Public Investment and Budget Rules for State vs. Local Governments

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Abstract

Across different layers of the U.S. government there are surprisingly large differences in institutional provisions that impose fiscal discipline, such as constitutionally mandated deficit or debt limits, or specific tax bases. In this paper we develop a framework that can be used to quantitatively assess their costs and benefits. The model features both endogenous and exogenous mobility across jurisdictions, so we can evaluate whether the different degree of mobility at the local vs. national level can justify different institutional restrictions. We show that pure land taxes have very beneficial incentive effects, but can only raise limited amounts of revenues. In contrast income taxes lead to insufficient incentives to invest in public capital, unless the fiscal constraints explicitly favor such investment. This conclusion is vastly strengthened by mobility. First, when households are likely to move out of a jurisdiction for exogenous reasons, they discount future costs and benefits more. Second, when a household's location choice is affected by local amenities and taxes, adverse congestion effects from inefficient migration more than offset the beneficial impact of (partial) capitalization of future taxes and amenities into land prices.

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1 Introduction

The Unites States offers a rich variety of different institutions for limiting government indebtedness at different levels of decentralization. While almost all states are constitutionally restricted to balance their budget every budget cycle, except for public investment, the federal government is only constrained by a legislated debt cap that is routinely lifted whenever needed. The practice of states does not uniformly extend to lower-level jurisdictions (such as counties and cities), where there is a wide heterogeneity in the forms of restrictions to indebtedness.[1]

In previous work (Bassetto with Sargent [4]), we quantified the role of mobility and demographics in generating departures from Ricardian equivalence at the state level and the federal level. Because of the higher degree of (gross) mobility, we found that states reap much bigger efficiency gains than the federal government from adopting a "golden rule" that forbids borrowing for recurring expenses but allows it for capital projects. In that paper we assumed mobility to be driven entirely by exogenous events, so that public investment has no effect on population size and/or property prices. This assumption seems a reasonable approximation for large entities such as states or countries, since mobility in that case is likely to be driven predominantly by job opportunities, family decisions, and other factors that are only weakly linked to government policy.[2] However, the same assumption is no longer appropriate in considering mobility at the local level, where households face a choice even when constrained by the job location and/or family ties.

This paper develops a framework to quantitatively assess the role of different institutional restrictions on government policy in delivering efficient public investment when mobility can be driven both by exogenous events and by an optimal location choice.

In developing our analysis, we build upon two sets of existing papers. First, there is a very large literature in local public finance that analyzes the interplay between mobility and the efficient provision of public goods. This literature starts from Tiebout [19], and highlights the role of the source of taxes (property vs. income or head taxes), the elasticity of the demand and supply of land (with particular emphasis on zoning restrictions for the latter), and the role of congestion externalities.[3] This literature has mostly dealt with static environments, where the location and policy decisions are taken at one point in time. A few papers have attempted to bring dynamics into the picture to better analyze the role of public investment and debt,[4] deriving some of the qualitative results that we will discuss below. However, these dynamic models rely on generations that live for two periods only, and are thus not well suited for quantitative work.

More recently, there has been research into computable models where agents face dynamic choices both privately and as participants in the political process.[5] These papers have mostly

[1]See e.g. Miranda, Picur, and Straley [16].

[2]For examples of the low estimate of endogenous mobility across states, see Meyer [14] and Gelbach [7].

[3]For a literature survey, see e.g. Mieszkowski and Zodrow [15]; Stiglitz [18] contains a thorough discussion of some of the central aspects in this debate.

[4]See e.g. Kotlikoff and Rosenthal [13], Wildasin and Wilson [22], Schulz and Sjöström [17], and Conley and Rangel [5].

[5]See e.g. Hassler et al. [9], Hassler et al. [8], Doepke and Zilibotti [6], Azzimonti [1], and Azzimonti, Battaglini, and Coate [2].

worked with what Klein, Krusell, and Ríos-Rull [12] defined a "generalized Euler equation." In this paper, we show how to apply similar tools to local public finance, and we provide some preliminary examples of the conclusions that can be drawn.

Our results support the view that, when households base their location decision on local amenities and taxes and the tax base is not tied to land, adverse congestion effects dominate capitalization, unless zoning restrictions are extremely strict in preventing population adjustments. Because of this, the introduction of the golden rule achieves significant efficiency improvements in the allocation of resources.

As an alternative, a pure land tax (per acre) avoids congestion and achieves full capitalization, but it can only raise a limited amount of resources before driving the value of a marginal plot of land to zero. Though this tax by itself is not sufficient to provide for the needs of government, improved efficiency would result if this tax were used as the *marginal* source of additional revenues.

2 The Model

2.1 Preferences and Technology

We consider an economy populated by a continuum of households $i \in \mathcal{I}$; each of them must choose to live in one of a continuum of towns $j \in \mathcal{J}$. We normalize to one the measure of households and towns. From the aggregate perspective, all towns are identical; in particular, each of them encompasses $\bar{L}$ units of land.

Each household consumes a private good and enjoys the services from land and a durable local public good. In addition, in each period the household has a set $\mathcal{N}_{it}$ of N towns where it can potentially live, and for each of those an idiosyncratic, location-specific utility shock ψ_{ijt} that is independent across the N towns and distributed according to a cumulative distribution function $\hat{F}$. Over time, the location-specific shocks evolve as follows: with probability θ, both the set of towns and the shock remain the same as in the previous period. With probability $1-\theta$, the household draws a new set of towns and a new location-specific utility shock, both independent of the previous realizations. This exogenous shock can be interpreted both as a major life event that affects location preferences and as the death of a household, which is then replaced by a newly born household to preserve a constant population. In the notation that follows, I will assume the first interpretation, whereby a household is infinitely lived (as an altruistically linked dynasty). However, the only change that is needed for the second interpretation to apply is to assume that annuities markets for wealth are present. For the purpose of calibration, we will interpret θ as stemming from both forces, and we will assume that the proper annuity markets are open.

Summarizing, household i's preferences are given by

$$E_0 \sum_{t=0}^{\infty} \beta^t [c_{it} + w\left(L_{it}\right) + v\left(\frac{G_{j_{it}t}}{\mu_{j_{it}t}}\right) + \psi_{ij_{it}t}],$$

where c_{it} is consumption by household i in period t, L_{it} is the amount of land whose services are consumed by household i in period t, j_{it} is the town where person i chooses to live in period t, $G_{j_{it}t}$ is the amount of a durable public good ("public capital") provided in town j_{it} in period t, $\mu_{j_{it}t}$ is the density of population in town j_{it} in period t, and w and v are continuously differentiable and strictly concave functions. The assumption of linear preferences in private consumption greatly simplifies the analysis by eliminating wealth effects from the household preferences over land and public goods.[6] For tractability, we also need to assume that all households benefit in the same way from the public good. Finally, note that we assume that public capital is subject to congestion externalities, so a household only benefits from its level per capita.[7] We assume v and w to be strictly increasing and concave. Preferences are only defined over location decisions that belong to the set $\mathcal{N}_{it}$ at each time t.

We assume that a law of large numbers applies across households,[8] so that in each period each town j has a density N of potential inhabitants, and the c.d.f. of the utility that each potential inhabitant receives compared to living in the next best city is given by the c.d.f. of $X - Y$, with $X \sim \hat{F}$ and $Y \sim \hat{F}^{N-1}$. We denote by F this c.d.f., and we assume that it is continuously differentiable.

In each period, households receive an exogenous endowment y.[9] There is a constant-returns-to-scale technology that turns one unit of endowment into one unit of private consumption. Likewise, another constant-returns-to-scale technology turns one unit of endowment from a unit density of households into one unit of public investment in any given location.

Public capital depreciates at a rate δ.

2.2 Government

The provision of the public good is decided by majority voting by the residents of each town. Public financing comes from either income or land taxes. We denote income taxes per capita as T_t and land taxes per unit of land τ_t. Since land is homogeneous and there are no structures, a land tax is equivalent to a property tax in this setup.

We assume that a fraction x of investment can be financed with debt, and that the town government is committed to repay interest and a fraction α of outstanding debt in each period.

[6] Bassetto with Sargent [4] discusses robustness of the results with respect to this assumption in the context of a model with exogenous mobility. In the present context, endogenous sorting by wealth would however potentially generate further complications.

[7] We could allow for a weaker congestion effect, as long as w is sufficiently increasing to ensure a uniform distribution of households across all towns. The analysis would be considerably more complicated if clustering of households emerged endogenously from the increasing returns intrinsic in the public good.

[8] See Judd [11] and Uhlig [20] for a discussion of the law of large numbers in the context of models with a continuum of households.

[9] Introducing private capital and labor would have no effect on the results; see Bassetto with Sargent [3, 4].

3 Efficient Allocations

Because of quasilinear preferences, the allocation of people, land, and public capital remains the same along the Pareto frontier; only the allocation of private consumption is affected.[10] To avoid well-known measurability issues, it is convenient to index each household by the sequence of realizations of idiosyncratic shocks.[11] A Pareto-optimal allocation will thus be described by a sequence of aggregate consumption $\{C_t\}_{t=0}^{\infty}$, a sequence of government spending by each town $\{\{G_{jt}\}_{j\in\mathcal{J}}\}_{t=0}^{\infty}$,[12] and stochastic sequences of land holdings and locations $\{L_t, j_t\}_{t=0}^{\infty}$, adapted to the history of location options $\{\mathcal{N}_s\}_{s=0}^{t}$ and the history of shocks $\{\{\psi_{js}\}_{j\in\mathcal{N}_s}\}_{s=0}^{t}$ that solve the following problem:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t [C_t + w\left(L_t\right) + v\left(\frac{G_{j_t t}}{\mu_{j_t t}}\right) + \psi_{j_t t}],$$

subject to the output endowment constraints,

$$C_t + \int_{j\in J} (G_{jt} - (1-\delta) G_{j\,t-1}) dj \leq y \quad \forall t$$

land constraints,

$$N \int_{(\{\mathcal{N}_s\}_{s=0}^{t}, \{\{\psi_{js}\}_{j\in\mathcal{N}_s}\}_{s=0}^{t}): j_t = j} L_t \prod_{s=0}^{t} \prod_{q\in\mathcal{N}_s} d\hat{F}(\psi_{qs}) \leq \bar{L} \quad \forall t, \text{ a.s. in } j \in \mathcal{J}.$$

and the definition of μ_{jt}

$$\mu_{jt} := N \int_{(\{\mathcal{N}_s\}_{s=0}^{t}, \{\{\psi_{js}\}_{j\in\mathcal{N}_s}\}_{s=0}^{t}): j_t = j} \prod_{s=0}^{t} \prod_{q\in\mathcal{N}_s} d\hat{F}(\psi_{qs}) \quad \forall t, \text{ a.s. in } j \in \mathcal{J}.$$

By the symmetry of the shocks, it is straightforward to verify that a Pareto-optimal allocation assigns each household to its most preferred location according to the idiosyncratic shock; furthermore, all households consume $\bar{L}$ units of land (so $\mu_{j_t t} \equiv 1$).

Finally, the efficient condition for the provision of public capital requires the same level of public capital in (almost) all towns:

$$v'(G^{\text{eff}}) = 1 - \beta(1-\delta) \tag{1}$$

The intuition behind equation (1) is straightforward: producing one additional unit of the public good in each town costs one unit of aggregate consumption, but has an immediate benefit captured by $v'(G^{\text{eff}})$ and a future benefit in that it allows to cut investment and increase aggregate consumption in the next period by $1-\delta$ units, which are discounted at the rate β.[13]

[10] We assume here that the nonnegativity constraint on consumption does not apply, or we restrict our attention to the region where it is not binding.

[11] See Jovanovic and Rosenthal [10] for related discussion.

[12] Measurability is not an issue for towns, since they will all be identical in the optimal allocation and in the equilibria that we will analyze. Still, we use L_∞ as the relevant space for $\{G_{jt}\}_{j\in\mathcal{J}}$, so public capital is only determined up to sets of towns of measure 0.

[13] Because of symmetry, the sentence above applies to any set of positive measure of towns, so we are not

4 Markets and Competitive Equilibrium

We assume that there is no rental market for land;[14] in order to live in each town, a household must own the land whose services it consumes. There are no transaction costs from selling or buying the land, nor are there moving costs, apart from the possible loss in location-specific utility.

Besides trading land, households can also trade both privately-issued and publicly-issued bonds. To the extent that they face a probability of death, households can also trade with financial intermediaries that annuitize the households' wealth.

A *symmetric steady state-competitive equilibrium* is

- an allocation (c^*, G^*, L^*);
- a price system (ρ^*, p^*), where ρ^* is the interest rate on government debt and p^* is the price of land;
- taxes and debt (T^*, B^*) or (τ^*, B^*)

such that:

- Households maximize their utility taking prices and government policy as given, subject to the budget constraint

$$B_{it} = B_{i\,t-1}(1+\rho^*) + y - C_{it} - T^* - p^*(L_{it} - L_{i\,t-1}) \tag{2}$$

  or

$$B_{it} = B_{i\,t-1}(1+\rho^*) + y - C_{it} - (p^* + \tau^*)L_{it} + p^* L_{i\,t-1} \tag{3}$$

  and a lower bound on debt holdings $-\underline{B}$ whose only role is to rule out Ponzi schemes.

- the towns' budget constraints are satisfied, i.e.,

$$\rho^* B^* + \delta G^* = T^*$$

  or

$$\rho^* B^* + \delta G^* = \tau^* \bar{L};$$

  furthermore, the towns respect their borrowing limits and repayment schedules, i.e.,[15]

$$\alpha B^* = \delta x G^*. \tag{4}$$

constraining the planner to deliver the same public good everywhere, but rather this is part of the optimal solution.

[14] The analysis will be extended to renters in future work.

[15] We assume that the deficit limit is always binding for towns. This will be the case in all of the numerical examples that we will consider, except for some cases in which Ricardian equivalence holds. When Ricardian equivalence holds, (4) is a weakly optimal choice, and (without loss of generality) we assume that this is how town debt is set.

- The market for land clears in each town, i.e., $L^* = \bar{L}$. Since all towns have the same land prices, households will always choose to locate where their idiosyncratic realization of ψ_{ijt} is highest.

- The market for debt clears, i.e., B^* is an optimal choice of assets for each household. Note that linearity implies that the actual distribution of assets in the population is indeterminate (but it is also irrelevant for what follows).

Characterizing a symmetric steady-state competitive equilibrium given an exogenous level of public capital G^* is straightforward. From the household problem, the equilibrium interest rate must be $\rho^* = (1-\beta)/\beta$. Given this interest rate, it is convenient to define the implicit land rent as $r_t := p_t - \beta p_{t+1}$, where p_t is the price of land in period t. In the steady state, this is yields $r^* = p^*(1-\beta)$. The demand for land by each household as a function of implicit rent is given by

$$\hat{L}(r) := \arg\max_{L} \left(w\left(L\right) - rL \right),$$

In the case of income taxes, a symmetric steady-state equilibrium requires $\bar{L} = \hat{L}(r^*)$: this is a (nonlinear) equation that can be solved for r^*.[16] Similarly, for land taxes, we obtain $\bar{L} = \hat{L}(r^* + \tau^*)$.[17]

Given G^*, the budget constraint of the governments and their debt limits determine T^* (or τ^*) and B^*. Finally, consumption is given by $C^* = y - \delta G^*$.

It is straightforward to verify that a symmetric steady-state competitive equilibrium is Pareto efficient, subject to the exogenously given amount of public spending.

To describe a political-economic equilibrium, we need to analyze the problem faced by voters of a town that contemplates setting a policy different from that of all other towns. Accordingly, we now define a *competitive equilibrium with one town deviating from the symmetric steady state*. This is given by the same objects as the symmetric steady-state equilibrium (with the same equilibrium conditions), complemented by what follows.

- An (exogenous) sequence $\{G_{j^0t}\}_{t=0}^{\infty}$, where G_{j^0t} is public capital in town j^0 in period t;

- A location decision as a function of the history of idiosyncratic shocks for all households for whom $j^0 \in \mathcal{N}_{it}$ at some time t. It is straightforward to prove that the household location decision is only affected by the contemporaneous realization of the idiosyncratic shocks, since there are no wealth effects nor moving costs. We denote this choice as $J(\psi_{ij^0t}, \psi_{ij^1t}, ...\psi_{ij^{N-1}t})$, where $(j^1, \ldots, j^{N-1})$ are the other elements of $\mathcal{N}_{it}$. Since all other towns behave identically and there is a continuum of them, the effect of the deviating town on their population is negligible. We thus only use the J function to characterize the population in town j^0. Accordingly, we set $J(\psi_{ij^0t}, \psi_{ij^1t}, ...\psi_{ij^{N-1}t}) = j^0$ for a household that optimally chooses to live in j^0, and normalize $J(\psi_{ij^0t}, \psi_{ij^1t}, ...\psi_{ij^{N-1}t}) = 0$ if the optimal choice is to live anywhere else.

[16] Our assumptions about preferences ensure that a solution exists and is unique.

[17] Existence of a solution is now only guaranteed if τ^* is not too high, while uniqueness is unaffected.

- Consumption, land, and asset holdings as a function of the history of idiosyncratic shocks for all households for whom $j^0 \in \mathcal{N}_{it}$ at some time t. Thanks again to quasilinearity of utility, all households that choose to live in the same town will choose the same land holdings, independently of the history of their idiosyncratic shocks. It thus follows that land holdings for households living in town j^0 can be summarized by a sequence $\{L_{j^0t}\}_{t=0}^{\infty}$.
- a land price sequence for town j^0, $\{p_{j^0t}\}_{t=0}^{\infty}$;[18]
- a sequence of taxes and debt in town j^0, (T_{j^0t}, B_{j^0t}) or (τ_{j^0t}, B_{j^0t})

such that:

- For all households for whom $j^0 \in \mathcal{N}_{it}$ at any time t, the location decision, consumption, asset and land holdings maximize their utility taking prices and government policy as given, subject to the budget constraints

$$B_{it} = B_{i\,t-1}(1+\rho^*) + y - C_{it} - T_{j_{it}t} - p_{j_{it}t}L_{it} + p_{j_{i\,t-1}t}L_{i\,t-1}$$

or

$$B_{it} = B_{i\,t-1}(1+\rho^*) + y - C_{it} - (p_{j_{it}t} + \tau_{j_{it}t})L_{it} + p_{j_{i\,t-1}t}L_{i\,t-1}$$

and the lower bound $-\underline{B}$, where j_{it} is the index of the town they choose to live in period t, and $p_{jt} = p^*, T_{jt} = T^*, \tau_{jt} = \tau^*$ for $j \neq j^0$.

- Towns j^0's budget constraint and borrowing limits are satisfied, i.e.,

$$(1+\rho^*)B_{j^0\,t-1} + G_{j^0t} = T_{j^0t} + (1-\delta)G_{j^0\,t-1} + B_{j^0t} \tag{5}$$

or

$$(1+\rho^*)B_{j^0\,t-1} + G_{j^0t} = \tau_{j^0t}\bar{L} + (1-\delta)G_{j^0\,t-1} + B_{j^0t} \tag{6}$$

and

$$B_{j^0t} - B_{j^0\,t-1}(1-\alpha) = x(G_{j^0t} - G_{j^0\,t-1}(1-\delta)). \tag{7}$$

- The market for land clears in town j^0, i.e.,

$$\mu_{j^0t} \equiv \int_{(\psi_{ij^0t},\psi_1,\ldots,\psi_{N-1}):J(\psi_{ij^0t},\psi_1,\ldots,\psi_{N-1})=j^0} d\hat{F}(\psi_{ij^0t})d\hat{F}(\psi_1)\cdots d\hat{F}(\psi_{N-1}) = \frac{\bar{L}}{L_{j^0t}} \tag{8}$$

We next characterize such an equilibrium. Consider first the case of income taxes. Given the sequence of public capital and initial debt B_{j^00}, equation (7) describes the evolution of debt, and equation (5) determines the sequence of taxes. Define

$$\hat{w}(r) := \max_L \left(w\left(L\right) - rL\right).$$

[18] The interest rate is an economy-wide variable and remains at ρ^*.

For any household for whom $j^0 \in \mathcal{N}_{it}$, simple algebra shows that the net benefit of living in town j^0 rather in the best alternative town is given by

$$\hat{w}(r_{j^0t}) + v\left(\frac{G_{j^0t}}{\mu_{j^0t}}\right) - \frac{T_{j^0t}}{\mu_{j^0t}} - u^* + \psi_{ij^0t} - \max_{j \in \mathcal{N}_{it} \setminus j^0} \psi_{ijt},$$

where u^* is the utility level attained in a town at the symmetric steady state, net of the private endowment and the idiosyncratic preference shock, i.e.,

$$u^* = \hat{w}(r^*) + v(G^*) - \delta G^* \left(1 + \frac{x(1-\beta)}{\alpha\beta}\right). \tag{9}$$

Population density in j^0 is thus

$$\mu_{j^0t} = N\left(1 - F\left[u^* - \hat{w}(r_{j^0t}) - v\left(\frac{G_{j^0t}}{\mu_{j^0t}}\right) + \frac{T_{j^0t}}{\mu_{j^0t}}\right]\right) \tag{10}$$

From equation (8), $\mu_{j^0t} = \bar{L}/\hat{L}(r_{j^0t})$, which we substitute into (10) to obtain an implicit function to be solved for r_{j^0t}. We cannot prove in general that a solution to this problem exists, nor that it is unique. However, in any computed example, both existence and uniqueness are straightforward to check numerically, given G^*. Given the implicit rent, the land price is given by

$$p_{j^0t} = \sum_{s=t}^{\infty} \beta^{s-t} r_{j^0s}.$$

Finally, when $\rho^* = (1-\beta)/\beta$ households are indifferent among all consumption and asset plans that satisfy their budget constraint, so the description is completed by assuming that households for whom $j^0 \in \mathcal{N}_{it}$ at any time t follow one of these paths.[19]

Similar equations apply in the case of land taxes. In this case, the implicit equation to be solved for r_{j^0t} is

$$\frac{\bar{L}}{\hat{L}(r_{j^0t} + \tau_{j^0t})} = N\left[1 - F\left[u^* - \hat{w}(r_{j^0t} + \tau_{j^0t}) - v\left(\frac{G_{j^0t}\hat{L}(r_{j^0t} + \tau_{j^0t})}{\bar{L}}\right)\right]\right]. \tag{11}$$

A non-symmetric competitive equilibrium will not be Pareto efficient in general, even conditional on the exogenous levels of public goods.[20] This is because, by moving, a household does not take into account the additional congestion that it causes in its destination nor the relief in the town of origin. In general, these effects cancel only in a symmetric equilibrium.

[19] Existence is guaranteed, since we do not impose a lower bound on consumption. Also, note that the set of households in question is of measure 0, so it is immaterial for market clearing conditions.

[20] Strictly speaking, a single town deviating has no efficiency consequences, since the allocation is defined up to sets of towns of measure 0. Nonetheless, (11) is not the solution to the limiting planning problem when a small measure of towns deviates.

5 Political Process and Political-Economic Equilibrium

We assume the following timing of events within each period t:

1. Households realize their idiosyncratic shocks, decide where to live for the period, and trade land accordingly;

2. Residents of each town vote over the provision of local public capital, subject to the town's budget constraint and borrowing limit;

3. The public good is produced and taxes are levied according to the outcome of the vote. Consumption takes place.[21]

For the case of income taxes, we define a *Markov political-economic equilibrium* (MPEE) as a vector $(c^*, G^*, L^*, \rho^*, p^*, T^*, B^*)$, and functions (Γ, Λ, Π) that depend on public capital and debt inherited from the previous period, such that:

(i) Starting from $G_{-1} = G, B_{-1} = B$, define recursively $G_t = \Gamma(G_{t-1}, B_{t-1})$, $L_t = \Lambda(G_{t-1}, B_{t-1})$, $p_t = \Pi(G_{t-1}, B_{t-1})$. Set T_t and B_t to the values implied by (5) and (7). Given any value of (G, B), $(c^*, G^*, L^*, \rho^*, p^*, T^*, B^*)$ and $(G_t, L_t, p_t, T_t, B_t)_{t=0}^{\infty}$, together with a suitable choice of household consumption, asset, and location decisions, must form a symmetric competitive equilibrium with one town deviating from the symmetric steady state.

(ii) $\Gamma(G^*, B^*) = G^*$, $\Lambda(G^*, B^*) = \bar{L}$, and $\Pi(G^*, B^*) = p^*$. In words, a town that starts at the symmetric steady state remains there.

(iii) Start from any initial condition (G, B). Let the distribution of idiosyncratic preferences for living in the town among the residents be the one that would prevail in the competitive equilibrium described in point (i). Specifically, this means that, among residents, the cumulative distribution function of the preference z for living in the current town relative to the next best alternative is given by

$$\frac{F(z) - F(\tilde{z})}{1 - F(\tilde{z})},$$

where $\tilde{z}$ is defined as the solution to

$$\frac{\bar{L}}{\Lambda(G, B)} = N(1 - F(\tilde{z})).$$

Let the current residents vote over choices of G'. Let they assume that the resulting allocation will be a competitive equilibrium with one town deviating from the steady state, characterized by current-period taxes and debt issuance from (5) and (7), and a future allocation that satisfies $G_t = \Gamma(G_{t-1}, B_{t-1})$, $L_t = \Lambda(G_{t-1}, B_{t-1})$, $p_t = \Pi(G_{t-1}, B_{t-1})$ at all future times t. Then, $\Gamma(G, B)$ is a Condorcet winner.

[21] Debt can be traded both at stages 1 and 3.

> In words, what we require is that a majority of the residents choose the policy $\Gamma(G, B)$ when they expect the future response of the economy to be described by the same functions that represent the current choices. While in principle this vote could take place starting from an arbitrary population density and distribution of tastes, we only need to check optimality for the density and the distribution of tastes that stem from an optimal location choice by households that (correctly) anticipate that the policy $\Gamma(G, B)$ will be implemented.

In the case of property taxes, the definition is identical, except that τ^* replaces T^* and (6) replaces (5).

In deciding which policy they prefer, households have to anticipate whether the policy will lead them to move to a different jurisdiction next period or to stay put (assuming that they are not hit by the exogenous mobility shock). It is straightforward to see that two households will have the same ranking over the set of policies that lead both of them to remain, and also over the set of policies that lead both of them to leave. Conflict will only emerge for policies that lead one of them to stay and the other to leave, or between choosing a policy that would lead both of them to stay and another one that would lead both of them to leave.

At the steady state, all households will remain put until hit by the exogenous shock. By continuity, around the steady state, stayers will remain a majority of the population, and we can characterize the equilibrium by looking at the first-order conditions for their preferred policy (assuming a differentiable equilibrium). Once we have characterized the equilibrium in such a neighborhood, we could then expand the search to regions where the pivotal voter might be moving, and check robustness to policies that might lead more than 50% of the population to decide to move out. Notice, however, that this case is relevant theoretically, but cannot be relevant empirically. We will typically consider a period to be a budget cycle (a year), and such a rapid population drop is implausible.

Let $W(G, B)$ be the value that a household expects to attain in the future by living in a community that has state variables described by G and B, net of the cost of acquiring the land and of the idiosyncratic location shock. Consider a household that anticipates to stay in the same location with probability θ and that lives in a town characterized by an initial population μ,[22] inherited capital (before depreciation) G, and debt B. Such a household will prefer a policy that solves the following problem:

$$\begin{aligned} \max_{G'} v\left(\frac{G'}{\mu}\right) + w\left(\frac{\bar{L}}{\mu}\right) - \frac{(\alpha + (1-\beta)/\beta)B + (1-x)(G' - (1-\delta)G)}{\mu} + \\ \beta\frac{\bar{L}}{\mu}\Pi(G', B') + \beta\theta W(G', B') + \beta(1-\theta)W(G^*, B^*), \end{aligned} \tag{12}$$

where

$$B' := (1-\alpha)B + x(G' - (1-\delta)G). \tag{13}$$

[22] We assume that the household owns $\bar{L}/\mu$ units of land. We could further generalize the description to nodes in which households picked different land holdings. However, this complication is irrelevant for the same reasons that will lead us to drop μ as a separate state variable.

Equation (12) illustrates the trade-offs faced by a household in choosing G'. First, the choice has a contemporaneous effect on current utility and taxes. Since all households face the same costs and benefits along this dimension, this component does not involve any externalities. Looking to the following period, the household is affected by the current choice in two ways:

- To the extent that higher G' and/or lower B are reflected into future land prices, the household realizes a capital gain on the land that it has purchased.
- The current choice of G affects future levels of spending and taxes; to the extent that the household anticipates remaining in the town, it will take these considerations into account. These will be reflected in the value $W(G', B')$. Note that part of the change in W will undo the benefits of the capital gains above: in order to remain in the town, the household needs to forgo realizing part of those capital gains, to retain land where to live.

The solution to (12) yields a function $\hat{\Gamma}(G, B, \mu)$: it would thus appear that the population size should appear as a state variable. However, in their location decision, households correctly anticipate the policy that will be undertaken. Substituting the resulting value $\hat{\Gamma}$ into (10) or (11), we see that in equilibrium the resulting population level will only depend on G and B inherited from the past.[23] Furthermore, while it would be easy to compute ex post, characterizing an equilibrium can be done without keeping track of the choices that would be made in a node in which (10) or (11) do not hold.

In the case of income taxes, the first-order conditions of the policy preferred by a household that anticipates to remain in town with probability θ are thus given by the solution to the following system of four functional equations:

1. Value function, along the equilibrium path:

$$\begin{aligned} W(G,B) = &-\Pi(G,B)\Lambda(G,B) + v\left(\frac{\Gamma(G,B)\Lambda(G,B)}{\bar{L}}\right) + w\left(\Lambda(G,B)\right) - \\ &\frac{\Lambda(G,B)\left[\left(\alpha + (1-\beta)/\beta\right)B + (1-x)\left(\Gamma(G,B) - (1-\delta)G\right)\right]}{\bar{L}} + \\ &\beta\Pi\left(\Gamma(G,B), B'\right)\Lambda(G,B) + \beta\theta W\left(\Gamma(G,B), B'\right) + \beta(1-\theta)W(G^*, B^*); \end{aligned} \tag{14}$$

2. First-order condition for the policy preferred by a household that anticipates to stay:

$$\begin{aligned} 0 = &\frac{\Lambda(G,B)}{\bar{L}}\left[v'\left(\frac{\Gamma(G,B)\Lambda(G,B)}{\bar{L}}\right) - (1-x)\right] + \\ &\beta\Big[\Pi_G(\Gamma(G,B),B') + x\Pi_B(\Gamma(G,B),B')\Big]\Lambda(G,B) + \\ &\beta\theta\Big[W_G(\Gamma(G,B),B') + xW_B(\Gamma(G,B),B')\Big]; \end{aligned} \tag{15}$$

[23] Of course, if the resulting equation does not have a solution, then an equilibrium does not exist. Conversely, if multiple solutions can be found, then we have multiple equilibria.

3. Market clearing for land:

$$\frac{\bar{L}}{\Lambda(G,B)} = N\Big[1 - F\Big[u^* - \hat{w}\left(\hat{L}^{-1}\left(\Lambda(G,B)\right)\right) - v\left(\frac{\Gamma(G,B)\Lambda(G,B)}{\bar{L}}\right) + \\ \left[(\alpha + (1-\beta)/\beta)B + (1-x)(\Gamma(G,B) - (1-\delta)G)\right]\frac{\Lambda(G,B)}{\bar{L}}\Big]\Big]; \tag{16}$$

4. Land price:

$$\Pi(G,B) = \hat{L}^{-1}(\Lambda(G,B)) + \beta\Pi\left(\Gamma(G,B), B'\right). \tag{17}$$

In equations (14)-(17), we used for brevity the definitions of u^* and B' of (9) and (13), with $G' = \Gamma(G,B)$.

In the case of land taxes, equations (14) and (15) remain unchanged, but equations (16) and (17) are replaced by

$$\frac{\bar{L}}{\Lambda(G,B)} = N\Big[1 - F\Big[u^* - \hat{w}\left(\hat{L}^{-1}(\Lambda(G,B))\right) - v\left(\frac{\Gamma(G,B)\Lambda(G,B)}{\bar{L}}\right)\Big]\Big] \tag{18}$$

and

$$\Pi(G,B) = \hat{L}^{-1}(\Lambda(G,B)) - \frac{1}{\bar{L}}\left[\left(\alpha + \frac{1-\beta}{\beta}\right)B + (1-x)(\Gamma(G,B) - (1-\delta)G)\right] + \beta\Pi(\Gamma(G,B), B'). \tag{19}$$

6 The Power and Limits of Land Taxes

It is straightforward to verify that, in the case of land taxes, we obtain the following simple solution:

$$\Gamma(G,B) = G^{\text{eff}} \tag{20}$$
$$\Lambda(G,B) = \bar{L},$$
$$\Pi(G,B) = \frac{\hat{L}^{-1}(\bar{L}) - \delta G^{\text{eff}}/\bar{L}}{1-\beta} + \frac{(1-\delta)(G - G^{\text{eff}})}{\bar{L}} - \frac{B}{\beta\bar{L}},$$

and

$$W(G,B) = \frac{v(G^{\text{eff}}) + w(\bar{L}) - \delta G^{\text{eff}}}{1-\beta} - \bar{L}\Pi(G^{\text{eff}}, B^*) - \frac{B^*}{\beta},$$

where G^{eff} is the efficient level of public capital defined in equation (1) and $B^* = x\delta G^{\text{eff}}/\alpha$. Land taxes induce an efficient provision of the public good in all periods. This is because future land prices fully reflect future taxes and debt: the current voter thus internalizes the effects of her choices on future residents of the town. This result follows Schultz and Sjöström [17] and Conley and Rangel [5].[24]

[24] In Schultz and Sjöström land taxes are not sufficient to restore efficiency, since the determination of the public good occurs before moving decisions, and the current benefits of the public good are not fully priced into land. Conley and Rangel distinguish between public goods that generate fiscal vs. direct intergenerational spillovers. Our paper focuses only on goods that generate fiscal spillovers: future generations can make up for the lack of past investment by increasing their own investment, with the only cost of additional taxes.

With capitalization of amenities and debt into future land prices, the degree of endogenous or exogenous mobility becomes irrelevant: the solution is independent of F and θ. The solution is also independent of x and α, since Ricardian equivalence holds: if the current voter leaves bigger debt to future generations, she will fetch a correspondingly lower price upon selling her land. Land taxes would thus appear a promising source of revenue to provide appropriate incentives for public investment.

In order for land taxes to reap such efficiency gains, it is very important that they only hit land, a factor on fixed net supply that enjoys pure rents. Hence, the tax does not resemble property taxes as currently assessed by most localities in the United States: those taxes apply both to land and to structures. It also is different from a tax on *land values*, which (in a richer model with nonuniform land) would distort the incentives to aggregate into cities.[25]

For quantitative analysis, land taxes are limited by the value of the land. As an example, the average value of farm real estate per acre in Illinois in 2007 was \$4,330.[26] Assuming a discount factor of 4%, and even assuming that this was the value of the *marginal* plot of land, Illinois would be able to raise less than 1.5% of Gross State Product in pure land taxes before driving to 0 the value of the marginal plot. Any increases beyond that point would generate distortions, since they would lead residents to abandon tracts of land.[27]

We conclude thus that, while appealing, land taxes alone are not likely to generate enough revenues to sustain sufficient government investment.

7 Some Numerical Examples about Income Taxes

We consider here some numerical examples that illustrate the consequences of endogenous and exogenous mobility on the efficiency of the allocation chosen by voters.[28]

In the first example, we focus on the role of endogenous mobility by assuming that the distribution $\hat{F}$ is degenerate on 0. In this case, a symmetric equilibrium requires households to be indifferent on where to live among the N towns that are available to them. Substituting (16) and (17) into (14), it follows that $W(G, B)$ is independent of (G, B): since households have no particular attachment to a specific town, they care about the provision of the public good and taxes in that town only to the extent that they affect the price of land that they own. For this reason, the degree of exogenous mobility becomes irrelevant.

We set the following parameter values: $\beta = 0.96$, $\delta = 0.03$, $\bar{L} = 1$, $v(G) \equiv G^{-2}/2$, $w(L) \equiv L^{1-\sigma}/(1-\sigma)$. We consider the case in which the town is not allowed to borrow to pay for capital expenses, i.e., $x = 0$, and look at the resulting equilibrium distortion (at the symmetric steady state). As in Bassetto with Sargent [4], we measure distortions as a wedge between the marginal

[25] However, Wallis and Weingast [21] point out that a tax on land value may actually be beneficial for incentives when the benefit of the public good does not accrue uniformly within the jurisdiction: when capitalization reflects the differences in benefits, owners of land that receives the most benefits will pay a larger share of the costs.

[26] Source: USDA web site. I thank David Oppedahl for pointing me to this information.

[27] It is also likely that this figure is close to the top of the Laffer curve for such a tax: once the tax led people to abandon farmland, the amount of land in use and available for taxes would shrink dramatically.

[28] A complete calibration is to be completed.

utility of public capital under the efficient allocation and under the equilibrium one:

$$\text{wedge} = \frac{v'(G^*) - v'(G^{\text{eff}})}{v'(G^{\text{eff}})}$$

We choose this metric because it is more likely to be robust to departures from the assumption of quasilinear preferences.[29] A positive (negative) wedge means that public capital is underprovided (overprovided).

The degree to which the voting outcome is inefficient depends on two forces:[30]

- Congestion: when a town has higher public capital than others, it becomes a more desirable location. This drives more households to live there, and the resulting congestion dilutes the benefits of the additional investment undertaken in the past.
- Capitalization: the newly arriving households bid up the price of land, which rewards the previous residents (as owners of land) for the investment undertaken.

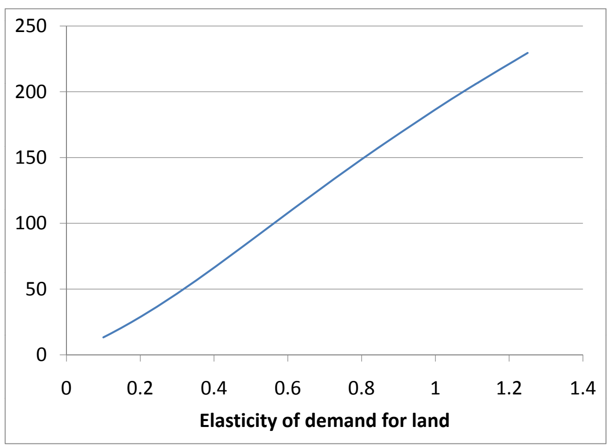

Figure 1: Efficiency wedge (%) with degenerate F

Whether congestion or capitalization will be more prevalent depends on whether equilibrium is achieved mostly by varying quantity or price. With a fixed supply, this is in turn driven by the elasticity of the demand for land ($1/\sigma$), which is thus the key parameter of interest. As figure 1 shows, for the case of degenerate F inefficiency is likely to be very large under a pure balanced budget, unless the demand for land is extremely inelastic. In the limit, as $\sigma \to +\infty$, efficiency is restored, since only a fixed number of households can live in the town, and the benefits of public investment are thus fully factored into land prices.

[29] See the appendix of Bassetto with Sargent [4] for further discussion.

[30] For further discussion of these forces, see e.g. Stiglitz [18] and Schultz and Sjöström [17].

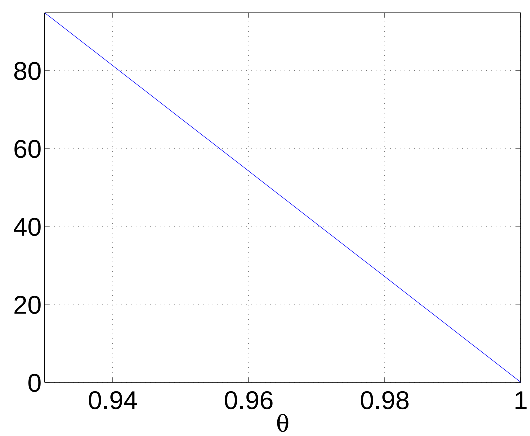

Figure 2: Efficiency wedge (%) with $N = 1$

In our second example, we consider the opposite polar extreme: we now assume that $N = 1$, so that households have no location choice. In this case, it is Π that is independent of (G, B): the price of land will be determined by the demand of the households that are captive to each town, and the demand is unrelated to the provision of public goods.[31] In equation (15), all long-term benefits that are internalized by the voters must now come from W. The key parameter is thus no longer σ, which is irrelevant, but θ, the probability that a household will remain in the same town. Results are shown in figure 2, where we retain the same parameter values and functional forms as above. When $\theta \approx 1$ the town looks like a closed economy with infinitely-lived households, and Ricardian equivalence holds; as figure 2 shows, this leads to efficiency. In contrast, the higher the probability that a household will move out of town (or die), the bigger the distortion generated by the fact that it neglects benefits accruing to future immigrants.

Next, we study how the wedge evolves as a function of the degree of endogenous mobility (figure 3). For this experiment, we retain the parameters chosen above. In addition, we set the inverse of the elasticity of the demand for land σ to 1.1, and the probability of an exogenous move to 3% ($\theta = 0.97$). We normalize N to two, choose an extreme-value distribution for the shock (yielding a logistic distribution), and let its standard deviation move between 0 and ∞.

At the parameters chosen here, congestion dominates capitalization, and endogenous mobility exacerbates the distortions arising from political choices under a pure balanced budget. By contrast, implementation of the golden rule leads to allocations that are very close to efficiency [graph to be provided].

If the degree of endogenous mobility is the only difference between state and local governments, the analysis above supports the widespread introduction of the golden rule even at the local level, with a clear distinction between capital and ordinary expenditure and strict prohibitions from borrowing to pay for the latter.

[31] Of course, this relies on the assumption that preferences are strongly separable in the public good and land.

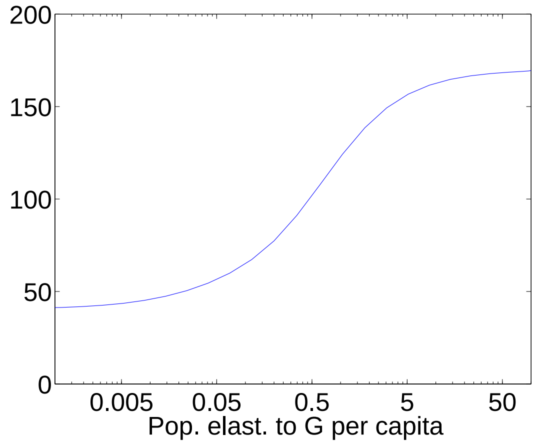

Figure 3: Efficiency wedge (%) as a function of endogenous mobility.

8 Conclusion

This paper has developed a framework to analyze the relevance of endogenous and exogenous mobility on the incentives that local communities face in providing efficient levels of public investment. The preliminary numerical examples presented here suggest the following conclusions:

- Land taxes (purely based on acreage owned by each taxpayer) deliver efficient incentives, but land per se is not valuable enough to fully support the needs of government investment.
- When households move in response to public amenities and debt, the adverse effect of congestion is likely to be as important as the beneficial incentive effect of capitalization. When taxes are primarily levied on income, relying on capitalization alone does not seem thus a good substitute for explicit rules that encourage investment at the local level, such as the golden rule.

This model has potential implications for the conduct of countercyclical fiscal policy. Our analysis only includes the costs, but not the benefits, of allowing the flexibility to run deficits; hence, a full assessment of countercyclical transfers across different layers of government requires further investigation. We do show that the costs of flexibility are smaller at the aggregate, federal level, and increase at lower-level jurisdictions. To the extent that benefits do not similarly increase at the disaggregated level, an implication is that countercyclical policy is more efficiently done at the federal level, possibly relying on federal transfers to state and local governments; this provides a rationale for the current stance of U.S. fiscal policy.

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