Education, Political Instability, and Growth

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Abstract

Empirical evidence suggests a positive association between income levels and growth rates on the one hand, and political stability and educational attainment on the other. This paper develops a simple finite–horizon overlapping growth model that in the absence of institutions for precommitment has a political equilibrium with inefficiently low growth, low educational attainment, and high returns to schooling. In the model, the laissez–faire growth rate is inefficient due to an intergenerational externality in the decision to accumulate knowledge. We then contrast the efficient growth rate with the outcome when there is a sequence of governments with an objective that reflects the preferences of the individuals currently alive. The result is an equilibrium in which growth remains inefficiently low because future agents are unable to reward those currently alive to induce them to accumulate knowledge. The ability to achieve higher efficient growth hinges on either the government's ability to set policies that cannot be undone by subsequent governments, or on an alternative "trigger strategy" equilibrium in which each government believes it will be punished by the next if it deviates from the optimal policy.

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The wide dispersion in both levels and growth rates of per capita income across countries has received a great deal of attention in recent years. Among many facts that researchers have uncovered is the association between low levels of educational attainment and high measured returns to schooling on the one hand, and low levels and growth rates of income on the other. Another is that low growth is associated with measures of political instability. One natural question to ask, then, is whether the political instability and low educational attainments (despite the high return to schooling) might be related.

This paper explores that idea in the context of a simple overlapping generations endogenous growth model. In the model, the accumulation of knowledge is the engine of growth, but there is an intergenerational externality that causes the *laissez–faire* outcome to exhibit suboptimal growth. While a planner with an infinite horizon will choose choose efficient educational attainment and growth, the presence of such farsightedness seems incongruous in a model in which the agents all have finite horizons. The government itself is presumably composed of agents who themselves have finite horizons, and—more importantly—whose decisions reflect the preferences of their constituents. Hence the main contribution of the paper is to address the question of how a government whose decision–makers reflect the finite horizons of their constituents would choose policies that affect the accumulation of knowledge. Specifically we assume that each government maximizes a weighted sum of utilities of those currently alive. Policy decisions are modeled as the outcome of a non–cooperative dynamic game: Each period the government selects a policy that takes into account any effect on subsequent policy decisions (and hence on the welfare of the current young generation). It turns out that this political equilibrium generally exhibits inefficiently low growth, and for plausible parameters is quantitatively significantly inferior to the Pareto optimum.[1]

1. Growth, Education, and Political Stability

This section briefly examines evidence of a link between education policies and political stability. The data for this exercise come from Barro and Lee (1994), and cover a total of 138 countries over the period 1960–1990. The motivation for looking at political stability is as follows: The model will distinguish between policymakers with an infinite horizon and those with a short horizon. One of the ways a farsighted policymaker could implement an efficient policy is to enact a law that is difficult to undo. That will almost certainly be more difficult to do in an environment of political instability. The measure of instability we use is the number of coups and/or revolutions experienced (per year) by each country over the period 1960–1984.

We also do not have direct measures of education policy. We consider three different types of variables: Government expenditures on education as a fraction of GDP (denoted GEXPSH), primary and secondary enrollment rates, and average years of schooling in the population over 25. The latter really measures a stock rather than a flow, but the panel structure of the data enables us to, for example, use this stock as of the end of the time period, as a function of what has occurred in the country over the prior 25 years. On the other hand, only the first really measures something like a government policy variable. Also, GEXPSH to some extent controls for income effects because it is expressed in terms of a share of GDP.

Table 1 displays the simple bivariate correlations between the educational

[1] See, for example, Persson and Svensson (1989), Persson, Persson, and Svenson (1987), Cukierman and Meltzer (1989).

variables and the political instability. The enrollment rate variable PSER is a combined primary and secondary enrollment rate, equal to $8\times$ primary rate + $4\times$ secondary rate, and has the interpretation of number of years or primary education (out of 12) the current school–age population is receiving on average. The variable YS85 is average years of schooling in the over 25 population as of 1986. All three education variables are significantly negatively correlated with political instability. Table 2 splits the sample into two groups: Those countries with REVCOUP $= 0$, and those with REVCOUP > 0. The conditional sample means differ by economically meaningful amounts.

Of course these facts could be explained entirely by the fact that both education and political stability are positively related to wealth or income. Even government expenditure on education could have an income elasticity significantly greater than one, which could account for the negative correlation of GEXPSH and political stability. To explore this possibility, Table 3 reports regression results of the education variabled on a constant, log(GDP) (where GDP is averaged over 1960–1990), and REVCOUP. Similar results obtained when REVCOUP was replaced with a dummy variable equal to one when REVCOUP > 0, zero otherwise. Similar results also obtained for regressions run separately for each time period in the sample (e.g. 1980–85 GEXPSH on 1980 log(GDP) and REVCOUP). Two sets of results are shown: Least squares weighted by 1960 population, and ordinary least squares.

The differences between the weighted and unweighted results suggest that a number of very small countries add a lot of noise to the OLS results, at least for PSER and YS85. But overall the results point strongly to a negative impact of political instability on educational attainment even after controlling for income level. The interpretation of the WLS results, for example, is that a country experiencing one coup or revolution per year (and there are such countries in the Barro–Lee data set) would have government expenditures on education as a share of GDP smaller by 2.1 percentage points (which is on the order of 50 percent of the mean!). The average years of schooling for the over age 25 population would be smaller by 2.7 years, and average primary–secondary enrollments would be smaller by about 3.3 years.

An alternative explanation of these facts is that education is simply less productive in poorer or less politically stable countries. Researchers have found, however, that less developed countries have significantly higher returns to schooling than developed countries (see Psacharopolous (1973)). [2]The explanation offered in the model that follows is that the high returns in those countries reflect endogenous policy decisions not to encourage human capital accumulation to the same extent as in developed countries. Those decisions in turn reflect a lack of incentive on the part each current generation to accumulate human capital when the benefit falls primarily on subsequent generations, together with the lack of stable political institutions that can achieve the desired intergenerational cooperation.

2. The Model

This section presents a simple overlapping–generations model with endogenous economic growth. Each generation (or "cohort") allocates time between labor and the accumulation of knowledge when young, and consumes when both young and old. Output is linear in effective labor and not storeable. Hence, as in Samuelson's (1958) model, consumption of the old is zero in the absence of

[2]Ljungqvist (1992) suggests a second–best insurance explanation for this stylized fact.

intergenerational transfers in their direction or of "money."

Knowledge is passed (at least to some degree) from one generation on to the next. We assume only that a higher level of knowledge attained in one generation makes it less costly for the next generation to attain the same level. Thus the fact that the Wright brothers' generation discovered how to make airplanes fly did not mean that the next generation was born with this knowledge, only that it could attain that knowledge more easily, and without fully rewarding their predecessors (hence the externality).

We assume that within each period knowledge accumulated by an individual translates directly into his human capital, without any external spillovers. Hence in what follows we will speak of knowledge and human capital interchangeably. There is, however, an intergenerational externality, owing to the nonexcludability of knowledge across generations. That is, the older generation cannot sell its stock of knowledge to the young generation. In the model this is simply assumed, but even if it were technically possible to make the stock of knowledge excludable, the young have nothing to offer the old in exchange for it. Thus there are two reasons for intervention in this economy: To mitigate the distortion in in the human capital market, and to keep the old from starving.[3]

2.1. Laissez–Faire Growth

In this section the government's role is limited to making lump–sum intergenerational transfers. Individuals live for two periods and are endowed with one unit of time in their first period (when they are "young"). All individuals within each cohort are identical. When young, they allocate their

[3]Of course in reality some knowledge is excludable. All that is required for the model is that some knowledge *not* be inter-generationally excludable. *Intra*-generational excludability is just a simplifying assumption.

time between labor and accumulation of knowledge. We will refer to the time spent on accumulation as "schooling", though a more apt interpretation is the share of flexible resources (in this case time) that productive individuals allocate to increasing their knowledge rather than producing. This could include on–the–job training or time spent doing R&D.

The wage they earn for labor depends on their accumulated knowledge. The government takes some lump–sum portion of their earnings and redistributes them to the old. Taking the relevant sequence of redistributions into account (with perfect foresight), each individual chooses ℓ_t to solve the problem

$$\text{Max } u(c_{1t}) + \frac{1}{1+\alpha} u(c_{2t+1})$$

subject to

$$c_{1t} = H_t \ell_t - \tau_t \bar{H}_t \tag{2.1}$$

$$c_{2t+1} = \tau_{t+1} \bar{H}_{t+1} \tag{2.2}$$

$$H_t = g(\ell_t) \bar{H}_{t-1} \tag{2.3}$$

where w_t is the wage per unit of human capital, H_t is the individual's human capital stock, $\bar{H}_t$ is the average human capital level of generation t, τ_t is the lump–sum redistribution from young to old in period t per unit of $\bar{H}$, and $\ell_t \in [0,1]$ is the proportion of time allocated to labor. The remaining time $1-\ell_t$ is allocated to human capital accumulation. We assume that $g' \leq 0$, that $g(0) < \infty$, $g(1) \geq 0$, and that $u' > 0$, $u'' < 0$. Since all individuals within a cohort are assumed to be identical, we know that $H_t = \bar{H}_t$, and the distinction is between what is exogenous and endogenous to the individual.

The first order condition for the individual's maximization problem is

$$\ell_t g'(\ell_t) + g(\ell_t) = 0 \tag{2.4}$$

assuming an interior solution. Thus the individual simply chooses ℓ_t to maximize his earnings $w_t \ell_t H_t$, given 2.1 and 2.3. The solution to 2.4—and consequently the equilibrium growth rate—is independent of $\bar{H}_{t-1}$.

Output Y_t is produced from a linear production technology $N_t \ell_t H_t$, where N_t is the number of individuals born in period t. We assume that $N_t = N_{t-1}(1+n)$. To keep the analysis interesting, we make one regularity assumption on $g(\ell)$. First define $\ell_{LF} \equiv \arg\max \ \ell g(\ell)$. Then we assume

A1: $\ell_{LF} < 1$.

The assumption that $g(0) < \infty$ already rules out $\ell^* = 0$, so **A1** guarantees an interior solution for 2.4

Equilibrium requires 2.1–2.4 and

$$N_t c_{1t} + N_{t-1} c_{2t} = H_t N_t \ell_t \tag{2.5}$$

or

$$c_{1t} + c_{2t}/(1+n) = H_{t-1} g(\ell_t) \ell_t \tag{2.6}$$

where H_{t-1} is a state variables for period t. Since ℓ_{LF} is independent of the state variables, we can fix $g(\ell)$ and ℓ $\forall t$. Consequently, H, c_1, and c_2 all grow at the rate $g(\ell) - 1$. We shall see shortly, however, that the competitive outcome is *always* Pareto inefficient.

2.2. A Planner's Problem

We first consider the solution of an infinitely lived social planner who discounts the utility of generations at rate ρ. At time 1 he chooses a path $\{c_{1t}, c_{2t}, \ell_t\}$ [4]from $t = 1$ to ∞ to solve the problem

$$\text{Max} \sum_{t=1}^{\infty} (1+\rho)^{-t+1} N_t [u(c_{1t}) + \frac{1}{1+\alpha} u(c_{2t+1})] + N_{t-1} u(c_{2t}) \tag{P1}$$

subject to

$$N_t c_{1t} + N_{t-1} c_{2t} = H_t N_t \ell_t \tag{2.7}$$

and

$$H_t = H_{t-1} g(\ell_t) \tag{2.8}$$

given H_0, and c_{21}. N_t enters the objective for convenience, but does not affect the analysis, since it just implies an effective discount factor of $(1+n)/(1+\rho)$. Thus we will need to assume

A2: $\rho > n$.

Also, we will generally look for solutions under the assumption

A3: $u(c) = \begin{cases} c^{1-1/\sigma}/(1-1/\sigma), & \text{if } \sigma \neq 1 \\ \log(c) & \text{otherwise} \end{cases}$.

We can set up the following Lagrangian:

$$\begin{aligned} \mathcal{L} = \ & \textstyle\sum_{t=1}^{\infty} (1+\rho)^{-t+1} \Big(N_t [u(c_{1t}) + \frac{1}{1+\alpha} u(c_{2t+1})] + \\ & \lambda_t [H_t N_t \ell_t - N_t c_{1t} - N_{t-1} c_{2t}] - \\ & \mu_t [H_t - H_{t-1} g(\ell_t)] \Big) + (1+\rho) u(c_{2t}) \end{aligned} \tag{2.9}$$

[4]Equivalently, the planner could choose $\{\tau_t, \ell_t\}$.

where λ_t and μ_t are multipliers associated with the two transition equations. The first order conditions for the solution of the optimization problem in $\{H_t, c_{1t}, c_{2t}, \ell_t, \lambda_t, \mu_t\}$ given $\bar{H}_{t-1}$ are

$$\begin{aligned} u'(c_{1t}) &= \lambda_t && (2.10) \\ u'(c_{2t}) &= \lambda_t(1+\alpha)/(1+\rho) && (2.11) \\ \lambda_t N_t H_t &= -\mu_t g'(\ell_t) H_{t-1} && (2.12) \\ \lambda_t N_t \ell_t &= \mu_t - \mu_{t+1} g(\ell_{t+1})/(1+\rho) && (2.13) \end{aligned}$$

along with the two constraints 2.7 and 2.8.

It is natural to conjecture given the structure of the problem that the choice of ℓ will constant, so we will assume that and then verify it to be the case. First, note 2.10 and 2.11 imply that the growth rates of c_{1t} and c_{2t} are the same, as one would expect. So we have

$$g(\ell)^{1/\sigma} = \lambda_t/\lambda_{t+1}. \tag{2.14}$$

We can get the levels of c_{1t} and c_{2t} directly from 2.7, 2.10, and 2.11:

$$\begin{aligned} c_{1t} &= \left[1 + \left(\frac{1+\rho}{1+\alpha}\right)^{\sigma} \frac{1}{1+n}\right]^{-1} H_t \ell \\ c_{2t} &= \left(\frac{1+\rho}{1+\alpha}\right)^{\sigma} \left[1 + \left(\frac{1+\rho}{1+\alpha}\right)^{\sigma} \frac{1}{1+n}\right]^{-1} H_t \ell. \end{aligned}$$

From equation 2.12 and 2.14 we have $\mu_{t+1}/\mu_t = (1+n)g(\ell)^{-1/\sigma}$, which, after some straightforward substitutions, yields:

$$1 + g'(\ell)\ell/g(\ell) = (1+n)g(\ell)^{1-1/\sigma}/(1+\rho). \tag{2.15}$$

which implicitly expresses the optimal ℓ as a function of the parameters ρ, n, and σ. Alternatively, we can express this in terms of the intertemporal marginal rate of substitution $(1+\alpha)^{-1}u'(c_{2t+1})/u'(c_{1t}) = g^{-1/\sigma}/(1+\rho)$ which has the interpretation of an implicit real interest factor $1/(1+r)$. We have

$$1 + g'(\ell)\ell/g(\ell) = (1+n)g(\ell)/\,(1+r)$$

Either of these expressions determines the planner's choice of ℓ, denoted ℓ^*—which in turn determines the optimal growth rate $g(\ell^*)$—as a function of ρ or the intertemporal marginal rate of substitution. It equates the marginal foregone output from additional work to the discounted value of the resulting increased output the following period, in utility terms.

We can compare 2.15 with the *laissez–faire* equilibrium condition implied by 2.4, $1 + g'(\ell_{LF})\ell_{LF}/g(\ell_{LF}) = 0$. The two conditions coincide only when $\rho = \infty$, as one might expect. The optimal and laissez–faire growth rates also coincide when σ, the intertemporal elasticity of substitution, is zero. Except for such extreme cases, however, we have $\ell^* < \ell_{LF}$, which means that the optimal growth rate generally exceeds the equilibrium growth rate for any $\rho < \infty$.

The remainder of the paper will drop the assumption that governments necessarily implement efficiency, and replace it with an assumption that governments have the same time horizon as their constituents, and act sequentially and in an uncoordinated fashion to maximize their welfare.

3. Political Economy

The normative implications of the model for government policy are straightforward, as we have seen. In particular, with the ability to make lump–sum transfers between individuals, government policy can in principle attain any point on the Pareto frontier. As a positive matter as well it would seem that a rational government ought to be interested in efficiency, regardless of how it chooses to split the rents. When distortions arise from the fact that individuals have finite horizons, however, it is less obvious that governments composed of such individuals will necessarily opt for efficiency. First, it might be necessary that those currently alive collectively appropriate the full gains from increased efficiency, or else they will lack the incentive to pursue it. Second, the gains must be distributed among those alive in accordance with the government's preferences. Otherwise the government could face a tradeoff between efficiency and the distribution of wealth.

In this part of the paper the political system is assumed each period to maximize a weighted sum of the utilities of those currently alive, taking into account the fact that the same decision process will take place in the next period, and that the choice today will in principle influence next period's choice through its influence on the state variables of the economy. Thus political choice is depicted as a dynamic Stackelberg game between governments at different time periods. [5] We assume that the political system chooses ℓ and the size and direction of intergenerational transfers.

In general the inability to coordinate with subsequent governments gives rise to inefficiency in the steady state. It turns out that the government improves

[5] Majority voting would not be very interesting in this context with only two types of agents.

upon the competitive equilibrium, but does not achieve Pareto efficiency. There exists a steady state policy that would make everyone better off by increasing growth (at the expense of current output) and decreasing transfers to the old. That policy is not selected, however, because each government cannot coordinate with subsequent governments to carry out the transfer that results in the Pareto improvement. In equilibrium some of the gains from growth spill over to those not yet alive. Consequently governments opt for inefficiently low growth.

The model economy is the same as in Section 1. The political system at time t is assumed to choose τ_t and ℓ_t to solve

$$\underset{\ell_t,\tau_t}{\text{Max}}\ \frac{\theta}{1+\alpha}u(c_{2t}) + (1-\theta)[u(c_{1t}) + \frac{1}{1+\alpha}u(c_{2t+1})] \tag{P2}$$

given $\bar{H}_{t-1}$, given 2.1–2.3 and 2.5, and knowing that at $t+1$ the same decision process will determine ℓ_{t+1} and τ_{t+1}.[6] Thus it follows that the political decision at t would take into account any effect it might have on all future political decisions, since the decision at $t+1$ takes into account its effect on $t+2$, and so forth. The parameter θ represents a welfare weight on the old relative to the young that is assumed for simplicity to be constant from one period to the next.

The result is a decision for $(\tau_t, \ell_t) = \Gamma_t$ that in general could depend directly only on H_{t-1} and next period's decision $(\tau_{t+1}, \ell_{t+1}) \equiv \Gamma_{t+1}(\bar{H}_t; ...)$. Consequently we have $\Gamma_t(\bar{H}_{t-1}; \Gamma_{t+1}(\bar{H}_t; \Gamma_{t+2}(\bar{H}_{t+1}; ...), ...))$. Note, however, that the homothetic structure of the model ensures that the policy choice will in fact be independent of $\bar{H}$. Moreover, we will limit attention to symmetric equilibria in which τ and ℓ are the same in all time periods. As a result, finding the solution

[6] Although some types of intergenerational altruism in which agents effectively have an infinite horizon—such as in Barro (1974)—would make this problem completely uninteresting, the results that follow are not sensitive to the inclusion of a conventional bequest motive.

will involve merely solving for a single number rather than for an entire function.[7]

The question is whether this political system, with its finite horizon, will choose an efficient solution. It will turn out that the political equilibrium is characterized by underaccumulation of knowledge. That is, the growth rate is too low relative to the size of intergenerational transfers. The intuition behind this result is that although starting from the equilibrium it would be possible to lower ℓ and more than compensate the current young for their sacrifice with additional consumption the next period, there is no way for the political system to bring about the compensation. Consequently, although the equilibrium with the shortsighted political system is an improvement over *laissez–faire*, the non–cooperative nature of the system leads to inefficiency relative to a system that binds current and future policy to the cooperative or efficient solution.

If we again deflate by $\bar{H}_{t-1}$, the resource constraint facing the government at time t is:

$$c_{1t}/\bar{H}_{t-1} + c_{2t}/[\bar{H}_{t-1}(1+n)] = g(\ell_t)\ell_t. \tag{3.1}$$

Consequently we have

$$c_{1t}/\bar{H}_{t-1} = g(\ell_t)[\ell_t - \tau_t] \tag{3.2}$$

$$c_{2t}/\bar{H}_{t-1} = \tau_t(1+n)g(\ell_t) \tag{3.3}$$

Assuming perfect foresight, and taking as given the policies (τ_{t+1}, ℓ_{t+1}), the

[7]Kahn–Lim (1996) solve the model with both physical and human capital, in which the equilibrium policies are state–dependent. In that case finding the equilibrium involves solving for functions rather than numbers.

current government would solve the problem

$$\underset{l_t\,,\tau_t}{\text{Max}}\ \frac{\theta}{1+\alpha}u(\tau_t(1+n)g(\ell_t)) + (1-\theta)[u(g(\ell_t)[\ell_t-\tau_t])+ \tag{P3}$$

$$\frac{1}{1+\alpha}u(\tau_{t+1}(1+n)g(\ell_t)g(\ell_{t+1}))]$$

The first–order condition from differentiation with respect to τ_t (given ℓ_t) yields the equilibrium policy directly as a function of ℓ_t:

$$\theta(1+n)u'(\tau_t(1+n)g(\ell_t)) = (1-\theta)(1+\alpha)u'(g(\ell_t)[\ell_t-\tau_t]) \tag{3.4}$$

For the CES preferences given by assumption A3 this implies

$$\tau_t = \xi\ell_t/(1+n+\xi) \tag{3.5}$$

where $\xi = \left[\frac{\theta(1+n)}{(1+\alpha)(1-\theta)}\right]^{\sigma}$. As for ℓ_t, we have the first–order condition

$$u'(c_{1t})[g'(\ell_t)\ell_t + g(\ell_t)] + \tag{3.6}$$

$$(1+\alpha)^{-1}u'(c_{2t+1})(1+n)\tau_{t+1}g'(\ell_t) = 0$$

Making these substitutions yields

$$1+g'(\ell_t)\ell_t/g(\ell_t) = \left(\frac{1+n}{1+\alpha}\right)\frac{u'(c_{2t+1})}{u'(c_{1t})}\left(\frac{g(\ell_{t+1})}{g(\ell_t)}\right)\frac{\xi\ell_{t+1}|g'(\ell_t)|}{1+n+\xi} \tag{3.7}$$

Hence the equilibrium policy ℓ_e is characterized by

$$1 + g'(\ell_e)\ell_e/g(\ell_e) = \left(\frac{1+n}{1+\alpha}\right)\frac{u'(c_{2t+1})}{u'(c_{1t})}\frac{\xi\ell_e|g'(\ell_e)|}{1+n+\xi} \tag{3.8}$$

Recall that the optimal policy can be expressed as

$$1 + g'(\ell^*)\ell^*/g(\ell^*) = \left(\frac{1+n}{1+\alpha}\right)\frac{u'(c_{2t+1})}{u'(c_{1t})}g(\ell^*). \tag{3.9}$$

The ratio of the right-hand side of 3.8 to that of 3.9 is $\frac{\xi\ell_e|g'(\ell_e)|}{(1+n+\xi)g(\ell^*)}$, which has to be less than one for any ℓ such that $|g'(\ell_t)|\ell_t/g(\ell_t) \leq 1$, which is to say for any $\ell \leq \ell_{LF}$. Consequently the sacrifice of current output for growth is smaller (relative to the intertemporal marginal rate of substitution) for the equilibrium policy than under the efficient policy, which means that growth is inefficiently low.[8]

If the governments could fix for all time (τ, ℓ) policies that satisfied 3.9, everyone could be better off: There exists a cooperative policy that would lead to a higher growth rate without any sacrifice in utility by any generation. The fact that $1 + g'(\ell)\ell/g(\ell)$ is smaller in equilibrium than under the efficient policy implies that a marginal sacrifice of current output for growth would yield more than enough gains in the next period to compensate the current young (who would then be old), while leaving the next and all future generations no worse off. The problem is that the next government will not make that compensation. The equilibrium policy fails to internalize the benefits of human capital

[8]It may be possible to find, given some value for ρ and the corresponding efficient growth rate, some value for θ that produces the same or higher growth rate with a much higher marginal rate of substitution. But conditioning on the MRS is the natural way to evaluate the growth rate, especially since in a more realistic model (e.g. Kahn–Lim, 1996) the MRS would be constrained by technology or by world capital markets.

accumulation. Consequently although the equilibrium ℓ is smaller than under *laissez–faire* (since the equilibrium policy does internalize some of the benefits), it is still too large.

The problem here is somewhat subtler than might first appear. In moving away from the *laissez–faire* outcome by reducing ℓ below ℓ_{LF}, current output is reduced. For given values of current τ and future (τ, ℓ), the current young are harmed and the current old benefit. Thus a Pareto improvement among those currently alive requires a transfer from old to young (or, rather, a smaller transfer from young to old). The political equilibrium can accomplish this. But what it cannot accomplish is a *further* reduction in ℓ that *could* make both old and young better off provided next period's policies were similarly altered. In other words, the movement from the political equilibrium to the efficient equilibrium requires redistribution from the next generation's young (in the form of choosing lower ℓ) to the current young when the latter become old. Unless that can be guaranteed, the current generation is unwilling to invest any further in accumulating knowledge beyond what the political equilibrium implies.

3.1. The Returns to Schooling

As mentioned earlier, researchers have found that returns to schooling are higher in poorer, low–growth countries. It is straightforward to see that in this model the return to schooling is also higher in the political equilibrium than in the efficient allocation. The usual definition of the return to schooling is the derivative of the log of earnings on years of school. In the model, earnings are $H_t\ell_t = \bar{H}_{t-1}g(\ell_t)\ell_t$. "Schooling" would correspond to $1 - \ell_t$ and the return to schooling R_t is

$$R_t = |g'(\ell_t)|/g(\ell_t) - 1/\ell_t.$$

This is increasing in ℓ over the relevant range (i.e. $0 < \ell \leq \ell_{LF}$), which implies that R would be higher in the political equilibrium (and higher still under *laissez–faire*) than under the efficient allocation.

Of course in practice there would have to be exogenous variation in ℓ across individuals within a country to produce actual estimates of return to schooling, whereas we have assumed that individuals are identical and all choose the same ℓ. The point here is that the evidence suggests that there is underinvestment in schooling in low–income/low–growth countries, as contrasted with just endogenously low investment because of a lower payoff, and that is what the model implies as well.[9]

3.2. Some Numerical Results

Results were computed for a variety of parameter settings with little qualitative variation in the outcomes. Figure 1 plots the equilibrium and efficient annualized growth rates (assuming a 30–year generation), assuming the marginal rate of substitution from the political equilibrium, for the parameters $\sigma = 1$, $\alpha = n = 0.3$, and with $g(\ell) = 2(1 - \ell^{\nu})^{1/\nu}$, and $\nu = 2$. Note that having $n = 0.3$ corresponds to approximately 1 percent population growth for a 30–year generation. Also note that for each value θ there is a corresponding value of ρ from the planner's problem that can be backed out from the marginal rate of substitution. Values of θ near 1 correspond to very large values of ρ, which explains why there is little difference between the political equilibrium and the optimum. For values of θ sufficiently low, the corresponding value of ρ falls

[9]Note that in the model the return actually equals zero for the *laissez–faire* choice of ℓ, and is negative for ℓ_e and ℓ^*. This is simply because the private decision problem for ℓ is essentially static, and there is no direct cost of schooling. It would be easy to modify the model to generate positive returns.

below n and consequently the planner's problem has no solution.

The main finding is that the for moderate values of θ and ρ the equilibrium growth rate falls substantially short of the efficient growth rate given any marginal rate of substitution. In fact, except for very large values of ρ and very small values of θ, the political equilibrium growth rate is globally smaller than the efficient growth rate, i.e. smaller than *any* efficient growth rate.[10] For the above parameters, the *laissez–faire* equilibrium annual growth rate (again assuming a 30–year generation) is 1.16 percent, the equilibrium growth rate hovers at about 1.4–1.5 percent, while the efficient rate ranges as high as 2.34 percent. For $\theta = 0.6$ (which corresponds to $\rho = 0.62$), for example, the efficient growth rate is 2.04 percent, while the political equilibrium growth rate is 1.40 percent. Going in the other direction, the θ corresponding to $\rho = 0.4$ is 0.578. For that value the equilibrium growth rate is 1.41 percent, while the efficient growth rate is 2.22 percent. For $\theta < 0.567$ the marginal rate of substitution implies $\rho < 0.3$, so no efficient growth rate is shown.

Thus the political equilibrium, despite involving a planner who is assumed to maximize the welfare of those currently alive, achieves a modest improvement over the *laissez–faire* outcome, but is still substantially below the efficient growth rate for reasonable welfare weights. In a more general model where there is a state variable such as a physical capital stock, each generation could in principle exert some influence on subsequent policy decisions through the state variables of the economy. It turns out, however (see Kahn and Lim,1996) that this generalization—while greatly complicating the analysis—does not alter the results. The basic outline of this model is provided in the Appendix, along with

[10] In the figure, the smallest value of ρ for which the efficient growth rate is below the highest equilibrium growth rate is 2 (i.e. $1/(1+\rho) = 0.33$).

numerical results depicted in Figure 2.

3.3. Trigger Strategy Equilibria

As an alternative to the Markovian equilibrium, we can consider the possibility of a more efficient "trigger strategy" equilibrium. Specifically, suppose the period t planner believes that if he chooses an efficient policy, the period $t+1$ planner will also choose an efficient policy, whereas if he chooses any inefficient policy, the $t+1$ planner will revert to the Markovian equilibrium. There will clearly exist a trigger strategy equilibrium that is efficient. For any suboptimal allocation there must by definition exist an allocation that yields a higher value of the planner's objective. Since planner t believes he can count on planner $t+1$ carrying on the efficient allocation, and further that if he deviates, planner $t+1$ will revert to the Markov equilibrium (in which case the best possible deviation would also be the Markov equilibrium), the beliefs of planner t will sustain the efficient equilibrium. Of course, once we allow for this equilibrium, it must be noted that there are undoubtedly infinitely many such equilibria, some of which may be efficient and some of which may be not. But this equilibrum does provide an alternative interpretation of the data: The more successful countries are either playing a different game (one in which the planner effectively has an infinite horizon) or they are simply in a better equilibrium of the same game.

4. Discussion and Conclusions

This paper has developed a model of non–cooperative sequential government decision–making in a finite–horizon setting, and applied it to a simple endogenous growth model. The approach yields explicit policy outcomes in equilibrium, and we suspect that it could be useful for a variety of policy questions beyond those addressed here. Each government's objective mirrors the objectives of the individuals currently alive. Attention has been focused on Markovian solutions, i.e. those in which policies only depend on the state of the economy, as a possible explanation for why low–growth economies appear to be underinvesting in knowledge accumulation. There are, of course, trigger–strategy equilibria that achieve optimal growth. Thus the observation of relatively successful economies could be interpreted within the general framework of this paper as either "good" trigger–strategy equilibria or as economies that somehow managed to set up durable institutions that implement efficient policies.[11] The main finding is that in the Markovian equilibrium governments will choose policies that involve systematic underinvestment in "schooling" (or more generally in the accumulation of knowledge). A Pareto improvement involving higher growth would be possible if governments could set up stable institutions that would guarantee the current young that their sacrifice today will definitely get rewarded when they are old with a comparable sacrifice by the next generation.

[11] See, for example, Kotlikoff, Persson, and Svensson (1988).

Appendix: The Model with Physical Capital

Each individual solves the problem

$$\text{Max } u(c_{1t}) + \frac{1}{1+\alpha} u(c_{2t+1})$$

subject to

$$c_{1t} + c_{2t+1}/(1 + r_{t+1}) = w_t H_t \ell_t \tag{A1}$$

$$H_t = g(\ell_t)\bar{H}_{t-1} \tag{A2}$$

where the only difference is the wage per efficiency unit of labor w_t, and the interest rate r_{t+1}. Output is produced from a constant returns to scale production technology $F(K_t, N_t\ell_t H_t)$. Defining $k_t = K_t/(N_t\ell_t H_t)$, and $f(k_t) = F(k_t, 1)$, profit maximization implies

$$f'(k_t) = r_t, \tag{A3}$$

and

$$f(k_t) - k_t f'(k_t) = w_t. \tag{A4}$$

The government is again assumed to solve P2, but now k_t is a state variable, and the government's choice of τ and ℓ will not only depend on k_t, but it will also affect k_{t+1}, which will in turn affect the next government's choice of τ and ℓ. These spillover effects matter to the current government because the current young will still be alive in $t + 1$. As one would expect, the direct effect of a transfer from young to old is normally to decrease the saving of the young (i.e. $dk_{t+1}/d\tau_t < 0$), while the effect of increased time working relative to accumulating knowledge is to increase saving (i.e. $dk_{t+1}/d\ell_t > 0$).

Let $1 + \gamma_{t+1} \equiv (1+n)g(\ell_{t+1})$ and $q_t \equiv g'(\ell_t)/g(\ell_t)$. The first-order conditions for turn out to be (see Kahn–Lim (1996) for details):

$$\theta(1+n)u'(c_{2t}) = (1-\theta)u'(c_{2t+1}) \times \tag{A5}$$

$$\left\{(1+f'(k_{t+1})) - (1+\gamma_{t+1})\frac{dk_{t+1}}{d\tau_t}\left(\tau_{t+1}q_{t+1}\frac{d\ell_{t+1}}{d\bar{k}_{t+1}} + k_{t+1}\ell_{t+1}f''(k_{t+1}) + \frac{d\tau_{t+1}}{d\bar{k}_{t+1}}\right)\right\}$$

and

$$\begin{aligned} &\theta(1+n)u'(c_{2t})[(1+q_t\ell_t)k_t(1+f'(k_t)) + \tau_t q_t] = \\ &(1-\theta)u'(c_{2t+1})\{(1+f'(k_{t+1}))[-(1+q_t\ell_t)(f_t - k_t f'(k_t)) + \tau_t q_t] - \\ &(1+\gamma_{t+1})\left[q_t\tau_{t+1} + \tfrac{dk_{t+1}}{d\ell_t}\left(\tau_{t+1}q_{t+1}\tfrac{d\ell_{t+1}}{d\bar{k}_{t+1}} + \ell_{t+1}k_{t+1}f''(k_{t+1}) + \tfrac{d\tau_{t+1}}{d\bar{k}_{t+1}}\right)\right]\} \end{aligned} \tag{A6}$$

where the various derivatives such as $\frac{dk_{t+1}}{d\ell_t}$ can be derived from the individual's maximization problem. Given k_t and $\tau_{t+1}(k_{t+1})$ and $\ell_{t+1}(k_{t+1})$, we can solve for the optimal τ_t and ℓ_t. An **equilibrium** is a pair of policy functions $\tau(k)$, $\ell(k)$ such that if $\tau_{t+1} = \tau(k_{t+1})$ and $\ell_{t+1} = \ell(k_{t+1})$, then the τ_t and ℓ_t values that satisfy (A5) and (A6), given that k_{t+1} comes from the consumer's maximization problem, are $\tau(k_t)$ and $\ell(k_t)$.

Kahn and Lim (1996) use numerical methods to compute equilibrium policy functions. Figure 2 provides a diagram of laissez–faire, equilibrium, and efficient growth rates as a function of θ for comparison to Figure 1 in this paper.

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Table 1: Correlations between Education Variables and Political Instability

PSER	YS85	GEXPSH
–0.339	–0.336	–0.337

Table 2: Sample Means Conditional on REVCOUP

	PSER	YS85	GEXPSH(%)
REVCOUP > 0	6.993	4.290	3.370
REVCOUP = 0	9.925	7.723	4.789

Table 3: Education Variable Cross–Section Regression Results Table

3a: WLS Results

	log(GDP)	REVCOUP	R^2	#obs
PSER	1.384	–3.275	0.996	98
	(0.050)	(0.544)		
YS85	2.549	–2.720	0.971	98
	(0.091)	(1.052)		
GEXPSH	0.0090	–0.021	0.983	89
	(0.0004)	(0.005)		

Table 3b: OLS Results

	log(GDP)	REVCOUP	R^2	#obs
PSER	2.302	–0.388	0.738	98
	(0.149)	(0.589)		
YS85	2.455	–1.102	0.759	98
	(0.154)	(0.607)		
GEXPSH	0.0066	-0.013	0.321	89
	(0.0014)	(0.005)		

Figure 1: Equilibrium versus Efficient Growth Rates

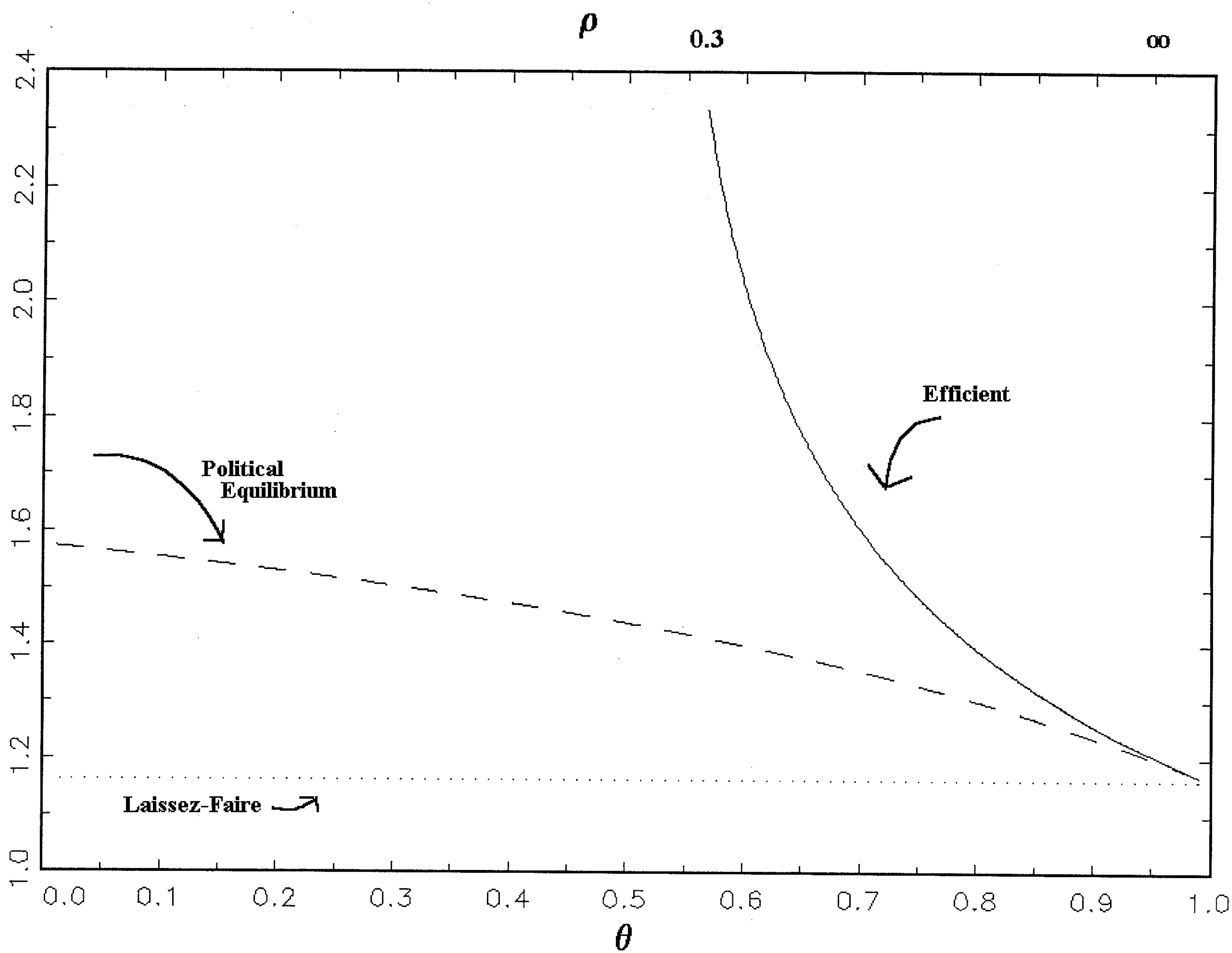

Figure 2: Equilibrium versus Efficient Growth Rates, Model with Capital