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The Politics of Endogenous Growth

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Abstract

Is it politically feasible for governments to engineer endogenous growth? This paper illustrates two reasonable political decision mechanisms by which fiscal policy generates endogenous growth with a single accumulable factor, and a constant returns to scale production technology without production externalities. In the first mechanism, policies are chosen by the government to maximize constituent support by raising aggregate income. In the second mechanism, policies are determined in a voting equilibrium where agents are concerned only with their own incomes. We demonstrate that policies that target aggregates generate balanced growth and are Pareto optimal. Policies chosen by the median voter also produce balanced growth, but result in public investment 50 percent below the socially optimal level. However, we identify a plausible restriction under which median voting replicates the socially optimal level. This shows that both mechanisms are linked through their effects on asset distribution.

KEYWORDS: Public Investment, Positive Political Economy, Median Voter Theorem, Endogenous Growth

1 Introduction

Public investment is recognized as a constituent of economic growth (Aschauer, 1989; Stinespring, 2002). Public investment is also important from a development viewpoint because it is a choice variable for the government. Recent empirical studies quantify the impact of public investment on growth. For instance, in a large sample of countries the World Bank (1994) reports that a 1% increase in the stock of infrastructure leads to a 1% increase in GDP. Hirschman (1958) identified public investment as attracting private investment, thereby serving as a viable development strategy, a notion formalized by Barro (1990). Rioja (1999) estimates an elasticity of public investment on growth of 2.5 when the "crowding in" of private investment is taken into account.[1] While these works identify the effect of public investment on growth, they ignore the *political process* that determines the level of public investment.

Because politicians determine government expenditures, fiscal flows reflect their objectives. Hence, political decisions have an important impact on the allocation of resources (Mueller, 1989; Besley & Coate, 1998; Ghate & Zak, 2002; Romer, 2003). However, one way through which politicians maintain constituent support is by raising incomes through enacted policies (Key, 1966; Tufte, 1978; Fiorina, 1981; Kiewiet and Rivers, 1985; Lewis-Beck, 1990; Harrington, 1993). For instance, in an exhaustive study examining economic conditions and electoral outcomes in the U.S. and Western Europe, Kiewiet and Rivers (1985) find that a 1 percent decline in real income is associated with a reduction of the incumbent's party vote share of between 0.5 percent and 1 percent. Likewise, Lewis-Beck (1990) reports that voters consistently reveal that economic health is among the most important factors affecting their choices in elections.[2]

This paper characterizes how political systems determine the choice of public investment, as in Persson & Tabellini (2000, ch. 12), and then analyzes the associated growth trajectories for each policy set. We do this to address a fundamental issue in the political economy of economic development: if policy is chosen by self-interested, short-sighted politicians, can endogenous growth obtain?

We cast our analysis in a framework that assumes a constant returns to scale

[1]Other empirical papers that quantify the output elasticity of public investment are Shioji (2001), Turnovsky & Fisher (1998), and Glomm & Ravikumar (1994, 1997). See also the survey by Easterly & Levine (2001).

[2]Indeed, there is now considerable empirical support for the hypothesis that politicians set policy (and claim credit for policies) presuming that voters care about aggregate economic outcomes. See Harrington (1993) and Section 3 in Ghate & Zak (2002) for a more detailed discussion (and review of the literature) motivating electoral success and economic performance. Bueno de Mesquita et al. (2002) identify institutional arrangements that lead politicians to enact poor economic policies in order to stay in power. This occurs when an autocrat or small cabal rules a country, a case we do not consider; for a related model with varying institutional arrangements see Feng, Kugler and Zak (2002).

production function without production externalities, a single accumulable factor, and short sighted politicians and voters. This allows us to ascertain the fiscal politics that are most likely to produce sustained growth. We show that while this environment leads to linear policies, endogenous growth doesn't obtain for *every* linear policy. In this sense, optimal policy choices matter, and the political motivation behind endogenous policy selection is important. We identify conditions under which linear sub-optimal policies lead to a contracting economy. Similarly, other sub-optimal policies such as concave policies are shown to lead to convergence to a steady state and hence long run income losses.[3]

Two political mechanisms are shown to induce endogenous growth. In the first mechanism, constituent support rises directly with the growth in aggregates so that policy-makers set policy with income growth explicitly as the goal. Here, policy setters are assumed to be short-sighted and set policies over a single electoral cycle. In the second mechanism, voters choose policy stances taking only their current individual incomes into account. In order to relate both mechanisms, we derive a set of conditions under which the aggregate dynamics and efficiency properties of mechanism-specific policy choices coincide.[4]

How does our model relate to the existing literature? The one-sector (with endogenous policy selection) form of our model makes it similar to Klein, Krussel and, Rios-Rull (2002) in which fiscal policies are also linear in private capital. However, while these authors focus on the efficiency implications of government consumption, we focus on both the growth *and* efficiency implications of endogenously determined public investment. It is also important to relate our model with Barro (1990). Like Barro, as well as Feehan (1998), the discussion following Aghion and Howitt (1998, pp. 46), Dasgupta (1999), and Rioja (1999), we interpret 'public investment' broadly to represent 'public investment *in infrastructure*', a public good provided by the government which enters into the production process. What is important is that public investment is a crucial expenditure that affects the productivity of privately owned factors (e.g., the better the roads are, the more efficient capital will be).[5] This introduces a mechanism whereby public policy can affect output levels and its growth rate.[6]

[3]Sub-optimal policies can occur for a variety of reasons such as congestion, administrative waste, and corruption.

[4]More broadly, the models in this paper also demonstrate how a period-to-period strategic policy-setting problem is embedded into a dynamic general equilibrium framework by presenting a "modified planning problem" in which only the economy's aggregate state, not agents' utility functions, are needed to set policy.

[5]Feehan (1998) suggests that a consensus in the public inputs literature has emerged to model productive public inputs like public investment as factor augmenting. Our interpretation of public investment as 'public investment in infrastructure' follows this literature.

[6]While Barro (1990) represents one of the first attempts to capture the role of infrastructure

However, our model differs from Barro in two respects. First, Barro assumes that the expenditures on publicly provided infrastructure services are financed by a flat tax on output. We assume that such expenditures are financed by lump sum taxes. This allows us to concentrate on the political feasibility of implementing first best policies, the central focus of this paper. Second, the constancy of the tax rate in Barro is necessary for endogenous growth to obtain both in the decentralized equilibrium and in the social planners problem. In our model, endogenous growth obtains as long as public investment increases linearly with private capital and the benefit of higher public investment offsets the depreciation in private capital. However, as we show in an important counter-example, even though it is optimal for policy setters to choose a constant expenditure-output ratio as in Barro, because of short-sighted and self-interested policy setting, this ratio does not correspond to Barro's elasticity rule. Indeed, we show that short-sighted policy setters typically underfund public investment relative to the amount dictated by Barros elasticity rule. This could be interpreted as a rough measure of the 'growth-drag' induced by opportunistic behavior (see Besley and Coate, 1998; Romer, 2003).

Finally, we demonstrate that the economy's growth trajectory when aggregate income is a politician's goal is Pareto efficient, while the voting equilibrium results in an under-provision of public investment. We also show that the shortfall in public investment in the voting equilibrium is proportional to the difference between the median voter's and average voter's assets. As a result, public investment is substantially lower when voters determine policy individually compared to when politicians set policy by focusing on aggregates. This corroborates the 'inefficiency-result' associated with majority voting identified by Lancaster (1973) and Boylan (1996).

In sum, our primary finding is that while both mechanisms generate perpetual growth, only when politicians choose public investment directly to maximize growth are policies efficient. However, the voting model replicates the efficient allocations in the long run under plausible restrictions on the savings rate. It is important to note that in general, policies that maximize growth are not welfare maximizing. Indeed, the environment in which policy choices are made in the first model is sufficiently special with the assumption that technology is Cobb-Douglas playing a crucial role.[7] Thus, we do not intend to over-estimate the generality of our results. However, broadly interpreted, the mechanisms identified by this paper illustrate how public investment can be viewed as a selection device in delivering Pareto optimal allocations. Further, as both mechanisms show, these allocations are consistent with the political incentives

in the form of publicly provided services, such services are indistinguishable from the final good produced in the economy. Like his model, a part of the latter is taxed away and routed back into the productive sector as an input in our model.

[7]For more general production functions, maximization of growth and utility yield different policy outcomes depending on the elasticity of substitution between capital and public investment in infrastructure. See Barro and Sala-i-Martin (1995), Chapter 4.

facing politicians. Public policy therefore has an important role in delivering Pareto optimal allocations which simultaneously induce sustained growth.

2 Policy Setting and Endogenous Growth

Since economic growth increases tax revenues and raises electoral success (Kiewiet and Rivers, 1985; Ghate and Zak, 2002), in this section we model a representative policy-maker as maximizing *capital deepening* by choosing an income tax rate at time t, $\tau_t \geq 0$, and public investment, $\lambda_t \geq 0$. This construct obviates the need for policy-setters to know consumers' utility functions; rather they need only observe the economy's state variable, private capital stock K_t, when making policy choices at time t.[8]

To recall, λ_t is assumed to represent public investment in infrastructure, a public good provided by the policy maker (government) which enters as an input into the production process. Increases in public investment raises private productivity but comes at the cost of higher taxes, so its growth effect is ambiguous. We assume that public investment is financed by a lump sum tax on output, τ_t. We assume the government can't borrow: hence, $\lambda_t = \tau_t$ in each time period t. Because we seek to generate balanced growth paths, we derive policy choices using a Cobb-Douglas production function, $Y_t = K_t^{\alpha}\lambda_t^{1-\alpha}$, for $\alpha \in (0,1)$.[9] Population is constant and normalized to unity, and leisure is not valued.

Policy setters are assumed to concerned primarily by near term electoral success.[10] However, in the tradition of Key (1966), voters are assumed to largely ignore the past decisions of politicians and instead focus on measures of performance; in particular, economic performance. This makes the model akin to a short-sighted political economy problem along the lines of Persson and Tabellini (2000, ch. 12).[11] In each election period, t, policy setters choose public investment on infrastructure, λ_t, to maximize capital deepening. We interpret each period, t, as an election cycle in which policy makers chose lump sum taxes and public investment that most closely align with the interest of voters. This is because growth maximizing policy choices maintain the support of constituents and therefore the likelihood of remaining in power by maxi-

[8]We assume consumers are Solovian which substantially simplifies the analysis. The proportional savings assumption has solid empirical support (Campbell & Mankiw, 1991; Blinder and Deaton, 1985).

[9]Barro (1990) assumes a similar technology.

[10]Denzau and Munger (1986) construct a simple static model in which resource allocation affects votes.

[11]For instance, the short political horizon could arise because of the prospect of frequently held elections.

mizing the growth of productive capacity.[12] Finally, we assume that all politicians are on the same election cycle. Under these assumptions, politicians can be considered as a unitary actor in setting policies.[13]

We now ask the following question: in the context of this simple environment, is it possible that the growth maximizing policies also deliver Pareto optimal allocations ? Strangely, we find that the growth maximizing policies are Pareto optimal. This suggests that capital deepening can be related to Pareto efficiency, at least in the context of this simple environment. This leads to an important implication: if policy setters target the growth rate of the economy to generate constituent support, then policy setters could use infrastructure spending as a selection device to choose amongst different Pareto rankable growth paths.

A politician's decision calculus at time t is

$$Max_{\lambda}\frac{K_{t+1}}{K_t} \tag{1}$$

s.t.

$$\begin{aligned} C_t + I_t &= Y_t - \tau_t &(2)\\ K_{t+1} &= s[Y_t - \tau_t] + (1-\delta_k)K_t &(3)\\ \tau_t &= \lambda_t. &(4)\end{aligned}$$

where C is aggregate consumption, $\delta_k \in [0,1]$ is the depreciation rate for capital, and $s \in (0,1)$ is the savings rate. Equation (2) represents the resource constraint of the economy. Equation (3) shows that in equilibrium, net investment, $K_{t+1} - (1-\delta)K_t$, equals savings from after-tax income. Equation (4) is the government budget constraint which equates tax revenue to public investment. For simplicity, government borrowing is disallowed. The specification of the government budget constraint follows several authors, including Barro (1990) and Klein, Krussel, & Rull (2002). Like them, we assume that the public investment does not accumulate. The lack of accumulation of public investment can be understood as 100 % depreciation on the infrastructure input generated from public projects.[14] It is important to reiterate that we model public investment as a non-accumulable factor since if two types of

[12]Maximization of the growth in the capital stock, or output growth are identical on a balanced growth path; with the former calculations simpler.

[13]Our assumptions on the political factors governing decision making are also enforced by a large politico-economic literature on strategic interactions among individuals with divergent interests. For instance, both Persson & Svensson (1989) and Tabellini & Alesina (1990) suggest that because elected leaders are unable to make binding commitments with their successors, they adopt inefficient policies. Similarly, Coate & Morris (1995) show how voter uncertainty about politician competence can lead to politicians adopting inefficient policies.

[14]We later relax this assumption to highlight the possibility of an interesting counter example.

capital accumulate, it is well-established that endogenous growth obtains (Aghion & Howitt, 1998).

The solution to the short-sighted political economy problem (1) to (4) is given by

$$\lambda_t^{\star} = (1-\alpha)^{\frac{1}{\alpha}} K_t = \tau_t^{\star}. \tag{5}$$

Importantly, public investment from (5) is linearly related to private capital.[15] The following proposition shows that the policy set $\{\lambda^{\star}, \tau^{\star}\}_{t=0}^{\infty}$ is Pareto optimal in a representative agent economy.

Proposition 1 *Suppose that all agents in the economy are identical and infinitely lived. Then the growth maximizing policy (5) for some initial condition* $K_0 > 0$*, is Pareto optimal.*

Proof. The Pareto optimal fiscal policy problem is the solution to

$$Max_{\lambda} \sum_{t=0}^{\infty} \beta^t U(C_t) \tag{6}$$

s.t

$$\begin{aligned} C_t + I_t &= Y_t - \tau_t & (7)\\ K_{t+1} &= s[F(K_t, \lambda_t) - \tau_t] + (1-\delta_k)K_t & (8)\\ \lambda_t &= \tau_t & (9) \end{aligned}$$

where $U(C)$ is a smooth representation of preferences with the usual properties. Using the Cobb-Douglas production function given above, the solution to the Pareto problem can be shown to match growth maximization problem as claimed. ∎

Next, we characterize the aggregate dynamics induced by this fiscal policy. Substituting (5) into the capital market equilibrium condition (3), the evolution of the economy is given by

$$K_{t+1} = [s\alpha(1-\alpha)^{\frac{1-\alpha}{\alpha}} + 1 - \delta_k]K_t. \tag{10}$$

The first term in (10) captures the complementarity of private capital and public investment in producing output, resulting in a term that is linear in K_t. That is, optimal fiscal policy using a constant returns to scale production function results in a linear mapping from capital to output due to production complementarities.

The economy grows without bound if

$$s \geq \frac{\delta_k(1-\alpha)^{\frac{\alpha-1}{\alpha}}}{\alpha}. \tag{11}$$

If inequality (11) is satisfied, the fiscal policy given by (5) produces an AK model - for any $K_0 > 0$, the economy exhibits balanced growth endogenously.[16]

[15] To obtain (5), substitute out for I_t in (3), divide both sides by K_t, and maximize the resulting expression with respect to λ_t.

[16] If condition (11) is not satisfied, the economy contracts to the origin.

To see how sub-optimal polices affect the aggregate dynamics of the economy, consider policy rules of the form $\lambda_t(K_t;\sigma,\beta) = (\sigma K_t)^{\beta}$, where $\sigma \in [0,1)$ and $0 < \beta < 1$.[17] Low σ polices could arise from a host of reasons such as opportunistic behavior, administrative waste, congestion, corruption, and socio-political instability. Substituting $\lambda_t(K_t;\sigma,\beta)$ into the production function gives $Y = \sigma^{\beta(1-\alpha)}K^{\alpha+\beta(1-\alpha)}$. Note, for any $\sigma > 0$, as $\beta \to 0$, $Y \to K^{\alpha}$. Hence, concave policies lead to a steady state and long run income losses. In contrast, if $\beta = 1$, policies are linear. However, endogenous growth obtains only if $s \geq \frac{\delta_k}{\sigma^{1-\alpha}(1-\sigma^{\alpha})}$. This implies that low σ policies (with $\beta = 1$) may still not induce sustained growth even though they are linear. Indeed, a lower value of σ requires a higher savings rate for endogenous growth to obtain. This suggests that not all linear policies are optimal from the point of view of inducing endogenous growth. In fact, some policies, such as linear low σ policies, can induce growth traps if the savings rate is sufficiently low. In this sense, fiscal choices can *directly* affect the aggregate dynamics of the economy.

2.1 A Counter-example

The model in the previous section illustrates that when politicians choose taxes and public investment to explicitly maximize growth, the resulting equilibrium trajectory is Pareto optimal and generates perpetual balanced growth as long as savings is not too low. This result provides a rationale for the government to choose the level of public investment wisely. If taxes are too high due to other expenditure items endogenous growth will not obtain (Ghate & Zak, 2002), nor will growth arise if public investment is too low.

Are the central implications of proposition (1) robust to alternative specifications of the government budget constraint ? For instance, suppose we allowed public investment in infrastructure (i.e., public capital) to accumulate.[18] Since both forms of capital accumulate, endogenous growth clearly obtains. We now consider whether fiscal policies are still Pareto optimal and equal to (5). The results of assuming this new interpretation constitute an important counter-example to proposition (1).[19]

Allowing public investment to accumulate implies that the planner chooses the entire sequence of λ_t to maximize welfare. The budget constraint is modified to,

$$\lambda_{t+1} = \tau_t + (1-\delta_{\lambda})\lambda_t \tag{12}$$

[17] Hence, (5) is a special case of this policy rule where $\beta = 1$, and $\sigma = (1-\alpha)^{\frac{1}{\alpha}}$.

[18] This specification is also assumed in the literature. For instance, see Devarajan, Danyang & Zou (1998), and Glomm & Ravikumar, (1997).

[19] We thank an anonymous referee for detailing the importance behind considering this counter-example and discuss it for the sake of completeness.

where $\delta_\lambda \in [0, 1]$ is the depreciation rate on public capital. To keep the model simple, we assume that $\delta_K = \delta_\lambda = \delta$. We now determine the optimal allocations by maximizing (6) subject to (8) and (12).

Since savings are now endogenous, the Euler equations determine optimal consumption and λ_t are

$$U'(c_t) = \beta U'(c_{t+1})[F_K(K_{t+1}, \lambda_{t+1}) + (1 - \delta_k)], \tag{13}$$

and

$$U'(c_t) = \beta U'(c_{t+1})[F_\lambda(K_{t+1}, \lambda_{t+1}) + (1 - \delta_\lambda)]. \tag{14}$$

Invoking the common depreciation rate assumption and equating (13) with (14) yields the optimality condition that determines λ_t in each period t,

$$R_{\lambda t} = R_{Kt}, \tag{15}$$

where $R_{\lambda t} = (1 - \alpha)K_t^\alpha \lambda_t^{-\alpha}$ and $R_{Kt} = \alpha K_t^{\alpha-1} \lambda_t^{1-\alpha}$. Using (15), the aggregate technology implies that,

$$\frac{\lambda_t}{K_t} = \frac{1 - \alpha}{\alpha}. \tag{16}$$

Equation (16) has a natural interpretation. The term $\frac{1-\alpha}{\alpha}$ is the ratio of the elasticities of output with respect to λ_t and K_t, respectively. Hence, when the planner optimizes over λ_{t+1} instead of λ_t, public investment is funded until the public capital - private capital ratio is exactly equal to the ratio of their respective elasticities. Hence, optimizing over λ_{t+1} replicates Barro's elasticity rule, and determines a natural benchmark for funding public projects.

To see how the policy rule implied by (16) relates to the level of public investment obtained in (5), recall that self interested policy setters care only about the current election cycle. Further, when making optimal allocations, policy setters take the savings rate as given. Hence, in the model in Section 2, the equivalent condition that determines public investment is easily seen to be

$$F_\lambda(K_t, \lambda_t) = 1, \qquad \forall t. \tag{17}$$

There are two things noteworthy of (17). First, (17) is a special case of the equilibrium condition (15) when $R_K = 1$. Intuitively, when politicians set public investment, they equate the marginal benefit of increased public investment to the marginal cost of lump sum taxes (which is 1) *in each time period t* while neglecting to internalize the inter-temporal effects of increased public investment. Hence, the a-temporal nature of the politician's problem introduces inefficiencies into the model. In contrast, in the planner's problem (with accumulating public capital), public investment is set keeping Barro's elasticity rule in mind. Further, the planner recognizes that the marginal cost of increasing taxes now is compensated by higher next period productivity. In this sense, the 'effective' marginal cost of financing public investment is less than one. Consequently, public investment is higher.[20]

To summarize, this section is highlighted an important counter-example to proposition (1). We show that policies from the politicians problem will typically underfund public investment relative to the Pareto efficient amount in the endogenous savings model. However, endogenous growth still obtains in both cases as policy choices are linear.

3 Voting For Policy

The foregoing result reveals that public investment can support sustained growth. Yet, the decision calculus, while appropriate for a highly unified government (e.g. a market-oriented dictatorship or a parliamentary system with a strong majority), it does not fit the decision-making process in a competitive democracy or an elected representative model. In this section, we extend the analysis above by investigating the dynamics of an economy with a continuum of heterogeneous agents who vote over the fiscal policies.[21]

In this model, agents are identified by their wealth, where a type i agent has assets a^i and agents have unit mass.[22] The index $i \in (0,1)$ orders agents so that $i_2 > i_1$ implies $a^{i_2} > a^{i_1}$. Because individual assets sum to aggregate capital, $\int_0^1 a_t^i d\mu = K_t$, where μ is an appropriately defined probability measure over agents, each individual owns some proportion of the capital stock. In order to compare this model to the one derived above, we assume that agents save a uniform and fixed proportion $s \in (0,1)$ of their labor income each period, and limit all investments to last a single period.

To determine equilibrium policies, agents vote in a period-by-period approach. However, when voting, agents are assumed to take the law of motion of the aggregate state variable, K, as given. In other words, when voting over policy in each period, agents are assumed to only care about the marginal costs and benefits *of* public investment *on* individual after-tax income in time period t.[23] As a modeling issue, this

[20] Note that the gap between the level of public investment in (5) and (16) is given by $g(\alpha) = \frac{1-\alpha}{\alpha} - (1-\alpha)^{\frac{1}{\alpha}}$. It is easy to see that as $\alpha \to 0$, $g(\alpha) \to \infty$. Likewise, when $\alpha \to 1$, $g(\alpha) \to 0$. Also, since $\alpha \in (0,1)$, $\frac{1-\alpha}{\alpha} > (1-\alpha)^{\frac{1}{\alpha}}, \forall \alpha$. Hence, unless $F_\lambda = 1$, the two levels of public investment - given by (16) and (5) - do not coincide.

[21] See Persson and Tabellini (2000, ch. 11 and ch. 12) for an exhaustive treatment of dynamic voting models. Boylan (1996) also analyzes the effects of different political systems on capital accumulation. In his model however, the median voter's discount factor yields the market inefficiency.

[22] For simplicity, we abstract from heterogeneity in wages.

[23] Our construct maintains consistency with the period-by-period approach in which policy choices are derived in Section 2.

construct allows us to simplify the analysis. However, it also allows us to derive a state-contingent time invariant policy that is consistent with the individual accumulation equation and the government budget constraint in each period.[24] Since voting occurs over a single issue (after substituting out τ_t using the government budget constraint), the equilibrium level of public investment is determined by the median voter in this economy.[25]

The $i'th$ voter's problem is,

$$Max_{\lambda}\Sigma_{t=0}^{\infty}\beta^t U(c_t^i) \tag{18}$$

s.t.

$$\begin{aligned} c_t^i &= w_t - \tau_t + R_t a_t^i - a_{t+1}^i &(19)\\ a_{t+1}^i &= s[w_t - \tau_t + R_t a_t^i] &(20)\\ \tau_t &= \lambda_t &(21) \end{aligned}$$

Equation (19) is the agent's budget constraint equating time period t consumption to after-tax wage and interest income minus assets held for the following period, a_{t+1}^i, with the assumption of proportional savings given by equation (20).[26] The term $R \equiv r + 1 - \delta$ is the yield on savings, with r the interest rate. The last equation, (21), is the government budget constraint equating tax revenue to public investment.

Profit maximization by competitive firms leads to the following factor prices,

$$\begin{aligned} r_t &= \alpha K_t^{\alpha-1}\lambda_t^{1-\alpha}, &(22)\\ w_t &= (1-\alpha)K_t^{\alpha}\lambda_t^{1-\alpha}. &(23) \end{aligned}$$

Setting $i = m$, the unique solution to the voting problem (18) to (21) is

$$\lambda_t^m = (1-\alpha)^{\frac{1}{\alpha}} K_t[1 - \alpha + \alpha a_t^m K_t^{-1}]^{\frac{1}{\alpha}}, \tag{24}$$

[24] More specifically, assuming that agents take the law of motion of K as given allows us to abstract from several issues relating to insincere voting and dynamic policy games in infinite horizon economies. This assumption is motivated by several examples in Persson and Tabellini (2000, ch. 11) and made by several authors (for example, see Benabou (1996, 2000)). See Krussel, Quadrini, and Rios-Rull (1997), Rios-Rull (1997), and Krussel and Rios-Rull (1999) for a discussion of problems that arise in dynamic voting models where the state variable is a distribution function. Our construct can be seen as abstracting from these problems. See Jack and Lagunoff (2003) for a preliminary attempt to solve a dynamic policy game which involves wealth accumulation and public capital.

[25] The dynamic equilibrium therefore constitutes a sequence of time-invariant equilibrium allocations for $t = 0, 1, 2....$where the median voter's preferred allocations are the equilibrium allocations in the economy. However, it is well known that if two politicians optimally set the tax rate they would converge to the median voter's preferences.

[26] Since a_{t+1}^i is proportional to a_t^i, the ordering of voters remains constant.

where a^m are the assets of the median voter.[27] Equation (24) shows that the preferred level of public investment is increasing in the assets of the median voter.[28] This obtains as λ increases wages and the return to savings, which, in turn, increases after-tax income. Similarly, public investment rises with the private capital stock.

It is important to note that as $a_t^m \to K_t$, λ_t^m converges to the first best policy $\lambda_t^\star$ given by (5). Hence, as the median voter wealth converges to the wealth of the average voter (the representative agent in the previous section), the level of public of investment preferred by the median voter converges to the Pareto optimal level identified by proposition (1). Lastly, the level of under-provision of public investment in a voting equilibrium is proportional to the difference between the median voter's and average voters assets.[29]

Before the aggregate dynamics induced by this fiscal policy can be determined, the relationship between the median voter's wealth and aggregate wealth must be specified since public investment (24) depends on the median voter's wealth. Define the proportion of the aggregate capital stock owned by the median voter as $a_t^m = \phi^m K_t$, for some $i = m$, where $\phi^i \in (0,1)$. That ϕ is constant over time is consistent with constraint (20) in which agents save a fixed proportion of income, and indicates that the distribution of wealth does not change over time. With a time-invariant distribution of wealth, the equilibrium level of public investment is

$$\lambda_t^m = (1-\alpha)^{\frac{1}{\alpha}}[(1-\alpha(1-\phi^m)]^{\frac{1}{\alpha}} K_t, \tag{25}$$

which is strictly positive under the maintained parameter restrictions. Note that $\frac{d\lambda_t}{d\phi_t^m} > 0$. This implies that the median agents preferred level of public investment is increasing in his asset share of the economy wide capital stock.

One aspect of (25) is noteworthy. Persistent wealth inequality can be introduced into the median voter model by assuming a positively skewed distribution on ϕ (e.g., a lognormal distribution). This implies that $\phi^m < \overline{\phi}$, where $\overline{\phi}$ is the mean agent's asset proportion, and the equilibrium level of public investment (relative to the mean agent's preferred level) corresponds to the exogenous distribution of ϕ. However, since $\phi^m < \overline{\phi}$, the equilibrium level of public investment is lower than the amount preferred by the representative agent in each t. Thus, growth is lower. And the Pareto optimal levels identified by proposition (1) does not obtain.

[27]See Persson and Tabellini (2000, pp. 285) for a discussion of several other time invariant policy rules.

[28]The first order condition of the median voter is $\frac{dw_t}{d\lambda_t} + \frac{dR_t}{d\lambda_t} a_t^i = 1$. Equation (24) obtains by setting $i = m$ and solving for λ_t^m.

[29]If the median voter optimizes with respect to λ_{t+1}, Barro's elasticity rule governs optimal choices again. In this case, the equilibrium level of public investment is given by $\lambda_{t+1}^m = \frac{1-\alpha}{\alpha}[1-\alpha(1-\phi^m)]^{\frac{1}{\alpha}} K_t$. Further, as $\phi^m \to 1$, λ_{t+1}^m converges to equation (17). The intuition is identical to that outlined in the counter-example and so we don't repeat it here.

However, in our model, since we do not assume any a-priori distribution on the asset proportion, the limiting distribution of wealth is pinned down by equation (20). From (20), a degenerate stationary asset distribution obtains unless $sR_t = 1$. When $sR_t > 1$, wealth inequality diverges. However, $sR_t > 1$ holds only if $\frac{\lambda_t}{K_t} > 1$ since $s, \alpha \in [0, 1]$. While this is an interesting theoretical case, there is no empirical support for this restriction.[30] When $sR_t < 1$, all households converge to the same wealth level. This implies there is *unanimity*, and the median household chooses the first best level of public investment given by (5). Thus, convergence to Pareto optimal policies occurs *endogenously* in the median voter model. From a policy standpoint, a redistributive policy that makes the median voter more asset rich would also lead to the attainment of the Pareto optimal outcomes. Proposition 2 summarizes the convergence result.

Proposition 2 *Suppose $sR < 1$. Then, the equilibrium level of public investment determined under majority voting in (25) converges to the Pareto optimal level given by (5).*

The main implication of Proposition 2 is that majority voting endogenously delivers the Pareto optimal allocation when a plausible restriction is satisfied. This result can be seen as extending the inefficiency result associated with majority voting identified by Lancaster (1973) and Boylan (1996): in our model, asset convergence through endogenous policy selection reduces the inefficiency associated with policy choices in the long run.

The aggregate dynamics of this economy are described by the capital market clearing condition

$$K_{t+1} = s \int_0^1 [w_t - \tau + R_t a_t^i] d\mu. \tag{26}$$

Using the adding up condition that relates individual assets to the capital stock, (26) can be written as,

$$K_{t+1} = s[w_t - \tau + R_t K_t]. \tag{27}$$

Embedding factor prices (22), (23), and the policy choice (25) into the capital market clearing condition (27), produces the dynamic equation

$$K_{t+1} = AK_t, \tag{28}$$

where $A = s[(1-\alpha)^{\frac{1}{\alpha}}(1-\alpha(1-\phi))^{\frac{1}{\alpha}} + \alpha(1-\alpha)^{\frac{1-\alpha}{\alpha}}(1-\alpha(1-\phi))^{\frac{1-\alpha}{\alpha}} + 1 - \delta] > 0$. Thus, voting over fiscal policies again produces an AK model. It is straightforward to prove that the level of public investment chosen by voters is below the Pareto optimal level as the median consumer does not take into account aggregate growth when choosing policy. The extent of this distortion appears to be quite large, with the proportional

[30]See Cassou and Lansing, 1998.

difference between the two policies being $[1-\alpha(1-\phi)]^{\frac{1}{\alpha}}$. For instance, in a large economy such as the U.S, the proportion of aggregate wealth held by the median voter, ϕ, is near zero, while α is typically measured around $\frac{1}{3}$ (Cooley, 1995, Ch. 1). This puts the public investment chosen by the median voter 54% below the Pareto optimal level.

4 Conclusion

We have demonstrated two simple mechanisms where the politics of choosing fiscal policies transform otherwise standard growth models into endogenous growth models, without appealing to externalities. Notably, the models herein produce balanced growth paths, qualitatively matching growth in developed countries, and do so using politically reasonable optimal policy selection techniques. Our primary result is that when voters care about the aggregate state of the economy, politicians set policy with this in mind resulting in first-best (Pareto optimal) outcomes. In contrast, when there is a continuum of policies to choose from and agents vote directly the policy that they individually prefer, endogenous growth still obtains, but public investment is only half the Pareto optimal level resulting in a substantial welfare loss. However, given plausible restrictions, we show that the levels of public investment converge endogenously to the first best levels identified by the politician's problem. Hence, because of the impact of policy choices on asset distribution, both mechanisms are linked. In this sense, there is unanimity, and Pareto optimal outcomes obtain in the voting model in the long run.

Colophon

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References

Aghion, Phillip, and Peter Howitt, *Endogenous Growth Theory*, Cambridge, Mass: MIT Press, 1998.

Aschauer, David A., "Is Public Expenditure Productive?," *Journal of Monetary Economics,* 1989, Vol. 23, 177-200.

Barro, Robert J., "Government Spending in a Simple Model of Endogenous Growth," *Journal of Political Economy*, 1990, Vol. 98, 103-25.

– – and Xavier Sala-i-Martin, *Economic Growth*, New York: NY, McGraw Hill, 1995.

Besley, Timothy and Stephen Coate, "Sources of Inefficiency in a Representative Democracy: A Dynamic Analysis," *American Economic Review,* 1998, Vol. 88, 139-156.

Benabou, Roland, "Inequality and Growth," in Ben Bernanke and Julio J. Rotemberg, eds., *NBER Macroeconomics Annual,* Cambridge, Mass: MIT Press, 1996

– –, "Unequal Societies: Income Distribution and the Social Contract," *American Economic Review*, 2000, Vol. 90, 97-129.

Blinder, Allen and Angus Deaton, "The Time-Series Consumption Function Revisited," in William C. Brainard and George L. Perry, eds., *Brookings Papers in Economic Activity 2*, Washington DC: The Brookings Institution Press, 1985.

Boylan, Richard, "Voting over Investment," *Journal of Mathematical Economics*, 1996, Vol. 26, 187-208.

Bueno de Mesquita, Bruce, Randy Siverson, Alastair Smith, and James Morrow, "The Logic of Political Survival," 2002, Stanford University, Unpublished manuscript.

Campbell, John Y. and Gregory N. Mankiw, "The Response of Consumption to Income: A Cross-Country Investigation," *European Economic Review*, 1991, Vol. 35, 723-56.

Cassou, Steven and Kevin Lansing, "Optimal Fiscal Policy, Public Capital, and the Productivity Slowdown," *Journal of Economic Dynamics and Control*, 1998, Vol. 22, 911-35.

Coate, Stephen and Stephen Morris, "On the form of transfers to special interests," *Journal of Political Economy*, 1995, Vol. 103, 1210-35.

Cooley, Thomas F., *Frontiers of Business Cycle Research*, Princeton, New Jersey: Princeton University Press, 1995.

Dasgupta, Dipankar, "Growth versus Welfare in a model of Non-rival Infrastructure," *Journal of Development Economics*, 1999, Vol. 58, 359-385.

Denzau, Arthur T. and Michael Munger, "Legislators and Interest Groups: How Unorganized Interests Get Represented," *American Political Science Review*, 1986, Vol. 80, 89-106.

Devarajan, Shantayanan, Danyang Xie, and Heng-fu Zou, "Should Public Capital Be Subsidized or Provided?," *Journal of Monetary Economics*, 1998, Vol. 41, 319-31.

Feng, Yi, Jacek Kugler, and Paul J. Zak, "The Politics of Economic Growth," *American Journal of Political Science*, 2003, forthcoming.

Easterly, William and Ross Levine, "It's not Factor Accumulation: Stylized Facts and Growth Models," *World Bank Economic Review*, 2001, Vol. 15(2), 177-219.

Feehan, James P., "Public Investment: Optimal Provision of Hicksian Public Inputs," *Canadian Journal of Economics*, 1998, Vol. 31, 693-707.

Fiorina, Morris, P., *Retrospective Voting in American National Elections*, New Haven, CN: Yale University Press, 1981.

Ghate, Chetan and Paul J. Zak, "Growth of Government and the Politics of Fiscal Policy," *Structural Change and Economic Dynamics*, 2002, Vol. 13, 435-455.

Glomm, Gerhard and B. Ravikumar, "Public Investment in Infrastructure in a Simple Growth Model," *Journal of Economic Dynamics and Control*, 1994, Vol. 18, 1173-1187.

– – and – –, "Productive Government Expenditures and Long-Run Growth." *Journal of Economic Dynamics and Control*, 1997, Vol. 21, 183-204.

Harrington, Joseph E., "Economic Policy, Economic Performance, and Elections," *American Economic Review*, 1993, Vol. 83, 27-42.

Hirschman, A., "The Strategy of Economic Development," New Haven, CN:Yale University Press, 1958.

Jack, William and Roger Lagunoff, "Dynamic Enfranchisement," 2003, W. Allen Wallis Institute of Political Economy Working Paper, No. 36.

Key, V.O., Jr., *The Responsible Electorate,* Cambridge: MA, Belknap, 1966.

Kiewiet, D. Roderick, and Douglas Rivers, "A Retrospective on Retrospective Voting," in Heinz Eulau and Michael S. Lewis-Beck, eds., *Economic Conditions and Electoral Outcomes: The United States and Western Europe*, New York:NY, Agathon, 1985.

Klein, Paul, Per Krussel, Jose Victor Rios-Rull, "Time Consistent Public Expenditures," 2002, University of Pennsylvania Working Paper.

Krussel, Per and Jose Victor Rios-Rull, "On the Size of US Government: Political Economy in Neo-Classical Growth Model," *American Economic Review*, 1999, Vol. 89, 1156-1181.

Krussel, Per, Vincenzo Quadrini, and Jose Victor Rios-Rull, "Politico-Economic Equilibrium and Economic Growth," *Journal of Economic Dynamics and Control*, 1997, Vol. 21, 243-272.

Lancaster, Kevin, "The Dynamic Inefficiency of Capitalism," *Journal-of-Political-Economy*, 1973, Vol. 81(5), 1092-1109.

Lewis-Beck, Michael S., *Economics and Elections: The Major Western Democracies,* Ann Arbor : MI, University of Michigan Press, 1990.

Mueller, Dennis, *Public Choice, 2nd Edition,* Cambridge : UK, Cambridge University Press, 1989.

Persson, Torsten and Lars E.O. Svensson, "Why a stubborn conservative would run a deficit: policy with time inconsistent preferences," *Quarterly Journal of Economics*, 1989, Vol. 104, 325-345.

− − and Guido Tabellini, *Political Economics,* Cambridge : MA, MIT Press, 2000.

Rioja, Felix, "Productiveness and Welfare Implications of Public Infrastructure: A Dynamic Two Sector General Equilibrium Analysis," *Journal of Development Economics*, 1999, Vol. 58 (2), 387-404.

Rios-Rull, Jose V., "Computation of Equilibria in Heterogenous Agent Models," 1997, Federal Reserve Bank of Minneapolis Staff Report 231.

Romer, David, "Misconceptions and Political Outcomes," *Economic Journal*, 2003, Vol. 113, 1-20.

Shioji, Etsuro, "Public Capital and Economic Growth: A Convergence Approach," *Journal of Economic Growth*, 2001, Vol. 6, 205-227.

Stinespring, John R., "Public Capital and Optimal Finance in a Growing Economy," Doctoral Dissertation, Claremont Graduate School, Claremont, CA, 2002.

Tabellini, Guido and Alberto Alesina, "Voting on the budget deficit," *American Economic Review*, 1990, Vol. 80, 37-49.

Tufte, Edward, *Political Control of the Economy,* Princeton : New Jersey, Princeton University Press, 1978.

Turnovsky, Steven and Walter H. Fisher, "Public Investment, Congestion, and Private Capital Accumulation," *The Economic Journal*, 1998, Vol. 108, 399-413.

World Development Report, The World Bank, Washington DC, 1994.