Federalism, Taxation, and Economic Growth

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Abstract

We present a model of endogenous growth where government provides a productive public good financed by income and capital taxes. In equilibrium, a decentralized government chooses tax policy to maximize economic growth, while a centralized government does not do so. Furthermore, these conclusions hold regardless of whether governments are beholden to a median voter or are rent-maximizing Leviathans. However, a decentralized government will underprovide a hedonic public good, while a central government beholden to the median voter will optimally invest in the hedonic public good.

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1 Introduction

Understanding how economic policy influences economic growth and welfare is one of the foremost challenges for today's economists. And yet understanding this relationship between economic growth and economic policy is only half the job. Economic policy is not decided by benevolent social planners, but by government officials, usually with at least one eye to their reelection prospects. Within this political context, we consider the question of how a centralized or decentralized government results in different economic policies, and hence in different growth outcomes. We show that, when capital is mobile across jurisdictions, decentralizing government policy decisions will enhance growth.

This question of is of foremost importance for development economists in particular. Dillinger (1994) reports that all but twelve of the world's seventy-five largest countries claim to be devolving political power to local government, and the devolution of political power is promoted as an instrument to encourage economic gains in the developing world (Bardhan, 2002). However, there is no simple answer to the question "Does federalism promote growth?". The question itself is ill-posed, as there are many different forms of federalism throughout the world; as Rodden (2004) points out, it is difficult to do empirical work on how decentralization affects outcomes, as using different measures of decentralization lead to very different conclusions regarding which countries are more decentralized.

This complexity calls for both careful theoretical and empirical work. In particular, theoretical work in this area must specify the form of decentralization necessary for predicted outcomes to take place. This theoretical literature can be divided, roughly, into three categories.

In the first category, many papers stress that decentralization places decisionmaking power in the hands of local politicians and that these local politicians are more accountable to voters. For instance, Besley and Case (1995) and Seabright (1996) argue that if voters can compare outcomes in different regions, then voters can more accurately observe actions by politicians, and this additional information enables voters to make better decisions. Although these "yardstick competition" models do not consider growth directly, they imply that political decisions will be of higher quality in decentralized regimes, which may lead to higher economic growth. However, in these models, since subnational units interact only politically, economic relationships across districts such as trade and capital movement are not necessary for decentralization to enhance growth. In contrast, our model relies on capital competition between subnational units as the driving factor in enhancing growth under decentralized government.

The second category of theoretical work on growth and decentralization relies on subnational units being able to better tailor their investments in public goods to local tastes. Oates (1993) argues that local leaders have better knowledge of local conditions, and so they will invest more efficiently in productive public goods than a less knowledgeable central government. Heterogeneity in local conditions may be due to the sorting of agents amongst jurisdictions, as first described by Tiebout (1956). Brueckner (1999) and Brueckner (2006) consider this effect in the context of age-related sorting, showing that this sorting may increase the incentives of agents to save and hence enhance economic growth. In contrast, our model posits no informational gap between the local and national authorities or sorting amongst jurisdictions, but instead relies on capital competition via the setting of tax rates as the driving factor in enhancing growth under decentralized government. This leads to different empirical predictions regarding the nature of decentralization and growth. In particular, for the mechanisms identified by Oates to function, all that is necessary is to decentralize spending decisions; higher growth outcomes will be realized when revenues are collected by a centralized government and then distributed to the states. In the papers by Brueckner, while it is important that the local governments can set the level of taxation (to reflect local tastes), there is no sense in which districts compete for capital. Our paper argues that additional growth gains should be realized by allowing for districts to compete for investment.

The third category of literature considers directly the effects of competition between subnational units for productive investment, and is most pertinent to our work here. Previous work on the decentralization of revenue provision has been dominated by the work of Zodrow and Mieszkowski (1986). These authors show that interjurisdictional tax competition may lead to a "race to the bottom", where productivity-enhancing public goods are underprovided by the subnational units in an effort to attract taxable but mobile factors of production.[1] A naïve reading of these works would imply that economic growth is lower under a decentralized regime. However, the work by Zodrow and Mieszkowski and others only considers the static problem, where agents' investment in capital is fixed.

In our work we consider the dynamic problem, where either a unitary central government or subnational district governments make taxation decisions and invest

[1] Wildasin (1988) and Wilson (1986) provide similar insights. See Wilson (1999) for a summary of this literature.

in productive public goods, and agents decide how much capital to accumulate.[2] This paper is the first, so far as we are aware, to explicitly consider the effects of capital tax competition on the savings decisions by individual agents.[3,4] We show that once the effects of taxation on individual investors' decisions are taken into account, the competition between districts drives policymakers to choose the policies which maximize economic growth.[5]

We use a model of endogenous growth, first developed by Uzawa (1965), and later expanded by Lucas (1988) and Barro (1990), among others. Barro's work includes a role for government, which provides a public good necessary for production, and this public good must be financed by taxation. Alesina and Rodrik (1994) show that in the Barro model, a centralized government with access to one tax instrument, a capital tax, will choose a tax rate that is too high to maximize economic growth.

In our work, we consider the case where governments have access to two tax instruments, a capital tax and a tax on labor income that is used to finance a productive public good. We show that, for a centralized government, a Condorcet winning policy exists and in equilibrium this policy does not maximize economic growth, similar to the results of Alesina and Rodrik (1994). The median voter is willing to sacrifice an increase in the growth rate for a higher level of starting consumption, and so a government concerned with the welfare of the median voter will choose tax policies to achieve this goal, by increasing the rate of return on labor at the expense of decreasing the rate of return of capital. In contrast, district level governments face the problem of attracting capital in order to increase the wages of workers within the district. This capital competition leads a district to choose policies that are the most favorable for capital, as that maximizes the wages (and hence the welfare) of the district's residents. These higher returns to capital induce agents to save more, and so interjurisdictional competition leads to higher economic growth.

While this paper considers the differences of how a federal versus a centralized

[2] Davoodi and Zou (1998) consider a different model where the allocation amongst productive public goods between the unitary central government and subnational governments is fixed, and all taxation decisions are made by the central government.

[3] A similar mechanism is used in Koethenburger and Lockwood (2009), which explicitly builds on the model developed in this work to consider the effects of region-specific shocks.

[4] In a subsequent paper, Hatfield and Padró i Miquel (2010), buliding on Rogoff (1985), consider how decentralization can be used as a precommitment device to lower capital taxation. In this paper, we show that even when the central government can fully commit decentralization may enhance growth.

[5] A related paper by Rauscher (2007) does allow for districts to compete for capital investment, but is concerned with how this affects the incentives of governments to invest in innovation for public services, and does not allow governments to compete directly for capital via taxation policies. Our work here centers on how competition for capital via taxation policies affects economic growth.

government affects tax policy and economic growth, our work also has implications for the political economy effects of international capital mobility. Both Obstfeld (1998) and DeLong (2004) consider issues of how the possibility of such capital flows may help to reduce incentives for corruption. The political economy effects of international capital mobility, however, are more general than simply stemming corruption. With international capital mobility, agents (and hence politicians) within a country are no longer directly concerned about internal rates of return on capital, but they must now worry about such issues as capital flight and foreign investment, and its effects on wages. These effects, again, can be seen as either beneficial or harmful—witness the current debate in Europe over tax harmonization. A world with capital controls would be analogous to our model with a centralized government, while a world with international capital mobility would be analogous to our model with a decentralized government structure. Hence, our paper could be seen as an argument that, with capital mobility, tax competition between nation-states will lead to higher economic growth.[6]

There is a also a large empirical literature on the relationship between growth and decentralization. This literature can be divided, roughly, into three categories.[7] The first category is cross-country regressions, where economic growth is regressed on a measure of decentralization such as local revenue share or local expenditure share. The results of this empirical exercise have been inconclusive, with Davoodi and Zou (1998) finding a negative relationship between fiscal decentralization and economic growth, Woller and Phillips (1998), Xie et al. (1999), Thornton (2007), and Baskaran and Feld (2009) not finding any clear relationship, and Yilmaz (1999), Thiessen (2003), and Iimi (2003) finding a positive relationship between fiscal decentralization and growth. One reason these works find different conclusions is that they do not agree on what variable captures the degree of fiscal dentralization: Davoodi and Zou (1998), Xie et al. (1999), and Iimi (2003) use the degree of decentralization of expenditures, while Thornton (2007) and Baskaran and Feld (2007) use revenue decentralization, and Woller and Phillips (1998) and Thiessen (2003) use both measures.[8] In the context of our model, revenue decentralization is of central importance, while expenditure decentralization would be central in the context of Oates (1993).

[6]This may be of particular interest for the nations of the European Union, which is engaged in a long-running debate over the benefits of tax harmonization versus tax competition. See, for instance, Kirchgässner and Pommerenhe (1996).

[7]For a recent survey of emprical work in this area, see Boadway and Shah (2009).

[8]Furthermore, Rodden (2004) and Ebel and Yilmaz (2002) argue that much of the empirical work using cross-country regressions to consider the effects of federalism is ill-posed, as decentralization is a mutifaceted phenomenon, while most studies use a unidimensional measure.

Furthermore, fiscal decentralization in the cross-country context may be endogenous, in the sense that the degree of decentralization within a country may be correlated with other factors that influence growth, such as the size of the country, or whether it uses common or civil law.

The second category of the empirical literature in this area considers a particular country and how variation in the local share of government revenues and expenditures across provinces or states affects outcomes. Zhang and Zou (1998) find a negative effect of decentralization in China, while Akai and Sakata (2002) find a positive effect of decentralization with the U.S. However, both of these papers may also suffer from an endogeneity bias similar to that in cross-country regressions: Low or high growth within a particular subnational unit may influence the taxation and expenditure decisions by the government of that unit.

Finally, the third category of literature considers inter-jurisdictional competition directly. Instead of measuring (possibly endogenous) differences in taxation and expenditures of various levels of government, this literature considers the number of jurisdictions within a geographical unit as a measure of competition. This estimation methodology eliminates the difficulties inherent in cross-country comparisons, and, as the work centers on the U.S. context, ensures that the local jurisdictions have significant power over revenue raising decisions; this work is probably the most helpful in evaluating the effects of decentralization as defined in this paper. Furthermore, the emprirical work in this category is more conclusive: both Stansel (2005) and Hatfield and Kosec (2010) use this methodology to find a strong positive effect of inter-jurisdictional competition on growth and wages in U.S. cities, implying a positive effect of decentralization on growth.

The next section of this paper establishes the model we shall use throughout the paper, characterizes the equilibrium economic policy of centralized and decentralized governments beholden to a median voter, and considers the effects of restricting the set of tax instruments available to the government. Section 3 considers the provision of a hedonic public good, and shows that it is provided only within a centralized regime. Section 4 shows that the proposition that tax policy will be growth-maximizing if and only if government is decentralized holds for Leviathan governments as well. Section 5 considers externalities between districts. The last section concludes. All proofs are in the Appendix.

2 Model

The nation is comprised of J districts. Each district has a continuum of agents of mass 1, each of whom is infinitely lived. At time 0, members of each district vote on a taxation policy for all time. Afterwards, at each time t, agents choose their labor input, where to invest their capital, and their consumption, taking future wages and capital returns as given.

2.1 Economic Model

There are three factors of production used within each district: capital (k_j), labor (l_j), and productive government services (g_j), where the subscript j refers to the district. The economy considered here is a closed economy, as the sum of capital investment in the J districts must equal the total amount of capital held by the populace; capital can move freely from district to district however.[9] We denote by k_j the amount of capital invested in productive activities within the district. Capital should be thought of in an expansive sense to include physical and other forms of mobile capital. Government services can be thought of as funding for police, roads, protection of property rights, etc.[10] Our production function, adapted from Barro (1990), is

$$y_j(t) = Ag_j(t)^{1-\alpha} k_j(t)^{\alpha} l_j(t)^{1-\alpha} \tag{1}$$

for each district. The single produced good is perfectly fungible: it can either be consumed or used as capital. We shall fix its price at time 0 at 1. We choose this model as it provides a role for government; the government must provide productive public services in order for production to occur. As in Barro (1990), we assume a linear production function: The total returns to capital (including returns due to public investment) are linear in the amount of capital.

Within a district, there are perfectly competitive markets for capital and labor. Hence the pre-tax rate of return on capital invested in district j, denoted $r_j(t)$, is given by

$$r_j(t) = \frac{\partial y_j(t)}{\partial k_j(t)} = A\alpha g_j(t)^{1-\alpha} k_j(t)^{\alpha-1} l_j(t)^{1-\alpha}.$$

[9] The fact that capital moves freely across state borders but not national ones is the key distinction between the problems facing local and national governments; if the national economy is small and open, then the national government will face the same maximization problem as local governments do. For more on this point, see the discussion after Proposition 4.

[10] If the productive government services require a one-time investment for a durable public good, we may think of g_j as including the rental price of that durable good.

Similarly, the pre-tax wage for workers in district j, denoted by $w_j(t)$, is given by

$$w_j(t) = \frac{\partial y_j(t)}{\partial l_j(t)} = A(1-\alpha)\, g_j(t)^{1-\alpha} k_j(t)^{\alpha} l_j(t)^{-\alpha}.$$

Note that no profits accrue to firms, as production is exactly equal to factor costs.

Government expenditures are financed through both a capital tax τ_j on capital employed within the district and a labor income tax σ_j that do not change with time.[11] At each moment in time, the government's budget is balanced, so that

$$g_j(t) = \sigma_j w_j(t)\, l_j(t) + \tau_j k_j(t) \tag{2}$$

where $w_j(t)$ is the wage in district j. Government revenue comes from both taxes on its own citizens' labor income and taxes on capital invested in the district. Under a decentralized regime, capital taxation does not directly affect the welfare of the citizens of the district; hence, it is an attractive tax for a district government that wishes to maximize the welfare of its citizens. However, high capital taxes may induce capital owners to invest elsewhere.

Under a centralized regime, the government can also use g_j as a vehicle for redistribution, as its choice of tax policy can influence the after-tax returns to capital and labor. For instance, increasing the capital tax will increase the marginal productivity of labor by increasing the amount of the productive public good, but may decrease the after-tax return to capital. Since each agent has the same disutility function for labor, but differing amounts of capital, the government canuse tax policy to redistribute between agents.

We impose the restriction that $\frac{1}{2} \leq \alpha < 1$ in the production function (1), as since the productive public good is partially funded by a labor tax, this restriction ensures that the production function will not have increasing returns to scale in labor.

Finally, each agent i in district j has a utility function given by

$$\int_0^{\infty} \left(\log\left(c_j^i(t)\right) - \beta\left(l_j^i(t)\right)\right) e^{-\delta t} dt.$$

The time preference rate δ is greater than 0. Furthermore, the disutility function β for labor is increasing, convex, and differentiable everywhere. Hence, the presence of a labor income tax will distort individual labor decisions. Agent i, choosing to invest

[11] Note that τ_j is a tax on capital employed within the district, not the returns on that capital. This is purely for notational convenience, as for any given rate of return on capital r, a tax on returns from capital of $\frac{\tau_j}{r}$ would be equivalent.

his capital in district $\hat{\jmath}$, is subject to a budget constraint that[12,13]

$$\dot{k}_j^i(t) = \left(r_{\hat{\jmath}(t)}(t) - \tau_{\hat{\jmath}(t)}\right) k_j^i(t) + (1-\sigma) w_j(t) l_j^i(t) - c_j^i(t).$$

The only difference between agents is the district they live in and their initial amount of capital $k^i(0)$. The initial distribution of capital within a district $F(k^i)$ is identical across districts.

2.2 Definition of Equilibrium

An equilibrium is a policy for each district $\{(\sigma_j, \tau_j)\}_{j=1}^J$, consumption, capital holdings, investment decisions, and labor supply for all agents $\left\{c_j^i(t), k_j^i(t), \hat{\jmath}_j^i(t), l_j^i(t)\right\}_{j=1}^J$, wages and rates of return on capital $\{w_j(t), r_j(t)\}_{j=1}^J$, and government investment and production $\{g_j(t), y_j(t)\}_{j=1}^J$ such that

1. Agent i in district j maximizes his welfare, taking the path of wages within his district and the rates of return on capital in each district as given. That is, he solves
$$\max_{c_j^i(t), k_j^i(t), \hat{\jmath}_j^i(t), l_j^i(t)} \int_0^\infty \left(\log\left(c_j^i(t)\right) - \beta\left(l_j^i(t)\right)\right) e^{-\delta t} dt \tag{3}$$
subject to
$$\begin{aligned} \dot{k}_j^i(t) &= \left(r_{\hat{\jmath}(t)}(t) - \tau_{\hat{\jmath}(t)}\right) k_j^i(t) + (1-\sigma) w_j(t) l_j^i(t) - c_j^i(t) \\ l_j^i(t) &\geq 0 \end{aligned}$$
with an initial capital of $k_j^i(0)$.

2. The rate of return on capital and the wage within each district are given by the marginal productivity of capital and labor, respectively. That is, there is perfect competition for the factors of production, so the rate of return on capital is given by
$$r_j(t) = \frac{\partial y_j(t)}{\partial k_j(t)} = A\alpha g_j(t)^{1-\alpha} k_j(t)^{\alpha-1} l_j(t)^{1-\alpha} \tag{4}$$
while the wage is given by
$$w_j(t) = \frac{\partial y_j(t)}{\partial l_j(t)} = A(1-\alpha) g_j(t)^{1-\alpha} k_j(t)^{\alpha} l_j(t)^{-\alpha}. \tag{5}$$

[12] Since agents are infinitesimal, it is without loss of generality to assume that an individual agent chooses to invest all of his capital in one district.

[13] A depreciation term could be added to the law of motion for capital with no substantive change in the results.

3. Agents vote on a policy (σ_j, τ_j), taking as given the policy of other districts, correctly understanding the path the economy will take given the policy choices of all districts. The Condorcet winner in the policy space is implemented by the district.

2.3 Characterization of the Economy

We first find an equilibrium for this economy, taking policy as given. Consider the investment decision of an agent i in district j at time t. To maximize his utility, this agent will choose to invest his capital in the district that has the highest after-tax return. Hence, in equilibrium, all capital will obtain the same private rate of return; we will call this after-tax rate of return $\rho(t)$.

Hence, from equilibrium condition (3) we can rewrite the agent's problem as

$$\max_{c_j^i(t), k_j^i(t), l_j^i(t)} \int_0^\infty \left(\log\left(c_j^i(t)\right) - \beta\left(l_j^i\right)\right) e^{-\delta t} dt \tag{6}$$

such that

$$\dot{k}_j^i(t) = \rho(t)\, k_j^i(t) + (1-\sigma)\, w_j(t)\, l_j^i(t) - c_j^i(t)$$

with initial capital of $k_j^i(0)$.

To find our equilibrium, we shall assume that the growth rate of capital, $\gamma(t)$, is given by

$$\gamma(t) \equiv \rho(t) - \delta \tag{7}$$

and that the wage/capital ratio is constant with respect to time. Hence, both capital and wages will grow at the rate γ. In finding our equilibrium, we will verify these conditions hold.

We first consider the labor supply problem of the agent. We show that if (7) holds, a constant labor supply is optimal for the agent.

Lemma 1 *If the growth rate is given by $\rho(t) - \delta$, then a constant labor supply is optimal for the agent.*

To see this, consider the case where $\gamma(t) = \gamma$. At time t, one unit of labor produces $w_j(0)\, e^{\gamma t}$ in terms of time t consumption and hence $w_j(0)\, e^{\gamma t} \cdot e^{-\rho t} = w_j(0)\, e^{\delta t}$ in terms of consumption at time 0; the marginal cost of labor is $\beta'(l(t))\, e^{-\delta t}$. Hence the marginal disutility from labor of increasing total labor income by a small amount ε at time 0 is, for any time t, equal to

$$\frac{1}{w_j(0)} e^{\delta t} \cdot \beta'(l(t))\, e^{-\delta t} \varepsilon = \frac{1}{w_j(0)} \beta'(l(t))\, \varepsilon$$

which depends only on the initial wage and the disutility of labor. Hence it is optimal for the agent, for whatever level of labor income he wishes to produce, to equalize the marginal cost of labor in each period; since β is convex, he chooses the same amount of labor to employ each period.

We now wish to solve the optimal consumption problem of the agent, assuming that l_j^i is fixed. Using standard methods from the calculus of variations,[14] we find that

$$\begin{aligned} \dot{c}_j^i(t) &= (\rho(t) - \delta) c_j(t) = \gamma_j(t) c_j(t) \\ c_j^i(0) &= \delta k_j^i + (1 - \sigma_j) w_j(0) l_j^i \end{aligned} \quad (8)$$

Note that the growth rate is indeed our assumed growth rate $\gamma(t)$. Also note that the growth rate is constant over time, as

$$\begin{aligned} \rho(t) - \delta &= A\alpha g_j(t)^{1-\alpha} k_j(t)^{\alpha-1} l_j^{1-\alpha} - \tau_j - \delta \\ &= A\alpha \left(\sigma_j \frac{w_j(t)}{k_j(t)} l_j + \tau \right)^{1-\alpha} l_j^{1-\alpha} - \tau_j - \delta. \end{aligned} \quad (9)$$

Since the wage is proportional to capital, the growth rate and the rate of return on capital must be constant in time.[15] Also note that the return to capital within a district is invariant to the amount of capital within that district; this is because we have chosen a linear growth model. Since the wage is linear with respect to the capital within a district, g_j increases linearly with k_j, and since the rate of return of capital is $A\alpha g_j(t)^{1-\alpha} k_j(t)^{\alpha-1} l_j^{1-\alpha}$, we have that the rate of return of capital is invariant with respect to the capital invested.

Finally, we solve for the optimal labor supply l^i. First, define the ratio of the after-tax wage to the total amount of capital in the economy as ω, i.e.

$$\omega \equiv \frac{(1 - \sigma) w(t)}{k(t)}. \quad (10)$$

Since wages and capital grow at the same rate, the after-tax wage-capital ratio ω is constant with respect to time. We can characterize ω by substituting the government

[14] See, for instance, Kamien and Schwartz (1991). The uniqueness of our solution can be checked using the Legendre condition.

[15] Note that if $l_j(t)$ is constant, we have from (5) that

$$1 = A(1 - \alpha) \left(\sigma l_j(t) + \tau \frac{k_j(t)}{w_j(t)} \right)^{1-\alpha} \left(\frac{k_j(t)}{w_j(t)} \right)^{\alpha} l_j(t)^{-\alpha}$$

by substituting the government budget constraint (2) for $g_j(t)$.

budget constraint (2) into equation (5) for the wage:

$$\frac{\omega}{1-\sigma} = A(1-\alpha)\left(\frac{\sigma}{1-\sigma}\omega l(\omega) + \tau\right)^{1-\alpha} l(\omega)^{-\alpha} \tag{11}$$

Hence, the wage-capital ratio ω is purely a function of the tax rates σ and τ and parameters of the production function.

Since capital grows at a constant rate, we can see from the solution to the agent's consumption problem (8) that each agent's amount of capital grows at the same rate. Hence, an agent's relative capital, i.e. the ratio of his capital to that of society as a whole, is constant for all time. Let us identify agents by their initial capital ratios,

$$\kappa^i \equiv \frac{k^i(0)}{\bar{k}(0)}$$

Capital-poor agents are those with a small κ^i while capital-rich agents are those with a large κ^i.

Noting the growth rate of capital and wages is γ, with a bit of calculus we can write the problem of optimal labor supply as[16]

$$\begin{aligned} & \max_{l^i} \left\{ U\left(l^i; \gamma, \kappa^i, \omega\right)\right\} && (12) \\ U\left(l^i\right) &\equiv \delta^{-2}\gamma + \delta^{-1}\left(\log\left(\delta\kappa^i + \omega l^i\right) - \beta\left(l^i\right)\right) + \delta^{-1}\log(k_0). \end{aligned}$$

First, note that the labor supply is increasing in the wage. This is clear since

$$\frac{\partial^2 U}{\partial\omega\partial l^i} = \frac{\delta\kappa^i}{\left(\delta\kappa^i + \omega l^i\right)^2} > 0 \tag{13}$$

and the result follows from Topkis' theorem. Furthermore,

$$\frac{\partial^2 U}{\partial\kappa^i\partial l^i} = \frac{-\delta\omega}{\left(\delta\kappa^i + \omega l^i\right)^2} < 0 \tag{14}$$

so rich agents, i.e. those with more capital, work less.

2.4 Political Outcomes

We now consider the mechanism by which tax policy is decided. Any mechanism that chooses the Condorcet winner, when one exists, is suitable for our purposes. Hence, a political equilibrium is a policy $(\hat{\sigma}, \hat{\tau})$ such that for any other policy (σ, τ), at least half of the electorate prefers $(\hat{\sigma}, \hat{\tau})$.

[16] A derivation of (12) may be found in the Appendix.

Tax policy is decided by a "Condorcet-consistent" mechanism at time $t = 0$. This assumption is substantive in two ways. First, in our model governments can commit to taxation policies, and only then are capital investment decisions made.[17] Second, we assume that policy is chosen only at $t = 0$, instead of an infinite number of times. We present a model of a one-shot voting game in order to eliminate the difficulties of equilibrium selection in infinitely repeated voting games. Duggan and Fey (2006) show a strong indeterminacy result in these settings when subgame perfection is used as the equilibrium concept. However, agents' preferences do not change over time (since κ^i is invariant with respect to time), so if they were allowed to revote, but still believed it would be their final chance to vote, policy would remain unchanged.

Under a decentralized government, each district chooses its own tax policy (σ_j, τ_j). We impose the restriction that under a centralized government, the tax and spending policy is the same in each district. In other words, the entire nation will choose a single tax policy (σ, τ) which will then be used to provide the productive public good for each district. Besley and Coate (2003) discuss the case where policy can vary between districts, and find that (for political economy reasons), central governments will have incentives to malapportion the funding of public goods; we wish to show that federalism will enhance growth even without considering this additional factor. Also, since every district is identical, decentralization cannot lead to better adaptation to local conditions in our model, and so the reasoning of Oates (1993) does not apply. As our goal is to show economic growth will be higher under a decentralized regime, incorporating these concerns would only strengthen our conclusion that federalism will lead to higher economic growth.

2.4.1 Tax Policy of a Centralized Government

For a centralized government, there exists only one district, and so the equilibrium condition that all districts have the same rate of return is vacuous; for simplicity, we shall drop the district subscript in this subsection. We first show that the policy most favored by the voter with the median amount of capital is a political equilibrium. Note that the utility of agent i, as a function of the tax policy, is given by:

$$\max_{l^i} \left\{ \int_0^\infty \left(\log \left(\delta k^i (t) + (1 - \sigma) w (t) l^i \right) - \beta \left(l^i \right) \right) e^{-\delta t} dt \right\} \tag{15}$$

[17] A model where governments are not able to precommit to capital taxation policies is presented in Hatfield and Padró i Miquel (2010).

where wages and capital depend on the tax policy. We can rewrite this as

$$V_{\kappa^i}(\gamma,\omega) \equiv \max_{l^i} \left\{ \begin{array}{c} \delta^{-2}\gamma(\sigma,\tau) + \\ \delta^{-1}\left(\log\left(\delta\kappa^i + \omega(\sigma,\tau)\, l^i\right) - \beta\left(l^i\right)\right) + \\ \delta^{-1}\log(k_0) \end{array} \right\} \tag{16}$$

where we now explicitly delineate the dependence of the growth rate and wage-capital ratio to the government's control parameters, the capital tax and labor tax. Note that the utility of each agent can be characterized as a growth term $(\delta^{-2}\gamma(\sigma,\tau))$, plus an initial level of utility term $(\delta^{-1}(\log(\delta\kappa^i + \omega(\sigma,\tau)\, l^i) - \beta(l^i)))$, plus a constant dependent on the initial state of the economy $(\delta^{-1}\log(k_0))$. By changing the tax rates, the government changes both the growth rate of consumption and the initial utility level.

Essentially, the government faces a trade-off in terms of balancing initial consumption and long-term growth. An agent's most preferred policy is not the policy that maximizes the growth rate of the economy as a different policy may make the agent's initial utility level higher. At the growth-maximizing policy, changing the policy a small amount results only in a second order decrease in the growth rate, but a first order change in ω. Hence, a small policy change to increase initial consumption will increase the utility of any agent who chooses a positive labor supply.

All agents prefer a policy that maximizes ω given a growth rate γ; hence these policies are Pareto efficient. However, it is not clear that an agent's preferences along this efficient frontier are single-peaked. However, agents' preferences do satisfy the Spence-Mirrlees condition, i.e. have the single crossing property. Note that

$$\frac{\partial V_{\kappa^i}}{\partial \gamma} = \delta^{-2} \tag{17}$$

and

$$\frac{\partial V_{\kappa^i}}{\partial \omega} = \frac{\delta^{-1} l^i(\omega)}{\delta\kappa^i + \omega l^i(\omega)} \tag{18}$$

by the envelope theorem. Hence the rate at which agent i is willing to substitute between growth and the after-tax wage/capital ratio is

$$\frac{\frac{\partial V_{\kappa^i}}{\partial \gamma}}{\frac{\partial V_{\kappa^i}}{\partial \omega}} = \frac{\kappa^i}{l^i(\omega)} + \delta^{-1}\omega \tag{19}$$

which is increasing in κ^i, as the labor supply of agent i is decreasing in his initial allocation of capital. Hence, when considering any two efficient policies, if the median voter prefers (γ,ω) to $(\hat{\gamma},\hat{\omega})$, and γ is greater (less) than $\hat{\gamma}$, then (γ,ω) will be preferred by all types with more (less) capital than the median voter as well. Therefore, against any other efficient point in pairwise voting, the point most favored by the median voter, (γ^m, ω^m), with associated tax policy (σ^m, τ^m), will be supported by at least half the electorate.[18] This argument is exemplified in Figure 1. For any inefficient point (γ, ω), there exists another policy $(\hat{\gamma}, \hat{\omega})$ with a greater after-tax wage-capital ratio and the same growth rate that all agents prefer. Since we know that (γ^m, ω^m) is preferred by at least half of the electorate to $(\hat{\gamma}, \hat{\omega})$, and all the agents prefer the efficient $(\hat{\gamma}, \hat{\omega})$ to the inefficient (γ, ω), by individual transitivity of preferences at least half of the electorate prefers (γ^m, ω^m) to (γ, ω).

Proposition 1 *With a centralized government, the median voter's most preferred tax policy, (σ^m, τ^m), is a political equilibrium. Furthermore, (σ^m, τ^m) does not maximize economic growth.*

We now characterize more precisely the policies that a central government will choose. From equation (11), note that the after-tax wage-capital ratio increases with the capital tax. Holding the income tax fixed, raising the capital tax transfers wealth from those agents with more capital to those with less by increasing wages. Hence, holding the labor income tax fixed, the median voter will prefer a capital tax that is too high to maximize economic growth, as the median voter uses the capital tax to inefficiently redistribute. This result generalizes the result in Alesina and Rodrik (1994), that showed a government with access to only a capital tax (and where the labor decision is fixed) will set that tax too high to maximize growth.

The labor income tax, in contrast, will be too low to maximize growth. Note from equations (2) and (4) that the private rate of return on capital is

$$\rho(\sigma, \tau) \equiv A\alpha \left(\frac{\sigma\omega(\sigma, \tau)}{(1-\sigma)} l(\omega(\sigma, \tau)) + \tau \right)^{1-\alpha} l(\omega(\sigma, \tau))^{1-\alpha} - \tau \tag{20}$$

Note that, from (13), the labor supply is increasing in ω. Hence, if at (σ^m, τ^m) increasing σ increased ω, it would increase ρ as well. Since $\gamma = \rho - \delta$, the policy (σ^m, τ^m) could then not be Pareto efficient, a contradiction. Hence, increasing σ when at the policy (σ^m, τ^m) must cause ω to fall.

Proposition 2 *With a centralized government, in political equilibrium, holding the labor income tax σ^m fixed, lowering the capital tax from τ^m will enhance economic growth. Furthermore, holding the capital tax τ^m fixed, raising the labor income tax from σ^m will enhance economic growth.*

[18] One of the first to use a single-crossing argument to show the existence of a Condorcet winner in a one-dimensional space is Roberts (1977).

Intuitively, agents choose a capital tax that is too high and a labor tax that is too low to maximize growth as this increases their initial after-tax wage, and hence their initial level of consumption. For capital-poor agents, this effect is more important, as a greater percentage of their consumption comes from their labor income; they are less willing to accept an increase in the growth rate for a decrease in the after-tax wage. Hence, the size of the distortion of the tax policy from the growth-maximizing policy depends on the distribution of capital, and in particular the relative amount of capital owned by the median voter. A very capital-poor median voter will result in a lower growth rate than a more capital-rich median voter.

Proposition 3 *With a centralized government, the lower κ^m, the lower the growth rate γ^m in political equilibrium.*

A centralized government uses tax policy as a lever to redistribute wealth to the median voter. The poorer that the median voter is, the greater the incentive to sacrifice growth for an increase in initial consumption and redistribution. This effect would still be present if the government can use revenues to finance a uniform transfer to all citizens: the government would still have an incentive to tax capital (and hence lower economic growth) in order to provide such transfers.

2.4.2 Tax Policy of a Decentralized Government

We now consider the policy under decentralized government. The key difference is that districts must now compete for capital. Recall from the previous section that the private rate of return on capital is

$$\begin{aligned} \rho_j(\sigma_j, \tau_j) &= A\alpha \left(\frac{\sigma \omega(\sigma_j, \tau_j)}{(1-\sigma)} l(\sigma_j, \tau_j) + \tau_j \right)^{1-\alpha} l(\sigma_j, \tau_j)^{1-\alpha} - \tau_j \\ &= \gamma(\sigma_j, \tau_j) + \delta \end{aligned} \tag{21}$$

where the after-tax wage capital ratio in district j is determined by its tax policy. Denote the policy which maximizes this expression $(\hat{\sigma}, \hat{\tau})$. This expression is independent of capital, so the rate of return in the district is independent of the amount of capital. Hence, the districts, by choosing their tax policy, set the rate of return on capital in their district.

Hence, to attract any capital, the district must have the most attractive rate of return available. The agents within each district clearly want to attract capital, as otherwise their wage will be 0. This competition will lead to a "race to the top," where a district, in order to attract any capital, must set tax policy to maximize the private rate of return. Since $\gamma = \rho_j - \delta$, this will maximize the growth rate of the economy as well.

Proposition 4 *With a decentralized government, in any political equilibrium at least one district will choose the growth-maximizing tax policy* $(\hat{\sigma}, \hat{\tau})$ *and all capital will be invested in districts with this tax policy.*

To understand this result, and why it differs from the result for a centralized government, it is perhaps best to concentrate on two key ideas. First, the growth rate of the economy γ is increasing in the private rate of return to capital ρ. Hence, the tax policy which maximizes the growth rate is also the tax policy which maximizes the private interest rate. The second key idea is that a central government can act like a monopolistic firm, except that the goal is to maximize the welfare of the median voter, not to maximize profits. However, this goal still leads the central government to change the parameters of its product (namely, the tax environment for capital and labor) to satisfy this goal. By contrast, the district governments compete in a Bertrand fashion for capital as the private rate of return is independent of the amount of capital in the district, as can be seen from (21). By tailoring their tax environment, district governments pay the highest possible price for capital, i.e. they set their tax policy to maximize the private rate of return on capital. Combining these two insights yields our result that the district governments will compete for capital, and, in so doing, choose the tax policy which maximizes growth.

The result that growth is higher for a decentralized government relies on the assumption that the economy is closed, i.e. that capital is not mobile across international borders. If capital is mobile across international borders, then the "centralized" government will choose the growth-maximizing policy; in an open economy, the national government faces the same constraints as jurisdictional governments, and so must set policy in order to compete for capital with other nations. If a confederation of nations, such as the EU, changes policy to allow for capital mobility between member states, then the model presented here predicts that those states will change policy to be more friendly to capital and, hence, engender higher economic growth.

Note that this result would still hold even if governments were allowed to choose time-varying policies, so long as agents may choose to move their their capital at any time. At every point in time, the local goverment will wish to choose the policy which maximizes the private rate of return on capital in order to attract investment. It follows, as for the case where districts choose a non-time varying policy, that at each moment in time all the capital will be invested in districts that maximize the private rate of return, i.e. the growth-maximizing tax policy. Hence, even if we allow for time-varying policies, we should expect still higher growth under a decentralized government.

The above proposition does not state that all districts will set their tax policy to $(\hat{\sigma}, \hat{\tau})$. There exist asymmetric equilibria, where one or more districts set their tax rates to $(\hat{\sigma}, \hat{\tau})$ and obtain all the capital, while some districts set another policy, but receive no capital. Even if a district with no investment were to change their policy to $(\hat{\sigma}, \hat{\tau})$, no agent would move his capital there.[19] However, if we introduce a slight home bias, where an agent when indifferent chooses to invest his capital in his home district, we obtain the following:

Proposition 5 *With a decentralized government and home bias, in every political equilibrium, every district will set tax policy to the growth-maximizing tax policy* $(\hat{\sigma}, \hat{\tau})$*, and all capital will be invested by agents in their own districts.*

Note that, in this decentralized world, we do not see the size of government go to zero, or even become inefficiently small, as predicted by such papers as Wilson (1986) and Zodrow and Mieszkowski (1986). Rather, government tax policy is chosen to maximize economic growth. The key difference between those papers and our present work is that our work accounts for the effects on the savings behavior of agents due to different tax policies.

We also note that in a model with home bias, we could allow labor to be mobile as well. Since in equilibrium the after-tax wages are the same in each district, no agent has any incentive to move.

2.5 Welfare

In this model, the national policy that maximizes economic growth is not the same as the policy that maximizes welfare. In particular, the national government chooses a policy with a higher initial level of wages but lower growth rate. Poorer agents are more willing to trade off growth for an immediately higher level of wages as a larger portion of their total consumption is made of wages. For many distributions of initial wealth, the welfare-maximizing policy may, in fact, entail choosing an even higher level of initial consumption (at the cost of an even lower growth rate) than the policy chosen by a national government, and a decentralized government would, in this case, only push policy farther from this optimum.

[19] These sorts of asymmetric equilibria are prevalent in models of Bertand competition between firms as well.

This result also implies that capital ownership, preferences for capital taxation, and preferences for decentralization should be aligned in the voting public. In particular, political parties who traditionally favor lower taxes, such as Republicans in the United States, should also favor greater degrees of decentralization.

2.6 Restriction of Tax Instruments

If tax policy is determined centrally, restricting the set of tax instruments available to the central government may enhance growth. The capital tax, in particular, allows governments to tax capital in order to increase ω. The tax policy most favored by the median voter in a centralized government when a capital tax is unavailable is denoted $\tilde{\sigma}^m$, and the tax policy most favored by the median voter in a decentralized government when a capital tax is unavailable is denoted $\hat{\sigma}^m$.

Proposition 6 *With a centralized government,* $\gamma(\sigma^m, \tau^m) < \gamma(\tilde{\sigma}^m, 0)$ *for some parameter values. With a decentralized government with home bias,* $\gamma(\hat{\sigma}, \hat{\tau}) \geq \gamma(\hat{\sigma}^m, 0)$ *for all* j*.*

This proposition is illustrated in Figure 2. For small δ, agents do not discount very much and hence the growth-maximizing policy and the median voter's most preferred policy are very close, since the median voter is most concerned with the growth rate, not the after-tax wage-capital ratio. Indeed, for very small values of δ, agents prefer not to tax capital at all, and instead rely completely on a labor income tax. For middle values of δ, taxing capital is part of the growth-maximizing policy. Furthermore, the ability to tax capital allows the central government to achieve a higher growth rate than if τ was constrained to be zero. For larger values of δ, however, a central government will set the capital tax even higher, resulting in much lower growth rates for a state with a centralized tax apparatus. Indeed, it can be seen that for high values of δ, constraining the government to have access to only an income tax will enhance economic growth. This is because capital is greatly overtaxed by the central government in order to increase ω. Hence, by restricting the set of tax instruments available to a centralized government, we may enhance growth.

Figure 3 illustrates the labor income tax rate as a function of δ when the labor tax is the only instrument the government has access to. When δ is small, agents are concerned mostly with the growth rate, so there is not much divergence in policy. However, as δ grows, a centralized government will choose a lower tax rate, in order to increase the after-tax wage capital ratio ω. Note here that a central government beholden to the median voter will be too small to maximize growth. This is in contrast to the usual Leviathan literature deploring inefficient government policy choices, where the problem is usually that the government is inefficiently large. The key result here is that federalism results in policy that maximizes growth, even if that policy calls for a larger role for government than the median voter may like.

2.7 Endogenous Government Choice

If the choice between a decentralized and centralized state is left to the voters, then the centralized state will always be chosen. Essentially, such a decision would be asking the electorate to choose between the median voter's most preferred point, and the policy which maximizes growth. From the proof of Proposition 1, the median voter's most preferred policy is pairwise preferred to the growth-maximizing policy, and so a majority of agents will vote for a centralized government.

3 Hedonic Public Goods

While federalism leads to growth-maximizing policies, that may be far from an optimal outcome, especially if there exists a hedonic public good. This is the dominant model of public goods in the "race to the bottom" literature.[20] In our model, we find much the same result for hedonic public goods: a central government will provide them at the level all agents prefer, while a decentralized government will not.

Consider agents who also gain utility from the provision of a second, hedonic, public good. For an amount of this good $h > 0$, the utility of the agent is given by

$$\max_{c_j^i(t), l_j^i(t), \tilde{j}_j^i(t)} \int_0^\infty \left(\log\left(c_j^i(t)\right) + \eta \log\left(h_j(t)\right) - \beta\left(l_j^i(t)\right)\right) e^{-\delta t} dt \tag{22}$$

Further, the agent prefers any outcome with positive amounts of h to any outcome with $h = 0$; when comparing outcomes with zero hedonic public good, his utility is, as before, given in equation (3).

To fund the new public good, the government will choose to divert some fraction of government revenues to the hedonic public good. However, for ease of analysis, it will be more useful to think of the government instituting a new capital surcharge θ. While these two models of government finances are interchangeable, all agents agree on the optimal value for θ, so it is easy to find the efficient frontier (i.e. the set of Pareto optimal policies) in this parametrization of policy space. Hence the

[20] See, for instance, Zodrow and Mieszkowski (1986).

government now faces two budget constraints:

$$\begin{aligned} g_j(t) &= \sigma_j w_j(t) l_j(t) + \tau_j k_j(t) \\ h_j(t) &= \theta_j k_j(t) \end{aligned} \tag{23}$$

The government will choose policy subject to these constraints.

3.1 Centralized Outcome

The utility of an agent as a function of policy can be written as

$$V_{\kappa^i}(\gamma, \omega, \theta) \equiv \max_{l^i} \left\{ \begin{array}{c} (1+\eta)\delta^{-2}(\gamma - \theta) + \\ \delta^{-1}\left(\log\left(\delta\kappa^i + \omega l^i\right) + \eta \log(\theta) - \beta\left(l^i\right)\right) + \\ (1+\eta)\delta^{-1}\log(k_0) \end{array} \right\} \tag{24}$$

where γ is now the growth rate that would be realized if $\theta = 0$. The initial level of utility term now includes a term for the amount of hedonic public good provided. Taking the first-order condition with respect to θ of the above expression, we find that all agents prefer that

$$\theta = \frac{\delta\eta}{1+\eta}. \tag{25}$$

It is straightforward that a political equilibrium still exists, even though we now have a three-dimensional policy space. In fact, the same σ and τ will be chosen by the median voter, along with an additional capital surcharge $\theta = \frac{\delta\eta}{1+\eta}$.

Proposition 7 *The median voter's most preferred tax policy, $(\sigma^m, \tau^m, \theta^m)$, is a political equilibrium. Furthermore, $\theta^m = \frac{\delta\eta}{1+\eta} > 0$ and (σ^m, τ^m) does not maximize economic growth, even taking θ^m as fixed.*

A central government will provide positive amounts of the hedonic public good, as this is desired by the median voter, and government policy is dictated by the wishes of that voter.

3.2 Decentralized Outcome

As in the previous literature, in our model hedonic public goods engender a "race to the bottom". Decentralized governments will choose $\theta_j = 0$ in equilibrium. The intuition behind this is straightforward: since districts are competing for capital, any district which sets $\theta_j > 0$ will not receive any capital, as it is not maximizing the private rate of return, and hence will not be able to provide any hedonic public good. Hence, no hedonic public good will be provided in equilibrium.

Proposition 8 *With a decentralized government, in every political equilibrium, all capital will be invested in districts with the growth-maximizing tax policy* $(\hat{\sigma}, \hat{\tau}, 0)$.

Hence, while decentralization may enhance outcomes for productive public goods, for hedonic public goods this is not necessarily the case: all agents agree that such goods should be centralized. Hence, even if capital owners are over-represented in the process of deciding the division of government responsibilities, we should still expect to see hedonic public goods centralized, while the result for productive public goods is less clear. Therefore, we should expect to see hedonic public goods, such as unemployment benefits and health care centralized at a weakly greater rate than productive public goods, such as roads and fire protection.

However, note that while the model predicts that the amount of hedonic public good will be zero, this is due to the fact that capital is perfectly mobile, while labor is immobile. Since districts compete for capital, but not for labor, they act as monopolists over the labor supply, and exploit this monopoly ruthlessly, driving the provision of the hedonic public good to zero. A richer model that considers labor mobility may draw different conclusions, but that is beyond the scope of this paper.

4 Political Outcomes for a Leviathan Government

We now consider a model where the government, instead of following the desires of the median voter, will choose to maximize its time discounted consumption of rents.[21] In particular, the objective function of the government is

$$\max_{\mu_j, \sigma_j, \tau_j} \left\{ \int_0^\infty \log \left(\mu_j g_j (t) \right) e^{-\delta t} dt \right\} \tag{26}$$

where μ_j is the percentage of government revenue consumed as rents. Each government will choose its own μ_j. Hence, the production function becomes

$$y = A \left(1 - \mu_j\right)^{1-\alpha} g_j^{1-\alpha} k_j^{\alpha} l_j^{1-\alpha} \tag{27}$$

at each point in time, so an increase in μ_j can be seen as a decrease in the total factor productivity of the economy.

The government's problem can be simplified to

$$\max_{\mu_j, \sigma_j, \tau_j, \theta_j} \left\{ \delta^{-2} \gamma + \delta^{-1} \log \left(\mu_j \left(\frac{\sigma_j \omega_j l_j (\omega)}{1 - \sigma_j} + \tau_j \right) \right) + \delta^{-1} \log (k_0) \right\}. \tag{28}$$

[21] For simplicity, we shall assume there is no hedonic public good. The model in this subsection can easily be generalized to that case.

The three terms in this expression mirror those of the expression for the utility of the median voter in equation (16). The first is a growth term, and the second is an initial level of utility term. Again, the policy chosen will not maximize growth, as its effect on this second term must be considered as well.

We can now characterize the behavior of a Leviathan centralized government. First, it will set $\mu > 0$, in order to ensure positive rents. However, even taking μ as fixed, it will set both the capital tax and the labor income tax to be too high, relative to the policy that maximizes growth. The reasoning here is similar to that in the previous section. If the capital tax were set at the the growth-maximizing level, a small increase would result in a second-order decrease in the growth rate, while increasing the level of rents a first-order amount. Defining the equilibrium policy choice as $\left(\mu^L, \sigma^L, \tau^L\right)$ we have the following proposition.

Proposition 9 *With a centralized government, in any politicial equilibrium the government will choose $\mu^L > 0$. Holding other policies fixed, lowering τ from τ^L would increase the growth rate. Holding other policies fixed, lowering σ from σ^L would increase the growth rate.*

The intuition behind this result is much like the intuition in the previous section. Since the government is monopolistic, it will distort the policy choice away from that which maximizes the private rate of return (and hence growth) to suit its own purposes. Increasing the capital tax increases the initial level of government size, and so this tax will be too high to maximize growth. Similarly, increasing the labor income tax also increases the initial level of government size, and so this tax will as well be too high to maximize growth.

Decentralization, however, again implies Bertrand competition for capital. Any district that does not offer the best possible private rate of return will not obtain any capital. Hence, there can not be any equilibrium in which all districts choose a strictly positive μ_j. Suppose there was such an equilibrium; consider any district that does not have all the capital invested in that district. That district could obtain all the capital simply by choosing a policy only slightly better for investors than the current best policy, and this would make the district strictly better off than it was before. Hence we have the following proposition:

Proposition 10 *With a decentralized government, in any political equilibrium, at least one district will choose the growth-maximizing tax policy $(0, \hat{\sigma}, \hat{\tau})$ and all capital will be invested in districts with this policy.*

This result captures much of the intuition of the informal arguments in the literature that federalism precludes a Leviathan from capturing as much in rents.[22] Indeed, rents are driven to zero due to competition in this model.

Note that if the government were simply a size-maximizing Leviathan, i.e. if the government's problem was

$$\max_{\sigma_j,\tau_j}\left\{\int_0^\infty \log\left(g_j\left(t\right)\right)e^{-\delta t}dt\right\} \tag{29}$$

then the above conclusions would still hold; a centralized government would choose tax policy that did not maximize economic growth, setting capital and labor taxes too high, while a decentralized government would set policy to $(\hat{\sigma},\hat{\tau})$, for much the same reasons as above.

5 Externalities

One natural question is how the presence of externalities affects policy in this model. We model externalities by changing the production function to

$$y = A\bar{g}_j^{\varepsilon}g_j^{1-\alpha-\varepsilon}k_j^{\alpha}l_j^{1-\alpha} \tag{30}$$

where $\bar{g}_n^{\varepsilon}$ is a (possibly weighted) average of the quantity of productive public good present in other districts. Hence, each individual district j takes $\bar{g}_j^{\varepsilon}$ as given.

This has two effects. First, there is the straightforward externality effect; the district's private rate of return is less enhanced by investing in the public good, and so it will tend to invest less. However, it is also no longer true that districts are engaging in strict Bertrand competition; the rate of return within an individual district now depends on the quantity of capital present. Hence, districts may actually tax capital more, increasing the amount of productive public good so as to increase ω. Hence we can not sign the changes in labor and capital tax rates as externalities become more important.

If we consider the model with just a capital tax and no labor supply decision and no labor tax, then we can explicitly solve for the equilibrium tax rate:

$$\tau_j = \left(\frac{1-\alpha-\varepsilon}{\left(1-\alpha\right)\left(1-\varepsilon\right)}\right)^{\frac{1}{\alpha}}\hat{\tau} \tag{31}$$

where $\hat{\tau} = \left(A\left(1-\alpha\right)\alpha l^{1-\alpha}\right)^{\frac{1}{\alpha}}$, which is the equilibrium rate of taxation when $\varepsilon = 0$. Hence, in this reduced model, the equilibrium rate of taxation falls as the externality

[22] See, for instance, Obstfeld (1998).

grows in importance. In this model, then, a centralized state will set capital taxes too high to maximize growth, while a decentralized state will set them too low, due to the externality.

6 Conclusion

We have shown that federalism, and the attendant competition for capital, will drive tax policy to the growth maximizing level, while a centralized government will choose tax policy that does not maximize growth. This is true for a variety of government objective functions. When many districts exist, competition will drive the districts to choose tax policies that maximize the private rate of return and hence the growth rate of the economy. A central government, in contrast, will choose to maximize its own objective function, the welfare of the median voter, which will not coincide with the problem of choosing tax policy to maximize growth. Similar results hold in a model with externalities from the production of the public good.

However, a decentralized government leads to a competition for capital between district governments that will force provision of a hedonic public good down to zero. The centralized government, on the other hand, will choose to invest in the hedonic public goods at the optimal level. This result captures the same intuition as in Zodrow and Mieszkowski (1986) and others[23], that competition for capital will lead to districts underproviding hedonic public goods in a “race to the bottom.” Hence, when considering additional decentralization, it is important to ask what types of public goods are being decentralized, not just how many.

One caveat to the work presented here is that all capital is considered to be mobile: capital may move freely across jurisdictions. For immobile capital, such as land or buildings upon such land, local governments would not be subject to competitive forces, and hence would act much like national governments with respect to taxing immobile capital. We have also assumed that governments do not have access to debt markets. If local governments did have access to such debt markets, they would exploit their ability to issue debt to the maximum degree possible due to their competition for capital; a centralized government would, in contrast, use access to debt markets to further maximize the welfare of the median voter.

There is a great deal of empirical literature examining the effects of fiscal decentralization, and many authors have argued that fiscal decentralization has been key to China’s recent growth success: see Weingast (1995) and Montinola et al. (1996).

[23] See, e.g., Wilson (1986), Wildasin (1988), Keen and Marchand 1996, and Rom *et al.* (1998).

However, subsequent authors as well have pointed out it is important that the taxes be levied at the local level as well for the effects described here to predominate; see Weingast (2000). We hope that this work can help identify which decentralization mechanisms are important in leading to higher economic growth. If the localization concerns of Oates (1993) are key, than decentralization of spending decisions should lead to higher growth, even if taxes are collected at the national level. However, in our model, decentralization will lead to higher growth if and only if revenue is locally generated. We hope that by understanding these different mechanisms by which decentralization may lead to higher growth, future empirical work can help us understand the importance of these different effects.

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7 Appendix

Derivation of (12): The utility of the agent is given by

$$\int_0^\infty \left(\log\left(c_j^i(t)\right) - \beta\left(l_j^i(t)\right)\right) e^{-\delta t} dt$$

Since labor is constant, and consumption is given by (8), we have

$$\begin{aligned}
&\int_0^\infty \left(\log\left(e^{\gamma t}\left(\delta k_j^i(0) + (1-\sigma_j) w_j(0) l_j^i\right)\right) - \beta\left(l_j^i\right)\right) e^{-\delta t} dt \\
&\int_0^\infty \left[\gamma t e^{-\delta t} + \log\left(\delta k_j^i(0) + (1-\sigma_j) w_j(0) l_j^i\right) e^{-\delta t} - \beta\left(l_j^i\right) e^{-\delta t}\right] dt \\
&\gamma \delta^{-2} + \delta^{-1}\left[\log\left(\delta k_j^i(0) + (1-\sigma_j) w_j(0) l_j^i\right) - \beta\left(l_j^i\right)\right] \\
&\gamma \delta^{-2} + \delta^{-1}\left[\log\left(\delta \kappa^i + \omega l_j^i\right) - \log(k_0) - \beta\left(l_j^i\right)\right]
\end{aligned}$$

Proof of Lemma 1: For simplicity, we drop the j subscript. Consider working one unit at time $t = 0$, which results in a wage of $(1-\sigma) w(0)$. The present discounted value of working one unit at time t is

$$\begin{aligned}
&(1-\sigma) w(t) \exp\left(-\int_0^t \left(r(t') - \tau\right) dt'\right) \qquad (32)\\
&(1-\sigma) w(t) \exp\left(-\int_0^t \gamma(t') dt'\right) \exp\left(-\int_0^t \delta dt'\right) \\
&(1-\sigma) w(0) e^{-\delta t}
\end{aligned}$$

as the economy, and hence the wage, grows at a rate $\gamma(t)$.

We will now show that a constant labor supply is optimal. Suppose not. Then there exist times t, t' such that $l^i(t) \neq l^i(t')$ and a total of

$$Z(1-\sigma) w(0) \equiv (1-\sigma) w(0) \left(e^{-\delta t} l^i(t) + e^{-\delta t'} l^i(t')\right) \qquad (33)$$

is earned in present value. The solution to the problem

$$\min_{l,l'} \left\{e^{-\delta t} \beta(l) + e^{-\delta t'} \beta(l')\right\} \qquad (34)$$

subject to the constraint

$$\left(e^{-\delta t} l + e^{-\delta t'} l'\right) = Z$$

is

$$l = l' = \frac{Z e^{\delta t'}}{e^{-\delta t'} + e^{-\delta t}} \qquad (35)$$

Hence, $l^i(t) \neq l^i(t')$ can not be optimal, as there is a different labor supply decision with the same present value and less disutility from labor. From this, we can see that it will be strictly optimal for him to choose a constant labor supply. Since each agent's labor supply is constant, the aggregate labor supply is constant as well.

Proof of Proposition 1: For simplicity, we drop the j subscript. The argument that (σ^m, τ^m) is a political equilibrium is given in the text. The second part of the argument follows from Proposition 2.

Proof of Proposition 2: For simplicity, we drop the j subscript. From the argument before the proposition, the government will try to maximize the welfare of the median voter. If $\gamma(\sigma, \tau)$ is weakly increasing in τ at (σ^m, τ^m), it must be that $\omega(\sigma, \tau)$ is decreasing in τ at (σ^m, τ^m), for (σ^m, τ^m) to be efficient. It suffices, then, to show that ω is increasing in τ for all (σ, τ).

We can rewrite equation (11) to become

$$\frac{\omega^{\alpha} l(\omega)^{2\alpha-1}}{1-\sigma} = A(1-\alpha)\left(\frac{\sigma}{1-\sigma} + \frac{\tau}{\omega l(\omega)}\right)^{1-\alpha}$$

and so increasing τ will increase ω. If τ were to increase and ω decrease, then $l(\omega)$ would decrease as well, so the left hand side would have decreased while the right hand side increased. (Recall that $\alpha \geq \frac{1}{2}$.)

Hence $\gamma(\sigma, \tau)$ is decreasing in τ at (σ^m, τ^m), and so decreasing the capital tax rate would increase the growth rate.

For the second point, If $\gamma(\sigma, \tau)$ is weakly decreasing in σ at (σ^m, τ^m), it must be that $\omega(\sigma, \tau)$ is increasing in σ at (σ^m, τ^m), for (σ^m, τ^m) to be efficient. However, if ω is increasing in σ at a policy (σ, τ), l is increasing in σ at (σ, τ), as l is increasing in ω, so we can see from (11) that

$$\left(\frac{\sigma}{1-\sigma} + \frac{\tau}{\omega l(\omega)}\right)^{1-\alpha}$$

is increasing in σ at (σ, τ), as $\frac{\omega^{\alpha} l(\omega)^{2\alpha-1}}{1-\sigma}$ is increasing in σ. Hence,

$$\left(\frac{\sigma}{1-\sigma} + \frac{\tau}{\omega l(\omega)}\right)^{1-\alpha} l(\omega)^{1-\alpha}$$

is increasing in σ at (σ, τ), so ρ is increasing in σ at (σ, τ). Hence, $\gamma(\sigma, \tau)$ is increasing in σ at (σ^m, τ^m), contradicting our assumption that $\gamma(\sigma, \tau)$ is weakly decreasing in σ at (σ^m, τ^m). Hence, $\gamma(\sigma, \tau)$ is increasing in σ at (σ^m, τ^m).

Proof of Proposition 3: It follows directly from the single crossing property shown in the text and Topkis' theorem that an agent of lower type κ^i will prefer a lower amount of growth along the efficient frontier.

Proof of Proposition 4: Suppose not. Then no district can be setting tax policy to $(\hat{\sigma}_j, \hat{\tau}_j)$, as otherwise all the capital would be in this district, since it is offering the highest rate of return on capital, since the rate of return on capital is constant with respect to the amount of capital, as can be seen from equation (20). Now consider a district which is not receiving any capital. By choosing a tax policy $(\hat{\sigma}_j, \hat{\tau}_j)$ the district becomes the one with the highest rate of return on capital, and so obtains all of its capital, making all of the citizens of that district better off, as their wages are now positive instead of 0, and they can get a higher rate of return on their capital. If no such district exists, then all districts are offering the same rate of return on capital. A district j, then, by changing its tax policy a small amount $\varepsilon > 0$ in the direction to improve the rate of return on capital, can ensure it has a higher rate of return than any other district. Hence it obtains all of the capital, causing a discrete positive increase in the wage of a worker in that district; it also allows the agents to obtain higher rates of return on their capital. Since the effect on the wage of the change in tax holding capital fixed is first-order in ε, the first effect dominates if ε is small enough, and so district n will wish to make this change in its taxes.

Proof of Proposition 5: Suppose not. Then some district is not setting tax policy to $(\hat{\sigma}_j, \hat{\tau}_j)$. Hence, unless no other district is setting this policy, this district is losing all of its capital, and all the agents in this district would be strictly better off with the policy $(\hat{\sigma}_j, \hat{\tau}_j)$, as this ensures them a positive wage. However, following the same lines of proof as in the preceding proposition, some district must be offering the policy $(\hat{\sigma}_j, \hat{\tau}_j)$, and so all districts must offer this policy.

Proof of Proposition 6: For the parameter values $A = 10, \alpha = \frac{1}{2}, \delta = \frac{7}{2}$, $\beta(l) = \frac{l^2}{2}$ and where all agents have the same starting capital, the growth rate in equilibrium for the unconstrainted, centralized government is $\gamma(\sigma^m, \tau^m) \approx 2.73$, while the constrained centralized government equilibrium has a growth rate of $\gamma(\tilde{\sigma}^m, 0) \approx 3.38$. For the second part, note that district governments choose policy to maximize growth (where the proof follows as in Proposition 3), so restricting their domain can never enhance growth.

Proof of Proposition 7: For simplicity, we drop the j subscript. Exactly corresponding arguments to those in the previous section show that the among the set of points most favored by some voter (the efficient frontier), $\left(\sigma^m, \tau^m, \frac{\delta\eta}{1+\eta}\right)$ is a Condorcet winner. For any inefficient point, as before, an efficient point that all agents prefer can be found, so by individual transitivity of preferences the point $\left(\sigma^m, \tau^m, \frac{\delta\eta}{1+\eta}\right)$ is favored over the inefficient point by a majority of voters. It is shown that $\theta = \frac{\delta\eta}{1+\eta}$ is the policy most favored by all voters (and hence the median voter) in the text. The tax policy in (σ, τ)-space is the same as in the previous section, and so will not maximize growth, just like in Proposition 2.

Proof of Proposition 8: Suppose not. Then no district can be setting tax policy to $(\hat{\sigma}, \hat{\tau}, 0)$, as otherwise all the capital would be in this district, since it is offering the highest rate of return on capital, since the rate of return on capital is constant with respect to the amount of capital, as the private rate of return is

$$A\alpha \left(\frac{\sigma_j \omega(\sigma_j, \tau_j)}{(1-\sigma_j)} l(\omega(\sigma_j, \tau_j)) + \tau_j \right)^{1-\alpha} l(\omega(\sigma_j, \tau_j))^{1-\alpha} - \tau_j - \theta_j$$

Now consider a district which is not receiving any capital. By choosing a tax policy $(\hat{\sigma}, \hat{\tau}, 0)$ the district becomes the one with the highest rate of return on capital, and so obtains all of its capital, making all of the citizens of that district better off, as their wages are now positive instead of 0, and they can get a higher rate of return on their capital. (They receive no hedonic public good in any event.) If no such district exists, then all districts are offering the same rate of return on capital. A district j, then, by changing its tax policy a small amount $\varepsilon > 0$ in the direction to improve the rate of return on capital, can ensure it has a higher rate of return than any other district. Hence it obtains all of the capital, causing a discrete positive increase in the wage of a worker in that district; it also allows the agents to obtain higher rates of return on their capital. Since the effect on the wage and the hedonic public good, holding capital fixed, of the change in tax is first-order in ε, the increase in utility due to obtaining all the capital dominates if ε is small enough, and so district j will wish to make this change in its taxes.

Proof of Proposition 9: For simplicity, we drop the j subscript. For the first statement, if the government chooses $\mu = 0$, it receives no rents, while $\mu > 0$ ensures positive rents.

Now, fixing μ and σ, consider the effect the initial level of government consumption by increasing τ.

$$\frac{\partial \left(\frac{\sigma \omega l}{1-\sigma} + \tau \right)}{\partial \tau} = \frac{\sigma l}{1-\sigma} \frac{\partial \omega}{\partial \tau} + \frac{\sigma \omega}{1-\sigma} \frac{\partial l(\omega)}{\partial \omega} \frac{\partial \omega}{\partial \tau} + 1$$

However, from the proof of Proposition 2, we know that $\frac{\partial \omega}{\partial \tau}$ is positive. Hence, the initial level of government size is increasing in τ. If γ were then nondecreasing in τ, the government would be unambiguously better off by raising τ. Since this violates optimality, γ must be decreasing in τ, and hence lowering τ would increase growth.

Now consider the effect of increasing σ on the initial level of government size $\frac{\sigma \omega l}{1-\sigma} + \tau$. This can only be decreasing in σ if ω is decreasing in σ, as $l(\omega)$ is increasing in ω. Then, however,

$$\hat{\gamma} = A\alpha \left(1-\mu\right)^{1-\alpha} \left(\frac{\sigma\omega\left(\sigma,\tau\right)}{\left(1-\sigma\right)} l\left(\omega\left(\sigma,\tau\right)\right) + \tau\right)^{1-\alpha} l\left(\omega\left(\sigma,\tau\right)\right)^{1-\alpha} - \tau - \delta$$

is also decreasing in σ. Since the Leviathan will always choose a tax policy that is efficient in terms of maximizing γ and $\frac{\sigma\omega l}{1-\sigma}+\tau$, given μ, it can not be that government size is weakly decreasing in σ. Hence, for the policy the Leviathan chooses to be efficient, it must be that increasing σ decreases the growth rate.

Proof of Proposition 10: Suppose not. Then no district can be setting policy to $(0, \hat{\sigma}, \hat{\tau})$, as otherwise all the capital would be in this district, since it is offering the highest rate of return on capital. Now consider a district j which is not receiving any capital. By choosing a policy such that $\mu_j = \min_{j' \neq j} \left\{\mu_{j'}\right\} - \varepsilon$ for some small $\varepsilon > 0$, and (σ_j, τ_j) to the policy that maximizes the private rate of return given μ_j, the district becomes the one with the highest rate of return on capital, and so obtains all of the capital, and so the government now obtains positive rents. If no such district exists, then all districts are offering the same rate of return on capital. A district j, then, by decreasing μ_j a small amount $\varepsilon > 0$, can ensure it has a higher rate of return than any other district. Hence it obtains all of the capital, causing a discrete increase in the g in that district. Since the direct effect on government rents is first-order in ε, the first effect dominates if ε is small enough, and so district j will wish to make this change in its policy.

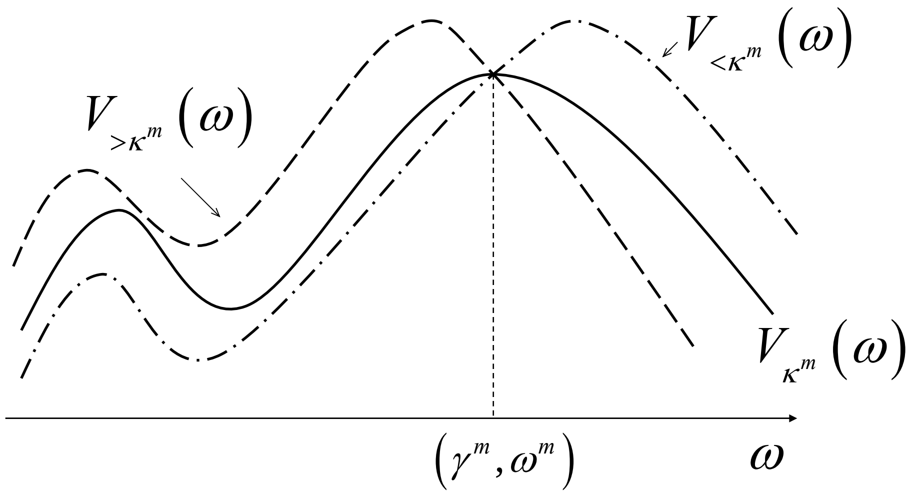

Figure 1. This figure shows the preferences of agents with various amounts of capital for policies along the efficient frontier. Note that all agents with less capital than the median voter will disprefer any policy with a lower ω than the median voter's preferred policy, while all agents with more capital than the median voter will disprefer any policy with a higher ω.

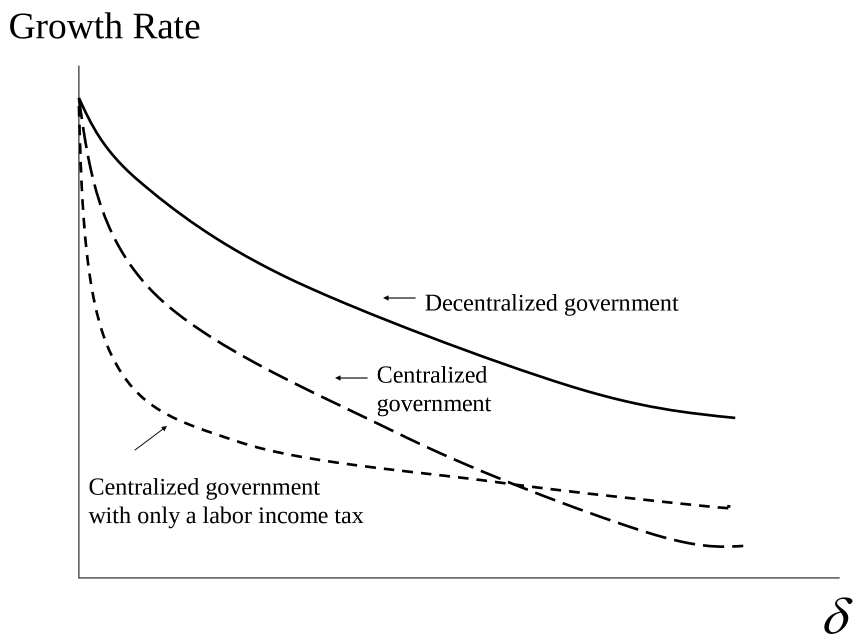

Figure 2. This graph shows the equilibrium growth rate $\gamma(\sigma, \tau)$ when government is decentralized, centralized, and centralized but with access to only a labor income tax σ. Note that for high discount rates, higher growth is achieved when the central government has access to only a labor income tax.

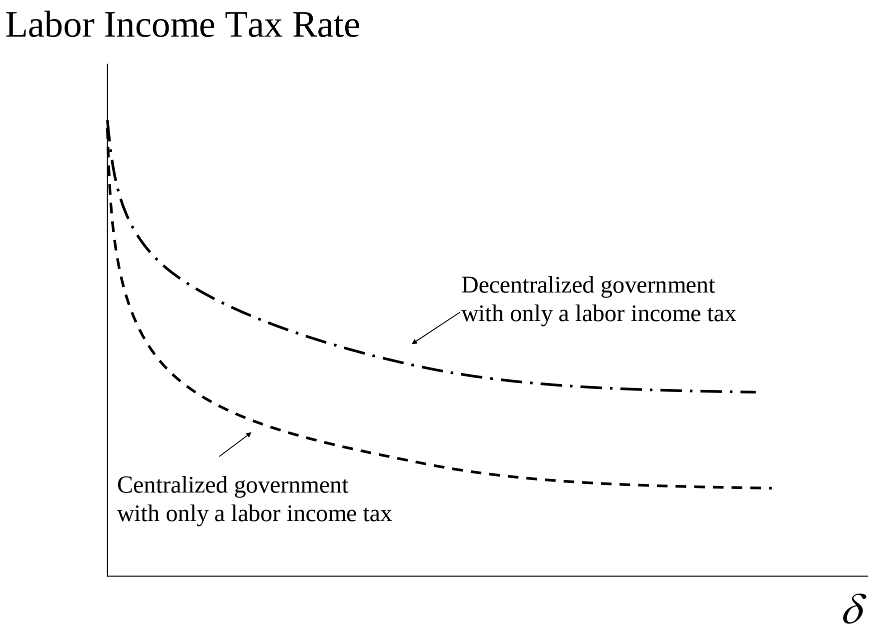

Figure 3. This graph shows how the labor income tax rate σ changes with the time discount rate δ for a centralized and a decentralized government with access to only a labor income tax. Note that the centralized government is too small to maximize growth.