Institutions, Property Rights, and Growth

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1 Introduction

SUSTAINED ECONOMIC GROWTH requires continual technological innovation. Indeed, growth in the "new economy" is predicated upon the expansion of knowledge which is transformed into productivity-enhancing goods (Romer, 1990; Amable, Breton & Ragot, 2002). Yet a substantial proportion of the world's economies exhibit little or no growth. There are several mechanisms that produce such poverty traps (Azariadis, 1997), though very little research has examined the institutional environment which inhibits or promotes growth-enhancing investment (exceptions are Zak & Knack, 2001; and Knack & Keefer, 1997).

The recognition that institutions affect economic outcomes can be traced from Adam Smith (1776/1937) through the theory by Haavelmo (1954) to the work of Douglass North (1988, 1990). North argues that institutions which define and enforce property rights affect economic performance because they reduce the transaction costs and uncertainty which arise in exchange. As such, a theory of growth is incomplete without a theory of

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institutions.[1] The enforcement of property rights is even more important in the new economy where "property" includes plans and ideas that are easily expropriated.

This paper proposes a theory of growth in which property rights are insecure and costly to enforce. Violations of property rights occur in the model unidirectionally between two groups in society; those without accumulated resources expropriate from those with such resources. This leads the latter to establish institutions designed to protect property. Four primary results come out of the model : *i)* Insecure property rights can cause countries to be caught in a poverty trap; *ii)* Countries with insecure property rights that escape a poverty trap will have permanently lower levels of per capita income as compared to countries with well-enforced property rights; *iii)* Property rights violations lead to the endogenous formation of government institutions to implement property protection policies; and *iv)* Developing countries with insecure property rights may not be able to escape a poverty trap even when the government allocates an optimal amount of resources to property rights protection. Empirical tests of the model demonstrate strong support for these propositions.

The model here is related to the conflict models of Herschel Grossman (1991, 1995), and Grossman & Kim (1995, 1996), in which economic agents have opportunities to gain resources via extra-legal means which occasions an institutional response.[2] Grossman shows that a primary force driving property rights violations is an unequal distribution of income. This suggests that one policy response may be income redistribution (Grossman, 1995). Indeed, the present paper provides a positive theory of income redistribution, and one that does not rely on the median voter theorem that casual observation suggests is ill-suited to the political economy of many developing countries.[3] Both income redistribution and defensive measures are examined as policy responses to property rights violations. These policies are shown to raise welfare of agents with accumulated wealth and stimulate output growth, but are unable to insulate countries from being mired in a poverty trap.

2 Growth and Property Rights

The essential element that this model seeks to capture is the dynamics of gaining resources through production versus expropriation. Jack Hirshleifer (1991) has written

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[1] The first empirical tests of this thesis appear in Venieris & Gupta (1985, 1986); more recent studies are Barro (1991), Alesina, Ozler, Roubini & Swagel (1996), Zak (2000a), and Ghate, Le & Zak (2001).

[2] Other related papers in this area include Skaperdas (1992), Konrad & Skaperdas (1998), Tornell (1997), and Hirshleifer (1995, 1991).

[3] Alesina & Rodrik (1994), Alesina & Perotti (1996), Perotti (1996, 1992), Persson & Tabellini (1994), Benhabib & Rustichini (1996) and Chang (1998).

People can satisfy their desires in two main ways: by *production* or else by *conflict.*

Consider an economy populated by a continuum of agents who live two periods in overlapping generations, with the mass of young workers normalized to unity. Workers are born without assets and allocate their time between production and expropriating accumulated resources from capital owners who are a generation older. Agents manage their capital holdings in the second period of life, consuming from their earnings. There is no leisure in the model; workers allocate their time to production and/or expropriative activities exclusively. Workers have access to an expropriation technology as in Hirshleifer (1991) and Grossman (1995), which is increasing in the time an individual allocates to expropriation.[4]

An increase in the time workers spend expropriating reduces the consumption of capital owners in two ways. First and most directly, if the extra time devoted to expropriation permits workers to procure capital, the consumption of capital owners falls. Secondly, spending more time expropriating reduces the time in production, reducing output and decreasing the return to capital.

Formally, an agent born at time t maximizes lifetime utility by choosing consumption and an allocation of labor hours between production and expropriation by solving

$$Max_{c_t^0, c_{t+1}^1, l_t} U(c_t^0, c_{t+1}^1) \tag{1}$$

s.t.

$$\begin{aligned} c_t^0 &= w_t l_t + \pi_t \tilde{R}_t K_t - s_t \\ c_{t+1}^1 &= \tilde{R}_{t+1} s_t (1 - \pi_{t+1}) \\ 1 &= e_t + l_t, \end{aligned}$$

where U is continuous, strictly concave and increasing in both arguments, c_t^i is the consumption at time t of an individual who is either a worker, $i = 0$ or a capital owner, $i = 1$, w is the wage rate, l is the time the individual spends working with L denoting the equilibrium time spent in production where the total time one has available is normalized to unity, s is savings with the yield on savings is $\tilde{R} = 1 + r - \delta$ for interest rate r and depreciation rate on capital $\delta \in [0, 1]$. Capital, K, is broadly defined to include both physical and intellectual capital, as the latter is particularly susceptible to expropriation because of its portability.

The function $\pi_t = \pi(e_t) : [0, 1] \rightarrow [0, 1]$ is the *expropriation technology*, through which a portion of the return to capital is expropriated by workers, with e_t the time spent expropriating. That is, expropriation is an illegal transfer of resources from capital owners to workers. In the second period of

4 I am focusing exclusively on *economic* rationale for expropriation. Clearly political and psychological reasons exist which may induce property rights violations, but these are outside the scope of the model. See North (1988) for a discussion of cultural and behavioral motivations for property rights violations.

life, agents are subject to the expropriation of their resources by the current cohort of workers. By assumption, individual effort applied to expropriation yields a weakly positive return, $\frac{\partial \pi}{\partial e} \geqslant 0$. Since time is spent either working or expropriating, if the labor supplied to production is increasing in the wage, higher wages raise the opportunity cost of time away from production. This reveals the feedback between aggregate economic conditions and the incentives to transgress others' rights to property.

Capital owners run firms and maximize profits by choosing the amount of capital and labor to use in production. The firm's optimization problem does not directly depend on the security of property rights as expropriation occurs after production decisions are made. Let $F(K, L)$ be a neoclassical production function which is increasing and concave in both arguments and satisfies the Inada conditions. Input markets are assumed competitive so that profit maximization results in input prices equal to their marginal products, $r_t = F_1(K_t, L_t)$, and $w_t = F_2(K_t, L_t)$. Using the factor prices above, the capital market clearing condition is given by

$$K_{t+1} = S(Y_t, R_{t+1}),$$

where income $Y_t \equiv w_t L_t + \pi_t \tilde{R}_t K_t$, the effective interest factor $R_{t+1} \equiv \tilde{R}_{t+1}(1-\pi_{t+1}) = (F_1(K_{t+1}, L_{t+1})+1-\delta)(1-\pi_{t+1})$, and the savings function $S(Y, R)$ is the optimal solution to the agent's optimization problem (1).

Although an increase in the income of workers by the amount expropriated, $\pi\tilde{R}K$, stimulates savings, expropriation also reduces the effective return to savings, $\tilde{R}_{t+1}(1 - \pi_{t+1})$. Thus, *a priori* the impact of property rights violations on growth is ambiguous, depending on the relative sizes of the income and substitution effects. The following result formalizes this notion.

Theorem 1. *Suppose that $\{c_0, c_1\}$ are normal goods and strict gross substitutes in the model given by (1) and that labor hours in production are strictly increasing in the wage. Then property rights violations lead to a lower level of steady state wealth relative to the standard model in which property rights are perfectly and costlessly enforced if the return from expropriation is not too large,*

$$\frac{\tilde{R}'(K)}{\tilde{R}(K)} > \frac{-\pi'(K)}{\pi(K)}$$

and

$$\frac{w'(K)(L(K)-1) + w(K)L'(K) + \pi'(K)\tilde{R}'(K)K + \pi(K)\tilde{R}'(K)K + \pi(K)\tilde{R}(K)}{\pi'(K)\tilde{R}(K) + \pi(K)\tilde{R}'(K)}$$

$$> \frac{S_R(Y, R)}{S_Y(Y, R)} > 0$$

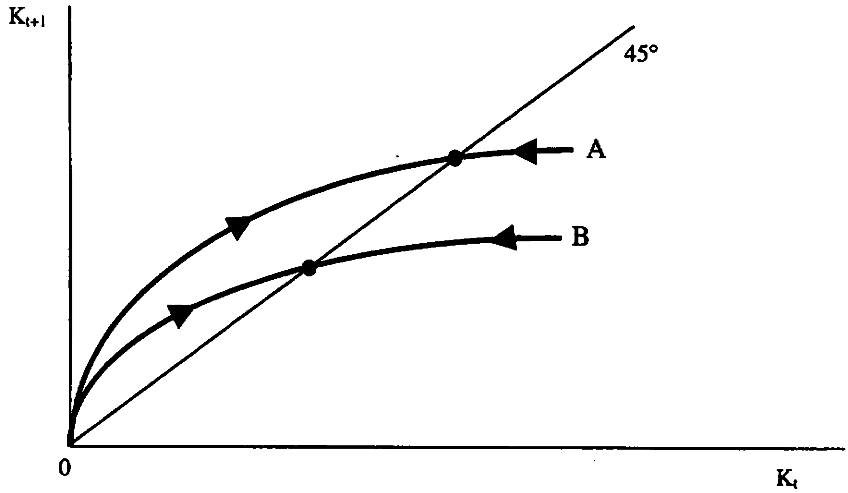

Figure 1 : *Path A : An economy with perfectly secure property rights; Path B : An economy with insecure property rights.*

Proof. See appendix.

This theorem obtains when savings is sufficiently sensitive to the return R relative to income Y. It specifies the conditions under which violations of property rights have a deleterious effect on an economy with a unique interior steady state, as depicted in Figure 1. Intuitively, the result shows that savings diminish because the effective interest factor $\tilde{R}(1-\pi)$ falls due to property rights violations. Note that the extra-legal transfer to workers does not produce a model which grows without bound as occurs in some models with redistribution (Jones & Manuelli, 1991; Caballé & Manresa, 1994). A steady state is reached in the model here because the amount expropriated declines with growth as the primary incentive to expropriate, a low wage, rises as capital accumulates.[5] It is straightforward to show that the distribution of income narrows with growth if the labor supplied to the production sector is increasing in the wage. This secondary effect of growth–a narrowing of the distribution of income–further weakens the incentive to expropriate as per capita income rises.[6]

Theorem 1 does not consider the case in which the amount of expropriation is so great that a positive rate of growth can not be sustained. Theorem 2 shows that when the expropriation technology is effective at procuring resources and savings are sufficiently sensitive to the net interest rate, the model with imperfect property rights protection generate multiple stationary equilibria.

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5 Endogenous perfect property rights protection obtains in this model as $K \to \infty$, but this is not observed since the steady state value of K is finite.

6 The model's prediction that the distribution of income narrows with sufficient growth is consistent with most empirical evidence. See Brenner, Kaelble & Thomas (1991).

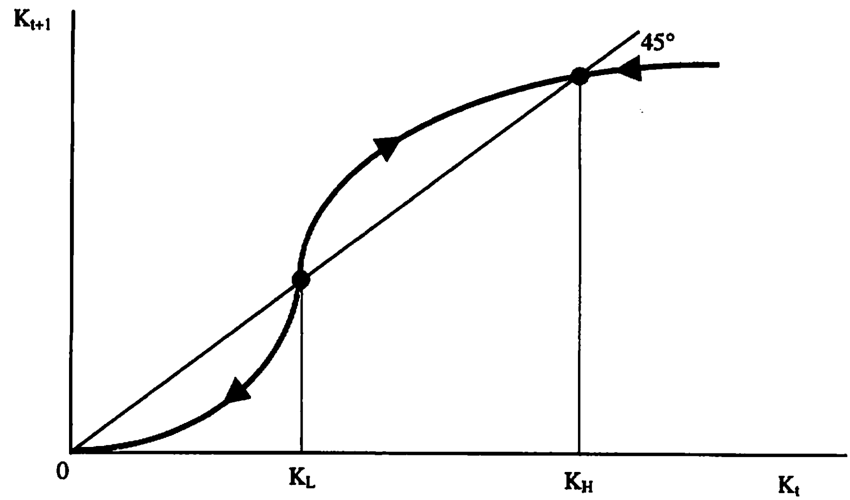

Figure 2 : *A time path of an economy with an effective expropriation technology.*

Theorem 2. *Let the optimal savings function be $s(Y, R)$ where Y is net income and R is net return to savings. Then, there are at least two nontrivial stationary equilibria for the economy in which the agent solves (1) if*

i) The labor supply is increasing in the wage,

ii) $\exists$ a small positive level of capital $K_\aleph$ such that $\pi(e(K_\aleph)) = 1$, and

iii) $$R(K) < -K[-\pi'(K)R(K) + R'(K)],$$

iv) and $\exists$ $K_{t+1} > K_t$.

Proof. See appendix.

The proof of Theorem 2 above relies heavily on the geometry of the dynamical system as depicted in Figure 2. The novelty of this result is the second condition which obtains if the expropriation technology is so effective that at some low level of capital workers optimally choose to allocate almost all of their time to expropriation.[7]

Theorem 2 suggests that poor economies (that is, $K_0 < K_L$ in Figure 2) with effective expropriation technologies may become mired in poverty traps. Wealthier economies, even with effective expropriation technologies, have the advantage of a higher wage rate which discourages expropriative activity. In this case, workers see themselves much more as "part of the system" which keeps property rights violations low. Growth reinforces the incentives to countenance property rights as wages rise and the distribution of income narrows.

[7] This result is similar to the appearance of a poverty trap when the the elasticity of substitution in production is sufficiently high so that at low levels of capital, savings is decreasing in the interest factor (Galor & Ryder, 1989; Azariadis, 1997).

Since expropriation is effectively a transfer from capital owners to workers, property rights violations unambiguously decrease the consumption the former. Owners of capital, therefore, would be willing to fund institutions which protect property rights if this would raise their utility. This issue is addressed by introducing a government.

3 Institutions

Because capital owners have an interest in property rights protection, they are the only group of agents who would be willing to pay to form institutions to enforce property rights. Indeed, the enforcement of property rights is a profound incentive for the endogenous establishment of institutions. Because of this incentive we examine the role that an institution, which we will call the government, has on the economy's growth trajectory. Further, because this institution is formed by a subset of the population, by assumption it is financed by taxing only members of its own group to fund policies, i.e. it cannot impose a tax on workers.[8] Thus, government policy is undertaken at the behest of those with wealth. Nevertheless, policy choices are not unconstrained since workers' responses to policies must be considered and policies are costly to implement. Note that maximizing the return to capital is equivalent to maximizing the economy's growth rate so that the policies considered here would also be chosen by policy-makers seeking to maximize aggregate income growth.

Two policies are examined which seek to reduce expropriative activity : *i)* subsidies to workers for the time spent in production and *ii)* police protection of assets. The former raises the opportunity cost of expropriation which reduces property rights violations, while the latter does this by decreasing the return to expropriation. Because policies are funded by a tax on capital, there is an indirect effect on expropriative activity as the income differential between workers and owners of capital is reduced by the tax, diminishing the relative payoff to expropriation.

Government policy is defined to be a triple $P = \{\sigma, M, \gamma\}$, which is a set of employment subsidies, σ, and security expenditures, M, both of which are funded by a capital tax, γ. In this case, an agent born at time t solves

$$\max_{c_t^0, c_{t+1}^1, l_t} \quad U(c_t^0, c_{t+1}^1) \tag{2}$$

s.t.

$$\begin{aligned} c_t^0 &= (w_t + \sigma_t)l_t + \pi_t \tilde{R}_t K_t (1 - \gamma_t) - s_t \\ c_{t+1}^1 &= \tilde{R}_{t+1} s_t (1 - \gamma_{t+1})(1 - \pi_{t+1}), \end{aligned}$$

[8] A reduction in the income of workers via a tax would generally raise property rights violations so this case is not considered here. In a related model, Zak (1994) shows that when a wage tax is the only source of revenue used to fund a police force, the optimal tax rate is near 100% and workers allocate almost all their time to production. More general results are contained in Zak (2000b).

taking as given the expropriation technology, $\pi_t = \pi(e_t, M_t) : [0,1] \times \boldsymbol{R}_+ \to [0,1]$ which now depends on expropriation effort e and security expenditures M. Optimal decisions at time t are given by a savings function, $s^\star(K_t, K_{t+1}; P_t, P_{t+1})$ and a labor allocation rule, $L^\star(K_t; P_t)$. The government maximizes capital owners' consumption by keeping labor supply in the production sector high and by protecting property rights. Observe that the distribution of income now depends on tax and subsidy rates as well as the level of capital, all of which evolve as the economy grows.

The following timing convention is adopted. The government, knowing the equilibrium labor supply function $L^\star$, chooses the optimal values for policies, P, collects tax revenue and implements policies. Workers observe the resulting policies and then execute their consumption and labor allocation choices as the period begins. Production and expropriation occur during a period. Thus, the government and workers play a Stackelberg game with the government moving first.

The government's optimization problem at time t is

$$Max_{P_t} \quad c_t^1 \tag{3}$$

s.t.

$$\gamma_t R_t K_t = \sigma_t L_t + M_t \tag{4}$$

$$L_t = L^\star(K_t; P_t) \tag{5}$$

The government chooses policies to maximize the consumption of capital owners, which is the after-tax after-expropriation return to capital. The government's optimization is subject to two constraints : The budget equation (4) equating tax revenue to government expenditures on policies σ and M, and the equilibrium labor supply function (5).

The solutions to the model which includes government institutions is a perfect Nash equilibrium which satisfies the following conditions.

Definition. *A political-economic equilibrium is a sequence of prices* $\{w_t, R_{t+1}\}_{t=0}^{\infty}$, *savings decisions* $\{s_t\}_{t=1}^{\infty}$, *labor allocations* $\{L_t\}_{t=1}^{\infty}$, *government policies* $\{P_t\}_{t=1}^{\infty}$ *and a law of motion for capital,* $K_{t+1} = \Gamma(K_t)$ *with* K_0 *given such that, given an expropriation technology* π *: firms choose inputs to maximize profits, policies* $P(K_t)$ *solve the government's optimization problem (3), and the decision rules* $s(K_t, K_{t+1}; P_t, P_{t+1})$, $L(K_t; P_t)$ *solve the agents' lifetime utility maximization problem (2); and the capital market clears*

$$s(K_t, K_{t+1}; P_t, P_{t+1}) = K_{t+1}$$

Next we examine the dynamics of an economy with imperfect property rights protection when the government implements policies $\{\sigma, M, \gamma\}$. Under conditions analogous to those in Theorem 1, it can be shown that the return to investment is higher with government policies than without

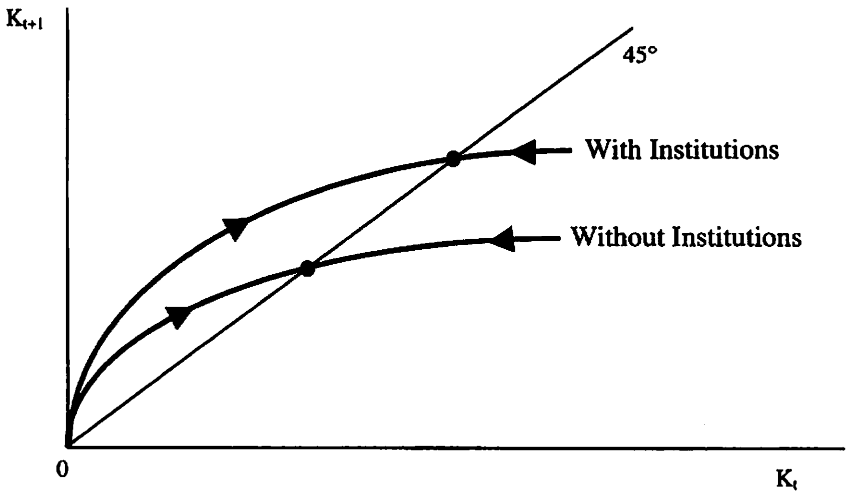

Figure 3 : *A time path of an economy with and without institutions.*

(otherwise capital owners would not fund these policies). As a result, institutions that protect property rights raise the level of steady state income. Figure 3 illustrates this.

A more pressing question is whether government policy rules out the possibility of a poverty trap. The following theorem shows that it does not.

Theorem 3. *There are at least two nontrivial stationary political-economic equilibria for the economy in which the agent's problem is given by (2) and the government solves (3) if*

i) The labor supply is increasing in the wage, \

ii) $\exists$ *a small positive level of capital* $K_\aleph$ *such that* $\pi(e(K_\aleph)) = 1$,

iii) as $K_t \to K_\aleph$,

$$R(K)[1-\gamma+\pi'(K)(1-\gamma(K))-K\gamma(K)] < -R'(K)K(1-\gamma(K))-\sigma(K)L'(K),$$

and

iv) $\exists K_{t+1} > K_t$.

Proof. See appendix.

This result shows that low wealth countries may be unable to escape a poverty trap even when the government optimally implements policies to reduce property rights violations. The intuition for the theorem is straightforward : When the incentives to expropriate are greatest (low values of K), tax revenue available to fund policies is low and therefore the property rights are poorly enforced. As the economy grows, the interests of workers and capital owners evolves from adversarial to congruent as wages and the labor supplied to production rise. With higher wages, workers countenance property rights as it is in their interest to do so. Moreover, since growth raises tax revenue over a range of the capital stock, policies $\sigma(K)$, and $M(K)$ receive increased funding, enhancing the enforcement of property rights and therefore further diminishing violations.

Even if the expropriation technology is insufficiently productive to cause a poverty trap, high rates of expropriation typically reduce steady state income relative to the perfect property rights protection case. In addition, if a nontrivial amount of resources are allocated to police protection of property, all equilibria are Pareto inefficient as police protection constitutes a deadweight loss to society.

Since most government policies are far from optimal, the imperfect enforcement of property rights may be one reason that we observe what appear to be poverty traps in many developing countries. Furthermore, the existence of a growth threshold indicates that small differences in initial conditions lead to significant differences in long-run outcomes. That is, countries which are initially similar may have much different economic histories if property rights protection differs.

4 Empirics

Empirical tests of the model are of two types. The first set of tests is based on the optimal government policy functions for police protection and employment subsidies from parameterized versions of the model. This is meant as a "reality check" of the model, rather than a full explanation of government spending patterns which is beyond the scope of the paper. Nevertheless, if estimated policy functions are consistent with the model's predictions, we can not dismiss the model out of hand. The second empirical test estimates cross-country growth regressions in which police expenditures and worker subsidies are used as explanatory variables.

Appendix A presents parameterized versions of the model in Section 3 from which closed-form optimal government policy functions are found. For reasons of tractability, the model is specialized to consider each policy to reduce expropriation – employment subsidies and police expenditures – in isolation of the other. The derived optimal policy functions specify and relationship between government expenditures on subsidies and the police as a function of the state variable, the capital stock K. Further, because of the use of Cobb-Douglas functional forms in the derivations, both optimal policy functions are log linear in capital and therefore directly estimable.

The derived policy functions are estimated for a panel of countries using annual data from 1970 to 1994. The data are from *Government Finance Statistics* (GFS) collected by the International Monetary Fund (1998) and cover 67 countries beginning in 1970. "Public order and safety" is used to measure police expenditures, and "transfers" proxy employment subsidies. The capital stock values are obtained from the *Penn World Tables*

Mark 5.6a (PWT), as described in Summers & Heston (1991). As the capital series is less complete and subject to greater measurement error than is income, an additional set of estimates for the policy functions is obtained using GDP rather than capital as the regressor.[9] A fixed-effects model is employed to control for different levels of capital stock across countries at the time of the initial observation. All observations are converted to real (1982) "international dollars" per worker using the price series from the PWT. The countries with available data that are used in the statistical analysis are listed in Appendix B.

Estimating the optimal policy functions for subsidies and police spending demonstrates strong support for the model, with both t-statistics for the coefficient of the log of capital per worker being significantly different than zero at greater than a 1% level. A second test that includes a larger set of countries estimated both policy functions using log of per-worker GDP as the regressor. Again both coefficients are significantly different than zero at greater than a 1% level.[10]

The estimation results for both police expenditures and employment subsidies demonstrate support for the model. These empirics should be viewed with some skepticism, though, as there are many reasons why government expenditures increase with national income. For example, we have not considered political goals which may lead policy-makers to increase government spending irrespective of considerations of economic efficiency.[11] Nevertheless, the empirical results for an extensive range of countries over a 24 year interval do not permit a rejection of the theory.

4.1 Growth Regressions

A second test of the model estimates standard growth regressions in which the savings rate is assumed constant and the (log of) public safety expenditures and transfers enter as explanatory variables. This analysis tests Barro's (1991) conjecture that countries which have well-enforced property rights will have higher per capita growth rates. The theory in this paper shows that expenditures on both public safety and transfers reduce property rights violations. Since both variables are endogenous, growth rate regressions are estimated using average expenditures for the period of study, 1970-1990, for a cross section of developing and developed countries. Growth regressions are estimated separately for public safety and transfers since the model predicts that these variables are highly collinear.

[9] Using income will change the value, but not the predicted sign, of the estimated coefficient.

[10] These regression results are not presented to conserve space, but are available upon request. Reported t-statistics are based on standard errors that are corrected for both heteroskedasticity using White's method and first-order serial correlation.

[11] On the propensity of politicians to increase fiscal expenditures, see Ghate & Zak (2001) and the survey in Holsey & Borcherding (1996).

Dependent variable : Ln(ΔGDP)

Regression 1 :		
Variable	Coefficient	t-Statistic
Constant	.078	2.77
Ln(GDP70)	−.009	−2.12
Ln(Transfers)	.004	1.98
Adjusted R^2	.034	
Observations	61	
Regression 2 :		
Variable	Coefficient	t-Statistic
Constant	.053	2.13
Ln(GDP70)	−.005	−1.64
Ln(PubSafty)	.002	1.30
Adjusted R^2	.033	
Observations	50	
Regression 3 :		
Variable	Coefficient	t-Statistic
Constant	.078	2.77
Ln(GDP70)	−.008	−2.35
Ln(PubSafty)	.004	2.21
Ln(PSaf*SPI)	−.002	−2.73
Adjusted R^2	.130	
Observations	50	

Table 1 : *Growth regressions.*

Table 1 reports the regression coefficients and t-statistics when per worker growth rates are regressed on the log of GDP per worker in 1970 and either log of transfers or log of public safety per worker. The estimated coefficient for transfers is positive as predicted by the theory and significantly different than zero at the 5% level.[12] The regression with public safety does not perform as well. The coefficient on public safety is positive but not different from zero at conventional levels of significance. This suggests that the theory may be incomplete. In particular, we have not considered the behavior of governments which are weak and in danger collapsing. Such a regime may spend resources at a rate beyond the optimal level required to protect property rights in order to buttress itself against defenestration (Feng & Zak, 1999; Bueno de Mesquita, Morrow, Siverson & Smith, 2000). To test this hypothesis, a measure of socio-political stability (SPI) is added to control for socio-political environments which might induce high public safety expenditures.

The third regression in Table 1 augments the specification in regression 2 to include the (log of) average SPI times average public safety as

[12] Reported standard errors are corrected for heteroskedasticity using White's method.

a regressor.[13] Including both public safety and the interaction term in the regression captures reasons why governments expend resources maintaining public order. The coefficient on the interaction term is negative and significant while the coefficient of average public safety expenditures is now positive and significant at the 5% level.

The empirical tests of the theory indicate that property rights enforcement is an important institutional precursor for growth. This result also decomposes Barro's (1990) finding that government consumption has a negative impact on growth by examining the impact of specific government programs. Policies which dispose citizens to uphold property rights are growth-promoting, and growth permits countries to better protect property rights.

5 Conclusion

This paper has presented a growth model in which property rights are insecure and costly to enforce. The model demonstrates that the imperfect enforcement of property rights may be part of the etiology of growth failures, and leads to the endogenous formation of institutions. The model demonstrates that developing countries with insecure property rights risk being caught in a poverty trap, even when government policy to enforce property rights is optimal. For countries able to avoid a poverty trap, the model also shows that long-run income will generally be lower the less secure are property rights. Estimation of optimal policy functions derived from the model as well as growth equations using a large set of countries demonstrate that the empirics support the theory.

The model's results stand in stark contrast vis-à-vis a-institutional growth models. Indeed, capital in the model was broadly defined to include intellectual property for which expropriation may be especially easy. The model here suggests that incomes are being reduced in countries with weak institutional structures even if such countries utilize information technologies to spur income growth (e.g. India). Conversely, countries with secure property rights (e.g. Singapore) will reap the benefits of the new economy through sustained innovation and income growth. Observation suggests, and the model demonstrates, that without an institutional environment which can offer sufficient protection of property rights, growth will be mediocre at best.

[13] The SPI index is from Venieris & Gupta (1986) and is constructed using factor analysis on the basis of ten social and political indicators, including political demonstrations, assassinations and the number of *coups d' état*.

A Proofs

Proof of Theorem 1

Let $S(Y, R)$ denote the savings function where savings depends on income Y and the effective yield on savings, R. When property rights are perfectly and costlessly protected, $\pi = 0$ and $L = 1$ since there is no utility to leisure so that income $Y = w$ and $R = \tilde{R}$. The assumptions on preferences guarantee that the savings function is strictly increasing in both arguments and concave, producing a single interior stationary equilibrium.

The theorem is proved by showing that the equilibrium path when property rights are perfectly enforced is everywhere above the equilibrium path when expropriation is permitted. Let K^E denote the steady state in the model with expropriation. Using the monotonicity property, the theorem holds for any level of capital $0 < K < \infty$, which we choose to set to K^E. Beginning with the second condition in the theorem, and applying the first indicates that

$$S_Y[w'(K)(L(K)-1)+w(K)L'(K)+\pi'(K)\tilde{R}'(K)K+\pi(K)\tilde{R}'(K)K+\pi(K)\tilde{R}(K)]$$

$$= S_R[\pi'(K)\tilde{R}(K) + \pi(K)\tilde{R}'(K)]$$

which is

$$\frac{dS[wL + \pi\tilde{R}K, \tilde{R}(1-\pi)]}{dK}_{|K=K^E} > \frac{dS[w, \tilde{R}]}{dK}_{|K=K^E}$$

where the second term is the savings function for the model with no expropriation ($e_t = 0, \forall t$) and in this savings function, next period's capital stock in the $\tilde{R}(K_{t+1})$ is approximated by $\tilde{R}(K^E)$. Under this approximation, the inequality above implies that next period's capital stock for the model without expropriation, K^N, exceeds the value with there is expropriation,

$$K^N > K^E$$

which holds since $S(Y, R)$ is strictly concave. □

Proof of Theorem 2

First, we show that with an effective expropriation technology the slope of the excess demand correspondence is less than unity at the origin. The savings correspondence $s(Y, R)$ has two arguments, income, Y, and the net return, R. Writing out these terms explicitly and noting that in equilibrium excess demand in the capital market must disappear we have

$$K_{t+1} = S[w(K_t)L(K_t) + \pi(K_t)R(K_t)K_t, R(\Gamma(K_t))(1 - \pi(\Gamma(K_t))],$$

where the law of motion $K_{t+1} = \Gamma(K_t)$ can always be found locally. Then,

$$\frac{dK_{t+1}}{dK_t} =$$

$$S_Y[w'(K)L(K)+w(K)L'(K)+\pi'(K)\tilde{R}'(K)K+\pi(K)\tilde{R}'(K)K+\pi(K)\tilde{R}(K)]$$

$$+S_R\Gamma'(K)[(1-\pi(\Gamma(K)))\tilde{R}'(\Gamma(K)) - \pi'(\Gamma(K))\tilde{R}\Gamma((K))]$$

Taking the limit as $K_t \to K_\aleph^+$, $\pi(K) \to 1$ and $L(K) \to 0$ and all derivatives of the production function are bounded,

$$\lim_{K_t \to K_\aleph^+} \frac{dK_{t+1}}{dK_t} = S_Y[w(K)L'(K) + \pi'(K)\tilde{R}'(K)K] - S_R\Gamma'(K)\pi'\Gamma((K))$$

Under the restriction in the theorem, $\lim_{K_t \to K_\aleph^+} \frac{dK_{t+1}}{dK_t} < 0$, which guarantees that $\lim_{K_t \to K_\aleph^+} \frac{dK_{t+1}}{dK_t} < 1$ and phase curve begins below the 45° ray in $K_t - K_{t+1}$ space. Thus, there is a poverty trap at the origin.

For at least one nontrivial stationary equilibrium to exist, the there must be some value of K_t such that $K_{t+1} > K_t$. Given the standard assumptions on preferences and the production function,

$$\lim_{K_t \to \infty} \frac{dK_{t+1}}{dK_t} = 0, \tag{A.1}$$

Therefore, the phase curve begins below the diagonal, ends below the diagonal and exceeds the diagonal for some value of K. Therefore, by continuity there are at least two interior fixed points of the system. □

Proof of Theorem 3

The proof of this theorem follows that of Theorem 2 above, so we simply sketch the differences. First, note that $\pi(K, M) = \pi(K)$ after the government solves its optimization problem for $M(K)$ and $\sigma(K)$. The conditions in the theorem are sufficient to guarantee that

$$\lim_{K_t \to K_\aleph^+} \frac{dK_{t+1}}{dK_t} < 1,$$

which is sufficient to prove that a poverty trap exists for the model with institutions. □

Next I describe the setup of the model that produces the optimal policy functions that were estimated in Section 4. For both cases, the utility and production functions are $U(c^0, c^1) = (1-\beta)\ln(c^0) + \beta\ln(c^1)$, and $F(K, L) = K^\alpha L^{1-\alpha}$, for α, $\beta \in (0,1)$. The first case considered is a variant of the model of Section 3 where the government maximizes the consumption of capital owners by choosing a capital tax, γ, to fund police expenditures, M, subject to the government budget constraint. In this model, the expropriation technology is $\pi = 1 - (1-e)^{\theta} M^{-\eta}$, for $\theta, \eta \in (0,1)$. Here θ is the productivity of effort applied to expropriative activities and η is the effectiveness of police spending at reducing the rate of expropriation. The optimal policy function is found by first solving the agent's problem for the labor supply function which is taken as a constraint in the Stackelberg problem solved by the government.

Optimal expenditures on police protection can be shown to be increasing in capital, over some range, $(0, K_M)$ and decreasing thereafter. As the country with the most capital per worker in 1992, Switzerland, has not decreased public safety expenditures, nor have any of the other capital-rich countries in the sample, in estimating optimal policy functions it is assumed that all countries are below K_M. Taking logs produces the testable police expenditure equation equation $\ln M = \zeta + \mu \ln K$, where $\zeta, \mu > 0$ are agglomerations of the deep parameters in the model.

In the second version of the model, a capital tax is used to fund an employment subsidy σ in order to reduce expropriation. The following expropriation technology is available to workers $\pi = 1 - (1-e)^{\theta}$, with $\theta \in (0,1)$. This is the same functional form used above when $M \equiv 1$.

In order to generate a nonconstant level of expropriation and to capture the deadweight loss inherent in administering a subsidy program, a friction is added to the model which is proportional to the level of employment L.[14] In this case, the government budget constraint is $\gamma RK = \sigma L + AL^{\Lambda}$, where the administrative cost, $A > 0$ and $\Lambda \in (0,1)$.

The same procedure discussed above is used to solve for the optimal policy function, though a closed form cannot be found except in the special case in which $\theta = \Lambda - 1 + \alpha > 0$. In this case, the optimal employment subsidy is increasing over a range of the capital stock, $(0, K_{\sigma})$, after which it decreases, matching the behavior of police expenditures. As with police expenditures, the optimal subsidy is also log linear in capital.

B Data

The countries for which there are either transfers (denoted with t) or public safety (denoted with p) in the GFS dataset are listed below. All available data were used in the reported regressions.

Botswana (tp), Cameroon (tp), Egypt (tp), Gambia (tp), Guinea Bissau (tp), Kenya (tp), Lesotho (tp), Malawi (tp), Mauritius (tp), Morocco

[14] The friction can further be justified by noting that the cost to collect tax revenue in the US has increased more than proportionally relative to the population. Source: Annual Report of the Internal Revenue Service, various years.

(tp), Nigeria (tp), Seychelles (tp), Swaziland (tp), Togo (t), Tunisia (tp), Zambia (tp), Barbados (tp), Canada (tp), Costa Rica (tp), Dominican Republic (t), El Salvador (tp), Guatemala (t), Mexico (tp), Panama (tp), United States (tp), Argentina (tp), Bolivia (tp), Brazil (tp), Chile (tp), Colombia (tp), Ecuador (p), Paraguay (tp), Peru (tp), Uruguay (tp), Venezuela (tp), India (t), Indonesia (tp), Israel (tp), Jordan (tp), South Korea (tp), Malaysia (tp), Pakistan (tp), Philippines (tp), Singapore (tp), Sri Lanka (tp), Thailand (tp), Austria (tp), Belgium (tp), Cyprus (tp), Denmark (tp), Finland (tp), France (tp), Germany (tp), Greece (tp), Iceland (tp), Ireland (tp), Italy (t), Luxembourg (tp), Malta (tp), Netherlands (tp), Norway (tp), Portugal (t), Spain (tp), Sweden (tp), Switzerland (tp), United Kingdom (tp), Australia (tp).

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