Revenue Decentralization, the Local Income Tax Deduction, and the Provision of Public Goods

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November 2006

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Abstract

We consider a model where local and national governments both tax income and use the revenue to invest in both productive and consumptive public goods. We show that a positive national income tax will lead to underprovision of local productive public goods, while the local consumptive public good will be produced efficiently. However, the introduction of a local income tax deduction incentivizes local districts to produce an optimal amount of the productive public good; however, such districts will now overinvest in local consumptive public goods. In both cases the central government will underinvest in both types of public goods. A national government that sets one, national tax rate, and gives grants to the states will also underinvest in both types of national goods, and will result in underprovision of the local productive public good. Further, this type of centralized revenue collection mechanism will result in lower welfare in equilibrium than the mechanism detailed earlier if the national government can choose the percentage of local tax deduction.

*We are grateful to Gerard Padró i Miquel, Kenneth Shotts, and Romain Wacziarg for helpful discussions. Any comments or suggestions are welcome and may be emailed to hatfield@stanford.edu.

1 Introduction

In the United States, the federal income tax deduction for state and local income taxes costs the federal government over fifty billion dollars annually in revenue.[1] Indeed, the most recent President's Advisory Panel on Federal Tax Reform (2005) has suggested we do away with this deduction. Indeed, it is straightforward that this component of the federal tax code is likely to make states spend more on public goods, as the cost to local taxpayers is reduced; for every $1 spent on public goods, the residents will only pay a fraction of that, since they will not have to pay federal taxes on the income lost to local taxation; it seems likely that this spending is inefficient, since the local residents do not bear the full burden of the local spending. However, we show that the local income tax is not necessarily inefficient: its efficiency or inefficiency depends on the nature of the local public goods. Local consumptive public goods will be overprovided relative to the efficient level with the local income tax deduction, while productive public goods will be underprovided without it, and so national policymakers face a trade-off when choosing the level of deductibility of local income taxes.

The intuition on why consumptive public goods are inefficiently overprovided is the basis of many an article decrying this "tax break."[2] Without such a deduction, a state which maximizes the welfare of its own citizens will invest in consumptive public goods up to the point where the marginal utility of the public good is equal to the marginal utility of private consumption, which is perfectly efficient; with a local income tax deduction, it will invest more, as some of the cost of the investment is paid for by the nation as a whole, through the mechanism of a reduced payment by local taxpayers to the national government. The above intuition for consumptive public goods is, in some respects, similar to that of soft budget constraints[3]: with a soft budget constraint, or with a local income tax deduction, the national government will pay for some investment by the state, and that leads the state to overinvest in consumptive public goods.

However, for productive public goods, the intuition is the reverse. Without such a deduction, the state will underinvest in productive public goods, since some of the gains from such investment will be taken by the national government through the income tax, while the state must pay all of the costs. With a local income tax deduction, the state does not capture all of the gains of investment, but no longer pays all of the costs, and these forces exactly balance out so that it is optimal for the state to invest an efficient amount in local productive public goods.

[1] See Mitchell (2005).
[2] Again, see Mitchell (2005).
[3] See Qian and Roland (1998) and references contained therein.

From the above, any level of deductibility of local income taxes will distort the state's decision away from optimality. Furthermore, the size of the deviation by states from optimal policy will depend on the national income tax rate: the higher the national income tax rate, the larger the distortion in the incentives of the states. Hence, a welfare-maximizing national government will take these effects into account when setting its own fiscal policy: it will underinvest in public goods of both types, consumptive and productive.

We also consider an alternative fiscal form, where all tax is collected by the national government, and then some is given to the state via transfers to pay for local public goods (but states do decide the distribution of spending on the two types of goods). This system is prevalent in much of the world, but is worse than one with local revenue generation, as long as the national government may choose the deductibility of local taxes. The problem is that the size of the distortion in state incentives depends on the size of the national income tax rate, and by designing the federal system so that the local income taxes are financed federally, it increases the national tax rate and the size of the distortion. Indeed, a stronger result can be shown: that it is never optimal for a national government to provide pure transfers to the local governments. Local governments will simply use these transfers to reduce their own local tax rates and refund the money to their citizens. Instead, the national government can simply reduce its tax rate, which refunds the money to the citizens directly, and at the same time reduces the national income tax rate, and hence the distortion in the incentives to the local governments. This is a conclusion at odds with much of the literature on fiscal federalism and transfers, which finds a positive role for such transfers, due to positive spillovers in investments in public goods, tax exporting and other reasons: see Oates (1972) and more recently, Nechyba and McKinnon (1997).

Surprisingly, for such an important provision of the tax code, it has received scant attention in the public finance literature. It is discussed by Feldstein and Metcalf (1987), but there they focus on the effects on the choice of local tax instruments, not on the effects on the efficiency of investment in local public goods. These effects have been discussed more comprehensively, although less formally, in the law literature: see Billman and Cunningham (1985). Gramlich (1985) mentions the possible efficiency gains by eliminating the deduction (as he only considers consumptive public goods) but his argument concentrates on the redistributive consequences of eliminating the deduction. Gordon (1983) mentions that the local income tax deduction may be a solution to distortions in states' incentives from spillovers; in our case, the distortion in states' incentives to invest in the productive public good is the presence of the national income tax itself.

The paper is structured as follows. The next section introduces the model, and provides conditions for optimality and equilibrium. We then characterize the equilibrium policy under decentralized revenue collection; the following section characterizes policy under centralized revenue collection and shows that the national government can always do better, if allowed to choose the level of deductibility of local taxes, under decentralized revenue collection than centralized revenue collection. The final section concludes.

2 Model

We consider an economy with two levels of government, national and local. The national government in this model is beneficent: it chooses policy so as to maximize the welfare of the representative agent. The local government is also beneficent: it chooses policy to maximize the welfare of the identical citizens within the state: for simplicity, we shall assume that all states are identical and normalize the population within each state to 1.

At time 0, the national government decides on a national income tax rate τ_n and per capita levels of investment in productive and consumptive national public goods, p_n and g_n, respectively, taking into account the subsequent decisions of the local government to be sure that the national budget will balance.

At time 1, the local states choose policy, taking the national level of income taxation, as well as national investment, as fixed. The local governments choose a local income tax τ_l and per capita levels of investment in productive and consumptive local public goods, p_l and g_l, respectively. Finally, at time 2, agents produce and then consume their private consumption and the consumptive public good. Note that since all states are identical, they will choose identical policy in equilibrium and we shall omit an index for the number of the state.

The productivity of labor within each state is given by $F(p_l, p_n)$, which is strictly increasing, concave, twice continuously differentiable and satisfies the Inada conditions.[4] We shall say that p_l and p_n are substitutes if the cross-partial of $F(p_l, p_n)$ is negative. Finally, to simplify the analysis, we shall assume that the labor supply of the representative agent within each state is fixed at 1, in order to concentrate on intergovernmental inefficiencies.

We can now write the budget constraints faced by the national and local governments. The local government faces a budget constraint

$$F(p_l, p_n)\,\tau_l = p_l + g_l$$

However, the national government, given the income tax rates τ_n and τ_l, must remit back to the citizens an amount equal to α times the tax paid on the income those citizens lost to local taxation; if $\alpha = 0$, there is no state income tax deduction, and if $\alpha = 1$, state income

[4] This last condition is not necessary, but greatly simplifies the analysis in that it elimanates the need to consider boundary conditions.

taxes are fully deductible. Hence, the budget constraint of the national government is

$$F(p_l, p_n)\,\tau_n = p_n + g_n + \alpha\tau_l\tau_n F(p_l, p_n)$$

The consumption enjoyed by an agent is his production after the taxes have been collected:

$$c = F(p_l, p_n)\,(1 - \tau_c - \tau_l + \alpha\tau_c\tau_l)$$

Each agent has a utility function given by

$$u(c) + H(g_l, g_n)$$

H denotes the level of utility obtained from investment in local and national consumptive public goods, while u is the level of utility the agent obtains from private consumption. These functions are strictly increasing, concave, twice continuously differentiable and satisfy the Inada conditions. We shall say that g_l and g_n are complements if the cross-partial of $H(g_l, g_n)$ is positive.

2.1 Welfare Optimality

We first wish to characterize the optimal choice of policy from the point of view of the representative agent. Hence, we consider the problem of a social planner who can decide on both τ_n and τ_l, as well as the investment levels in both national and local public goods, subject only to the budget constraints of the governments. He will solve

$$\max_{\tau_l, p_l, g_l, \tau_n, p_n, g_n} \left\{ u\left(F(p_l, p_n)(1 - \tau_n - \tau_l + \alpha\tau_n\tau_l)\right) + H(g_l, g_n) \right\}$$

subject to

$$\begin{aligned} F(p_l, p_n)\,\tau_l &= p_l + g_l \\ F(p_l, p_n)\,\tau_n(1 - \alpha\tau_l) &= p_n + g_n \end{aligned}$$

By substituting the budget constraints into the maximization problem, we have that the social planner solves:

$$\max_{p_l, p_n, g_l, g_n} \left\{ u\left(F(p_l, p_n) - (p_l + p_n + g_l + g_n)\right) + H(g_l, g_n) \right\}$$

The social planner simply chooses the level of investment in each of the public goods, taking into account the resulting decrease in consumption.

The first-order conditions of the social planner's problem are[5]:

$$\begin{aligned} F_l\left(p_l^*, p_n^*\right) &= 1 \\ F_n\left(p_l^*, p_n^*\right) &= 1 \\ \frac{H_l\left(g_l^*, g_n^*\right)}{u'\left(c\right)} &= 1 \\ \frac{H_n\left(g_l^*, g_n^*\right)}{u'\left(c\right)} &= 1 \end{aligned}$$

The first two equations state that at the optimal policy, the marginal increase in production by increasing public investment is exactly offset by the marginal cost of the that increase in production. The third and fourth equations are essentially Samuelson conditions for investment in the consumptive public good.

2.2 Equilibrium

Equilibrium of the game is defined as a Nash equilibrium of the game between the national government and the states. The national government moves first, choosing a level of investment in both productive and consumptive public goods. This will imply, of course, a level of national income tax once the states have made their decisions. The states then choose their levels of investment in productive and consumptive public goods, as well as their tax rate, taking into account their own budget constraints. We shall assume here that a state is small—that is, it does not take into account the effect of its own policies on the national government's spending decisions and taxation rate, but rather takes these as given when making its decision.

An equilibrium is a set of investment levels $\{p_l, p_n, g_l, g_n\}$ and tax rates $\{\tau_l, \tau_n\}$ such that:

1. The state government maximizes the welfare of the representative agent within the state taking the national income tax rate and national levels of investment in the public goods as given. The state government solves:

$$\max_{\tau_l, p_l, g_l} \left\{u\left(F\left(p_l, p_n\right)\left(1-\tau_n-\tau_l+\alpha\tau_n\tau_l\right)\right)+H\left(g_l, g_n\right)\right\} \tag{1}$$

subject to the budget constraint that

$$F\left(p_l, p_n\right)\tau_l = p_l + g_l \tag{2}$$

taking the tax rate τ_n and investment decisions p_n and g_n of the national government as given.

[5] We denote the derivates of $F\left(p_l, p_n\right)$ with respect to p_l and p_n by $F_l\left(p_l, p_n\right)$ and $F_n\left(p_l, p_n\right)$, respectively. $H_l\left(g_l, g_n\right)$ and $H_n\left(g_l, g_n\right)$ are similarly defined.

2. The national government maximizes the welfare of the representative agent taking the state's response to the national government's policy choices as given. The national government solves

$$\max_{c_j, l_j} \{u (F (p_l, p_n) (1 - \tau_n - \tau_l + \alpha \tau_n \tau_l)) + H (g_l, g_n)\} \tag{3}$$

subject to the budget constraint that

$$F (p_l, p_n) \tau_n (1 - \alpha \tau_l) = p_n + g_n \tag{4}$$

taking the tax rate τ_l and investment decisions p_l and g_l of the state government as functions of the national government's decisions, as calculated in condition 1 of the equilibrium definition.

3 Policy under the Decentralized Revenue Mechanism

To characterize the equilibrium outcome, we must first consider the choices made by the local states, who take both the national tax rate and provision of public goods as given.

3.1 The Problem of the State Government

Plugging the local budget constraint (2) into the local maximization problem (1), we obtain that the problem for the states is

$$\max_{p_l, g_l} \{u (F (p_l, p_n) (1 - \tau_n) - (1 - \alpha \tau_n) (p_l + g_l)) + H (g_l, g_n)\} \tag{5}$$

Taking the first order condition for the problem of the state with respect to local investment in the productive public good, we obtain

$$F_l (p_l, p_n) = \frac{1 - \alpha \tau_n}{1 - \tau_n} \tag{6}$$

The local productive public good is underprovided, relative to the optimal provision $p_n^* (p_l)$. The states discount part of the return from investing in the local productive public good, since some of the benefits of that investment go to the national government. Hence the national income tax has created a fiscal "tragedy of the commons"—a state will underinvest in the productive public good since some of the returns are captured by other states in the form of the national provision of public goods. Since all the states benefit from investment in the commons, no one state is willing to invest up to the point where the total marginal benefit is equal to the total marginal cost.

Note that if $\alpha = 1$, then the local productive public good is provided at efficient levels. This is a key implication of a state income tax deduction: since it refunds money to the citizens of a state for local taxes incurred, it behooves the state to invest in the productive public good up to the efficient amount. An increase taxes of ε to increase p_l costs $\approx (1-\tau_n)\,\varepsilon$ to the state and results in an increase in locally used production of $\approx F_l(p_l, p_n)(1-\tau_n)\,\varepsilon$. Hence, states will choose to have $F_l(p_l, p_n) = 1$ and will invest efficiently in the local productive public good.

Taking the first order condition for the problem of the state with respect to local investment in the consumptive public good, we obtain

$$\frac{H_l(g_l, g_n)}{u'(c)} = 1 - \alpha\tau_n \tag{7}$$

The local consumptive public good is overprovided, relative to the optimal provision $g_n^*(g_l)$. The intuition for this is the reverse of that for the productive public good. Here, the cost for each state to invest \$1 in the local consumptive public good is not \$1, but instead $\$1 - \alpha\tau_n$, as their citizens receive a rebate from the national government for the spending done by their state. Hence we have a different fiscal tragedy of the commons—each state overinvests in the consumptive public good since some of the costs of this investment are borne by other states through the mechanism of the state income tax deduction. Each state has a tendency to overuse the commons, since they pay only part of the cost while gaining the entire benefit.

Note that if $\alpha = 0$, i.e. there is no state income tax deduction, we will have efficient investment in the local consumptive public good, since the state spending \$1 dollar on the consumptive public good costs the state \$1, and so they will spend up to the point where $u'(c) = H_l(g_l, g_n)$.

The preceding results are summarized in the following proposition

Proposition 1 *For a state income tax deduction level $\alpha \in [0,1]$, given investments of p_n and g_n and a tax rate of $\tau_n > 0$ by the central government,*

1. *the level of local investment in productive public goods is less than optimal, i.e. $\hat{p}_l(p_n) \leq p_l^*(p_n)$, with equality if and only if $\alpha = 1$, and decreasing in τ_n, and*

2. *the level of local investment in consumptive public goods is more than optimal, i.e. $\hat{g}_l(g_n) \geq g_l^*(g_n)$, with equality if and only if $\alpha = 0$, and increasing in τ_n.*

Note that, in both cases, the level of distortion in the decisions by the states is increasing in the level of the national income tax. We can define a level of distortion in local decisions, independent of the level of α, as the ratio of the two first order conditions:

$$\frac{H_l(g_l, g_n)}{F_l(p_l, p_n)\,u'(c)} = 1 - \tau_n \tag{8}$$

As the national income tax rate increases, the "tax wedge" between spending on local consumptive and public goods increases. By changing α, we can change which decision gets distorted, but the level of distortion, as measured by the tax wedge, remains the same.

3.2 The Problem of the National Government

We now turn to the problem of the national government. The national government wishes to maximize the welfare of all citizens, but it takes the response functions of the states as given. By plugging in the identity $F(p_l, p_n)\tau_l = p_l + g_l$ for the state income tax, we obtain that the problem of the national government is:

$$\max_{\tau_n, p_n, g_n} \left\{ u\left(F(p_l, p_n)(1-\tau_n) - (p_l + g_l)(1 - \alpha\tau_n)\right) + H(g_l, g_n) \right\} \tag{9}$$

subject to

$$F(p_l, p_n)\tau_n = p_n + g_n + \alpha\tau_n(p_l + g_l)$$

where p_l and g_l are functions of the national government's decisions.

Taking the first order condition with respect to the tax rate τ_n, we obtain

$$\lambda = u'(c)\frac{F(p_l, p_n) - \alpha(p_l + g_l)}{F(p_l, p_n) - \alpha(p_l + g_l) + \alpha\tau_n\left((F_l(p_l, p_n) - 1)\frac{\partial p_l}{\partial \tau_n} - \alpha\tau_n\frac{\partial g_l}{\partial \tau_n}\right)} \tag{10}$$

where λ represents the Lagrangian multiplier with respect to the budget constraint of the national government. Note that the "shadow price" of the budget constraint is larger than $u'(c)$, as $\frac{\partial p_l}{\partial \tau_n} \leq 0$ and $\frac{\partial g_l}{\partial \tau_n} \geq 0$, where at least one inequality is strict. The shadow price is larger than $u'(c)$ since, when the government raises the tax rate τ_n, it not only costs the representative agent directly due to the consumption lost, but also because it now further distorts the decisions of the state government, by increasing the tax wedge. For the national government, spending is costly both as it reduces the consumption of the representative agent directly through τ_n and it increases the deviations from optimality by the states.

Taking the first order condition of the problem of the national government with respect to p_n and g_n, and simplifying, we obtain

$$\begin{aligned} F_n(p_l, p_n) &= \frac{\lambda\left(1 - \frac{\partial p_l}{\partial p_n}\tau_n(F_l(p_l, p_n) - \alpha)\right)}{\lambda\tau_n + u'(c)(1-\tau_n)} \\ H_n(g_l, g_n) &= \lambda\left(1 + \alpha\tau_n\frac{\partial g_l}{\partial g_n}\right) \end{aligned} \tag{11}$$

so we see that the national government has an incentive to underinvest in both types of public goods, as $\lambda > u'(c)$. By underinvesting in national public goods, the national government can reduce the tax wedge, and hence reduce the distortion from optimality in states' choices. For productive public goods, the states may overinvest if there are complementarities between p_l and p_n; by overinvesting in the national productive public good, the national government may induce states to invest more due to the complementarties. However, if p_l and p_n are substitutes, then the national government has even more reason to underinvest in the productive public good, as such investment will reduce the already low investment in productive public goods by the states. Similarly, for consumptive public goods, the national government may overinvest if g_l and g_n are substitutes; by overinvesting in the national consumptive public good, the national government may induce the states to invest less in g_n due to the substitutability. If g_l and g_n are complements, then then the national government has even more reason to underinvest in the consumptive public good, as such investment will reduce the already high investment in consumptive public goods by the states.

We summarize these results in the following proposition:

Proposition 2 *For a state income tax deduction level* $\alpha \in [0,1]$*,*

1. *the level of national investment in productive public goods is less than optimal, i.e.* $F_n(\hat{p}_l, \hat{p}_n) > 1$*, as long as* p_l *and* p_n *are substitutes, and*
2. *the level of national investment in consumptive public goods is less than optimal, i.e.* $H_n(\hat{g}_l, \hat{g}_n) > u'(c)$*, as long as* g_l *and* g_n *are complements.*

If states are given only one responsibility, and the national government can choose α, then it is possible to attain the first-best. For example, assume that $H(g_l, g_n) = H(g_n)$, i.e., local consumptive public goods do not exist. Then by choosing $\alpha = 1$, the central government can attain first-best. Proposition 1 assures that the local productive public good will be chosen efficiently; since this happens regardless of the national income tax τ_n, the national government can now choose to implement the optimal national policy.

However, the optimal choice of α is not necessarily monotonic in the importance of local public goods. Consider the case where the utility of the agent is given by

$$c + H(g_l)$$

that is, utility is quasilinear and there is no national public good. If $H(g_l) = \theta \min\{1, g_l\}$, then for $\theta = 0$ or $\theta \geq 1$, the optimal choice of $\alpha = 1$. If $\theta = 0$, there is no local consumptive public good, and so the national government can obtain the first-best by choosing $\alpha = 1$, which eliminates the distortion in the choice of p_l by the state government. If $\theta \geq 1$, then the local government will choose $g_l = 1$ for any nonnegative rate of state income tax deduction, so again, the national government can obtain the first-best by choosing $\alpha = 1$.

However, if $\theta = \frac{1}{2}$, then it may behoove the state government to choose an $\alpha < 1$ so that the state government does not wish to invest in the local consumptive public good, even if this slightly distorts the choice of p_l by the state government.

4 Policy under the Centralized Revenue Mechanism

We now wish to consider a different model of federalism. While states retain their power to make spending decisions, their budget is set by the national government, who provides all of their funding via a transfer T. Hence, the national budget constraint is now

$$F(p_l, p_n)\,\tau_n = p_n + g_n + T$$

and the local budget constraint is completely defined by the funding of the national government:

$$p_l + g_l = T$$

4.1 The Problem of the State Government

Under a centralized revenue mechanism, the state faces the following problem:

$$\max_{p_l, g_l} \{u(F(p_l, p_n)(1 - \tau_n)) + H(g_l, g_n)\} \tag{12}$$

subject to

$$p_l + g_l = T$$

Taking the first order conditions of the state's problem, and simplifying, we obtain

$$\begin{aligned} F_l(p_l, p_n) &= \frac{\kappa}{u'(c)(1 - \tau_n)} \\ H_l(g_l, g_n) &= \kappa \end{aligned} \tag{13}$$

where κ is the Lagrange multiplier with respect to the budget constraint of the state government. Dividing these two expressions, we find that the tax wedge is

$$\frac{H_l(g_l, g_n)}{F_l(p_l, p_n)\,u'(c)} = 1 - \tau_n \tag{14}$$

so that the choices of the state government are distorted in a similar way to the decentralized revenue mechanism. However, τ_n is likely to be larger under the centralized revenue mechanism, as all government revenues come from the national income tax τ_n.

4.2 The Problem of the National Government

We now turn to the problem of the national government. The national government wishes to maximize the welfare of all citizens, but it takes the response functions of the states as given. Hence, we can model the national government as maximizing the welfare of its citizens, taking into account not only its budget constraint but also taking as a constraint (14), how the state will choose to spend the resources given to it. Hence we can write the problem of the national government as

$$\max_{p_l, p_n, g_l, g_n, \tau_n} \{u(F(p_l, p_n)(1-\tau_n)) + H(g_l, g_n)\} \tag{15}$$

subject to

$$\begin{aligned} F(p_l, p_n)\tau_n - (p_l + p_n + g_l + g_n) &= 0 \\ (1-\tau_n) - \frac{H_l(g_l, g_n)}{F_l(p_l, p_n)\,u'(c)} &= 0 \end{aligned}$$

Let μ denote the Lagrangian multiplier for the first constraint, and ν the Lagrangian multiplier for the second constraint. Note that both are positive given the formulation of the problem.

Taking the first order condition with respect to the tax rate, and simplifying, we obtain:

$$\mu = u'(c) + \frac{\nu}{F(p_l, p_n)}\left(1 - \frac{u''(c)}{u'(c)}(1-\tau_n)\right) \tag{16}$$

As in the case of the decentralized revenue mechanism, the Lagrange multiplier on the budget constraint of the national government is larger than $u'(c)$. The logic is similar as well: since a higher tax rate increases the distortion in the states' resource allocations, the cost to the representative agent of an increase in the tax rate is more than simply the foregone consumption. Here, the additional cost is parameterized by the shadow price ν: the larger the price of the constraint due to the states' actions, the larger the cost to the representative agent from an increase in the national income tax.

Taking the first order condition with respect to the local productive public good, and simplifying, we obtain:

$$F_l(p_l, p_n) = \frac{\mu - \nu(1-\tau_n)\left(\frac{F_{l,l}(p_l,p_n)}{F_l(p_l,p_n)} + \frac{u''(c)}{u'(c)}\right)}{\mu\tau_n + u'(c)(1-\tau_n)} \tag{17}$$

and so $F_l(p_l, p_n) > 1$, and so the local consumptive public good is underprovided. To fund the local productive public good at efficient levels, the national government would have to set taxes quite high, as it would have to provide a large enough transfer T to the states that they would fund p_l at the efficient level, even given the tax wedge. Further, the tax wedge at that point would be quite large, since the national government must raise all the revenue to fund p_l. Since providing a large enough transfer to fund p_l at efficient levels would distort choices in g_l to such a large degree, the national government chooses to provide a transfer of the size that the local productive public good will be underprovided.

Taking the first order condition with respect to the local consumptive public good, and simplifying, we obtain:

$$H_l(g_l, g_n) = \mu + \nu \left(\frac{H_{l,l}(g_l, g_n)}{F_l(p_l, p_n) u'(c)} - \frac{H_l(g_l, g_n) u''(c)}{F_l(p_l, p_n) (u'(c))^2} \right) \tag{18}$$

Note that we can not determine whether the local consumptive public good is under or over provided. We would expect it to be overprovided, as is the case with the decentralized revenue mechanism, but that is not necessarily the case. The national government may not provide a large enough transfer so that g_l will be overprovided, as by keeping the transfer small, the national government can reduce the distortion in the decisions by the states.

Taking the first order condition with respect to the national productive public good, and simplifying, we obtain:

$$F_n(p_l, p_n) = \frac{\mu - \nu(1 - \tau_n)\left(\frac{F_{l,n}(p_l,p_n)}{F_l(p_l,p_n)} + \frac{u''(c)}{u'(c)}\right)}{\mu\tau_n + u'(c)(1 - \tau_n)} \tag{19}$$

and so $F_n(p_l, p_n) > 1$ as long as $F_{l,n}(p_l, p_n)$ is not too positive. The reasoning here is similar to that for the decentralized revenue mechanism. As long as p_l and p_n are substitutes, the national government will underfund the national productive public good. By doing so, it is able to reduce taxes and hence lower the tax wedge which distorts the choices of the states. And if p_l and p_n are substitutes, lowering p_n increases the incentives for the states to invest in local productive public goods.

Taking the first order condition with respect to the national productive public good, and simplifying, we obtain:

$$H_n(g_l, g_n) = \mu + \nu \left(\frac{H_{l,n}(g_l, g_n)}{F_l(p_l, p_n) u'(c)} - \frac{H_l(g_l, g_n) u''(c)}{F_l(p_l, p_n) (u'(c))^2} \right) \tag{20}$$

and so $H_n(g_l, g_n) > 1$ as long as $H_{l,n}(g_l, g_n)$ is not too negative. Again, the reasoning here is similar to that for the decentralized revenue mechanism. As long as g_l and g_n are complements, the national government will underfund the national consumptive public good. By doing so, it is able to reduce taxes and hence lower the tax wedge which distorts the choices of the states. And if g_l and g_n are complements, lowering g_n decreases the incentives for the states to invest in local consumptive public goods, given the amount of funding T they are given.

We summarize these results in the following proposition:

Proposition 3 *The optimal policy of the central government with centralized revenue generation will result in:*

1. *the level of local investment in productive public goods is less than optimal, i.e.* $F_l(\hat{p}_l, \hat{p}_n) < 1$,
2. *the level of local investment in consumptive public goods* $\hat{g}_l$ *may be less than, equal to, or more than optimal,*
3. *the level of national investment in productive public goods is less than optimal, i.e.* $F_n(\hat{p}_l, \hat{p}_n) < 1$, *as long as* p_l *and* p_n *are substitutes, and*
4. *the level of national investment in consumptive public goods is less than optimal, i.e.* $H_n(\hat{g}_l, \hat{g}_n) > u'(c)$, *as long as* g_l *and* g_n *are complements.*

Note that, as in the decentralized revenue mechanism, the national government can implement the first best if the state has responsibility over only productive goods or only over consumptive goods. In that case, the state has no power at all, since the transfer will simply be invested in which ever type of good it does have jurisdiction over.

5 Regime Comparison

We now turn to the natural question of comparing the two revenue generation mechanisms. We find that, if the national government is free to choose the level of state income tax deduction α, then the representative agent has a higher welfare under decentralized revenue generation than under centralized revenue generation. This result may be surprising in light of the fact that the central government, who wishes to maximize the welfare of the representative agent, has more control under the centralized revenue mechanism: it can determine exactly how much is spent by the local government. However, the fundamental problem for the national government is not how much the local government spends, but the misallocation of the money it does spend. Recall that the tax wedge is given by:

$$\frac{H_l(g_l, g_n)}{F_l(p_l, p_n)\, u'(c)} = 1 - \tau_n \tag{21}$$

Under both systems, the national income tax distorts the allocation of resources: the state government spends too much on local consumptive public goods, and too little on local productive public goods. Under the decentralized revenue mechanism, which we denote by a superscript d, we have that

$$\tau_n^d = \frac{p_n^d + g_n^d + \alpha \tau_l^d \tau_n^d F\left(p_l^d, p_n^d\right)}{F\left(p_l^d, p_n^d\right)} = \frac{p_n^d + g_n^d + \alpha \tau_n^d \left(p_l^d + g_l^d\right)}{F\left(p_l^d, p_n^d\right)} < \frac{p_n^d + g_n^d + p_l^d + g_l^d}{F\left(p_l^d, p_n^d\right)} \tag{22}$$

as $\alpha \leq 1$ and $\tau_n < 1$. However, under a centralized revenue mechanism, which we denote denote by a superscript c, we have that

$$\tau_n^c = \frac{p_n^c + g_n^c + T}{F\left(p_l^c, p_n^c\right)} = \frac{p_n^c + g_n^c + p_l^c + g_l^c}{F\left(p_l^c, p_n^c\right)} \tag{23}$$

so that, for the same level of funding of the public goods, the tax wedge will be smaller under a decentralized revenue mechanism. This is the key idea behind the following result:

Proposition 4 *The optimal policy under decentralized revenue collection provides higher welfare than the optimal policy centralized revenue collection.*

To sketch the proof, consider what happens when the national government under the decentralized revenue mechanism attempts to replicate the optimal provision by the national government under the centralized revenue mechanism. Let it choose the same levels of national public goods. To replicate the local provision of goods, it must choose the same tax rate, so the tax wedge remains the same. Then, by varying α, it can ensure that the level of both local public goods are the same.[6] However, if the level of funding for all the public goods is the same, then, the national government under the decentralized revenue mechanism has a budget surplus, as it is collecting $\tau_n F(p_l, p_n)$ but only spending $p_n + g_n + \alpha\tau_n (p_l + g_l) < p_n + g_n + p_l + g_l$. Hence, the national government under the decentralized revenue mechanism can lower its taxes, which will make its citizens better off both directly as the level of national taxation will decrease, and indirectly as the distortion in the states' decisions due to the tax wedge will decrease.

5.1 Decentralized Revenue Generation with Transfers to the States

We now consider a combined mechanism: that is, the states raise their own revenue, but the government may supplement this by adding a transfer to the states. The problem for the state is now

$$\max_{p_l, g_l, \tau_l} \left\{u\left(F\left(p_l, p_n\right)\left(1 - \tau_n - \tau_l + \alpha\tau_n\tau_l\right)\right) + H\left(g_l, g_n\right)\right\} \tag{24}$$

subject to

$$F\left(p_l, p_n\right)\tau_n\left(1 - \alpha\tau_l\right) + T = p_n + g_n$$

while the problem for the national government is

$$\max_{p_n, g_n, \tau_n, T} \left\{u\left(F\left(p_l, p_n\right)\left(1 - \tau_n\right)\right) + H\left(g_l, g_n\right)\right\} \tag{25}$$

[6] If $g_l^c < g_l^*(g_n)$, then the national government must choose an $\alpha < 0$. While this can not be optimal for the national government under the decentralized revenue mechanism, we are only interested here in showing it can do better than the national government under the centralized revenue mechanism.

subject to

$$F(p_l, p_n)\,\tau_n = p_n + g_n + \alpha\tau_l\,(p_l + g_l) + T$$

However, if the government is able to set α, the optimal transfer to the states will be 0. The state governments will simply treat the transfer as a lump sum and reduce their own taxation by an equivalent amount. Hence, holding p_n, g_n, and τ_n constant, the decisions by the states regarding p_l and g_l will be the same regardless of the transfer, so long as the transfer is not so large as to completely crowd out state revenue generation. Note that the first order conditions for the state are, after plugging in for the budget constraint

$$\begin{aligned} F_l(p_l, p_n) &= \frac{1 - \alpha\tau_n}{1 - \tau_n} \\ \frac{H_l(g_l, g_n)}{u'(c)} &= 1 - \alpha\tau_n \end{aligned} \tag{26}$$

which is exactly the same as without any transfer. Hence, it would always be better to reduce the transfer so as to reduce national taxation and the tax wedge distorting the choices of the states.

Proposition 5 *A government structure with decentralized revenue collection will find the optimal transfer to the states is 0.*

Indeed, in our model, a national government that could prescribe negative transfers to the states could achieve first-best by choosing the optimal levels of both national public goods, and then simply demanding of the states the appropriate amount of money to pay for central expenditures. The tax wedge would then be zero, as since national income taxes are zero, and the states would have no incentive to underinvest in productive public goods in comparison to consumptive public goods.

This result is in some respects similar to that of Boadway and Keen (1996), who show that the optimal transfer from the national government to the states may be negative. However, in their model, a key issue is the efficiency of the tax instrument available to each level of government; in their model, a national government which controlled all of the tax instruments could achieve the best outcome; this is not the case here, as shown in Proposition 4. This result is closest in spirit to Sobel (1997), although there the mechanism is very different: if both federal and state governments use the same distortive tax, then the state government will not take into account that raising its tax rate will make increase the deadweight loss associated with the federal government raising its revenue. In our model, both governments have access to the same tax instrument, which does not distort the behavior of consumers, but both governments also make expenditure decisions: the key issue is that the national income tax will distort the expenditure choices made by the states, while a simple transfer, a head tax on the states if you will, not induce the same distortions in behavior by the states.

6 Conclusions

We have shown that the local income tax deduction can be welfare-enhancing if the local government must provide both productive and consumptive public goods. While a local income tax deduction will cause overinvestment in consumptive public goods, it will increase investment in local public goods, which will be underprovided without a full local income tax deduction. Further, since there does not exist a level of local income tax deduction that correctly aligns local government's incentives for both productive and consumptive public goods, national governments will underinvest in public goods to reduce the distortion in the local government's decisions.

However, this problem is not solved, but is rather exacerbated, by having the national government be the sole revenue collector. This increases the national tax rate, and hence further distorts the incentives of the local governments to underinvest in productive public goods and overinvest in consumptive public goods. Indeed, a national government can always do better by allowing the local governments to raise all the resources they wish to spend and choosing an appropriate level of local income tax deduction.

While we have not modeled positive externalities in this work, the presence of positive spillovers in either productive or consumptive local public goods only strengthens the argument for a local income tax deduction. Provision of both types of goods are increasing in the level of local income tax deduction, so if both are underprovided with no local income tax deduction, the introduction of such a deduction may bring us closer to welfare-maximizing levels of both types of goods.

We end this paper with the caveat that we have assumed welfare-maximizing governments, and such governments are not wholly reflected in reality. However, even in a model with political factors, the incentive disalignment between local and national governments identified here would still be present, in so far as the governments will react to the wishes of their citizens. We leave for future research the question of how politics will influence the outcomes identified in this model.

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7 Appendix

The proof of Propostion 1 is given in the text. The proof of the second proposition follows:

Proof. The problem of the central government is:

$$\max_{\tau_n, p_n, g_n} \{u(F(p_l, p_n)(1-\tau_n) - (p_l + g_l)(1 - \alpha\tau_n)) + H(g_l, g_n)\}$$

subject to

$$F(p_l, p_n)\tau_n = p_n + g_n + \alpha\tau_n(p_l + g_l)$$

Taking the first order condition of the problem of the national government with respect to p_n and g_n, and simplifying, we obtain

$$\begin{aligned} H_n(g_l, g_n) + \frac{\partial g_l}{\partial g_n}\left(H_l(g_l, g_n) - u'(c)(1-\alpha\tau_n)\right) &= \lambda\left(1 + \alpha\tau_n \frac{\partial g_l}{\partial g_n}\right) \\ H_n(g_l, g_n) &= \lambda\left(1 + \alpha\tau_n \frac{\partial g_l}{\partial g_n}\right) \end{aligned}$$

using (7) and

$$\begin{aligned} u'(c)\begin{pmatrix} F_n(p_l, p_n)(1-\tau_n) + \\ \frac{\partial p_l}{\partial p_n}\left(F_l(p_l, p_n)(1-\tau_n) - (1-\alpha\tau_n)\right) \end{pmatrix} &= \lambda\left(1 - \begin{pmatrix} F_n(p_l, p_n)\tau_n + \\ \frac{\partial p_l}{\partial p_n}\tau_n\left(F_l(p_l, p_n) - \alpha\right) \end{pmatrix}\right) \\ u'(c) F_n(p_l, p_n) &= \lambda\left(1 - \begin{pmatrix} F_n(p_l, p_n)\tau_n + \\ \frac{\partial p_l}{\partial p_n}\tau_n\left(F_l(p_l, p_n) - \alpha\right) \end{pmatrix}\right) \\ F_n(p_l, p_n) &= \frac{\lambda\left(1 - \frac{\partial p_l}{\partial p_n}\tau_n\left(F_l(p_l, p_n) - \alpha\right)\right)}{\lambda\tau_n + u'(c)(1-\tau_n)} \end{aligned}$$

using (6).

Now taking the first order condition with respect to τ_n, we have

$$\begin{aligned} u'(c)\begin{pmatrix} -F(p_l, p_n) + \\ F_l(p_l, p_n)(1-\tau_n)\frac{\partial p_l}{\partial \tau_n} + \\ \alpha(p_l + g_l) - \\ (1-\alpha\tau_n)\left(\frac{\partial p_l}{\partial \tau_n} + \frac{\partial g_l}{\partial \tau_n}\right) \end{pmatrix} + H_l(g_l, g_n)\frac{\partial g_l}{\partial \tau_n} &= \lambda\begin{pmatrix} -F(p_l, p_n) - F_l(p_l, p_n)\tau_n\frac{\partial p_l}{\partial \tau_n} + \\ \alpha(p_l + g_l) + \alpha\tau_n\left(\frac{\partial p_l}{\partial \tau_n} + \frac{\partial g_l}{\partial \tau_n}\right) \end{pmatrix} \\ u'(c)\left(F(p_l, p_n) - \alpha(p_l + g_l)\right) &= \lambda\begin{pmatrix} F(p_l, p_n) + F_l(p_l, p_n)\tau_n\frac{\partial p_l}{\partial \tau_n} - \\ -\alpha(p_l + g_l) + \alpha\tau_n\left(\frac{\partial p_l}{\partial \tau_n} + \frac{\partial g_l}{\partial \tau_n}\right) \end{pmatrix} \\ u'(c)\frac{F(p_l, p_n) - \alpha(p_l + g_l)}{\begin{pmatrix} F(p_l, p_n) - \alpha(p_l + g_l) + \\ \alpha\tau_n\left(\left(F_l(p_l, p_n) - 1\right)\frac{\partial p_l}{\partial \tau_n} - \alpha\tau_n\frac{\partial g_l}{\partial \tau_n}\right) \end{pmatrix}} &= \lambda \end{aligned}$$

where the second step follows from (6) and (7). Hence, since $\alpha \leq 1$, $F(p_l, p_n) > \alpha(p_l + g_l)$ and so $\lambda > u'(c)$, as $F_l(p_l, p_n) > 1$ from (6), and $\frac{\partial p_l}{\partial \tau_n}$ is negative and $\frac{\partial g_l}{\partial \tau_n}$ is positive (from Proposition 1).

The problem for the state is

$$\max_{p_l, g_l}\left\{u\begin{pmatrix} F(p_l, p_n)(1-\tau_n) - \\ (1-\alpha\tau_n)(p_l + g_l) \end{pmatrix} + H(g_l, g_n)\right\}$$

so g_l is increasing in g_n if $\frac{\partial^2 H(g_l, g_n)}{\partial g_l \partial g_n} \geq 0$, by Topkis' Theorem, i.e. if g_l and g_n are complements. Similarly, p_l is increasing in p_n if

$$\begin{aligned} u'(c) F_n(p_l, p_n)(1-\tau_n) &> 0 \\ u'(c) F_{n,l}(p_l, p_n)(1-\tau_n) + u''(c) F_n(p_l, p_n)(1-\tau_n)\left(F_l(p_l, p_n)(1-\tau_n) - (1-\alpha\tau_n)\right) &> 0 \\ u'(c) F_{n,l}(p_l, p_n)(1-\tau_n) &> 0 \end{aligned}$$

by Topkis' theorem: i.e., if if p_l and p_n are complements.

Hence,

$$\frac{H_n(g_l, g_n)}{u'(c)} > 1 + \alpha\tau_n \frac{\partial g_l}{\partial g_n}$$

so as long as g_l is increasing in g_n, we have that

$$\frac{H_n(g_l, g_n)}{u'(c)} > 1$$

■

The proof of the third propostion is given in the text. The proof of the fourth propostion is as follows:

Proof. Consider the allocation of the government with centralized revenue collection. Now, under decentralized revenue collection, let the level of investment in national public goods be the same and choose α and τ_n^d so that the level of investment in each of the local public goods is the same. Note that if $g_l^c \leq g_l^*$, we will need $\alpha \leq 0$. However, by Proposition 3, we know that the level of provision of p_l^c is less than optimal, and so the necessary $\alpha < 1$.

Since the level of provision of both local goods is the same, we have that

$$\begin{aligned} 1 - \tau_n^c &= \frac{H_l(g_l, g_n)}{F_l(p_l, p_n) u'(c)} = 1 - \tau_n \\ \tau_n^c &= \tau_n^d \end{aligned}$$

Now note that under centralized revenue collection, we have that

$$F(p_l, p_n) \tau_n^c = (p_n^c + g_n^c) + (p_l^c + g_l^c)$$

and under decentralized revenue collection

$$\begin{aligned} F(p_l, p_n) \tau_n^d \left(1 - \alpha\tau_l^d\right) &= p_n^d + g_n^d \\ F(p_l, p_n) \tau_n^d &= p_n^d + g_n^d + \alpha\tau_l^d \tau_n^d F(p_l, p_n) \end{aligned}$$

but from the solution to the state's problem, we know that

$$\tau_l^d = \frac{p_l^d + g_l^d}{F(p_l, p_n)}$$

so

$$F(p_l, p_n) \tau_n^d = \left(p_n^d + g_n^d\right) + \alpha\tau_n^d (p_n^c + g_n^c) < (p_n^c + g_n^c) + (p_l^c + g_l^c)$$

as $\alpha < 1$. Hence, if the national government, under the decentralized revenue mechanism, chooses τ_n^d and α in order to incentivize the state government to choose the same investment in local public goods as under the centralized revenue mechanism, and invests the same amount in the national public goods, it will have a revenue surplus.

Hence, holding investment in the national public goods fixed at the levels chosen under the centralized revenue mechanism, lower τ_n^d until the central government's budget is balanced. Since

$$F_l\left(p_l^d, p_n^d\right) = \frac{1-\alpha\tau_n^d}{1-\tau_n^d} \text{ and } \frac{H_l\left(g_l^d, g_n^d\right)}{u'(c)} = 1-\alpha\tau_n^d$$

this will cause both local investments to move closer to the optimal level.[7] Hence, the welfare of the represenative agent is higher and we have found a policy for the national government, under decentralized revenue generation, that does strictly better than the outcome under the optimal policy choice with centralized revenue generation. Hence, the optimal policy under decentralized revenue generation will result in higher welfare than the optimal policy choice under centralized revenue generation. ■

The proof of the fifth proposition is as follows:

Proof. Note that the first-order conditions for the state are the same, as in the text. First, consider any policy such that the local government still collects revenue after recieving the transfer. If we plug in the national government's budget constraint into its maximization problem, we obtain:

$$\max_{p_n, g_n, \tau_n, T} \left\{u\left(F\left(p_l, p_n\right) - p_n + g_n + \alpha\left(p_l + g_l\right) + T\right) + H\left(g_l, g_n\right)\right\}$$

subject to the constraint that $T \geq 0$. Taking a derivative with respect to T, we obtain

$$-u'(c) + \eta = 0$$

where η is the Lagrangian multiplier on the constraint that $T = 0$. Hence, η must be positive and hence the constraint is binding: $T = 0$, and so the optimal policy must involve either a transfer of 0 or the local government choosing to raise no revenue.

However, if the local government is not collecting revenue, then this policy outcome is worse than that under the centralized revenue mechanism, which we know in turn is (by the previous proposition) worse than the optimal policy under the decentralized revenue mechanism. ■

[7] Unless $\alpha = 0$, in which case only p_l^c will move closer to the optimal level.