Federal Reserve Bank of Chicago

On the Relationship between Mobility, Population Growth, and Capital Spending in the United States

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WP 2009-25

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November 30, 2009

Abstract

In this paper, we assess the empirical relationship between population growth, mobility, and state-level capital spending in the United States. To evaluate the magnitude of the coefficients, we introduce an explicit, quantitative political-economy model of government spending determination, where mobility and population growth generate departures from Ricardian equivalence. Our estimates find strong responses in the level of capital provision per capita to these demographic movements; in fact, the resulting coefficients are stronger than the model delivers. Regression coefficients on population growth and mobility also yield opposite implications for the direction to which spending is distorted by the political-economy friction, posing a further challenge.

1 Introduction

The sharp recession recently experienced by the United States has highlighted once more the plight of states whose finances are bound by constitutional restrictions on their indebtedness. The

*Very preliminary. We thank R. Andrew Butters for valuable research assistance. Marco Bassetto gratefully acknowledges the National Science Foundation for support through grant # 0754551.

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magnitude of the shortfalls in many states' revenue projections and their anticipated expenses calls into serious question their ability to balance their books without substantial help from the federal government, which is not bound by similar rules. Throughout the recession, the federal government has been able to borrow large resources from the capital markets.

While almost all states are in principle prevented from borrowing to cover their ordinary budget, most of them routinely issue bonds to pay for capital improvements. This rule, commonly known as "the golden rule," has long been rationalized with the fact that capital improvements benefit generations to come, who should be called to share the burden.[1] Of course, such a rationale only holds in an economy that is far from Ricardian equivalence, for otherwise government debt would have no effects on allocations and welfare (Barro [1]).

In this paper, we look at the evidence that state-level capital spending is driven by departures from Ricardian equivalence stemming from mobility and population growth. We are certainly not the first ones to study this question; indeed, one of our goals is to supplement Poterba [10] by considering additional and more recent data. However, our main objective is to interpret the magnitudes of the coefficients that we find through the lens of an explicit political-economy model that has sharp quantitative predictions about magnitudes of departure from Ricardian equivalence. This turns out to be important; while the model is rejected by the data, this happens because the response of capital provision to population growth and mobility is *too strong* compared to the limited deviations that the model would expect.

Our starting point is a simple environment where the population is spread across different states, and voters choose public spending year by year, taking into account the exogenous prospects for mobility that they face and an exogenous path for the population growth in the state they reside in.[2] Voters discount future costs and benefits of their policy choices more heavily than efficiency would dictate: this occurs because they neglect costs and benefits that will

[1] See e.g. Studensky [15].

[2] By assuming that the evolution of population is exogenous, we abstract from the capitalization effects that play a very important role in the literature on urban economics. A recent survey of this research is in Ross and Yinger [12]. By looking at state-level data rather than local data, we expect capitalization to be much less prevalent.

accrue to future residents of the state that are not yet present. This effect will be larger, the faster a state's population is growing or the more turnover among residents. In the absence of any restriction on government indebtedness we would thus expect states to run large deficits. However, as mentioned above, a version of the "golden rule" prevents voters from financing non-capital expenses with debt. If strictly enforced, the golden rule fully restores incentives to provide the correct amount of nondurable public goods: this is because both costs and benefits accrue immediately, and no long-term consequences emerge. However, in the case of public capital, both benefits (of current investment) and costs (of current debt issuance) spill over into the future. These costs and benefits could align if debt issuance were structured so that the debt was paid off at the same time as the benefits accrued, but the two need not be aligned correctly. In particular, whether costs or benefits will be shifted further into the future depends on many parameters of the model, but especially on the duration of capital, the maturity of debt, and the fraction of debt financing. The shorter the duration of capital, the longer the maturity of debt, and the larger the fraction of debt financing, the more costs are shifted to the future relative to benefits, to the point that voters might actually be induced to overspend.

The degree by which cost/benefit mismatches lead to inefficient spending depends on the magnitude of departures from Ricardian equivalence. At one extreme, in a world of no mobility and no population growth, the set of voters would be fixed and the distribution of costs and benefits over time should be irrelevant. The model thus delivers quantitative predictions on how mobility and population growth affect capital spending. It is these predictions that we take to the data.

In our empirical exercise we document two main facts:

1. Capital spending by the states reacts to population growth much less than would be needed to preserve a constant capital stock per capita. This implies that the capital stock per capita *declines* with population growth.

2. For a given the population growth rate, capital spending is positively related to mobility, i.e., it declines with the fraction of the population that remains in the state in any given year.

We find that the magnitude of both effects is somewhat stronger than the model would be able to predict, based on a plausible choice of parameters. Moreover, the two empirical facts pose a greater challenge for the model when considered jointly. In the model, the inability of public capital to keep up with population growth occurs when *too little borrowing* is allowed and future benefits exceed future costs: when this is the case, higher population growth leads to more severe *underinvestment*, rationalizing the weak response of investment to the capital needs of a growing population. In contrast, a positive relationship between mobility and capital spending is interpreted by the model as evidence of *too much borrowing*: when future costs exceed the benefits, a more mobile population is more prone to *overspending*.

Section 2 presents the model through which we interpret the data. Section 3 provides further intuition on the equilibrium relationship between government spending, population growth, and mobility, and discusses ways in which this relationship can be informative about the parameters of the model. Section 4 describes the data and provides a brief institutional overview. Our main results are presented in section 5, while section 6 speculates on directions for future research.

2 Model

The model we adopt is based on Bassetto with Sargent [4]. However, we explicitly introduce here the sources of variation across states and over time that will form the basis of our estimation procedure. While highly stylized, the model we present provides an explicit account of the forces that drive political decisions, and thus offers a transparent interpretation of the findings of our empirical exercise.

We consider N states (jurisdictions), each populated by a continuum of households. Each state n is characterized by the following random variables:

- n_{st}, the population growth in state s at time t.
- θ_{st}, the probability that a household living in state s at $t-1$ is alive and in the same state at t. For simplicity, we adopt the Blanchard [5] assumption that the probability of dying (and of moving) is independent of age; time variation in mobility will thus affect all

residents uniformly.[3]

- ϕ_{st}, a measure of the household preference for public goods in the state;

We assume that all residents of a state share the same mobility and the same preferences for (state-level) public goods.[4] By assuming that these random variables depend on the state, rather than the household, we make our analysis tractable, but our results would be robust to the extent that endogenous mobility across states is limited.[5]

Within period t, a household residing in state s has preferences given by

$$c_{it} + \phi_{st} \frac{G_{st}^{1-\sigma}}{1-\sigma}, \tag{1}$$

where c_{it} is consumption of a private good by household i (residing in state s) and G_{st} is the per-capita level of a state-level public good.[6]

Households discount the future at a rate $\beta\tilde{\theta}$, where $\tilde{\theta}$ is the mortality rate (assumed constant across states for simplicity). We assume that the probability that a household that moves from one state to another will move back is negligible. Because of this, households discount future benefits from the public goods and future taxes in the state in which they reside by $\beta\theta_{s\,t+1}$.

In each period, each person alive produces y units of output, which can be either consumed as a private good[7] or invested in the public good:

$$G_{st} = \frac{1-\delta}{1+n_{st}} G_{s\,t-1} + \gamma_{st}, \tag{2}$$

where δ is the depreciation rate of the public good and γ_{st} is public spending per capita in period t in state s. In our empirical specifications, we will consider several public goods, characterized

[3] As shown in Bassetto and Lepetyuk [3] (e.g., figure 1), variation by age is not as important, except for the old that are far from being pivotal.

[4] Upon moving, each household thus inherits a new mobility and preference parameter, based on its new state of residence.

[5] For evidence of limited mobility across states, see Meyer[9] and Gelbach [7]. A model of policy determination with endogenous mobility is developed in Bassetto [2].

[6] We assume that public goods are subject to congestion externalities. Although this assumption does not seem central to our results, we will study robustness in future versions.

[7] The private good is nondurable. Private capital could be introduced with no effect on the results, if income taxes are restricted to labor; see Bassetto with Sargent [4].

by different degrees of durability; in particular, we will constrast current expenditures (for which we assume $\delta = 1$) to capital expenditures. The analysis developed here immediately generalizes to multiple public goods by assuming that each good enters additively in the utility function.[8] In particular, our key equation (9) will hold for each good independently.

Each state has a government that is empowered to levy income taxes and produce public goods.[9] Taxes and spending are chosen by majority vote each period by the residents of the state,[10] subject to two borrowing restrictions. The first restriction limits to a value x the fraction of public spending that can be financed with debt. The constitutions of most U.S. states prevent borrowing, except to finance capital expenditures; this would correspond to $x = 0$ for current (nondurable) expenses, and $x = 1$ for capital projects. We will both study the implications of setting x to these values and make inference on x from the data. The second restriction limits the duration of debt. In the model, this is represented by a parameter α, which represents the minimal fraction of outstanding debt that must be bought back in any given period. This parameter is a parsimonious representation of the limited duration of debt issued by U.S. states; for some states, this limit is imposed by their constitution, while in other cases it might be driven by other forces that are outside of the model, such as the lack of liquidity of maturities longer than 30 years. The two borrowing restrictions give rise to the following constraints on government behavior:

$$B_{st} = (1 + r_t)\frac{B_{s\,t-1}}{1 + n_{st}} + G_{st} - T_{st} \tag{3}$$

and

$$T_{st} \geq (1 - x)G_{st} + \frac{\alpha + r_t}{1 + n_{st}} B_{s\,t-1}, \tag{4}$$

where B_{st} is government debt per capita, r_t is the real interest rate, and T_{st} are tax revenues per capita.

We assume that households can annuitize their wealth, so the equilibrium interest rate of the economy is the constant $r_t = (1 - \beta)/\beta$.

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[8] The preferences over K public goods would thus be described by $c_{it} + \sum_{j=1}^{K} \phi_{sjt} \frac{G_{sjt}^{1-\sigma_j}}{1-\sigma_j}$.

[9] Given that all residents of a state are identical and that location and income are exogenous, income taxes are equivalent to fixed lump-sum payments.

[10] Given our assumptions, all residents will share the same preferences, and the vote will be unanimous.

Details of the definition and characterization of an equilibrium are provided by Bassetto with Sargent [4]. As in that paper, we focus on Markov equilibria, where the equilibrium provision of public capital is independent of the past.[11] In these equilibria, households believe that any additional investment in public goods beyond the equilibrium level would only last for one period, and would be undone by the voters next period. This is an equilibrium because next-period voters will indeed choose to undo any past investment that exceeds the equilibrium level, if they expect future voters to do the same.

To determine the equilibrium level of spending, we analyze the decision faced by voters in period t. Given the nature of the equilibrium, an increase in the time-t provision of the public good will be reversed in the subsequent period; such a policy change would thus have effects on public good provision for only for one period, but its tax implications would stretch into the future. On the cost side, equations (3) and (4) imply that an additional unit of G_{st} increases time-t taxes in state s by $1-x$ units. In period $t+1$, the additional investment is undone by reducing spending in the public good by $(1-\delta)/(1+n_{s\,t+1})$ units. Period-$t+1$ taxes respond to this investment reduction by $1-x$, and they are also affected by the additional debt issued in period t. The combined effect is thus given by

$$\frac{x}{1+n_{s\,t+1}}\left(\frac{1-\beta}{\beta}+\alpha\right)-\frac{(1-x)(1-\delta)}{1+n_{s\,t+1}}.$$

An additional unit of spending in period t has no further effects on public spending beyond period $t+1$, but the consequences of debt linger, and taxes in period $t+j$ vary by the following amount:

$$x\prod_{v=1}^{j}\frac{1}{1+n_{s\,t+v}}\left[\frac{1-\beta}{\beta}+\alpha\right][\delta-\alpha](1-\alpha)^{j-2},\quad j>1.$$

Whether taxes increase or decrease after period $t+1$ depends on whether the public good depreciates faster or slower than the rate at which government debt is paid back. When the public good is not very durable and debt is paid back slowly, we have $\delta>\alpha$ and taxes increase in the long run.

[11] Bassetto with Sargent does not include time variation in preferences and demographics. However, it is straightforward to prove that, with quasilinear preferences, a Markov equilibrium of the same type exists even when this time variation is introduced.

To a current resident of the state at time t, the expected present value of taxes per unit of public investment is the discounted sum of all these present and future tax changes:

$$Q_{st} \equiv E_t \Bigg\{ 1 - x + \frac{\beta \theta_{s\,t+1}}{1 + n_{s\,t+1}} \left[x \left(\frac{1-\beta}{\beta} + \alpha \right) - (1-x)(1-\delta) \right] + \\ x \left[\frac{1-\beta}{\beta} + \alpha \right] (\delta - \alpha) \sum_{j=2}^{\infty} \beta^j (1-\alpha)^{j-2} \prod_{v=1}^{j} \frac{\theta_{s\,t+v}}{1 + n_{s\,t+v}} \Bigg\}, \tag{5}$$

where E_t is the conditional expectation taken with respect to the statewide shocks.

In voting, a resident will equate the marginal utility of the additional public good provision in period t with the expected present value of tax changes that will be triggered by this additional provision:

$$\phi_{st} G_{st}^{-\sigma} = Q_{st} \Longrightarrow \log G_{st} = \frac{1}{\sigma} (\log \phi_{st} - \log Q_{st}) \tag{6}$$

To simplify our expressions, we linearize $\log Q_{st}$ around $n_{st} = 0$ and $\theta_{st} = 1$, and assume that population growth and (one minus) the mobility rate follow AR(1) processes with autocorrelations ρ_n and ρ_θ and long-term means $\bar{n}$ and $\bar{\theta}$. This yields the following expression:

$$\log Q_{st} \approx \log(1 - \beta(1-\delta)) + \frac{\beta(1-\delta)}{1-\beta(1-\delta)} (1 + \bar{n} - \bar{\theta} - \rho_\theta(\theta_{st} - \bar{\theta}) + \rho_n(n_{st} - \bar{n})) - \\ x \left[\frac{1 + \bar{n} - \bar{\theta}}{1 - \beta(1-\alpha)} + \frac{\rho_n(n_{st} - \bar{n})(1 - \beta\rho_n(1-\delta))}{(1-\beta(1-\delta))(1-\beta\rho_n(1-\alpha))} - \frac{\rho_\theta(\theta_{st} - \bar{\theta})(1 - \beta\rho_\theta(1-\delta))}{(1-\beta(1-\delta))(1-\beta\rho_\theta(1-\alpha))} \right]. \tag{7}$$

To derive intuition, we consider four components of equation (7) in turn:

1. $\log(1 - \beta(1-\delta))$. This is the only term that would apply if $n_{st} \equiv \bar{n} = 0$ and $\theta_{st} \equiv \bar{\theta} = 1$. With no population growth and no mobility ever, this is a standard representative-agent economy where Ricardian equivalence holds. Consequently, neither the fraction of debt financing x not debt maturity α have any effect on public good provision. Furthermore, it is straightforward to verify that the representative agent votes for the efficient level of G_{st}.[12]

2. $\frac{\beta(1-\delta)}{1-\beta(1-\delta)}(1 + \bar{n} - \bar{\theta} - \rho_\theta(\theta_{st} - \bar{\theta}) + \rho_n(n_{st} - \bar{n}))$. This piece is the only relevant addition when borrowing is ruled out ($x = 0$). In this case, higher mobility and/or population

[12]See Bassetto with Sargent [4] for the derivation of the efficient level.

growth between period t and period $t+1$ implies a higher effective discount factor by the voters, and an accordingly lower level of government investment (provided depreciation is less than full, i.e., $\delta < 1$). Future expected population growth is driven by the long-term mean $\bar{n}$ and, given the highly persistent process, by the past realization n_t. The reasoning for mobility is analogous, keeping in mind that mobility is represented by $1 - \theta_{s\,t+1}$.

3.
$$x\left[\frac{1+\bar{n}-\bar{\theta}}{1-\beta(1-\alpha)}\right]. \tag{8}$$
This piece of the cost describes how debt financing changes the cost perceived by the voters when population growth and mobility are constant over time. In this case, higher population growth (higher $\bar{n}$) and/or higher mobility (lower $\bar{\theta}$) increase effective discounting, and imply that the perceived cost of a public project is lower. Mobility and population growth thus interact with debt financing to encourage government spending. For sufficiently high values of x, this effect dominates the previous effect, and overspending can occur. This is particularly likely if α is close to 0, i.e., when debt repayment occurs far into the future.

   In practice, while population growth and mobility are not constant, they are very persistent. It is straightforward to see that, as $\rho_n \to 1$ and $\rho_\theta \to 1$, the entire effect of debt on the perceived cost of funding the public good is captured by equation (8), where $\bar{n}$ is replaced by n_{st} and $\bar{\theta}$ is replaced by θ_{st}. In this case, the intuition derived above for constant growth and mobility still applies.

4. The remaining terms in equation (7) capture the way in which the speed of the repayment schedule interacts with the demographic processes as n_{st} and θ_{st} converge (in expectation) back to their long-run steady states. Given the high level of persistence of these processes, they are not quantitatively important in driving voters' choices, except of course insofar as they replace $\bar{n}$ with n_{st} and $\bar{\theta}$ with θ_{st} in equation (8).

Based on the intuition developed above, the model predicts that the stock of public capital will be lower in states with more population growth and/or higher mobility if no borrowing is allowed. When enough borrowing of sufficiently long maturity is allowed, this relation reverses, and more population growth (mobility) is associated with *higher* capital. This is more likely to happen for capital that depreciates faster.

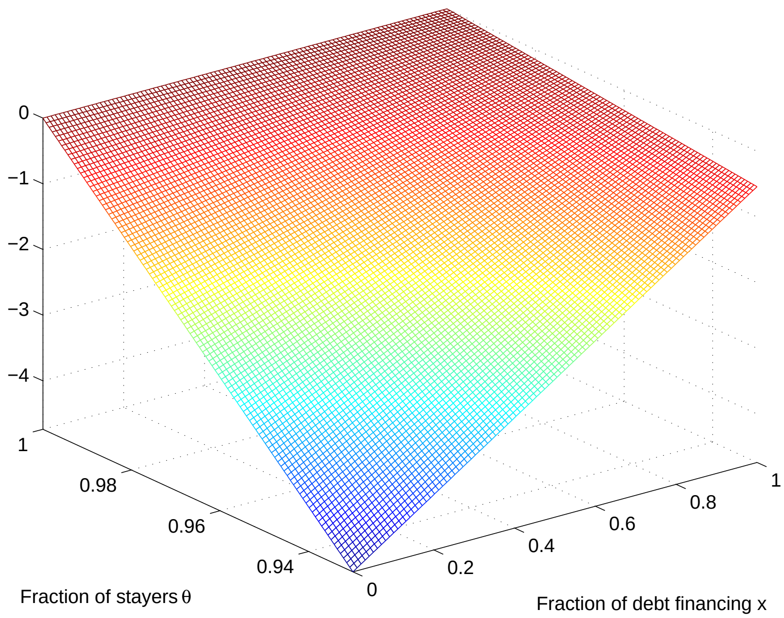

Figure 1: Logarithm of public good provision with no pop. growth and constant mobility rate, $\delta = 0.03$.

To gain further insight, in figures 1 and 2 we plot the log of the stock of the public good as a function of the fraction of households that stay within the state from one year to the next ("the stayers") and the degree to which debt financing is allowed.[13] In both figures we set $\beta = 0.96$, $\sigma = 0.2$, and α so that the half-life of debt is 15 years; we set population growth to 0 (to isolate the effects of mobility), and we assume a constant mobility. Finally, we also normalize preferences so that the efficient provision of the public good (in logs) is 0.

In figure 1 we set $\delta = 0.03$, which may be appropriate for major infrastructure investment, whereas figure 2 adopts $\delta = 0.06$, in line with many estimates of the depreciation of private capital. For each one of the figures, we set the preference shock ϕ_{st} so that 0 corresponds to the efficient level.

Not surprisingly, figures 1 and 2 show that Ricardian equivalence holds if there is no mobility

[13] The effects of population growth are analogous to those of mobility, so we do not plot them here.

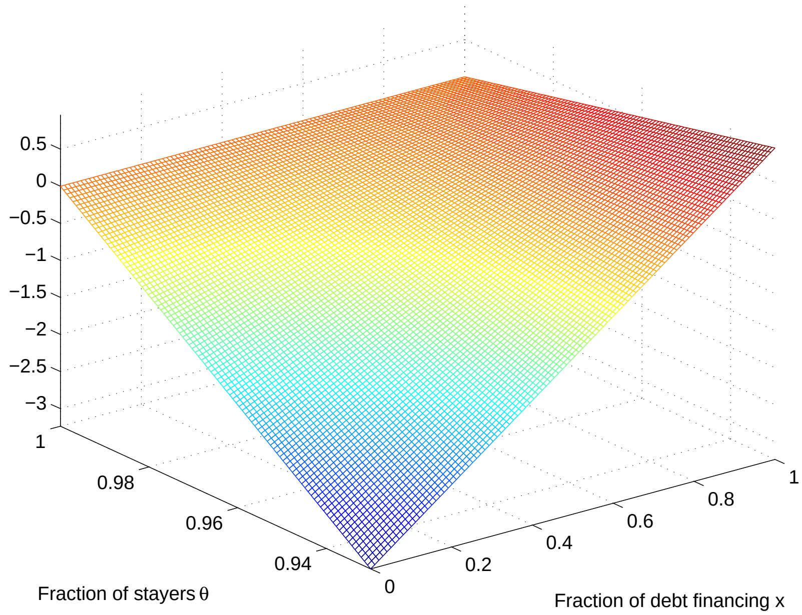

Figure 2: Logarithm of public good provision with no pop. growth and constant mobility rate, $\delta = 0.06$.

($\theta = 1$), while spending departs more and more from the efficient level when the fraction of stayers decreases. More interestingly, the *sign* of this departure depends on the circumstances. Under a pure balanced budget ($x = 0$), we unambiguously obtain that public capital is underprovided. However, under 100% debt financing, when capital is not very durable ($\delta = 0.06$) costs are shifted into the future to an extent that makes it worthwhile for voters to actually *overprovide* public capital. In this case, increasing mobility (decreasing the fraction of stayers) *increases* the provision of public capital. The main implication of the model is that, for high degrees of debt financing, we should observe a *positive* relationship between the level of public capital and mobility for capital goods subject to rapid depreciation, and a negative relationship for very long-term projects.

In figure 3 we show that the basic intuition is unchanged when time-varying mobility and population growth are introduced. This figure picks the same depreciation rate as figure 2 ($\delta = 0.06$) and holds all parameters the same, except population growth is set at the long-term mean of the AR(1) process that we estimate from the data, and autocorrelations ρ_n and

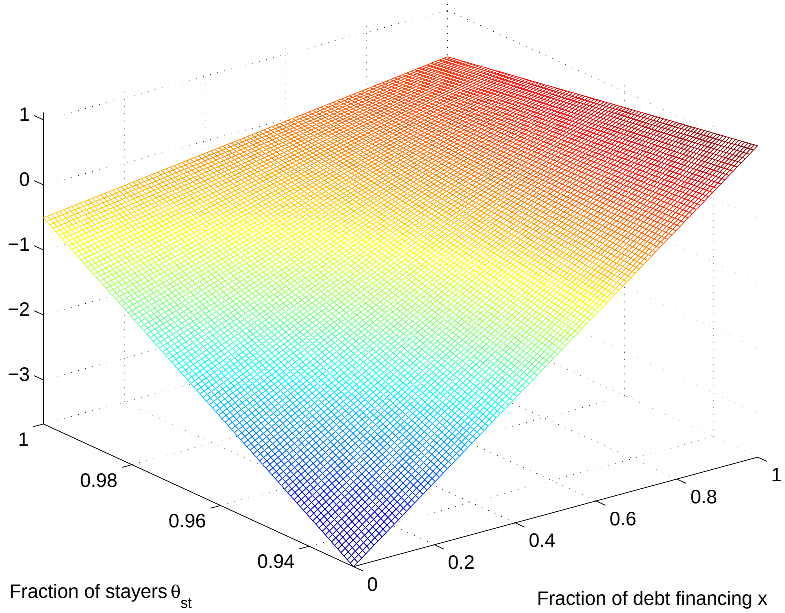

Figure 3: Logarithm of public good provision, $\delta = 0.06$, with population growth and mean reversion in the mobility rate.

ρ_θ are also set at their respective estimates. Because of positive population growth, Ricardian equivalence no longer holds even when there is no mobility across states, but this effect is small.

The discussion above refers to the stock of public capital. In the data, we actually observe the flows of public investment (and expenses in nondurable goods). In the model, this is captured by the variable γ_{st} in equation (2). After appropriate substitutions, we obtain the following expression:

$$
\begin{aligned}
\log\gamma_{st} \approx & \log\delta + \frac{1-\delta}{\delta}n_{st} + \frac{1}{\delta\sigma}\Bigg\{\log\phi_{st} - (1-\delta)\log\phi_{s\,t-1} - \delta\log(1-\beta(1-\delta)) - \\
& \frac{\beta\delta(1-\delta)}{1-\beta(1-\delta)}(1+\bar{n}-\bar{\theta}-\rho_\theta(\theta_{st}-\bar{\theta})+\rho_n(n_{st}-\bar{n}))+ \\
& x\delta\left[\frac{1+\bar{n}-\bar{\theta}}{1-\beta(1-\alpha)} + \frac{\rho_n(n_{st}-\bar{n})(1-\beta\rho_n(1-\delta))}{(1-\beta(1-\delta))(1-\beta\rho_n(1-\alpha))} - \frac{\rho_\theta(\theta_{st}-\bar{\theta})(1-\beta\rho_\theta(1-\delta))}{(1-\beta(1-\delta))(1-\beta\rho_\theta(1-\alpha))}\right] - \\
& \frac{\beta(1-\delta)^2}{1-\beta(1-\delta)}(\rho_n(n_{st}-n_{s\,t-1}) - \rho_\theta(\theta_{st}-\theta_{s\,t-1}))+ \\
& x(1-\delta)\left[\frac{\rho_n(n_{st}-n_{s\,t-1})(1-\beta\rho_n(1-\delta))}{(1-\beta(1-\delta))(1-\beta\rho_n(1-\alpha))} - \frac{\rho_\theta(\theta_{st}-\theta_{s\,t-1})(1-\beta\rho_\theta(1-\delta))}{(1-\beta(1-\delta))(1-\beta\rho_\theta(1-\alpha))}\right]\Bigg\}.
\end{aligned} \tag{9}
$$

For high values of ρ_n and ρ_θ, public investment behaves very similarly to the stock of public capital; in particular, the relationship between mobility and investment is very similar to that between mobility and the stock of public capital. One important exception is the additional term $(1-\delta)n_{st}/\delta$, which affects the relationship between investment and population growth. This term captures the need to provide infrastructure for the additional population, and introduces an additional reason why we should expect higher public investment in faster-growing states.[14]

3 Empirical Strategy and Identification

Equation (9) forms the basis of our empirical strategy. We will estimate the following regression:

$$
\log\gamma_{st} = a + b_1 n_{st} + b_2(n_{st} - n_{s\,t-1}) + b_3\theta_{st} + b_4(\theta_{st} - \theta_{s\,t-1}) + \epsilon_{st}. \tag{10}
$$

In practice, the high degree of persistence and the difficulty in matching the timing of political choice and demographic movements imply that the estimates of b_2 and b_4 will be unreliable, while estimates of b_1 and b_3 will be robust to slight mismatches in the timing of events. Because of this, we will focus our discussion on estimates of b_1 and b_3.

[14] It is worth stressing that this result does not rely on our assumption about congestion. With no congestion newcomers would not need any additional infrastructure, but the resulting increasing returns would make it desirable to expand the stock of public capital per capita when population is higher.

Our identifying restriction is that the preference shock in (9) is uncorrelated with population growth and mobility. In our preferred regression, we introduce several controls that are meant to capture elements of the preference shock that may be correlated with demographics.

To assess the success and the shortcomings of the model in explaining the data, we proceed in two steps. First, we completely parameterize the model imposing plausible values into equation (9), and we study the dimensions in which the results diverge from the data. These parameter values are summarized in table 1. Second, we give the model one degree of freedom and use estimates of b_1 and b_3 to infer the amount of debt financing allowed at the margin (x), while holding all other parameters at their calibrated values. This gives us an alternative measure of the aspects of the data that the model is able to capture, and those that it misses.

Parameter	Assigned Value	Comment
β	0.96	
δ	0.06	
α	$1 - 2^{-1/15}$	Half-life of debt: 15 years
ρ_n	0.897	Estimate from data
ρ_θ	0.973	Estimate from data (annualized)
σ	0.2	Lower range of estimates surveyed by DelRossi and Inman [6]
x	1	100% debt financing allowed for capital projects

Table 1: Baseline calibration

To gain further intuition, consider what would happen if public investment were always at its efficient level in all states. In this case, the model would deliver $b_3 = 0$ and $b_1 = (1-\delta)/\delta$: mobility should have no effect, while public investment should react positively to population growth by an amount that matches exactly what is needed to keep the same stock of capital per resident.

When b_3 is different from zero, we can infer from its sign whether mobility is a force that generates underprovision or overprovision of public capital in the model. Specifically, if $b_3 > 0$, more mobility (a lower θ_{st}) lowers public investment. In this case, mobility is a force that leans to *underprovision.* The opposite intuition applies when $b_3 < 0$.

In the case of b_1, we can infer whether population growth is a force that leads to under– or overprovision by looking at the sign of $b_1 - (1-\delta)/\delta$. When $b_1 < (>)(1-\delta)/\delta$, higher population growth is not matched (more than matched) by adequate public investment, so population growth is a force leading to underprovision (overprovision).

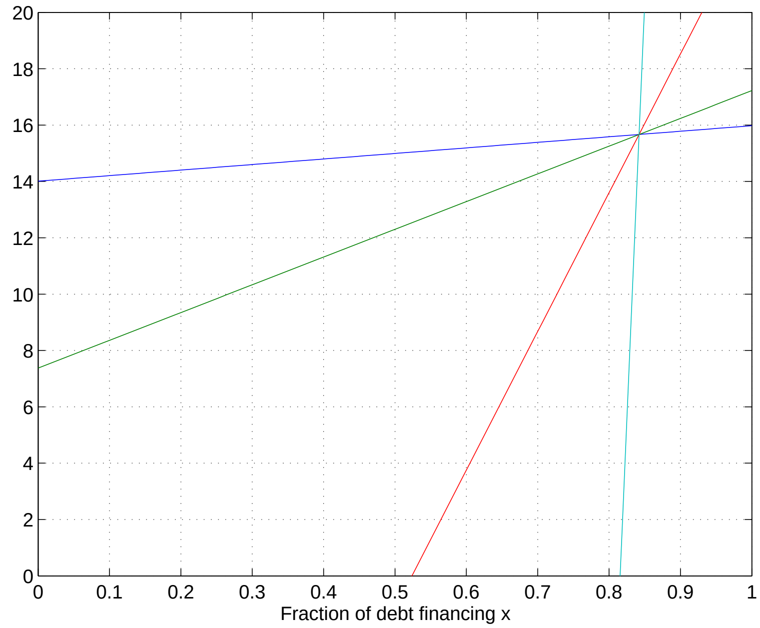

Figure 4: Coefficient b_1 as a function of x, for four values of σ: 1/60,1/5,1,5 (flatter lines represent higher σ).

Figures 4 and 5 adopt our baseline calibration and show how the coefficients b_1 and b_3 are affected by x, for various values of σ. Within each graph, the four lines correspond to different price elasticities of the demand for public goods: the higher is the elasticity (lower σ), the more responsive are the coefficients to changes in x. In both graphs, there is a value of x that delivers the neutral value ($(1-\delta)/\delta$ for b_1 and 0 for b_3), independently of σ. For values below this critical threshold, borrowing is not sufficient to restore proper incentives, and underprovision ensues; we then obtain $b_1 < (1-\delta)/\delta$ and $b_3 > 0$. Above the threshold, enough costs are shifted into the future that more mobility (population growth) makes voters choose higher capital spending.

Using equation (9), simple algebra shows that the value of x such that $b_1 = 0$ and that which delivers $b_3 = (1-\delta)/\delta$ will be different, unless $\rho_n = \rho_\theta$. This can be seen in the pictures, where the critical threshold is above 80% for population growth and below for mobility. In the

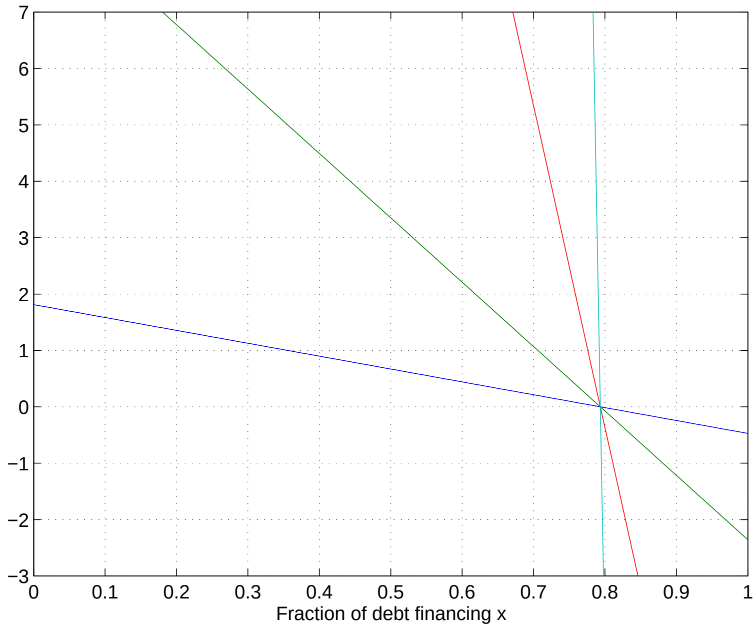

Figure 5: Coefficient b_3 as a function of x, for four values of σ: 1/60,1/5,1,2 (flatter lines represent higher σ).

range between the two critical thresholds, we cannot establish whether public capital is under– or overprovided: greater population growth leads towards underprovision, but greater mobility goes in the opposite direction. In practice, given the high autocorrelation of both processes, the critical thresholds are very close to each other, and it is implausible for x to fall in this narrow range.

4 Data and Institutional Features of the States

The assumptions in the model correspond to many of the basic features of state government finance in the United States. Nearly all states operate under the strictures of balanced budget requirements. These require that at some point in the budgeting process, current expenditures are expected to be paid for out of current revenues. States differ in when in the budget process balance must be obtained. As a result, these can differ in how binding they are in practice. For example, the Illinois constitution states, “The Governor shall prepare and submit to the

General Assembly... a State budget for the ensuing fiscal year....Proposed expenditures shall not exceed funds estimated to be available for the fiscal year as shown in the budget." In Illinois, the legislature is also required to pass a balanced budget. However, if circumstances change within the fiscal year, the state can borrow to cover unexpected deficits.

Borrowing for capital expenditures lays outside these balanced budget requirements and separate provisions cover state ability to issue debt for capital projects. In Illinois, for example, the state can issue debt provided that it is for a specific purpose and is approved by 3/5 of the legislature or by a majority of voters in a referendum. Nearly all states also have capital budgets that specifically detail how capital projects are to be financed.

For most municipal bonds, the state issues debt of a certain duration, gets the money up front, spends the money within 2-5 years of issuance, pays interest over time (usually semi-annually) and then pays the entire principal back when the bond matures. Most municipal bonds are callable and most states allow bonds to be called and refunded provided that the duration is not extended. Municipal bonds tend to be of fairly long duration. In October 2009, the average maturity of municipal bonds was 16.9 years, while the average maturity of corporate bonds was 13.5 years.[15] Also in contrast to corporate bonds, one municipal bonds issuance often contains several maturities (these are called serial maturities). In addition, there are often sinking funds associated with non-serial bonds where the issuer makes several payments into a sinking fund so that the entire principal does not need to be funded at one point.

In order to estimate our model, our first need is to measure γ_{st} for current and capital spending. For this purpose, we use data from the Annual Survey of State Government Finances. This data has been collected for all states by the Census Bureau since 1915 with the omission of some years in the 20s and 30s. Since 1952, the survey has followed a fairly consistent format. The data are available in electronic format for (Fiscal Years) 1972 and from 1977-2007 and contain detailed information on government expenditures, revenues, and debt. These state government finances data are extremely detailed and data are reported for over 400 categories for each state. For example, expenditures are divided into 64 different government functions, such

[15] See [13, 14].

as Air Transportation, Corrections, and Elementary and Secondary Education. For each function, expenditure data is available for numerous different purposes such as capital expenditures, current expenditures and intergovernmental expenditure.

In this paper we are concerned with patterns of current and capital expenditures. According to the survey's classification manual, current expenditures include expenditures for employee compensation, supplies and materials. By contrast, capital outlay includes "expenditure for the purchase or construction, by contract or government employee, construction of buildings and other improvements; for purchase of land, equipment, and existing structures; and for payments on capital leases.[16]" In the data, capital outlay is further divided into construction, purchase of land and existing structures, and purchase of equipment.

We supplement this with data on state population growth and state mobility. State population data is available annually from the Census Bureau. It is straightforward to calculate population growth rates, n_{st} and annual changes in these population growth rates, $n_{st} - n_{s\,t-1}$ from this data. The measure of mobility delineated in the theory is the probability that a household living in state s at t is alive and in the same state at $t+1$. As mentioned earlier, we extrapolate away from the death by assuming a constant hazard of death. Data on state migration flows are available in the Decennial Census. In the Census individuals are asked whether they changed residences in the past five years and if so where they lived five years prior. We define a state's mobility as the number of people who lived in the state five years ago who live in a different state in the Census year, divided by the number of people from the state five years prior who still live in the US. We linearly interpolate between Census Years and use regression analysis to predict migration flows since the last decennial Census.[17] Because these are five-year migration flows and we are interested in annual migration, we divide the resulting rates by five. The percent of the population living in the same state is then one minus the percent of the population who had moved. We label these individuals "stayers".

[16]See [16], chapter 5.

[17]For extrapolation only, state migration rates are predicted based on state dummies, state specific time trends, state population, median income, state poverty rates, percent over 65, percent under 25, percent urban, homeownership rate, percent with a high-school diploma, and percent with a bachelor's degree.

We can only consistently estimate b_1, b_2, b_3, and b_4 if the preference shock captured in ϵ_{st} is orthogonal to population growth and immobility. As a result, we include in the regression features of states that we believe are correlated with spending and are also correlated with either mobility or population growth. In particular we are concerned with proxying for state resident preferences for fiscal variables that may also be related to population growth or mobility. We choose several population attributes – average personal income, median household income, percent of the population with a high-school diploma, percent urban, population density, percent over 65, percent under 25, home ownership rate, population liberalism, and resident taste for mobility. Most of these variables are available annually or by decade from the Census Bureau. We interpolate between Census years for data that is available less frequently. Two measures merit further discussion – population liberalism and resident taste for mobility. For population liberalism, we use factor analysis; specifically, we take the first factor from five state political variables – the percent of the popular vote for the Democratic Presidential candidate in the previous election, the percent of the state's Senate delegation that belongs to the Democratic Party, the percent of the state's House delegation that belongs to the Democratic party, the average Americans for Democratic Action (ADA; a liberal political organization) score for the state's Senate delegation, and the average ADA score for the state's House delegation. The resident taste for mobility is measured as the number of people that moved to a new house in state in the five years leading up to the Census divided by the number of people that stayed in state. We add this proxy for preferences for mobility because we believe that many unobsevable attributes of populations that would influence interstate mobility would influence within-state mobility in a similar manner.

Variable means for these variables are presented in Table 2 for the 48 contiguous United States. Alaska and Hawaii are omitted from the analysis.[18] We can see from this table that states vary substantially in per capita fiscal variables. We also note that state current spending is about 8 times the level of state capital spending on average. Most capital spending is for construction while smaller amounts are dedicated to land and equipment expenditure.

[18]The inclusion of Alaska would alter the means and results due to unusual capital spending patterns in the state.

Variable	Obs	Mean	Std. Dev.
Per Capita Capital Spending (2007 $)	1440	314.107	128.570
Per Capita Spending on Land and Existing Structures (2007 $)	1440	16.548	16.211
Per Capita Spending on Equipment (2007 $)	1440	42.619	19.971
Per Capita Construction Spending (2007 $)	1440	254.941	115.580
Per Capita Current Spending (2007 $)	1440	2443.777	686.4024
Stayers (Fraction of Residents Remaining in State, 1-year horizon)	1440	0.979	0.00609
Fraction of Stayers Changing House within State (5-year horizon)	1440	0.380	0.0406
State Personal Income Per Capita (000 of 2007 $)	1440	28.274	6.596
Median Household Income (000 of 2007 $)	1440	43.762	7.615
Fraction with a High School Degree	1440	0.782	0.0904
Fraction Urban	1440	0.695	0.147
Population Density	1440	0.148	0.189
Fraction Over 65	1440	0.124	0.0181
Fraction Under 25	1440	0.373	0.0358
Democratic Leanings of State	1440	-0.00833	0.943
Homeownership Rate	1440	0.680	0.0507

Table 2: Sample Moments

5 Results

In Table 3, we present regressions predicting the natural log of per capita fiscal variables based on population growth, mobility, their first differences, and the preference parameters.[19] We also include year dummies to capture nationwide trends in spending. We cluster the standard errors by state. We are particularly concerned with predictions of capital spending (in column 1) and current expenditures (in column 5). Following the variable labels, we note those variables that directly map into variables in our equations. In addition to capital and current spending we estimate the determinants of subcategories of capital spending.

In the regression on capital spending, we note that states with more permanent resident populations (more stayers), have significantly lower capital expenditures. A one standard deviation increase in the fraction of stayers (.006) decreases log per capita capital expenditure by

[19] In the case of purchases of land and existing structures we lose two state-year observations due to zeros.

VARIABLES	(1) Total Capital Spending	(2) Land and Purchases of Existing Structures	(3) Equipment	(4) Construction Expenditures	(5) Current
Pop. growth (n_t)	3.412	18.25***	6.120**	1.250	0.285
	(2.287)	(6.625)	(2.730)	(2.603)	(1.635)
Pop. growth change ($n_t - n_{t-1}$)	-3.634**	-15.53**	-3.792*	-2.530	-0.251
	(1.409)	(5.924)	(2.145)	(1.550)	(1.110)
Fraction of stayers (θ_t)	-33.49***	21.76*	-17.77***	-38.88***	-7.007**
	(5.172)	(12.89)	(4.732)	(5.652)	(3.245)
Change in frac. stayers ($\theta_t - \theta_{t-1}$)	-10.44	-16.93	9.982	-15.95	4.967
	(25.42)	(62.46)	(37.14)	(24.72)	(17.21)
Internal migration	-1.606	2.748	-2.379	-1.450	-2.757***
	(1.188)	(2.975)	(1.831)	(1.095)	(0.725)
Average pers. income	0.0283***	0.00457	0.0314*	0.0283***	-0.00157
	(0.00858)	(0.0311)	(0.0165)	(0.00838)	(0.00831)
Median income	-0.0139**	-0.0146	-0.00800	-0.0142**	-0.00153
	(0.00631)	(0.0190)	(0.0104)	(0.00665)	(0.00340)
Frac HS diploma	-0.217	1.409	0.103	-0.370	0.986***
	(0.622)	(1.689)	(0.665)	(0.708)	(0.342)
Frac urban	-0.435	-0.619	-0.638	-0.406	-0.413*
	(0.327)	(0.809)	(0.390)	(0.332)	(0.234)
Pop. dens.	0.316	1.892***	0.0327	0.316	0.253
	(0.200)	(0.685)	(0.303)	(0.202)	(0.204)
Fraction over 65	0.288	-0.0529	1.390	-0.0803	2.843**
	(1.985)	(5.583)	(2.073)	(2.271)	(1.340)
Fraction under 25	3.588**	0.554	6.455***	3.355**	-0.0248
	(1.453)	(3.638)	(1.708)	(1.587)	(0.930)
Liberal index	0.0218	-0.125	0.00982	0.0298	0.0628***
	(0.0307)	(0.0779)	(0.0355)	(0.0329)	(0.0143)
Fraction homeowners	0.265	0.962	0.272	0.246	-0.464
	(0.722)	(1.653)	(1.044)	(0.686)	(0.462)
Constant	37.30***	-21.21	18.22***	42.59***	15.96***
	(5.117)	(13.20)	(4.208)	(5.733)	(3.265)
Year dummies	yes	yes	yes	yes	yes
Obs.	1440	1438	1440	1440	1440
R-sq.	0.575	0.119	0.472	0.549	0.740

Table 3: Regression results. Each column corresponds to a different dependent variable. All dependent variables are in logs of their per capita value. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

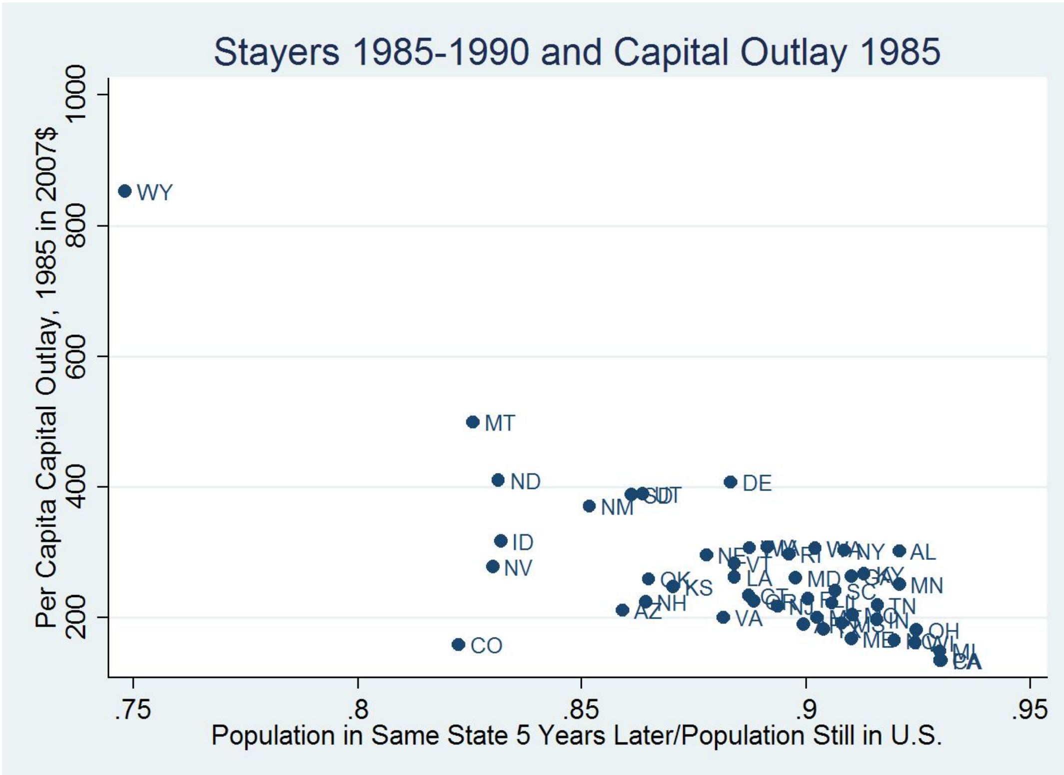

Figure 6:

-0.2, or about half a standard deviation. In figure 6, we display the relationship between per capita capital spending and stayers for 1985. Even with no controls, a clear negative pattern emerges, which is robust to excluding outliers such as Wyoming. As shown in table 3, column 2, this relation reverses in the case of purchases of land and existing structures, arguably the most durable component of spending.

The relationship between spending and population growth is far weaker; it is always positive, but not statistically significant for overall capital spending and for the large category of construction.[20] Figure 7 shows the 1985 snapshot with no controls: unlike the case of movers,

[20] In Poterba [10], the relationship is negative. However, both in our paper and his, these coefficients are mostly not significantly away from zero, so a different sign is not indicative of a large discrepancy. In future versions, we plan to study in more details the differences between our results and Poterba's. Three main differences stand out in our methodology: first, our analysis considers a long range of years, while he looks at a single year; second, we include highway spending, which is heavily affected by federal transfers and might thus behave differently; and

no clear pattern emerges, except for the outlier Wyoming, whose population contracted in that year.

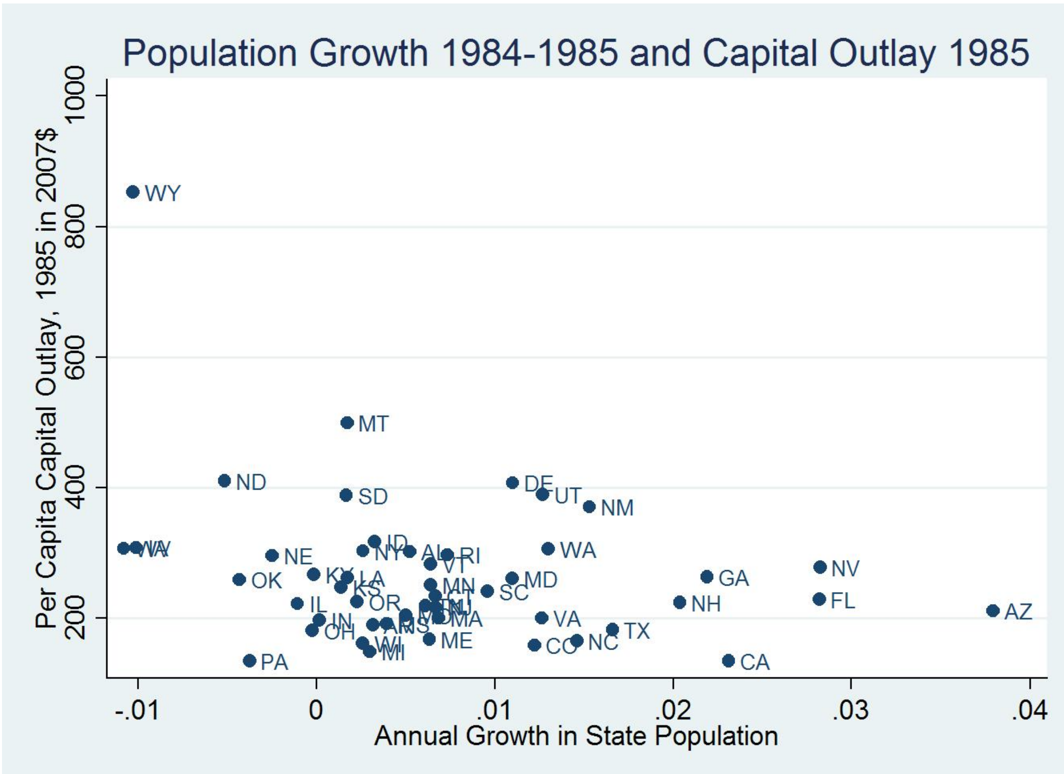

Figure 7:

Most of the variables measuring preference shocks are statistically insignificant in the capital spending regression. There are two exceptions – the income variables and the percent of the population under 25. For the income variables, the positive personal income effect dominates the median income effect and we find that states with richer populations spend more on capital goods. We also find that states with younger populations spend more on capital projects. This may be explained by the large role of states in the purchase and construction of school buildings.

In column 5 we look at the determinants of current spending. Here we also find that having a more stable population decreases expenditures. However, the magnitude of the effect is much smaller. Here a one standard deviation increase in stayers (.006) decreases log current per

third, we regress logs of spending per capita rather than levels, to be consistent with our model.

capita expenditure by -0.04, or about one seventh of a standard deviation. Our model could be consistent with this relationship if all the benefits of current spending occur in the current period, while some of it is financed by debt. On the other hand, this relationship may be an indication that we have not adequately captured some attributes of state population that both decrease mobility and tastes for current expenditures. A number of other population attributes also have statistically significant effects on current per capita expenditure. States with high internal mobility also have lower current spending. This may be because individuals who move within the state may be less tied into government services. We also find that states with a high proportion of individuals with a high-school diploma have higher current expenditures. In addition we find states with a higher percent urban have lower levels of current expenditure. This may be due to the role of municipalities in the provision of public services in urban areas. This conjecture is supported by the fact that this relationship goes away if we look at the determinants of state and local spending combined. We also find that more liberal states have higher levels of current expenditures.

To see how the results in table 3 square with the model, table 4 compares the coefficients of interest to those predicted by the model. For general capital, we use the baseline calibration of table 1; for its subcategories, we use different values of δ: $\delta = 0.02$ for puchases of land and existing structures, $\delta = 0.12$ for equipment, and $\delta = 0.03$ for construction. In the case of current expenses, we set $\delta = 1$ (full depreciation), and $x = 0$ (no borrowing allowed).

Consider first the case of total capital expenditures (column 1). At first glance, it may seem surprising that both the model and the data point to a negative relationship between these expenditures and the fraction of stayers. However, as we noted in section 3, this result emerges when capital is financed mostly through long-term borrowing. As is noted in Inman [8] and Poterba [10], states with high mobility can use debt issuance to transfer the funding of capital projects to future residents and therefore may demand *more* spending. While current residents get some of the benefits of the capital spending now, future residents pay. We also previously established that a negative relationship between stayers and spending is less likely for capital expenses that are very long-lasting. This can be viewed in the other columns. Our calibrated

VARIABLES	(1) Total Capital Spending	(2) Land and Purchases of Existing Structures	(3) Equipment	(4) Construction Expenditures	(5) Current
Coefficient on the fraction of stayers:					
Regression (data)	-33.49***	21.76*	-17.77***	-38.88***	-7.007**
	(5.172)	(12.89)	(4.732)	(5.652)	(3.245)
Calibration (model)	-13.44	18.64	-31.80	7.26	0
Coefficient on population growth:					
Regression (data)	3.412	18.25***	6.120**	1.250	0.285
	(2.287)	(6.625)	(2.730)	(2.603)	(1.635)
Calibration (model)	23.44	44.27	22.27	32.04	0
Needed to keep per-capita level	15.67	49	7.33	32.33	0

Table 4: Comparison of coefficients of interest in the regression with their predicted values according to the calibrated model.

model predicts an even stronger negative relationship between investment and stayers in the case of equipment, while it predicts a strong positive relationship with land and a very weak one in the case of construction. Qualitatively, the data fit with the model, with the important exception of construction, where the model and the data are completely at odds. However, quantitatively large discrepancies emerge. In particular, for the case of total capital expenditures, the data suggest a much stronger response to the fraction of stayers compared to the one that the model can justify. We could get a somewhat better fit by increasing the price elasticity of the demand for public goods, but by choosing $\sigma = 0.2$ (a value at the low end of the spectrum of estimates) we already gave the model some leeway in this dimension.

Table 4 shows even bigger discrepancies between the calibrated model and the data in the case of population growth. For all categories of investment, the regression coefficients are below what would be needed to maintain a constant per-capita provision of capital; in most cases, the regression coefficients are far below this level. In contrast, the model would predict values even higher than the replacement value for total capital: since 100% debt financing is associated with overinvestment in the model, higher population growth induces bigger departures from Ricardian equivalence and thus bigger overspending. Even for the categories in which underspending is predicted, the model would expect coefficients close to those needed to keep a constant per-capita profile. Our regression suggests one of three possible explanations:

1. States have been unable to keep up capital provision for a growing population in the last 30 years;

2. Congestion is much more limited than we assume, so there is less need for additional capital for the growing population; furthermore, states do not exploit these increasing returns to increase the per-capita provision as we would expect from Samuelson's rule;

3. Population growth and preferences for capital spending are correlated; specifically, the population of fast-growing states tends to have preferences skewed for small government.[21] However, no evidence of this small-government bias appears for current expenses, for which we obtain the predicted coefficient of 0.

The previous analysis imposed extremely tight constraints on the ability of the model to fit the data, since no parameter was allowed to vary based on our empirical findings. We next give the model one degree of freedom by inferring values of x from our regression results, while keeping all other parameters fixed. Specifically, we look for the values of x that can match the regression coefficients to those implied by the model. We do so independently for the coefficients on population growth and the fraction of stayers. In order to identify x, we need measures of ρ_n and ρ_θ. For population growth, our estimate from the data yields:

$$\begin{array}{ccccccc} n_{st} & = & 0.000961 & + & 0.897 & n_{s\,t-1} & + \text{error term} \\ & & (0.00017) & & (0.0111) & & \end{array}$$

For mobility, we rely on data from the decennial census, which asks respondents to report their state of residence 5 years prior. We estimate the 10-year persistence in the fraction of 5-year

[21]In the case of counties, Rappaport [11] argues that there is evidence that movers tend to favor smaller-government areas, leading to growth in those areas.

stayers. This yields:

$$5(1-\theta_{st}) = \underset{(0.0043)}{0.0206} + \underset{(0.0356)}{0.760} \quad 5(1-\theta_{s\,t-10}) \quad +\text{error term}$$

The implied 1-year autocorrelation ρ_θ is 0.973.

Table 5 presents the values of x that reconcile the regression coefficients with the model, along with the standard deviation computed using the delta method.[22]

(1) Total Capital	(2) Land and Spending of Existing Structures	(3) Equipment Purchases	(4) Construction	(5) Current Expenditures
x needed to match coefficient on the fraction of stayers:				
1.337	0.949	0.762	1.766	0.121
(0.0982)	(0.226)	(0.108)	(0.11)	(0.0605)
x needed to match coefficient on population growth:				
0.593	0.609	0.590	0.49	0.011
(0.0468)	(0.221)	(0.192)	(0.16)	(0.0663)

Table 5: Indirect estimates of the fraction of debt financing.

If we look at the inferred values for x needed to match each coefficient in isolation, it would seem that the model could be reconciled with the data with just some slight stretches (except for construction, where implied values of x are far from the reasonable range). In the case of population growth, all of the implied values for x are well below 1: as we already know, the regression coefficients on population growth would suggest underprovision of public capital, which in the model only occurs if debt financing is markedly lower than 100%. In the case of mobility, the regression coefficients imply overprovision of the public good, which the model can reconcile if x takes a much higher value, even above 1 in some cases.

The main challenge arising from table 5 is that it is impossible to reconcile the regression coefficients on population growth and mobility *at the same time*. The model implies a very tight

[22] In computing the standard deviation, we take into account the uncertainty about the autocorrelation parameters. We assume independence of the errors across regression equations.

connection between the effects of population growth and the fraction of stayers on the provision of the public good, and this connection is clearly rejected by the data. The fit of the model might be improved if with some more freedom of moving other parameters, but this would be unlikely to address the main difficulty: that the regression coefficients on population growth and the fraction of stayers have *opposite* implications within the context of the model.[23]

Table 5 also contains estimates for the degree of debt financing of current expenses. These estimates show that our results for current expenses are consistent with the ability by states to borrow for a small fraction of these expenses. This is in line with the informal evidence that states have a little room for "creative accounting" before the restrictions of the balanced-budget requirement kick in. Although we reject the hypothesis that the implied values of x from population growth and mobility are the same (the P-value is about 4.5%), column (5) is much closer to the theoretical results than the others.

6 Conclusion

In this preliminary draft, we have studied the relationship between population growth, mobility, and capital and current spending at the state level in the United States. To interpret our empirical results, we considered a full-fledged political-economy model, where the provision of public goods is endogenously derived from the underlying demographic primitives.

When interpreted by the model, our regression coefficients behave schizophrenically: the effect of population growth points to the range of underprovision of public capital, whereas the response to increased mobility points to the opposite range of overprovision.

A maintained assumption in our analysis is that preferences for public goods are not systematically related to mobility and population growth at the state level, except through the variables

[23]If we let σ vary as well as x, it would be possible to reconcile the coefficients b_1 and b_3 in the regression with the model, by picking values of x in the narrow range in which population growth and mobility work in opposite directions and blowing up the magnitude of the effect through a very low estimate of σ. However, this would require values of the price elasticity of the demand for public goods that are much higher than anything reasonable.

for which we directly controlled. A first step in reconciling data and theory is to look further into the determinants of mobility and population growth.

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