system is non-monotonic and displays a hump-shaped relationship with respect to capital mobility. Since higher capital mobility induces stronger tax competition, this finding implies that there is an optimal degree of tax competition; some tax competition is desirable, but fierce tax competition may be harmful. We also show that there is a critical level of spillovers of public goods above which centralization dominates decentralization in terms of social welfare, as in previous studies; however, if spillovers are below this critical level, capital mobility also matters in the welfare comparison between centralized and decentralized systems.

1. Introduction

This paper develops an endogenous growth model with spillovers of public goods, Leviathan taxation, and mobile capital to examine the relative merits of centralized and decentralized fiscal systems for economic growth and social welfare. Fiscal centralization (FC) internalizes spillovers across jurisdictions and eliminates tax competition for mobile capital via the coordination of fiscal policy, while fiscal decentralization (FD) features tax competition and spillovers due to coordination failures. Put differently, whether or not fiscal policy is coordinated between jurisdictions is the defining characteristic that distinguishes between FC and FD in our study.[1]

We consider a plausible scenario in which politicians are partly self-interested (i.e., Leviathan or rent seeking) and partly benevolent (i.e., citizen-welfare maximizing). The "weight" that politicians attach to their self-interest could be viewed as reflecting the varying extent of government accountability across different political institutions (Lockwood, 2006). With such political preferences, we develop an endogenous growth model characterized by three exogenous parameters capturing (i) the degree to which politicians are rent seeking, (ii) the degree of spillovers of public goods across jurisdictions, and (iii) the degree of capital mobility. Different economies, due to their histories or for other reasons, are likely to vary in terms of these three parameters. The central purpose of this paper is to provide a framework to analyze the advantages and disadvantages of FD versus FC under different combinations of these three parameters. We examine how economic growth and social welfare are impacted by the choice between FC and FD.

Under FC, the central government internalizes spillovers and provides a relatively high level of public goods, but the economy is vulnerable to excessive Leviathan taxation due to the lack of tax competition. Under FD, local governments are constrained in Leviathan taxation due to the presence of tax competition, but they fail to internalize spillovers and may provide an insufficient

* Corresponding author at: Institute of Economics, Academia Sinica, Taipei, Taiwan.

E-mail addresses: anguscccc@gmail.com (A.C. Chu), ccyang@econ.sinica.edu.tw (C.C. Yang).

[1] This defining characteristic is consistent with that in Lockwood (2006). The so-called "central government" in FC may be understood as an institutional arrangement that facilitates and accomplishes fiscal coordination.

0094-1190/$ - see front matter © 2011 Elsevier Inc. All rights reserved.
doi:10.1016/j.jue.2011.10.003

level of public goods. We show that FD dominates FC in terms of economic growth; however, the social welfare difference between FD and FC is non-monotonic and displays a hump-shaped relationship with respect to capital mobility. Since higher capital mobility induces stronger tax competition, this finding implies that there is an optimal degree of tax competition; some tax competition is desirable, but fierce tax competition may be harmful. We also show that there is a critical level of spillovers of public goods above which centralization dominates decentralization in terms of social welfare, as in previous studies; however, if spillovers are below this critical level, capital mobility also matters in the welfare comparison between centralized and decentralized systems.

Edwards and Keen (1996) introduce Brennan and Buchanan's (1980) idea of taming the Leviathan via tax competition to the standard tax competition literature.[2] We follow their paper closely, but with three departures. First, while Edwards and Keen analyze the welfare effects of tax competition versus tax coordination in a static framework, we analyze both the growth and welfare effects in a dynamic framework. As will be shown, pursuing growth and welfare may be in conflict with each other. Second, while Edwards and Keen consider the "local" case where capital is perfectly mobile, we allow for all degrees of capital mobility. We show that higher capital mobility under FD tends to tame the Leviathan government in taxing capital, which promotes economic growth, but at the same time, higher capital mobility could worsen social welfare by reducing the provision of public goods relative to FC. The tradeoff leads to an optimal degree of capital mobility preferred by citizens and a hump-shaped welfare difference between FD and FC with respect to the degree of capital mobility. This non-monotonic hump-shaped relationship is absent in Edwards and Keen (1996) since they only consider the "local" case where capital is perfectly mobile. Third, interactions between governments could come from the expenditure side as well as the revenue side. We address both interactions in our model, whereas Edwards and Keen only address the interaction on the revenue side. It will be shown that leaving spillovers out of the picture in an analysis of tax competition may overweigh the beneficial power of tax competition in taming the Leviathan.

In the absence of tax competition and in a static framework, Besley and Coate (2003) adopt a political economy approach to the choice between centralization and decentralization.[3] They basically show that there is a critical level of spillovers of public goods above (below) which FC dominates (is dominated by) FD in terms of welfare. This result resembles Oates's (1972) classic finding regarding the tradeoff between FC and FD, but its derivation is immune to the artificial assumption of policy uniformity across jurisdictions as in Oates. We also follow Besley and Coate (2003) closely and, indeed, a main part of our model is borrowed directly from their paper. However, unlike Besley and Coate (2003) in which an explicit political process is modeled, we summarize the inefficiency of the political process with a parameter capturing the degree to which politicians are rent seeking. Epple and Nechyba (2004, p. 2455) sum up the gist of the recent political approach to FC versus FD as popularized by Besley and Coate (2003): "decentralization becomes less attractive as inter-jurisdictional spillovers increase, and inefficiencies in political systems provide a decentralizing force." Within our model, the political inefficiency of FC relative to FD arises due to the lack of a discipline device in the form of tax competition in FC. As will be shown, Besley and Coate's results will be qualified to a significant extent when tax competition is present.

[2] See also Rauscher (1998, 2000).

[3] See also Lockwood (2002).

A number of studies, such as Devereux and Mansoorian (1992), Lejour and Verbon (1997), Razin and Yuen (1999) and Koethenbuerger and Lockwood (2010), analyze the growth effect of tax competition versus tax coordination. Brueckner (1999, 2006) considers a growth model with overlapping generations of households and shows that economic growth is higher under fiscal federalism.[4] However, all of these studies follow the Pigouvian tradition by assuming that governments are benevolent. This approach assumes away the potential role of tax competition in constraining the extravagant public sector and, consequently, FC always dominates FD in terms of welfare since FC internalizes externalities while FD does not.[5] By contrast, FD may dominate, or be dominated by, FC in terms of welfare in our framework.

Our study follows Rauscher (2005) in exploring the possibility of taming Leviathan governments via tax competition in an endogenous growth model, but we differ from Rauscher (2005) in terms of the modeling details and derived results. A key difference is that we compare the performance of FD versus FC in terms of both economic growth and social welfare while Rauscher's study is confined to the growth performance within FD.

The remainder of the paper is organized as follows. Section 2 introduces our model. Section 3 performs the analysis. Sections 4 and 5 make comparisons between FD and FC in terms of economic growth and social welfare, respectively. Section 6 concludes. Proofs are relegated to the Appendix.

2. Model

Our model may be viewed as a complement to Edwards and Keen (1996) and Besley and Coate (2003) in the sense that (i) while Edwards and Keen address the effects of tax competition under perfect capital mobility in a static model without spillovers of public goods, we address the effects of tax competition under all degrees of capital mobility in a dynamic model with spillovers of public goods, and (ii) while Besley and Coate address the effects of spillovers in a static model in the absence of tax competition, we address the effects of spillovers in a dynamic model in the presence of tax competition. Both Edwards and Keen (1996) and Besley and Coate (2003) confine their analysis to consumption-type public goods. To facilitate comparisons with them, we follow their confinement.[6]

2.1. Citizens

There is a continuum of identical citizens, who reside in each of two geographically distinct but symmetric jurisdictions. For simplicity, we shall suppress the jurisdiction index and use a superscript $*$ to denote foreign variables. The two jurisdictions may be understood as two neighboring districts of some metropolis like Tokyo, or two neighboring member states in the EU such as France and Germany. The two jurisdictions are assumed to have equal

[4] In addition to Brueckner (1999, 2006), in a recent interesting study Hatfield (2009) also analyzes the growth effect of fiscal federalism. He finds that fiscal decentralization maximizes growth but results in an underprovision of public goods, while fiscal centralization achieves the optimal provision of public goods under a median voter.

[5] This may explain why all of these studies focus on the growth rather than the welfare comparison between FD and FC. Although correct in our context, the statement "FC always dominates FD in terms of welfare" may be a sweeping generalization; see Kehoe (1989), who shows that coordination of capital taxation can be counterproductive in mitigating the time inconsistency problem, even if politicians are benevolent.

[6] For analyses of production-type public goods, see Rauscher (2000, 2005).

populations, which we normalize to unity. The lifetime utility of citizens in each jurisdiction is represented by[7]

$$U = \int_0^{\infty} e^{-\rho \cdot t}\left[\ln C_t + (1-s)\ln G_t + s\ln G_t^*\right]dt, \tag{1}$$

where $\rho > 0$ is the common subjective discount rate, C_t is the level of consumption at time t, G_t is the level of local public goods provided in the home jurisdiction at time t, and G_t^* is the level of local public goods provided in the foreign jurisdiction at time t. The parameter $s \in [0, 0.5]$ indexes the degree of positive spillovers: if $s = 0$, citizens care only about the public good in their home jurisdiction; if $s = 0.5$, citizens care equally about the public goods in both jurisdictions. This setup of spillovers and the functional form $(1-s)\ln G_t + s\ln G_t^*$ are identical to those in Besley and Coate (2003).

There is a single malleable good that can be used for consumption, investment, or providing public goods. The production in each jurisdiction is given by an *AK* production function[8]

$$Y_t = AK_t,$$

where Y_t and K_t are respectively output and capital per citizen at time t, and A is a technology parameter. The domestic (foreign) jurisdiction levies a tax at rate τ_t (τ_t^*) on each unit of capital employed in its own jurisdiction.[9]

Given K_0, a citizen decides how much to consume and how much to save/invest at each point of time to maximize lifetime utility (1) subject to the following flow budget constraint

$$\dot{K}_t = Y_t - C_t - (\tau_t D_t + \tau_t^* F_t) - M(\theta_t, K_t, m), \tag{2}$$

where D_t (F_t) is the amount of the citizen's capital allocated to the home (foreign) jurisdiction at time t and $\tau_t D_t + \tau_t^* F_t$ is the capital tax paid by the citizen at time t. $\theta_t \equiv F_t/K_t \in [0,1]$ is defined as the share of capital allocated to the foreign jurisdiction, and hence $1 - \theta_t = D_t/K_t$ is the share of capital allocated to the home jurisdiction. Similar to Persson and Tabellini (1992), the last term of (2) represents a cost of capital allocation incurred by a citizen who allocates a share θ_t of capital to the foreign jurisdiction (m is a shift parameter to be explained later). This cost represents all the extra frictions of foreign capital allocation compared with domestic allocation, including those associated with less familiar foreign legal issues, possible foreign capital controls, foreign country-specific risk, and so on. It is meant to capture imperfect capital mobility across jurisdictions.[10]

For analytical tractability, the cost $M(\cdot)$ in (2) is assumed to take the following functional form[11]

$$M(\theta_t, K_t, m) = (\theta_t)^2 K_t/m,$$

which is increasing and convex in θ_t, implying that it is costly for citizens to exercise portfolio allocation abroad rather than at home and that the associated marginal cost is increasing in the share of foreign capital. We let K_t enter $M(\cdot)$ linearly to ensure a balanced-growth path. The parameter $m \in [0, \infty]$ indexes the degree of capital mobility across jurisdictions: when $m = 0$, the foreign portfolio-allocation cost goes to infinity and capital is de facto immobile; when $m = \infty$, the foreign portfolio-allocation cost goes to zero and capital is perfectly mobile. As we will show later, other things being equal, the higher the m the lower the equilibrium τ_t will be. Thus, the parameter m can also be viewed as an index measuring the degree of tax competition. Given τ_t, τ_t^* and $M(\cdot)$, citizens will allocate their capital between the two jurisdictions to arbitrage away any difference in the net-of-tax capital return. Citizens themselves are assumed to be immobile, and this assumption allows us to focus on the impact of tax competition on mobile capital.[12]

2.2. Politicians

There are politicians in each jurisdiction. Politicians are finite in number and hence they form a measure-zero subset in the set of the continuum of citizens. One way of modeling politicians' preferences is to assume that they are identical to citizens', except that politicians will utilize their political power to seek rents once they are in power. The other way of modeling these preferences is to follow the Weberian tradition and let politicians be distinct from citizens. More specifically, politicians are assumed to take politics as a vocation and to strive to make politics a permanent source of income. However, to be elected or reelected, politicians must pay some attention to citizen welfare as well. Consistent with either interpretation, the lifetime utility of politicians in each jurisdiction in our model is given by

$$V = (1-L)U + L\left(\int_0^{\infty} e^{-\rho \cdot t}\ln R_t dt\right), \tag{3}$$

where R_t is the amount of tax revenue extracted and expended by politicians for their own self-interested purposes at time t. The parameter $L \in [0, 1]$ indexes the exogenous degree to which politicians are rent seeking: when $L = 0$, the politicians become completely benevolent; when $L = 1$, the politicians become completely self-interested. This degree to which politicians are rent seeking reflects the extent of the government's accountability in various political institutions. The higher the accountability, the lower the L should be (Lockwood, 2006). Similar political preferences have been utilized by Edwards and Keen (1996), Rauscher (1998, 2000) and others.[13]

Given the citizens' best response, politicians in each jurisdiction choose a capital tax rate and the allocation of tax revenue between

---

[7] Including an additional parameter such that $\ln C + \phi[(1-s)\ln G + s\ln G^*]$ in the utility function would add an extra parameter to the equilibrium outcomes without changing the qualitative properties of our results. Also, the log utility function implies that the elasticity of intertemporal substitution (EIS) is one. Guvenen (2006) summarizes the contradicting results from the empirical literature regarding the value of this elasticity and reconciles the different results by recognizing two kinds of heterogeneity: (i) the majority of households do not participate in stock markets and (ii) wealthy households have a higher EIS than less-wealthy households. He also argues that the properties of aggregate variables such as investment and output that are related to wealth are mainly determined by the high-EIS stockholders. In the context of tax competition, which involves capital investment, a high EIS seems more appropriate.

[8] In the standard AK model, capital is broadly interpreted to include human capital, tangible and intangible capital with embodied technologies. Within our model, however, agents are not free to move and so this interpretation should be modified in that tax competition occurs only in the case of the mobile types of capital.

[9] This is known as the source principle, under which "tax is paid at the rate of and to the jurisdiction in which the income arises" (Keen, 1993, p. 27). Due to the administrative difficulties of monitoring and taxing accrued income from "foreign sources" in the real world, the source principle is typically assumed in the tax competition literature; see Wellisch (2000, Chapter 4) and Haufler (2008, Chapter 4).

[10] See Rauscher (2005) for a discussion on alternative approaches to model imperfect capital mobility.

[11] This functional form is consistent with Persson and Tabellini (1992). Lejour and Verbon (1997) also consider a similar cost function but with an extra term that captures the portfolio-allocation *benefits*. Under this formulation, there are opposing effects of tax competition on the equilibrium tax rate. We focus on the negative effect of tax competition on the equilibrium tax rate in accordance with the empirical evidence discussed below.

[12] Thus, we shall not address the issue of residential mobility á la Tiebout (1956). For a model that integrates the tax competition literature with the Tiebout tradition, see Brueckner (2000, 2004).

[13] We apply the same L to both FC and FD, and focus on the different impacts of FC versus FD under the same L. It can nevertheless be imagined that the degree to which politicians are rent seeking may vary across FC and FD. Put differently, FC and FD may differ in selecting "good" or "bad" types of politicians; see Lockwood (2006) for a review of the issue.

rents and public goods to maximize (3) subject to the law of motion for capital and the instantaneous balanced budget constraint. Depending on whether the regime is FC or FD, however, the problem formulations are somewhat different. We describe them in the next section.

3. Fiscal centralization versus decentralization

As is standard in the literature, we take the Ramsey approach in which governments move first and, given the policy chosen by the governments, citizens make their best response. In the case of FC, politicians from local jurisdictions form a "central government" to coordinate or harmonize their fiscal policy: they internalize spillovers of public goods across jurisdictions and set a uniform tax rate to eliminate tax competition for mobile capital. In the case of FD, politicians in each jurisdiction choose their policy independently and simultaneously at each point of time. In this case, they fail to internalize spillovers of public goods across jurisdictions and set the tax rates non-cooperatively due to coordination failures. We spell out the details of the interactions between the various players below.[14]

3.1. Fiscal centralization

Because the two jurisdictions are identical by assumption, we seek a symmetric solution. Politicians under FC are assumed to coordinate their policy and enforce $\tau_t = \tau_t^*$ at all times. Therefore, citizens will choose $\theta_t = 0$ to avoid the portfolio-allocation cost. The amount of tax revenue collected from each district at time t is $T_t = \tau_t K_t$. Denote $g_t \equiv G_t/K_t$ as the share of capital allocated to public goods, $r_t \equiv R_t/K_t$ as the share of capital extracted by politicians, and $c_t \equiv C_t/K_t$ as the share of capital consumed by the households. Taking the path of τ_t as given, the households choose the path of c_t to maximize (1) subject to (2). Taking the households' best response as given, the politicians choose the paths of τ_t, g_t and r_t to maximize the joint payoff (i.e., $V + V^*$) subject to the citizens' best response, the law of motion for capital, and the instantaneous balanced-budget condition.

The solution concept that we use is Markov perfect equilibrium.[15] Lemma 1 gives the equilibrium outcomes under FC denoted by a superscript c. We define $f_t \equiv G_t/T_t = g_t/\tau_t$ as the share of tax revenue devoted to the provision of public goods (and hence $1 - f_t$ is the share of tax revenue devoted to politicians' own expenses).

Lemma 1. *Under FC, the symmetric Markov perfect equilibrium outcomes for all t are*

$$c_t^c = \rho, \tag{4}$$
$$\tau_t^c = \rho/(2 - L), \tag{5}$$
$$f_t^c = 1 - L, \tag{6}$$
$$\gamma_t^c = A - \rho - \tau_t^c, \tag{7}$$

where $\gamma_t^c \equiv \dot{K}_t^c/K_t^c$.

Given the log utility function, we have the standard result in growth models that citizens consume a fixed share ρ of K_t^c. Note that K_t is predetermined at time t. Because citizens consume a fixed share of this predetermined variable, the government cannot use current or future policies to affect citizens' current consumption. This implies that the government has no incentive to deviate from the chosen policies at any point of time. Therefore, the policies are time consistent, which is not surprising given the finding of Xie (1997).[16] Note that any subgame starting at $(K_t, t > 0)$ has the same structure as the original game at $(K_0, t = 0)$ in our model. Since the players' strategies derived are stationary (c_t, τ_t, g_t and r_t are all constants and do not depend on time), they are subgame perfect; see Dockner et al. (2000, Section 4.3).

At each point of time, citizens consume a share ρ of capital (see (4)), while the central government transfers a share τ^c of capital to the public sector via taxation (see (5)). Thus, the saving rate on capital is $A - \rho - \tau^c$, and this saving rate directly determines the growth rate of the economy (see (7)). Of the capital transferred to the public sector, a share L is expended by politicians for their self-interested purposes and the rest $1 - L$ is used for the provision of public goods (see (6)). It is observed that the growth rate γ^c is decreasing in τ^c. This is because a higher τ^c implies a higher share of non-productive public consumption by both citizens and politicians; hence, a lower saving rate for capital investment. Note that τ^c is increasing in L while f^c is decreasing in L. Both results seem intuitive.

Because this simple AK model does not exhibit transition dynamics, the citizens' lifetime utility (1) can be expressed as

$$U = \left(\frac{\ln C_0}{\rho} + \frac{\gamma}{\rho^2}\right) + (1 - s)\left(\frac{\ln G_0}{\rho} + \frac{\gamma}{\rho^2}\right) + s\left(\frac{\ln G_0^*}{\rho} + \frac{\gamma^*}{\rho^2}\right). \tag{8}$$

From (4), $C_0^c = \rho.K_0$. Without loss of generality, we shall set $K_0 = 1$. After dropping the constant term $\ln C_0/\rho$ (which is independent of L, s and m) and letting $G_0 = G_0^*$ by symmetry, (8) gives rise to

$$\rho.U^c = \ln G_0^c + 2\gamma^c/\rho, \tag{9}$$

where $G_0^c = f^c \tau^c K_0 = f^c \tau^c$ · U^c in (9) gives the citizens' welfare under FC. Note that the higher is L, the lower will U^c be. This is because both G_0^c and γ^c are decreasing in L.

3.2. Fiscal decentralization

In the case of FD, the domestic government maximizes (3) subject to: (i) the balanced-budget condition

$$G_t + R_t = T_t = \tau_t(D_t + F_t^*) = \tau_t\left[(1 - \theta_t)K_t + \theta_t^* K_t^*\right], \tag{10}$$

(ii) the foreign government's policy choice, (iii) the citizens' best response, and (iv) the laws of motion for domestic and foreign capital. The term $\theta_t^*.K_t^*$ in (10) represents the amount of foreign capital allocated to the home jurisdiction.

Given τ_t, τ_t^*, G_t and G_t^*, each citizen consumes a share c_t of her own capital and allocates a share θ_t of capital to the foreign jurisdiction to maximize (1) subject to (2). There is no fiscal coordination between local governments under FD. To seek mutual best responses between local governments, the solution concept that we use is again the Markov perfect equilibrium.[17] In the Proof of lemma 2, we show that the citizens' capital-allocation rule is $\theta_t = \min\{(m/2)(\tau_t - \tau_t^*), 1\}$ if $\tau_t \geqslant \tau_t^*$ and $\theta_t = 0$ otherwise. This capital-allocation rule equates the marginal benefit of foreign portfolio allocation $\tau_t - \tau_t^*$ with the marginal cost $2\theta_t/m$. Given that we focus on the symmetric equilibrium, θ_t equals zero with $\tau_t = \tau_t^*$ in equilibrium. Nonetheless, the possibility of capital outflow under FD still

[14] Technically, we are solving a differential game. See Dockner et al. (2000) for a textbook treatment of this topic.

[15] The Markov perfect equilibrium is a popular solution concept in the dynamic-game literature because Markovian strategies are based on only the payoff-relevant state variables. In the case of history-dependent strategies that are mappings from the entire history, multiple equilibria often arise; see for example Acemoglu (2009, Appendix C) for a discussion.

[16] Xie (1997) shows that time-consistent fiscal policies will arise in Stackelberg differential games for the class of utility-production pairs $U = (C^{1-\sigma} - 1)/(1 - \sigma)$ and $Y = AK^{\sigma}$ for $\sigma \in (0, 1]$. We have $\sigma = 1$ in our model.

[17] When solving this simultaneous-move differential game between politicians in the two jurisdictions, we focus on strongly symmetric strategies (i.e., politicians take the same action both on and off the equilibrium path). This restriction is only for the purpose of ensuring that the equilibrium is subgame perfect among the set of off-equilibrium (symmetric) trajectories. See Fudenberg and Tirole (1991, pp. 163-65) for a discussion on strongly symmetric equilibrium.

exerts its impact, forcing local governments to set a lower tax rate than that under FC. Lemma 2 gives the equilibrium outcomes under FD denoted by a superscript d.

Lemma 2. *Under FD, the symmetric Markov perfect equilibrium outcomes for all t are*

$$c_t^d = \rho, \tag{11}$$

$$\tau_t^d = \rho\left(\frac{L+(1-s)(1-L)}{1+(1-s)(1-L)+m\rho[L+(1-s)(1-L)]}\right), \tag{12}$$

$$f_t^d = \frac{(1-s)(1-L)}{L+(1-s)(1-L)}, \tag{13}$$

$$\gamma_t^d = A-\rho-\tau_t^d, \tag{14}$$

where $\gamma_t^d \equiv \dot{K}_t^d/K_t^d$.

Again, citizens consume a fixed share ρ of K_t^d; thus, the policies are time consistent. Since the players' strategies derived are stationary, they are again subgame perfect. At each point of time, citizens consume a share ρ of capital (see (11)) while each local government transfers a share τ^d of capital to the public sector via taxation (see (12)). Thus, the saving rate on capital is $A-\rho-\tau^d$, and this saving rate again directly determines the growth rate (see (14)). Note that $\tau^c = \tau^d$, $f^c = f^d$ and $\gamma^c = \gamma^d$ if $s = m = 0$. In other words, FD is equivalent to FC in terms of economic growth if spillovers of public goods are absent and capital mobility is zero.

From (12), we see that the higher is m, the lower will τ^d be. Given the citizens' capital allocation rule, each local government has a stronger incentive to undercut its own capital tax rate to prevent capital outflow and attract capital inflow when capital mobility m is higher. Thus, higher capital mobility generates stronger tax competition and drives down the equilibrium tax rate if the regime is characterized by FD rather than FC.[18] As before, (8) gives rise to

$$\rho.U^d = \ln G_0^d + 2\gamma^d/\rho \tag{15}$$

where $G_0^d = f^d\tau^d K_0 = f^d\tau^d$. U^d in (15) gives the citizens' welfare under FD. Because both G_0^d and γ^d are decreasing in L, U^d is also decreasing in L.

4. Economic growth

This section compares the effects of FD versus FC on economic growth as the degree to which politicians are rent seeking, the degree of spillovers, and the degree of capital mobility (or tax competition) varies. From Lemmas 1 and 2, given $L \in [0, 1]$, $\tau^c \geqslant \tau^d$ and $\gamma^c \leqslant \gamma^d$ always hold, and $\tau^c > \tau^d$ and $\gamma^c < \gamma^d$ unless $m = 0$ plus $s = 0$ or $L = 1$. The intuition for this result is straightforward. First, tax competition under FD leads to a lower tax rate. Second, the internalization of spillovers under FC reinforces the absence of tax competition and leads to a higher tax rate. Therefore, FC gives rise to a higher tax rate than FD. Imposing a higher tax rate is detrimental to growth in our model because a larger share of capital is transferred to the public sector for non-productive consumption (consumption-type public goods or expended rents). However, one should not interpret this finding beyond our model since it omits productive public expenditures.[19] Nevertheless, Proposition 1 delivers a clear message: as far as non-productive public expenditures are concerned, FD dominates FC in terms of growth.[20] Proposition 1 summarizes this result, and Fig. 1 plots the equilibrium growth rates against the degree of capital mobility under FD and FC for $L \in [0,1)$.

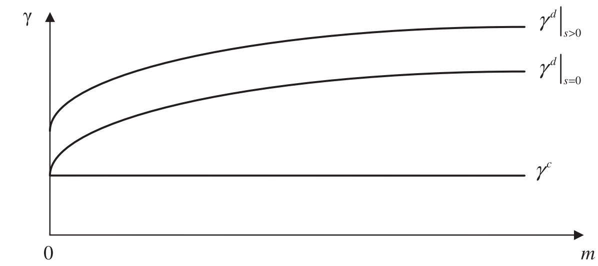

Fig. 1. Growth effects of FD versus FC.

Proposition 1. *Suppose politicians are not completely self-interested (i.e., $L \in [0,1)$).*

(i) In the absence of spillovers of public goods (i.e., $s = 0$), FD strictly dominates FC in terms of economic growth if and only if the degree of capital mobility is positive (i.e., $m > 0$).
(ii) In the presence of spillovers of public goods (i.e., $s > 0$), FD strictly dominates FC in terms of economic growth.

Proof. Substitute (5) into (7) and (12) into (14). Then, compare (7) and (14). □

Fig. 1 shows that the higher the degree of tax competition (i.e., a larger m), the higher will be the growth rate of FD relative to FC (i.e., a higher γ^d relative to γ^c). One can imagine that greater fiscal decentralization in some economies is partly or even mainly motivated by a desire to promote economic growth. Oates (2005, p. 349) indeed observes: "In the developing nations, such restructuring [decentralization] has been, in part, a response to the failure of centralized planning to bring the sustained growth that was one of its major objectives." However, as we will demonstrate below, enhancing growth does not necessarily improve welfare and, in fact, may be welfare decreasing.

5. Social welfare

We start our analysis with the extreme cases $L = 0$ and $L = 1$. Both spillovers and capital mobility can be viewed as fiscal externalities (one is on the expenditure side and the other is on the revenue side).[21] FC internalizes these fiscal externalities, whereas FD does not. As a result, FC dominates FD in terms of welfare if politicians are completely benevolent (i.e., $L = 0$). However, if politicians are completely self-interested ($L = 1$), FC and FD are equally detrimental to welfare: both U^c and U^d go to negative infinity, since G_0^c in (9) and G_0^d in (15) are both equal to zero.

For the rest of this section, we examine the more interesting and, arguably, more realistic cases with $L \in (0,1)$. Using Lemmas 1 and 2, (9) and (15) yields

$$\rho(U^d - U^c) = \ln\left(\frac{G_0^d}{G_0^c}\right) + \left(\frac{2}{\rho}\right)(\gamma^d-\gamma^c) = \ln\left(\frac{f^d\tau^d}{f^c\tau^c}\right) + \left(\frac{2}{\rho}\right)(\tau^c-\tau^d). \tag{16}$$

[18] A recent empirical study by Devereux et al. (2008) demonstrates that the substantial fall in the statutory corporate tax rates of OECD countries in the 1980s and 1990s can be explained by more intense tax competition, which was triggered by the relaxation of capital controls (related to our index m). Similarly, Winner (2005) finds that capital mobility exerts a significant negative impact on capital tax for a sample of 23 OECD countries from 1965 to 2000.

[19] Rauscher (2005) considers productive public expenditures with Leviathan governments and finds that the effects of increased capital mobility on the equilibrium tax rate and the growth of an economy are ambiguous in general.

[20] Brueckner (2006) observes that initial empirical studies tend to find a negative or no relationship between fiscal decentralization and growth, while the more recent studies tend to obtain a positive relationship.

[21] When one jurisdiction raises its tax rate on mobile capital, the other jurisdiction will gain in its tax base; see Wildasin (1989) for the details.

$\tau^c \geqslant \tau^d$ always holds and $\tau^c > \tau^d$ unless $s = m = 0$. In addition, $f^c \geqslant f^d$ always holds and $f^c > f^d$ unless $s = 0$. Therefore, $\gamma^d > \gamma^c$; however, $G_0^d < G_0^c$ unless $s = m = 0$. We then see from (16) that FD has its welfare edge in growth ($\gamma^d > \gamma^c$) while FC has its welfare edge in public goods $\left(G_0^d < G_0^c\right)$.

In the following, we first examine the case where $s = 0$ (i.e., there are no spillovers), and then we examine the other case where $s > 0$ (i.e., there are spillovers).

5.1. No spillovers (s = 0)

In this case, $f^d = f^c$ always holds, $\tau^d = \tau^c$ if $m = 0$, and $\tau^d < \tau^c$ if $m > 0$. Eq. (16) becomes

$$\rho(U^d - U^c) = \ln\left(\frac{G_0^d}{G_0^c}\right) + \left(\frac{2}{\rho}\right)(\gamma^d - \gamma^c) = \ln\left(\frac{\tau^d}{\tau^c}\right) + \left(\frac{2}{\rho}\right)(\tau^c - \tau^d) \tag{16-1}$$

which clearly shows the dilemma of stronger tax competition: tax competition under FD promotes economic growth by taming Leviathan governments ($\gamma^d - \gamma^c = \tau^c - \tau^d > 0$), but at the same time it reduces the provision of beneficial public goods relative to FC ($G_0^d/G_0^c = \tau^d/\tau^c < 1$). The tradeoff between promoting economic growth and reducing public good provision suggests that there may exist an optimal degree of capital mobility/tax competition and hence a corresponding optimal capital tax rate preferred by citizens. We confirm this possibility below. As we have emphasized before, this feature of optimality is absent in Edwards and Keen (1996) since they only consider the "local" case where capital is perfectly mobile, whereas we allow for all degrees of capital mobility.

Using Lemmas 1 and 2, (16) with $s = 0$ gives the following results.

Proposition 2. *Suppose that politicians are partly self-interested (i.e., $L \in (0,1)$) and that spillovers of public goods are absent (i.e., $s = 0$). Then, the welfare difference between FD and FC (i.e., $U^d - U^c$) is concave in the degree of capital mobility m and reaches its maximum at $m = L/\rho \equiv \tilde{m}|_{s=0}$. Whether $U^d - U^c$ is positive or negative varies with the degree of capital mobility:*

(i) *Under zero capital mobility (i.e., $m = 0$), FD and FC are equivalent in terms of welfare (i.e., $U^d - U^c = 0$);*
(ii) *Under perfect capital mobility (i.e., $m = \infty$), FD is dominated by FC in terms of welfare (i.e., $U^d - U^c < 0$);*
(iii) *Under imperfect capital mobility (i.e., $m \in (0,\infty)$), there exists a threshold degree of capital mobility, denoted by $\hat{m}$, below which FD dominates FC in terms of welfare (i.e., $U^d - U^c > 0$) but above which FD is dominated by FC in terms of welfare (i.e., $U^d - U^c < 0$). The threshold $\hat{m}$ has the following properties: (a) $\hat{m} > \tilde{m}|_{s=0}$, (b) $\partial\hat{m}/\partial L > 0$, (c) $\hat{m} \to 0$ as $L \to 0$, and (d) $\hat{m} \to x < \infty$ as $L \to 1$ with x satisfying $(1 + x\rho)\ln(1 + x\rho) = 2x\rho$.*

Fig. 2 plots $U^d - U^c$ against m, along with the comparative static effect of varying the degree to which politicians are rent seeking. The comparative static effect shows that the curve representing $U^d - U^c$ will extend to the right as the degree to which politicians are rent seeking increases ($L_2 > L_1 > 0$).

We explain each of (i), (ii) and (iii) below. For (i), in the absence of both capital mobility and spillovers (i.e., $s = m = 0$), FD is equivalent to FC. Therefore, $U^d = U^c$ must be true. For (ii), when $m = \infty$, $\tau^c > 0$ while $\tau^d = 0$ according to (5) and (12). It is then clear from (16-1) that $U^d < U^c$ because a zero provision of public goods under FD leads to an infinitely negative utility.

The intuition for (iii) is as follows. In the absence of tax competition under FC, Leviathan governments will always choose too high a tax rate relative to the optimal tax rate for citizens. As such, tax competition can be employed to "correct" this excessive Leviathan taxation and move the equilibrium tax rate closer toward the optimum. The optimal degree of capital mobility preferred by citizens is $\tilde{m}|_{s=0} = L/\rho$ because, given the equilibrium tax rate $\tau^d = \rho/(2 - L + m\rho)$ under FD ($s = 0$), this degree of capital mobility will result in the optimal tax rate given by $\tilde{\tau}|_{s=0} = \rho/2$.[22] The effect of m on $U^d - U^c$ is hump-shaped since the negative effect of fewer public goods dominates (is dominated by) the positive effect of a higher growth rate if the value of m is higher (lower) than the optimal degree $\tilde{m}|_{s=0}$.

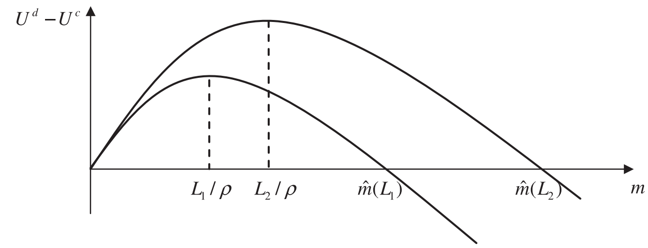

Fig. 2. Welfare effects of FD versus FC in the absence of spillovers.

Contrasting the equilibrium tax rate $\tau^d = \rho/(2 - L + m\rho)$ with the optimal tax rate $\tilde{\tau}|_{s=0} = \rho/2$ shows that the higher the degree to which politicians are rent seeking (i.e., a higher L), the larger will be the role for tax competition (i.e., a larger m). This indirectly explains why $\partial\hat{m}/\partial L > 0$ holds. Stronger tax competition will be needed to enhance citizen welfare if the "weight" that politicians attach to their self-interest or the extent of the rent diversion increases.

From the Proof of proposition 3, we see that the derivative of $U^d - U^c$ with respect to m will be (weakly) negative if $L = 0$. Thus, introducing tax competition would not improve citizen welfare at all if politicians were completely benevolent; see also Proposition 2 (iii)-(c). This dynamic finding is consistent with a fundamental static result in the tax competition literature, namely, that tax competition for mobile capital is harmful since it tends to produce a low tax rate and result in an undersupply of local public goods.[23] The fundamental static result is derived under the Pigouvian tradition which assumes that politicians act in the best interests of citizens. As Wilson (2005, p. 2) notes, the assumption that politicians act benevolently "clearly stacks the deck against tax competition." On the other hand, since the threshold $\hat{m}$ only approaches a finite number as $L \to 1$ (see Proposition 2 (iii)-(d)), tax competition under FD can be excessive and harmful to welfare even if politicians are almost completely rent seeking. Using L'Hôpital's rule, one can show that $\lim_{m\to\infty}(G_0^d/G_0^c) = 0$. From (16-1), it is then implied that $(U^d - U^c) \to -\infty$ as $m \to \infty$. This result holds even if $L \to 1$. Intuitively, stronger tax competition per se has its own tradeoff (promoting growth against reducing the provision of public goods) and hence if tax competition is fierce, it can be excessive and harmful to welfare even if $L \to 1$.

Devereux et al. (2008) observe (p. 1210): "Statutory rates of corporation tax in developed countries have fallen substantially since the early 1980s. The average rate amongst OECD countries in the early 1980s was nearly 50%; by 2001 this had fallen to under 35%." In fact, they find that one third of the members of the

[22] From Lemmas 1 and 2, (9) and (15), we have $\rho U = \ln G_0 + \gamma(2/\rho)$, where $G_0 = \tau(1 - L)$ and $\gamma = A - \rho - \tau$. Using $\partial(\rho U)/\partial\tau = 0$ yields the optimal tax rate preferred by citizens. Note that the second-order condition for the optimal tax rate is satisfied.

[23] This result is originally articulated by Oates (1972) and formally modeled by Wilson (1986) and Zodrow and Mieszkowski (1986). It is stated as Proposition 4.1 in Wellisch (2000, p. 64) and as Proposition 4.2 in Haufler (2001, p. 65).

European Union had a rate at or below 30% by 2001, even though almost all members had a rate above 30% in 1992. According to our model, this downward trend in tax rates is likely generated by more intense tax competition, which is triggered by higher capital mobility. This hypothesis is corroborated by the recent empirical work of Devereux et al. (2008), which concludes (p. 1213): "The relaxation of capital controls has generated competition between an increasing number of countries; it is this more intense competition which has driven down equilibrium tax rates."[24] Higher capital mobility is identified with the relaxation of capital controls in Devereux et al. (2008). Other measures of capital mobility consistently suggest a significant increase in international capital mobility during the 1980s and 1990s as compared to the 1970s (Obstfeld, 1996; Bretschger and Hettich, 2002; Monadjemi and Loadewijks, 2003; Winner, 2005).

Devereux et al. (2008) also observe increased attempts at international coordination (p. 1211): "Both the European Union and the OECD introduced initiatives in the late 1990s designed to combat what they see as 'harmful' tax competition." Our finding is consistent with this observation, in that some tax competition is desirable in social welfare, but fierce tax competition may be harmful.

It is immediately seen from contrasting Proposition 1 (Fig. 1) with Proposition 2 (Fig. 2) that enhancing growth may be inconsistent with improving welfare. The reason behind this result is obvious: the tax-financed public good provision, though detrimental to growth, may be utility enhancing. The possible inconsistency between growth and welfare derived from our model suggests that one should not translate empirical evidence in support of economic growth directly into evidence for welfare improvement. If economic growth is only a means to achieving higher citizen welfare, then focusing on the growth effect of FD alone may be incomplete, if not misleading.

5.2. Spillovers ($s > 0$)

Our analysis above is confined to the case in which spillovers of public goods are absent ($s = 0$). This section considers the more general and, perhaps more realistic, case in which spillovers of public goods are present ($s > 0$). In the absence of tax competition and in a static framework, Besley and Coate (2003) adopt a political economy approach to the choice between FC versus FD. They basically show that there is a critical level of spillovers above which FC dominates FD in welfare, but below which the opposite occurs. This result resembles Oates's (1972) classical finding regarding the tradeoff between FC and FD. It is interesting to know whether this result remains robust in the presence of tax competition in our dynamic setting.

With $s > 0$, both $f^d < f^c$ and $\tau^d < \tau^c$ hold at any $m \in [0,\infty]$. From (16) and Lemmas 1 and 2, we obtain the following results.

Proposition 3. *Suppose that politicians are partly self-interested (i.e., $L \in (0,1)$) and that spillovers of public goods are present (i.e., $s > 0$). Then, the welfare difference between FD and FC (i.e., $U^d - U^c$) is concave in the degree of capital mobility m and reaches its maximum at $m = \frac{2L-1+(1-s)(1-L)}{\rho[L+(1-s)(1-L)]} \equiv \tilde{m}|_{s>0}$. Whether $U^d - U^c$ is positive or negative varies with the degree of capital mobility:*

(i) *Under zero capital mobility (i.e., $m = 0$), FD is dominated by FC in terms of welfare (i.e., $U^d - U^c < 0$);*
(ii) *Under perfect capital mobility (i.e., $m = \infty$), FD is dominated by FC in terms of welfare (i.e., $U^d - U^c < 0$);*
(iii) *Under imperfect capital mobility (i.e., $m \in (0,\infty)$), there exists a threshold degree of spillovers of public goods, denoted by $\bar{s}$, above which FD is dominated by FC in terms of welfare (i.e., $U^d - U^c < 0$) for all $m \in (0,\infty)$; but below which FD dominates FC in terms of welfare (i.e., $U^d - U^c > 0$) if and only if the degree of capital mobility falls within an intermediate range $m \in (\underline{m}, \bar{m})$, where $(\underline{m}, \bar{m})$ corresponds to s with $\partial \underline{m}/\partial s > 0$ and $\partial \bar{m}/\partial s < 0$. The threshold $\bar{s}$ has the following properties: (a) it yields $U^d - U^c = 0$ at $m = \tilde{m}|_{s>0}$, and (b) $\partial \bar{s}/\partial L > 0$.*

Fig. 3 plots $U^d - U^c$ against m, in the presence as well as in the absence of spillovers of public goods. According to Proposition 3 (iii), the hump-shaped curve associated with $s > 0$ in Fig. 3 will shift downward as the degree of spillovers increases.

FC internalizes spillovers while FD ignores them and hence, other things being equal, the presence of spillovers will reduce the welfare edge of FD relative to FC. The intriguing question is how the presence of spillovers would modify the power of tax competition. Our result (iii) shows that when the degree of spillovers is relatively small (i.e., $s < \bar{s}$), FD dominates FC if and only if the degree of capital mobility (and hence tax competition) falls within an intermediate range (i.e., $m \in (\underline{m}, \bar{m})$). Note that $\partial \underline{m}/\partial s > 0$ and $\partial \bar{m}/\partial s < 0$; as a result, once the degree of spillovers is large enough (i.e., $s > \bar{s}$), FD is always dominated by FC. From the definition of $\tilde{m}|_{s>0}$, we also see that the optimal degree of capital mobility preferred by citizens becomes lower if the degree of spillovers increases or the degree to which politicians are rent seeking decreases.

The intuition is as follows. In the absence of tax competition under FC, Leviathan governments will always choose too high a tax rate relative to the optimum. Therefore, tax competition can be again employed to "correct" this excessive Leviathan taxation. However, starting from $m = 0$, a small increase in tax competition is not sufficient to overcome the welfare loss of FD relative to FC due to the presence of spillovers. This explains why $U^d > U^c$ only if m is large enough to exceed $\underline{m}$, which is increasing in s. On the other hand, the presence of spillovers exacerbates the underprovision of public goods caused by tax competition under FD relative to FC. This explains why $U^d > U^c$ only if m is below $\bar{m}$, which is smaller than $\hat{m}$ and decreasing in s. If spillovers are severe enough so that U becomes much lower under FD than FC, no tax competition can overcome and compensate for the welfare loss due to the presence of spillovers. This explains the result of $s > \bar{s}$ stated in Proposition 3 (iii).

With the incorporation of tax competition, our result that FC dominates FD if $s > \bar{s}$ parallels the classical result found by Oates (1972) and Besley and Coate (2003) in the absence of tax competition. However, if $s < \bar{s}$, the outcome becomes a bit more complicated. Whether FC or FD is preferred in terms of welfare in our

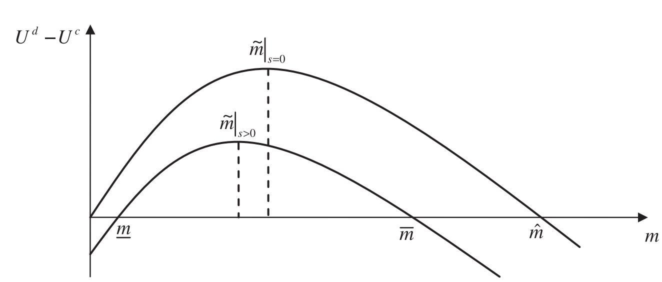

Fig. 3. Welfare effects of FD versus FC in the presence of spillovers.

[24] See also another recent empirical work by Winner (2005), who finds, among other things, a significant negative impact of capital mobility on capital tax burdens for a sample of 23 OECD countries for the time period 1965–2000. One may argue that the evidence of a "race to the bottom" in tax rates is consistent with alternative hypotheses including yardstick competition and a common intellectual trend. Devereux et al. (2008) respond to the argument, showing that it is not well explained by other hypotheses since strategic interactions are generally present only between economies without significant capital controls.

model is more subtle: the spillover effect alone determines the welfare comparison if $s > \bar{s}$, whereas tax competition also plays a role if $s < \bar{s}$.[25]

Contrasting $s > 0$ with $s = 0$ in Fig. 3 enables us to see that the presence of spillovers mitigates the welfare edge of tax competition in taming the Leviathan under FD relative to FC. In particular, Proposition 3 (iii) shows that the welfare edge of tax competition under FD would disappear completely once the degree of spillovers of public goods is large enough. In this sense, leaving out the picture of spillovers in an analysis of tax competition may overweigh the beneficial power of tax competition in taming the Leviathan.

6. Concluding remarks

Economists seem to have an ambivalent attitude toward the force of tax competition. On the one hand, the literature following Wilson (1986) and Zodrow and Mieszkowski (1986) tends to blame tax competition for setting inefficiently low tax rates and undersupplying public goods. On the other hand, the literature following Brennan and Buchanan (1980) tends to praise tax competition for taming Leviathans and mitigating the abuse of taxing power. These two contrasting views reflect not merely different perceptions of governments (Pigouvian versus Leviathan), but also real policy concerns. In this paper, we develop a model to reconcile the two divergent views of tax competition in the context of the choice between FC versus FD in a dynamic framework. We also incorporate spillovers of public expenditures and examine how their presence may modify the power of tax competition. We show that FD dominates FC in terms of economic growth; however, the social welfare difference between FD and FC is non-monotonic and displays a hump-shaped relationship with respect to capital mobility. Since higher capital mobility induces stronger tax competition, this finding implies that there is an optimal level of tax competition; some tax competition is desirable, but fierce tax competition may be harmful. We also show that there is a critical level of spillovers of public goods above which centralization dominates decentralization in terms of social welfare, as in previous studies; however, if spillovers are below this critical level, capital mobility also matters in the welfare comparison between centralized and decentralized systems.

We conclude our paper with several remarks about potential extensions. First, following many others, we model FC versus FD as a discrete choice as if there were no other alternatives. This is of course not true in the real world. One often-observed approach is to complement FD with central government intervention through intergovernmental grants, subsidies, or regulations. The EU's special funds and the US's federal-state transfer and grant programs are examples. As noted by Epple and Nechyba (2004), this approach lies in attempts to combine the benefits of FD with the benefits of FC. A recent study by Hatfield and Padró i Miquel (forthcoming) is also worth noting. They consider a political economy theory of FC versus FD, showing that the capital poor decisive voter would favor a partial degree of decentralization since decentralization with its presence of tax competition provides a commitment to lower excessive capital taxes. In our framework, partial decentralization can be introduced by allowing for a continuum of public goods differentiated by the degree of spillovers. It would then be interesting to analyze how different public goods should be provided by local governments as opposed to a central government. However, these and other related extensions are beyond the scope of our study. A related issue is that we identify FC with "cooperative" solutions while FD is identified with "uncooperative" solutions. This dichotomy may be too simple to hold in the real world. Still, this dichotomous framework provides a useful benchmark to organize the problem.

Secondly, our formulation of politicians' preferences as represented by (3) is obviously a reduced-form approach to politics. Like the standard production function of the firm, this formulation is a "black box" and its details are left unspecified. Because of its "black box" nature, the formulation can be interpreted to accommodate a variety of political institutions and is flexible enough to incorporate a continuum of possible government objectives with the Pigouvian and the Leviathan as two extreme ends. Another advantage of this formulation is that it enables us to focus more on economics than politics in the analysis. Nevertheless, just as unraveling the production function of the firm has been proven to be fruitful, unraveling the political process and making explicit political institutions should be fruitful, too. In fact, the recent political economy approach to FC versus FD is precisely moving in this direction; see Lockwood (2006) for a survey of the literature. Incorporating explicit political institutions into our model should merit further study.

Finally, our model is highly stylized and abstracts from many possible directions of generalization, such as incorporating public capital goods, allowing for labor mobility, taking account of heterogeneous citizens, expanding tax instruments for governments to include labor or consumption taxes, and considering more general utility or production functions. Nonetheless, it is hoped that our simple model may well serve as a useful first approximation to the real world and enable us to focus on what we believe to be the essence of our problem.

Acknowledgments

Chu gratefully acknowledges the support by the Leading Academic Discipline Program, 211 Project for Shanghai University of Finance and Economics (the 3rd phase).

The authors would like to thank Robert Helsley (Co-Editor) and the two anonymous referees for their helpful comments and suggestions. The usual disclaimer applies.

Appendix A

Proof of Lemma 1. Given that there is a unit continuum of citizens indexed by a superscript $h \in [0,1]$ in each jurisdiction, each citizen controls her own capital K_t^h without being able to affect the total capital stock $K_t \equiv \int K_t^h dh$ within the jurisdiction. Therefore, each citizen takes $G_t = g_t K_t$ as given. Each citizen consumes a share c_t^h of her own capital to maximize (1) subject to (2) taking τ_t, τ_t^*, G_t and G_t^* as given. Since citizens are identical, we will suppress the index h from now on. With $\theta_t = 0$, the representative citizen's current-value Hamiltonian becomes

$$\mathrm{H}_t = \ln(c_t K_t) + \mu_t (A - c_t - \tau_t) K_t. \tag{A1}$$

The first-order conditions are

[25] Bjorvatn and Schjelderup (2002) consider interactions between spillovers and tax competition, showing that the existence of spillovers may reduce the extent of tax competition. This result arises because each government realizes that its aggressiveness will dampen the amount of capital income tax collected by other governments and hence their contributions to international public goods. In our model, tax competition is driven by the degree of capital mobility, and spillovers and capital mobility exert their respective effects independently on equilibrium tax rates. By comparison, in Bjorvatn and Schjelderup (2002), tax competition is driven by the number of competing jurisdictions, and equilibrium tax rates are determined by interactions between spillovers and the number of competing jurisdictions.

$$\frac{\partial H_t}{\partial c_t} = \frac{1}{c_t} - \mu_t K_t = 0, \tag{A2}$$

$$\frac{\partial H_t}{\partial K_t} = \frac{1}{K_t} + \mu_t(A - c_t - \tau_t) = \mu_t\rho - \dot{\mu}_t, \tag{A3}$$

$$\frac{\partial H_t}{\partial \mu_t} = (A - c_t - \tau_t)K_t = \dot{K}_t, \tag{A4}$$

and the transversality condition is

$$\lim_{t\to\infty} e^{-\rho\cdot t}\mu_t K_t = 0. \tag{A5}$$

Combining (A3) and (A4) yields

$$\dot{\mu}_t K_t + \mu_t \dot{K}_t = \rho\mu_t K_t - 1. \tag{A6}$$

Integrating (A6) with respect to time yields $\mu_t K_t = e^{\rho\cdot t}\Omega + 1/\rho$, and (A5) implies that the integration constant Ω must equal zero. Therefore, we have

$$\mu_t = (\rho K_t)^{-1}. \tag{A7}$$

Combining (A2) and (A7) yields

$$C_t = \rho \cdot K_t. \tag{A8}$$

Substituting (A8) into (A4) shows that $\gamma_t \equiv \dot{K}_t/K_t = A - \rho - \tau_t$.

From (A7), $\mu_0 = (\rho \cdot K_0)^{-1}$ is predetermined and hence non-controllable in the sense that μ_0 cannot be manipulated by changing the government policy. Thus it is implied from (A2) that c_t is also non-controllable and, as a result, the government policy is time consistent; see Karp and Lee (2003). In this case, there are two ways to solve the government problem; see Xie (1997). First, taking the citizens' best response as given, the central government chooses T_t, T_t^*, R_t, R_t^*, G_t and G_t^* to maximize (4) subject to the balanced budget, (A3) and (A4) (i.e., treating μ_t as a state variable in the optimization problem). Alternatively, by exploiting the relationship between μ_t and c_t, one can directly substitute (A8) into (4) and (A4) without explicitly invoking (A3). We follow the second approach. Furthermore, solving for the symmetric equilibrium is the same as solving for the equilibrium outcome in each jurisdiction by internalizing the spillovers, so we will only derive the solution for $T_t = \tau_t K_t$, $R_t = r_t K_t$ and $G_t = g_t K_t$ to conserve space. The current-value Hamiltonian for the central government is

$$\begin{aligned}\widetilde{H}_t = {} & (1-L)[\ln(\rho K_t) + \ln(g_t K_t)] + L\ln(r_t K_t) + \lambda_t(\tau_t - g_t \\ & - r_t)K_t + \tilde{\mu}_t(A - \rho - \tau_t)K_t,\end{aligned} \tag{A9}$$

where λ_t is the multiplier for the balanced-budget condition $T_t = G_t + R_t$.[26] The first-order conditions are

$$\frac{\partial \widetilde{H}_t}{\partial g_t} = \frac{1-L}{g_t} - \lambda_t K_t = 0, \tag{A10}$$

$$\frac{\partial \widetilde{H}_t}{\partial r_t} = \frac{L}{r_t} - \lambda_t K_t = 0, \tag{A11}$$

$$\frac{\partial \widetilde{H}_t}{\partial \tau_t} = \lambda_t K_t - \tilde{\mu}_t K_t = 0, \tag{A12}$$

$$\frac{\partial \widetilde{H}_t}{\partial \lambda_t} = (\tau_t - g_t - r_t)K_t = 0, \tag{A13}$$

$$\frac{\partial \widetilde{H}_t}{\partial K_t} = \frac{2(1-L)+L}{K_t} + \lambda_t(\tau_t - g_t - r_t) + \tilde{\mu}_t(A - \rho - \tau_t) = \tilde{\mu}_t\rho - \dot{\tilde{\mu}}_t, \tag{A14}$$

$$\frac{\partial \widetilde{H}_t}{\partial \tilde{\mu}_t} = (A - \rho - \tau_t)K_t = \dot{K}_t, \tag{A15}$$

and the transversality condition is

$$im_{t\to\infty} e^{-\rho t}\tilde{\mu}_t K_t = 0. \tag{A16}$$

(A10)–(A12) implies that $R_t/L = G_t/(1-L) = 1/\lambda_t = 1/\tilde{\mu}_t$ for all t. Applying these conditions to (A13) yields

$$\tau_t K_t = \left(\frac{1}{1-L}\right)G_t = \frac{1}{\lambda_t} = \frac{1}{\tilde{\mu}_t}. \tag{A17}$$

Substituting (A17) into (A14) and then combining the resulting expression with (A15) yields

$$\dot{\tilde{\mu}}_t K_t + \tilde{\mu}_t \dot{K}_t = \rho \cdot \tilde{\mu}_t K_t - (2-L). \tag{A18}$$

Integrating (A18) with respect to time yields

$$\tilde{\mu}_t K_t = e^{\rho\cdot t}\tilde{\Omega} + (2-L)/\rho. \tag{A19}$$

(A16) implies that the integration constant $\widetilde{\Omega}$ must equal zero. Therefore, we have

$$\tilde{\mu}_t K_t = (2-L)/\rho. \tag{A20}$$

for all t. Then, substituting (A20) into (A17) yields

$$\tau_t = \rho\left(\frac{1}{2-L}\right) \tag{A21}$$

for all t. Substituting (A21) into (A15) yields

$$\gamma_t = A - \rho - \rho/(2-L). \tag{A22}$$

for all t. Substituting (A21) into (A17) yields

$$G_t = \rho\left(\frac{1-L}{2-L}\right)K_t. \tag{A23}$$

Define $f_t \equiv G_t/(\tau_t K_t) = 1 - L$ for all t.

Finally, we need to verify that the second-order conditions are satisfied. They are satisfied because the control sets (i.e., c_t, τ_t, g_t and r_t) that we specified are convex, the instantaneous payoff functions are strictly concave in K, and the accumulation equation is linear in K (see Leonard and Long, 1992, Section 6.5).

Proof of Lemma 2. As in the proof for Lemma 1, each citizen takes $G_t = g_t K_t$ and $G_t^* = g_t^* K_t^*$ as given. Taking τ_t, τ_t^*, G_t and G_t^* as given, the representative citizen chooses $C_t = c_t K_t$ and $F_t = \theta_t K_t$ to maximize (1) subject to (2). The current-value Hamiltonian is

$$H_t = \ln(c_t K_t) + \mu_t\left[A - c_t - \tau_t(1-\theta_t) - \tau_t^*\theta_t - (\theta_t)^2/m\right]K_t, \tag{A24}$$

The first-order conditions are

$$\frac{\partial H_t}{\partial c_t} = \frac{1}{c_t} - \mu_t K_t = 0, \tag{A25}$$

$$\begin{aligned}\frac{\partial H_t}{\partial K_t} &= \frac{1}{K_t} + \mu_t[A - c_t - \tau_t(1-\theta_t) - \tau_t^*\theta_t - (\theta_t)^2/m] \\ &= \mu_t\rho - \dot{\mu}_t,\end{aligned} \tag{A26}$$

$$\frac{\partial H_t}{\partial \mu_t} = [A - c_t - \tau_t(1-\theta_t) - \tau_t^*\theta_t - (\theta_t)^2/m]K_t = \dot{K}_t, \tag{A27}$$

$$\frac{\partial H_t}{\partial \theta_t} = \mu_t(\tau_t - \tau_t^* - 2\theta_t/m)K_t = 0. \tag{A28}$$

(A28) yields the optimal capital-allocation rule given by

$$\theta_t = (m/2)(\tau_t - \tau_t^*). \tag{A29}$$

[26] It is useful to note that while each household chooses consumption to affect individual capital accumulation, the government chooses the tax rate to affect aggregate capital accumulation.

The transversality condition is $\lim_{t\to\infty} e^{-}\rho_t \mu_t K_t = 0$. Combining (A25), (A26) and A27) yields

$$\dot{\mu}_t K_t + \mu_t \dot{K}_t = \rho \mu_t K_t - 1. \tag{A30}$$

Integrating (A30) with respect to time yields $\mu_t K_t = e^{\rho \cdot t}\Omega + 1/\rho$. The transversality condition implies that the integration constant Ω must equal zero, and we have $\mu_t = (\rho \cdot K_t)^{-1}$. Because $\mu_0 = (\rho . K_0)^{-1}$ is predetermined, it is non-controllable. From (A25), the optimal consumption path is

$$C_t = \rho \cdot K_t. \tag{A31}$$

Substituting (A31) into (A27) yields $\gamma_t = A - \rho - \tau_t(1-\theta_t) - \tau_t'\theta_t - (\theta_t)^2/m$.

Taking (A31), τ_t^* and g_t^* as given, each local government chooses $R_t = r_t K_t$, $G_t = g_t K_t$ and $T_t = \tau_t(D_t + F_t^*) = \tau_t[(1-\theta_t)K_t + \theta_t^* K_t^*]$ to maximize (3) subject to (10), (A27) and (2′). The current-value Hamiltonian is

$$\begin{aligned}\widetilde{\mathrm{H}}_t = {} & (1-L)\left[\ln(\rho . K_t) + (1-s)\ln(g_t K_t) + s\ln\left(g_t^* K_t^*\right)\right] + L \\ & \times \ln(r_t K_t) + \lambda_t\{\tau_t[(1-\theta_t)K_t + \theta_t^* K_t^*] - g_t K_t - r_t K_t\} \\ & + \tilde{\mu}_t\left[A - \rho - \tau_t(1-\theta_t) - \tau_t^*\theta_t - (\theta_t)^2/m\right]K_t \\ & + \tilde{\mu}_t^*\left[A - \rho - \tau_t^*(1-\theta_t^*) - \tau_t\theta_t^* - (\theta_t^*)^2/m\right]K_t^*,\end{aligned} \tag{A32}$$

where $\theta_t = (m/2)(\tau_t - \tau_t^*)$ and $\theta_t^* = (m/2)(\tau_t^* - \tau_t)$. Imposing symmetry (i.e., $\tau_t = \tau_t^*$ for all t) on the first-order conditions yields

$$\frac{\partial \widetilde{\mathrm{H}}_t}{\partial g_t} = \frac{(1-s)(1-L)}{g_t} - \lambda_t K_t = 0, \tag{A33}$$

$$\frac{\partial \widetilde{\mathrm{H}}_t}{\partial r_t} = \frac{L}{r_t} - \lambda_t K_t = 0, \tag{A34}$$

$$\frac{\partial \widetilde{\mathrm{H}}_t}{\partial \tau_t} = \lambda_t[K_t - \tau_t(m/2)(K_t + K_t^*)] - \tilde{\mu}_t K_t = 0, \tag{A35}$$

$$\frac{\partial \widetilde{\mathrm{H}}_t}{\partial \lambda_t} = (\tau_t - g_t - r_t)K_t = 0, \tag{A36}$$

$$\begin{aligned}\frac{\partial \widetilde{\mathrm{H}}_t}{\partial K_t} &= \frac{1+(1-s)(1-L)}{K_t} + \lambda_t(\tau_t - g_t - r_t) + \tilde{\mu}_t(A - \rho - \tau_t) \\ &= \tilde{\mu}_t\rho - \dot{\tilde{\mu}}_t,\end{aligned} \tag{A37}$$

$$\frac{\partial \widetilde{\mathrm{H}}_t}{\partial K_t^*} = \frac{(1-L)s}{K_t^*} + \tilde{\mu}_t^*(A - \rho - \tau_t^*) = \tilde{\mu}_t^*\rho - \dot{\tilde{\mu}}_t^*, \tag{A38}$$

$$\frac{\partial \widetilde{\mathrm{H}}_t}{\partial \tilde{\mu}_t} = (A - \rho - \tau_t)K_t = \dot{K}_t, \tag{A39}$$

$$\frac{\partial \widetilde{\mathrm{H}}_t}{\partial \tilde{\mu}_t^*} = (A - \rho - \tau_t^*)K_t^* = \dot{K}_t^*, \tag{A40}$$

and the transversality conditions are

$$\lim_{t\to\infty} e^{-\rho \cdot t}\tilde{\mu}_t K_t = 0, \tag{A41}$$

$$\lim_{t\to\infty} e^{-\rho \cdot t}\tilde{\mu}_t^* K_t^* = 0. \tag{A42}$$

Given $K_0 = K_0^*$, $\tau_t = \tau_t^*$ implies that $K_t = K_t^*$ for all $t$from (A39) and (A40). Then, (A33)–(A35) implies that $R_t/L = G_t/[(1-s)(1-L)] = 1/\lambda_t = (1-\tau_t m)/\tilde{\mu}_t$ for all t. Then, applying these equalities to (A36) yields

$$\begin{aligned}\tau_t K_t &= \left(\frac{L+(1-s)(1-L)}{(1-s)(1-L)}\right)G_t = \frac{L+(1-s)(1-L)}{\lambda_t} \\ &= \frac{L+(1-s)(1-L)}{\tilde{\mu}_t/(1-\tau_t m)}.\end{aligned} \tag{A43}$$

Combining (A37) and (A39) yields

$$\dot{\tilde{\mu}}_t K_t + \tilde{\mu}_t \dot{K}_t = \rho \cdot \tilde{\mu}_t K_t - [1 + (1-s)(1-L)]. \tag{A44}$$

Integrating (A44) with respect to time yields

$$\tilde{\mu}_t K_t = e^{\rho \cdot t}\widetilde{\Omega} + [1 + (1-s)(1-L)]/\rho. \tag{A45}$$

(A41) implies that the integration constant $\widetilde{\Omega}$ must equal zero. Therefore, we have

$$\tilde{\mu}_t K_t = [1 + (1-s)(1-L)]/\rho. \tag{A46}$$

for all t. Then, substituting (A46) in (A43) yields

$$\tau_t = \rho\left(\frac{L+(1-s)(1-L)}{1+(1-s)(1-L)+m\rho[L+(1-s)(1-L)]}\right). \tag{A47}$$

for all t. Substituting (A47) into (A39) yields

$$\gamma_t = 1 - \rho - \rho\left(\frac{L+(1-s)(1-L)}{1+(1-s)(1-L)+m\rho[L+(1-s)(1-L)]}\right). \tag{A48}$$

for all t. Substituting (A47) into (A43) yields

$$G_t = \rho\left(\frac{(1-s)(1-L)}{1+(1-s)(1-L)+m\rho[L+(1-s)(1-L)]}\right)K_t. \tag{A49}$$

Define $f_t \equiv G_t/T_t = \frac{(1-s)(1-L)}{L+(1-s)(1-L)}$. Finally, similar to the Proof of lemma 1, one can verify that the second-order conditions are satisfied.

Proof of Proposition 2. Using Lemmas 1 and 2, (16) with $s = 0$ gives

$$\rho(U^d - U^c) = \ln\left(\frac{2-L}{2-L+m\rho}\right) + 2\left(\frac{1}{2-L} - \frac{1}{2-L+m\rho}\right). \tag{A50}$$

Differentiating (A50) with respect to m yields

$$\frac{\partial\rho(U^d - U^c)}{\partial m} = \frac{-\rho}{2-L+m\rho} + \frac{2\rho}{(2-L+m\rho)^2} = \frac{\rho(L-m\rho)}{(2-L+m\rho)^2}.$$

Since $\partial^2(U^d - U^c)/\partial m^2 < 0$, $\rho\,(U^d - U^c)$ is a concave function in m and reaches its maximum at $\tilde{m}|_{s=0} = L/\rho$.

Proof of (i): From Lemmas 1 and 2, $\tau^c = \tau^d$, $f^c = f^d$ and $\gamma^c = \gamma^d$ if $s = m = 0$. Thus, $U^d = U^c$ by (16).

Proof of (ii): $m = \infty$ implies that $\tau^d = 0$ from (12). Since $f^c = f^d > 0$ and $\tau^c > 0$ by Lemmas 1 and 2, the term $\ln(G_0^d/G_0^c)$ in (16) goes to negative infinity.

Proof of (iii): Because (a) $U^d - U^c = 0$ at $m = 0$, and (b) $U^d - U^c$ is concave in m and reaches its maximum at $\tilde{m}|_{s=0} = L/\rho$, there must exist an $\hat{m} > \tilde{m}|_{s=0}$ to uphold $U^d = U^c$. Let $U^d = U^c$, then taking the total differential of (A50) yields

$$\frac{d\hat{m}}{dL} = \left(\frac{L}{(2-L)^2} + \frac{\hat{m}\rho - L}{(2-L-\hat{m}\rho)^2}\right) \Big/ \left(\frac{\rho(\hat{m}\rho - L)}{(2-L+\hat{m}\rho)^2}\right).$$

We know that $\hat{m} > \tilde{m}|_{s=0} = L/\rho > 0$ so that $d\hat{m}/dL > 0$. Setting $U^d = U^c$ in (A50), we obtain (a) $\hat{m} \to 0$ as $L \to 0$, and (b) $\hat{m} \to x$ with x satisfying $(1 + x\rho)\ln(1 + x\rho) = 2x\rho$ as $L \to 1$.

Proof of Proposition 3. From Lemmas 1 and 2 and (16)

$$\begin{aligned}\rho(U^d - U^c) = {} & \ln\left(\frac{(1-s)(2-L)}{1+(1-s)(1-L)+m\rho[L+(1-s)(1-L)]}\right) \\ & + 2\left(\frac{1}{2-L} - \frac{L+(1-s)(1-L)}{1+(1-s)(1-L)+m\rho[L+(1-s)(1-L)]}\right).\end{aligned} \tag{A51}$$

To show that $U^d - U^c$ is concave in m, differentiating (A51) with respect to m yields

$$\frac{\partial\rho(U^d - U^c)}{\partial m} = \frac{-\rho[L + (1-s)(1-L)]}{1 + (1-s)(1-L) + m\rho[L + (1-s)(1-L)]} + 2\rho\left(\frac{L + (1-s)(1-L)}{1 + (1-s)(1-L) + m\rho[L + (1-s)(1-L)]}\right)^2.$$

Since $\partial^2(U^d - U^c)/\partial m^2 < 0, \rho(U^d - U^c)$ is a concave function in m and reaches its maximum at $\tilde{m}|_{s>0} = \max\left(0, \frac{2L-1+(1-s)(1-L)}{\rho[L+(1-s)(1-L)]}\right)$. In addition, $\partial\tilde{m}|_{s>0}/\partial L > 0$ and $\partial\tilde{m}|_{s>0}/\partial s < 0$.

Next, we show that $U^d - U^c$ is decreasing in s. Differentiating (A51) with respect to s yields

$$\frac{\partial\rho(U^d - U^c)}{\partial s} = -\frac{1}{1-s} + \frac{(1-L)}{1 + Lm\rho + (1+m\rho)(1-s)(1-L)} \times \left(1 + m\rho + \frac{2(1-L)}{1 + Lm\rho + (1+m\rho)(1-s)(1-L)}\right).$$

Finally, we show that $\frac{\partial\rho(U^d - U^c)}{\partial s} < 0$

$$\begin{aligned} &\Longleftrightarrow \left(1 + m\rho + \frac{2(1-L)}{1 + Lm\rho + (1+m\rho)(1-s)(1-L)}\right) < \frac{1 + Lm\rho + (1+m\rho)(1-s)(1-L)}{(1-s)(1-L)} \\ &\Longleftrightarrow (1 + Lm\rho)^2 + (1 + Lm\rho)(1+m\rho)(1-s)(1-L) - 2(1-s)(1-L)^2 > 0 \\ &\Longleftrightarrow \underbrace{\{(1 + Lm\rho)^2 - (1-s)(1-L)^2\}}_{>0} + \underbrace{\{(1 + Lm\rho)(1+m\rho) + L - 1\}}_{>0}(1-s)(1-L) > 0. \end{aligned}$$

Proof of (i): Given $\partial\rho(U^d - U^c)/\partial s < 0, U^d < U^c$ if $m = 0$ and $s > 0$.

Proof of (ii): $m = \infty$ implies that $\tau^d = 0$ from (12). Since $f^c > f^d > 0$ and $\tau^c > 0$ by Lemmas 1 and 2, the term $\ln\left(G_0^d/G_0^c\right)$ in (16) goes to negative infinity.

Proof of (iii): Because (a) $U^d < U^c$ with $s > 0$ at $m = 0$, (b) U^c is independent of m, and (c) U^d is concave in m and reaches its maximum at $\tilde{m}(s > 0)$, either there must exist $\underline{m}$ and $\bar{m}$ with $\underline{m} < \tilde{m}|_{s>0} < \bar{m}$ such that $U^d > U^c$ if $m \in (\underline{m}, \bar{m})$ or $U^d < U^c$ for all m. Since $U^d - U^c$ is decreasing in s at any m and $U^d - U^c$ is concave in m, it must be the case that $\partial\underline{m}/\partial s > 0$ and $\partial\bar{m}/\partial s < 0$. In addition, the case in which $U^d < U^c$ for all m occurs if s is large enough. To see this, evaluating $(U^d - U^c)$ at $m = \tilde{m}|_{s>0}$ yields

$$U^d - U^c = \ln\left(\frac{(1-s)(2-L)}{2(1-s)(1-L) + 2L}\right) + 2\left(\frac{1}{2-L} - \frac{L + (1-s)(1-L)}{2(1-s)(1-L) + 2L}\right).$$

Note that $U^d - U^c > 0$ if and only if $s < \bar{s}$, where $\bar{s}$ solves $U^d - U^c = 0$ at $m = \tilde{m}|_{s>0}$. $\bar{s}$ is an implicit function in L that needs to be solved numerically. It turns out that $\bar{s}(L)$ is strictly increasing in L, $\bar{s}(L) \to 0$ as $L \to 0$, and $\bar{s}(L) \to 1 - (2/e) \approx 0.2642$ as $L \to 1$.

References

Acemoglu, D., 2009. Introduction of Modern Economic Growth. Princeton University Press.
Besley, T., Coate, S., 2003. Centralized versus decentralized provision of local public goods: a political economy approach. Journal of Public Economics 87, 2611–2637.
Bjorvatn, K., Schjelderup, G., 2002. Tax competition and international public goods. International Tax and Public Finance 9, 111–120.
Brennan, G., Buchanan, J.M., 1980. The Power to Tax: Analytical Foundations of a Fiscal Constitution. Cambridge University Press, New York.
Bretschger, L., Hettich, F., 2002. Globalization, capital mobility and tax competition: theory and evidence for OECD countries. European Journal of Political Economy 18, 695–716.
Brueckner, J.K., 1999. Fiscal federalism and capital accumulation. Journal of Public Economic Theory 1, 205–224.
Brueckner, J.K., 2000. A Tiebout/tax-competition model. Journal of Public Economics 77, 285–306.
Brueckner, J.K., 2004. Fiscal decentralization with distortionary taxation: Tiebout vs. tax competition. International Tax and Public Finance 11, 133–153.
Brueckner, J.K., 2006. Fiscal federalism and economic growth. Journal of Public Economics 90, 2107–2120.
Devereux, M.B., Mansoorian, A., 1992. International fiscal policy coordination and economic growth. International Economic Review 33, 249–268.
Devereux, M.P., Lockwood, B., Redoano, M., 2008. Do countries compete over corporate tax rates? Journal of Public Economics 92, 1210–1235.
Dockner, E.J., Jorgensen, S., Long, N.V., Sorger, G., 2000. Differential Games in Economics and Management Science. Cambridge University Press.
Edwards, J., Keen, M., 1996. Tax competition and Leviathan. European Economic Review 40, 113–134.
Epple, D., Nechyba, T., 2004. Fiscal decentralization. In: Henderson, J.V., Thisse, J.F. (Eds.), Handbook of Regional and Urban Economics, vol. 4.
Fudenberg, D., Tirole, J., 1991. Game Theory. MIT Press.
Guvenen, F., 2006. Reconciling conflicting evidence on the elasticity of intertemporal substitution: a macroeconomic perspective. Journal of Monetary Economics 53, 1451–1472.
Hatfield, J., 2009. Federalism, Taxation, and Economic Growth. Stanford University Working Paper.
Hatfield, J., Padró i Miquel, G., forthcoming. A political economy theory of partial decentralization. Journal of the European Economic Association.
Haufler, A., 2008. Taxation in a Global Economy: Theory and Evidence. Cambridge University Press.
Karp, L., Lee, I.H., 2003. Time-consistent policies. Journal of Economic Theory 112, 353–364.
Keen, M., 1993. The welfare economics of tax co-ordination in the European community: a survey. Fiscal Studies 14, 15–36.
Kehoe, P.J., 1989. Policy cooperation among benevolent governments may be undesirable. Review of Economic Studies 56, 289–296.
Koethenbuerger, M., Lockwood, B., 2010. Does tax competition really promote growth? Journal of Economic Dynamics and Control 34, 191–206.
Lejour, A., Verbon, H.A., 1997. Tax competition and redistribution in a two-country endogenous-growth model. International Tax and Public Finance 4, 485–497.
Leonard, D., Long, N.V., 1992. Optimal Control Theory and Static Optimization in Economics. Cambridge University Press.
Lockwood, B., 2002. Distributive politics and the costs of centralization. Review of Economic Studies 69, 313–337.
Lockwood, B., 2006. Fiscal decentralization: a political economy perspective. In: Ahmad, E., Brosio, G. (Eds.), Handbook of Fiscal Federalism. Edward Elgar.
Monadjemi, M., Loadewijks, J., 2003. Testing changes in international capital mobility: evidence from current account and real interest rates. ICFAI Journal of Applied Economics 4, 21–31.
Oates, W.E., 1972. Fiscal Federalism. Harcourt Brace Jovanovich, New York.
Oates, W.E., 2005. Toward a second-generation theory of fiscal federalism. International Tax and Public Finance 12, 349–373.
Obstfeld, M., 1996. International Capital Mobility in the 1990s. NBER Working Paper No. W4534.
Persson, T., Tabellini, G., 1992. The politics of 1992: fiscal policy and European integration. Review of Economic Studies 59, 689–701.
Rauscher, M., 1998. Leviathan and competition among jurisdictions: the case of benefit taxation. Journal of Urban Economics 44, 59–67.
Rauscher, M., 2000. Interjurisdictional competition and public-sector prodigality: the triumph of the market over the state? FinanzArchiv 57, 89–105.
Rauscher, M., 2005. Economic growth and tax-competing Leviathans. International Tax and Public Finance 12, 457–474.
Razin, A., Yuen, C-W., 1999. Optimal international taxation and growth rate convergence: tax competition vs coordination. International Tax and Public Finance 6, 61–78.
Tiebout, C.M., 1956. A pure theory of local expenditures. Journal of Political Economy 64, 416–424.
Wellisch, D., 2000. Theory of Public Finance in a Federal State. Cambridge University Press.

Wildasin, D.E., 1989. Interjurisdictional capital mobility: fiscal externality and a corrective subsidy. Journal of Urban Economics 25, 193–212.
Wilson, J.D., 1986. A theory of interregional tax competition. Journal of Urban Economics 19, 296–315.
Wilson, J.D., 2005. Welfare-improving competition for mobile capital. Journal of Urban Economics 57, 1–18.
Winner, H., 2005. Has tax competition emerged in OECD countries? Evidence from panel data. International Tax and Public Finance 12, 667–687.
Xie, D., 1997. On time inconsistency: a technical issue in Stackelberg differential games. Journal of Economic Theory 76, 412–430.
Zodrow, G.R., Mieszkowski, P.M., 1986. Pigou, Tiebout, property taxation and the underprovision of local public goods. Journal of Urban Economics 19, 356–370.