Endogenous Insecurity and Economic Development

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Abstract

We explore the implications of endogenous credit market imperfections for the endogenous relationship between investment insecurity and the process of economic development. In the initial stages of development, the fraction of agents engaged in non–productive diversionary activities (e.g. rent–seeking) grows as the opportunities to gain from diversionary activities expand. In later stages, however, diversion falls as capital market imperfections are overcome and productive activities become more secure and more profitable. We detail the forces which determine whether the insecurity generated by an economy’s early development will choke off the growth process. We also compare the cost–effectiveness of alternative policies designed to prevent diversion.

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1 Introduction

The capacity to ensure a secure return on an investment is one the most powerful incentives to invest.\(^1\) Since investment in human, physical or other forms of capital contributes to growth, it follows that the degree of insecurity prevailing in an economy is a key determinant of development. Indeed, recent empirical work has found that indexes of the degree of investment insecurity and government measures to induce greater security are strongly correlated with international variations in both levels and growth rates of labor productivity.\(^2\) Of course, a number of contributing factors combine to determine the degree of insecurity observed in an economy, and the importance of each factor will vary depending on the level of economic development. It follows that there is an endogenous, dynamic relationship between insecurity and development. This relationship is the subject of this paper.

The degree of insecurity faced by investors depends on many factors. Clearly, insecurity will be greater the higher is the crime rate, the larger the number of rent-seekers, the larger the number of corrupt officials, etc. In short, insecurity is likely to be increasing in the number of individuals who prefer to undertake ‘directly unproductive profit-seeking activities’.\(^3\) Hall and Jones (1999) refer to such activities collectively as “diversion” and argue that the suppression of diversion is a central element of social infrastructures that are favorable to economic development. As they point out, the economic costs of diversion include not only the resulting lack of investment, but also the direct costs of suppressing diversion.\(^4\) These costs include private expenditures such as private security arrangements (e.g. bodyguards, watchmen, security systems, etc.) and side payments to deter appropriation of profits (e.g. mafia protection and bribes to local officials). The costs also include public expenditures, ultimately financed through taxation, to prevent diversion (e.g. auditing of local officials), and to prosecute and punish those who engage in such activities.

While it therefore seems clear that the degree of insecurity tends to slow the pace of development, it is not so clear how the level of economic of development impacts upon the degree of insecurity. A traditional view in economics suggests that insecurity is likely to rise with development as the opportunities for diversion expand:

“Wherever there is great property, there is great inequality. For one very rich man, there must be at least five hundred poor, and the affluence of the few supposes the indigence of the many. The affluence of the rich excites the indignation of the poor, who are often both driven by want, and prompted by envy, to invade his possessions.”

Adam Smith (1776 [1937], p. 670)

However, recent contributions emphasize how a negative relationship is likely to arise between economic development and diversion. In Baumol (1990) and Murphy, Shleifer and Vishny (1993), for example, individuals choose between productive and diversionary activities by comparing their relative rewards. Since these rewards are determined by the allocation of individuals between

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2 See, for example, Barro (1991) and Hall and Jones (1999).
3 This term was coined by Bhagwati (1982).
4 Grossman and Kim (1995) analyze the relationship between the security of claims to property rights and the level of welfare. In particular, they emphasize the role of activities which are purely defensive, as well as those that are offensive. Usher (1989) also emphasizes the distinction between defensive and offensive measures.
activities, multiple equilibria can arise.\textsuperscript{5} A crucial feature of these equilibria is that high levels of appropriation are associated with low levels of development.\textsuperscript{6}

In these models, the alternative equilibria arise endogenously in a static environment.\textsuperscript{7} In contrast, this paper studies the joint dynamic evolution of the degree of insecurity and economic development from low levels of development to more advanced stages. As we describe below, these dynamics are the result of the inherent interaction between investment insecurity and credit market failures. If productive individuals need to borrow prior to investment, the insecurity emerges as a natural, \textit{endogenous} source of repayment uncertainty. In the absence of fully developed property rights and with no access to insurance,\textsuperscript{8} entrepreneurs must protect their investments through private arrangements.\textsuperscript{9} As a result, the credit market is characterized by dual interest rates: those with low wealth have low incentives to self-protect and face prohibitively high borrowing costs. These high borrowing costs, in effect, force them out of production and into diversion, thereby reinforcing the investment disincentive.

We study the dynamic interaction between insecurity, credit markets and economic development in the context of a two-period OLG model. Young agents earn heterogeneous wages and choose either to become capitalist producers, “parasites” or to subsist when old. Producers invest, borrowing capital if necessary, and hire young agents at the going wage. Parasites do not produce, but instead try to appropriate the profits of producers. Agents who are unable to become capitalists and for whom the returns to diversion are small, subsist on relatively low incomes. Producers can make private payments (e.g. mafia protection, bribes to local officials) which reduce the probability that any attempted appropriation of their profits is successful. However, because these security measures are inherently unobservable, the incentives to pay for them increase with the wealth of the borrower. Consequently, the less wealthy face higher lending rates than the rich and are effectively shut out of the capital market.

In the initial stages of development, few agents have sufficient wealth to qualify for a profitable loan. The remainder are left with a choice between the low subsistence income and diversionary activities. However, the opportunities to gain from diversion are constrained by the level of economic activity, and the degree of insecurity faced by any one producer is driven to its maximum level. If the average wage received by the young exceeds that received by the previous generation, the fraction of agents to whom investors are willing to lend at the low-interest rate grows in the next period. As production expands, so also do the opportunities to gain from diversion, so that there is a matching increase in the fraction of parasites.

Eventually, however, the increased opportunities to undertake productive activities draws agents out of the pool of potential parasites. The associated reduction in insecurity encourages lenders

\textsuperscript{5}Multiple equilibria can also arise in Sah (1991) and Fender (1997) because for a given level of resources allocated to apprehension and punishment, the probability of arrest declines with the crime rate. Glaeser, Sacerdote, and Scheinkman (1996) discuss multiple equilibria in models of crime.

\textsuperscript{6}Our model may also generate multiple equilibria with this feature, but the mechanism is somewhat different. There can be equilibria with many parasites and a large risk premium, so that credit is inaccessible and output is low. Alternatively, there can be equilibria with no parasites and no risk premium, so that all agents have equal access to productive opportunities and output is high.

\textsuperscript{7}Acemoglu (1995) develops a dynamic version of the Murphy–Shleifer–Vishny story. He shows that their static equilibria are all potential steady-state equilibria. However, there is no accumulation of wealth and the results are driven by forward-looking behavior. See also Baland and Francois (1997).

\textsuperscript{8}Missing insurance markets are common in the real world. Standard explanation for this state of affairs are the prevalence of moral hazard and/or adverse selection.

\textsuperscript{9}Ehrlich and Becker (1972) study the joint consumption of insurance and self-protection.
to reduce the risk premium, thereby raising the fraction of agents who are eligible for low interest
loans even further. Thus, the existence of borrowing constraints, also implies that at some stage
the accumulation of wealth helps to reduce the fraction of parasites. If the effectiveness of private
security is high and/or its cost is low, the economy will always experience this second phase of
development, with falling insecurity and high long-run productivity. Otherwise, the economy may
become trapped in an insecure, low-productivity steady state.10

Endogenous credit constraints of the type described here also have important implications for
the effectiveness of public expenditures on alternative institutions designed to deter diversion.
According to Becker (1968) harsher punishments or a greater likelihood of successful prosecution,
reduce the payoff to diversion and induce more people to undertake productive activities. In
our analysis, the fact that individuals are credit–constrained implies that increasing the expected
punishment may have little impact on insecurity.11 In contrast, public expenditures which reduce
the likelihood that diversion will be successful ex ante, can have large effects. By reducing the degree
of insecurity, public investments such as these help to reduce the interest rate faced by borrowers
and the cost of protection. This, in turn, reduces diversion and induces greater productive activity.

The remainder of the paper is organized as follows. Section 2 lays out the assumptions of our
model and Section 3 characterizes the equilibrium. In Section 4, we characterize the development
process that arises from the model, and in Section 5, we discuss the policy implications.

2 Analytical Framework

2.1 Endowments and Preferences

In each period \( t \) a unit population of two-period lived individuals is born into a small open economy.
Each young person is endowed with efficiency units of labor \( \varepsilon \), drawn from a time-invariant uniform
distribution function \( F(\cdot) \), with support \([0, 2H]\). It follows that the aggregate supply of labor
efficiency units is given by \( H \):

\[
\int_0^{2H} \varepsilon dF(\varepsilon) = H. \quad (1)
\]

The young supply their labor to old producers and receive the equilibrium wage, \( w_t \), per efficiency
unit of labor supplied. This, in turn, generates a distribution of incomes amongst these agents
when they become old. At \( t = 0 \), the initial old generation are assumed to have earned a wage per
efficiency unit of labor, given by \( w_0 \), where \( w_0 \) is sufficiently small.12

An agent born at time \( t \) has preferences described by the linear utility function:

\[
u(c_t, d_{t+1}) = c_t + \beta E_t d_{t+1}, \quad (2)\]

where \( c_t \) and \( d_{t+1} \) represent consumption when young and old, respectively, \( \beta \) is the discount factor
and \( E_t \) denotes the expectations operator conditional on time \( t \) information. Let \( r > 1 \) be the gross

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10 The recent experience of Russia and other transition economies illustrates the consequences of parasitism (organ-
ized crime in this context) on economic development. See Goldman (1996).
11 Empirical evidence on the impact of punishment on crime rates is mixed. Marceau and Mongrain (1999) survey
several alternative theories regarding the impact of punishment on crime.
12 We clarify what we mean by ‘sufficiently small’ in Section 5.
risk-free interest rate that can be earned on world capital markets. We assume that the rest of the world has identical preferences, so that \( r = 1/\beta \). Since the economy is small relative to the rest of the world, competition drives the interest rate on deposits to \( r \). These preferences imply that agents are risk-neutral and that if capital markets were perfect, agents would be indifferent about the timing of their consumption.

### 2.2 Production

All members of the old generation have access to a subsistence activity which generates a low income, \( y \). However, depending on the equilibrium prevailing, they may be able to earn more by becoming producers or parasites. Those who become producers undertake projects that combine a fixed quantity of capital, \( k \), with variable efficiency units of labor, \( h \), according to a simple Cobb–Douglas production technology. Producers choose efficiency units of labor so as to maximize short-run profits:

\[
\max_h A k^{1-\alpha} h^\alpha - w_t h.
\]

This yields a demand for efficiency units of labor given by

\[
h(w_t) = \left( \frac{\alpha A}{w_t} \right)^{\frac{1}{1-\alpha}} k,
\]

and short-run profits \( \theta_t k \), where

\[
\theta_t = (1 - \alpha) \left( \frac{\alpha A}{w_t} \right)^{\frac{\alpha}{1-\alpha}} A.
\]

### 2.3 The Market for Protection

For reasons described below, a fraction \( n_t \) of the population become parasites and attempt to appropriate the profit of producers. We assume that a parasite can attempt to appropriate from at most one producer and denote the expected income from doing so by \( X_t \). If an appropriation attempt fails, the victim keeps his profits and the parasite gets nothing. If it is successful, there is still a chance that the parasite will be apprehended and punished. We distinguish between the degree of insecurity, \( \pi_t \), — the probability that a producer’s profits are appropriated — and the rate of diversion, \( n_t \) — the fraction of the population engaged in diversionary activities.

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13The assumption of a fixed-size project is not necessary. All that is required is that investments be larger than some minimum scale, so that low-wealth individuals have to borrow.

14The fixed investment could be interpreted as a cost of acquiring specific human capital. In that case, we could more generally think of entrepreneurs as being skilled workers who are residual claimants, and profits as their salaries.

15The qualitative nature of our results would not change if parasites could attempt more than one appropriation. What is crucial however is that each entrepreneur can only be a victim a small number of times. Normalizing to one significantly simplifies the exposition.

16We rule out the possibility that borrowers simply voluntarily default on their loan. We assume that the probability of getting away with such embezzlement is arbitrarily close to zero, since the borrower is easily identified by the lender. In contrast, we assume that output appropriation is anonymous, so that the probability of success is much higher.
An entrepreneur can reduce the likelihood of appropriation by making a side payment (e.g. mafia protection, a bribe to a corrupt official, etc.). Once this payment is made, the probability that an attempt to appropriate the entrepreneur’s profits is thwarted is given by $\rho < 1$ (such measures are imperfect). We assume there exists a market for this protection. The market price of protection is $p_t$. The marginal cost of security is $\gamma k$ (e.g. the effort required to hinder appropriation) in the event of an appropriation attempt and is zero otherwise. With perfect competition, this implies that providers of protection earn zero expected profits:

$$p_t = \pi_t \gamma k.$$  \hspace{1cm} (6)

Thus, the market for protection acts like an imperfect insurance market.

### 2.4 The Capital Market

At the beginning of the second period of life, if an individual has accumulated wealth $b < k$, he can borrow $(k - b)$ to undertake a project. If he has accumulated $b > k$, he can undertake the project and deposit $(b - k)$ in the bank. He must also choose $ex \ ante$ whether to invest an additional $p_t$ in private security measures. Although the lender can observe the loan size, he cannot observe $ex \ ante$ whether security measures are actually adopted. Only those with sufficient wealth carried over from the first period will find it in their interest to invest in private security. Since there is limited liability, the remainder would rather consume the additional funds and face the greater risk of appropriation and default. The lender therefore screens borrowers based on the size of the loan (or wealth).

An entrepreneur will undertake private security measures only if his expected profit when the required portion of the loan is invested in security measures exceeds that when it is simply consumed

$$(1 - \pi_t + \rho \pi_t) \left( \theta_t k - r_t^s [k + p_t - b] \right) > (1 - \pi_t) \left( \theta_t k - r_t^s [k + p_t - b] \right) + r p_t,$$

which can be re-written as

$$\rho \pi_t (\theta_t k - r_t^s [k + p_t - b]) > r p_t.$$  \hspace{1cm} (8)

The left hand expression represents the gain in expected profit from paying for security while the right hand expression is the opportunity cost of doing so. It follows that there exists a critical wealth level,

$$b^c_t = \left( 1 + \pi_t \gamma - \frac{[\rho \theta - r \gamma]}{\rho r} \right) k = \left( 1 + \frac{\gamma}{1 - \rho} - \left[ 1 - (1 - \rho) \pi_t \right] \left[ \frac{\theta_t}{r} + \frac{\gamma}{1 - \rho} - \frac{\gamma}{\rho} \right] \right) k,$$  \hspace{1cm} (9)

17Expressing variables as a fraction of $k$ simplifies the exposition.

18One way to get around the unobservability of security expenditures is for the banks to provide the security themselves. There are several reasons why this might not be possible. If security measures are transferable, then the existence of a market for security implies that entrepreneurs, if forced to buy from the banks, could simply resell to adjust the amount they wish to consume. Even if security measures are non-transferable, the efficient scale — the compromise between scale economies and agency costs — for firms offering banking services and those providing security services may not be the same. If banks were to offer security, they would not be able to compete with firms specializing in this particular business. Alternatively, we could have assumed that entrepreneurs have to provide an unobservable effort to secure their investment. If effort can also be used to generate income using some other technology, then the moral hazard problem remains and banks have an incentive to screen investors.
such that only those with greater wealth will pay the fee. Note that $b_c^t$ is an increasing function of the degree of insecurity, $\pi_t$.

Although individuals with $b \geq b_c^t$ pay for protection, they are only successful in thwarting diversion with probability $\rho < 1$. If the probability of an appropriation attempt is $\pi_t$, then the probability that a lender is ultimately repaid by these individuals is $(1 - \pi_t + \pi_t \rho)$. Competition amongst lenders drives their profits to zero, so that these borrowers are charged an interest rate

$$r_t^s = \frac{r}{1 - \pi_t + \pi_t \rho},$$

where the superscript $s$ denotes ‘security’. The net income of borrowing individuals with $b \geq b_c^t$ is therefore $Z_t^s + rb$, where

$$Z_t^s = [1 - \pi_t + \pi_t \rho] \theta_t k - r(1 + \gamma \pi_t)k,$$

Those borrowers for whom it is too costly to invest in security ($b < b_c^t$) will default with probability $\pi_t$. Lenders, understanding this, will charge a greater risk-premium to these borrowers. The probability that an individual with $b < b_c^t$ will repay is $(1 - \pi_t)$. Therefore, lenders will charge them

$$r_t^n = \frac{r}{1 - \pi_t} > r_t^s,$$

where the superscript $n$ denotes ‘no security’. The expected net income of an individual with $b < b_c^t$, were he to become a producer, is therefore $Z_t^n + rb$, where

$$Z_t^n = (1 - \pi_t) \theta_t k - rk.$$

### 2.5 Occupational Choice and Saving

An agent who earns $w_{t-1} < b_c^t$ in the first period of his life cannot save enough to qualify for a low-interest loan. Since he is risk-neutral and $\beta = 1/r$, he is indifferent between consuming all of his income in the first period and saving some of it to invest in his project. We arbitrarily assume that he consumes all of his first period income. This assumption does not affect any of the results that follow.

An agent who earns first period income $w_{t-1} \geq b_c^t$ will always choose to save at least $b_c^t$ because this will make him eligible for a low-interest loan. However, he is indifferent between consuming the remainder of his income in the first period or saving more than $b_c^t$. Again we assume, without loss of generality, that he consumes all of his income in excess of $b_c^t$ in the first period.

It follows that we can define a critical level of labor efficiency units given by

$$\varepsilon_c^t = \frac{b_c^t}{w_{t-1}},$$

and that the expected lifetime utility of an agent born at $t-1$ with ability $\varepsilon$ is given by

$$v(\varepsilon; w_{t-1}, X_t, Z_t^n, Z_t^s) = \begin{cases} w_{t-1} \varepsilon + \beta \max[y, X_t, Z_t^n], & \text{if } \varepsilon < \varepsilon_c^t, \\ w_{t-1} \varepsilon + \beta \max[y, X_t, Z_t^s], & \text{if } \varepsilon \geq \varepsilon_c^t. \end{cases}$$
3 Equilibrium

Since the efficiency units of labor supplied by each generation is fixed, it is possible to define a period \( t \) equilibrium, given the wage per efficiency unit received in the previous period, \( w_{t-1} \). We then characterize the alternative equilibria that can arise.

A period \( t \) equilibrium is a vector \( \{n_t^*, \varepsilon_t^*, \pi_t^*, w_t^*, X_t^*, Z_t^*, Z_t^*, r_t^*, r_t^*, r_t^*\} \) such that:

- Producers choose the level of labor efficiency units to maximize profits, (4).
- The labor market for the young clears at the equilibrium wage, \( w_t^* \).
- Given the degree of insecurity, \( \varepsilon_t^* \), lenders set their loan rates, \( r_t^* \) and \( r_t^* \), and the critical level, \( \varepsilon_t^* \), to maximize expected profits, (9), (10), (12) and (14). Competition drives these expected profits to zero.
- Given their first period incomes, the available interest rates and the degree of insecurity, agents choose the occupations that maximize their expected utility, (15).
- Agents’ beliefs about the degree of insecurity are consistent with the fraction of the population that are parasites.

3.1 Secure Equilibrium

In a secure equilibrium \( n_t^* = 0 \), so that \( \pi_t^* = 0 \) and \( r_t^* = r_t^* = r_t^* = r_t^* \). For this to be the case, all agents must have income above the critical level and, in equilibrium, they must prefer to produce. In such an equilibrium the market clearing wage must be at its maximum possible level, \( \bar{w} \), where

\[
\bar{w} = \alpha A \left( \frac{k}{H} \right)^{1-\alpha},
\]

and producers’ short-run profit is at its minimum possible level, \( \theta k \), where

\[
\theta k = (1-\alpha)AH^\alpha k^{1-\alpha}.
\]

The expected net income of all old agents is

\[
Z^* = (\theta - r)k.
\]

The expected lifetime utility from deviating from this equilibrium by becoming a parasite is \( w_{t-1} \varepsilon + \beta X^* \) where

\[
X^* = (1-\rho)\theta k.
\]

If the parameters are such that \( Z^* > X^* \) and \( \theta > r \), then a secure equilibrium exists, since all agents prefer to produce and are not constrained from doing so. Note that we assume that \( X^* > y \), so that diversion is always preferred to subsistence for all \( \theta_t \geq \theta \).
3.2 Insecure Equilibria

Two distinct types of equilibrium featuring positive levels of insecurity are possible:

- **Opportunity–Constrained Equilibrium** — in such an equilibrium the degree of appropriation is constrained by the measure of producers, so that producers are the victims of appropriation attempts with the maximum probability: \( \pi_t^* = 1 \). A parasite’s expected payoff is \( X_t^* = (1 - \rho)\theta_t^*k \), where \( \theta_t^* \) is given by equation (5) when evaluated at \( w_t^* \). If he adopts security measures, a producer’s expected payoff is therefore

\[
Z_t^{\pi^*} = \rho \theta_t^*k - r(1 + \gamma)k. \tag{20}
\]

The following assumption ensures that in such an equilibrium all agents who earn more than \( w_t - 1 \) become producers rather than parasites:

**Assumption A1:**

\[
\rho \theta - r(1 + \gamma) > (1 - \rho)\theta. \tag{21}
\]

Note that so long as this condition holds for \( \theta_t = \theta \), it must hold for all \( \theta_t > \theta \).\(^{19}\) Poorer agents with \( \varepsilon < \varepsilon_t^{\pi^*} \) are better off subsisting than producing because the effective interest rate that they face is infinite and makes their expected net return from production negative:

\[
Z_t^{n^*} = -rk < 0. \tag{22}
\]

It follows that the measure of producers is \( 1 - F(\varepsilon_t^{\pi^*}) \). Since parasites attempt an appropriation from one producer, in an opportunity–constrained equilibrium it must be the case that

\[
n_t^* = 1 - F(\varepsilon_t^{\pi^*}). \tag{23}
\]

The expected payoff to any of the remaining agents with \( \varepsilon < \varepsilon_t^{\pi^*} \) from becoming a parasite is zero since there are no remaining victims. Since parasites are exclusively poorer members of the old generation, with \( \varepsilon < \varepsilon_t^{\pi^*} \), it follows that there are \( (F(\varepsilon_t^{\pi^*}) - n_t^*) \) individuals with \( \varepsilon < \varepsilon_t^{\pi^*} \) who cannot become parasites (and therefore subsist). For an opportunity–constrained insecure equilibrium to exist it must be the case that

\[
F(\varepsilon_t^{\pi^*}) > \frac{1}{2}. \tag{24}
\]

- **Parasite–Constrained Equilibrium** — in this case the number of appropriation attempts is determined by the number of potential parasites. The expected equilibrium payoff to parasitism is, once again, \( X_t^* = (1 - \rho)\theta_t^*k \). Since the degree of insecurity in such an equilibrium is \( \pi_t^* < 1 \), the expected payoff to wealthy producers must exceed that in the opportunity–constrained equilibrium. Since the expected equilibrium payoff from diversion is the same, Assumption A1 implies that \( Z_t^{\pi^*} > X_t^* \). In such an equilibrium there are more than enough potential victims amongst the wealthy, so either all less wealthy agents will become parasites or none will. If all become parasites then \( n_t^* = F(\varepsilon_t^{\pi^*}) < \frac{1}{2} \) and \( \pi_t^* = F(\varepsilon_t^{\pi^*})/[1 - F(\varepsilon_t^{\pi^*})] < 1 \). The payoff from deviating by becoming a non-protected producer is

\[
Z_t^{n^*} = \left[\frac{1 - 2F(\varepsilon_t^{\pi^*})}{1 - F(\varepsilon_t^{\pi^*})}\right] \theta_t^*k - rk. \tag{25}
\]

\(^{19}\)Assumption A1 also implies that the secure equilibrium exists.
Because it must be that \( X_t^* > Z_t^{\pi^*} \) in a parasite-constrained equilibrium, it follows that

\[
\frac{1}{2} > F(\varepsilon_t^{\pi^*}) > \frac{\theta_t^* - r - (1 - \rho)\theta_t^*}{2\theta_t^* - r - (1 - \rho)\theta_t^*}.
\]  

(26)

In both types of insecure equilibrium, no agent with first-period income below \( w_{t-1}\varepsilon_t^{\pi^*} \) ever produces. In other words, in any insecure equilibrium the interest rate faced by low income agents is always so high that they are effectively shut out of the capital market and either subsist or engage in diversion. As a result, the aggregate demand for labor efficiency units is equal to the demand from each producer (4), multiplied by the measure of agents with \( \varepsilon > \varepsilon_t^{\pi^*} \). The labor market clearing condition is therefore

\[
[1 - F(\varepsilon_t^{\pi^*})] \left( \frac{\alpha A}{w_t^*} \right)^{1 - \sigma} k = H.
\]  

(27)

Aggregate equilibrium output \( Y_t^* \) can then be expressed as a function of the fraction of agents with wealth above the critical level:

\[
Y_t^* = AH^\alpha ([1 - F(\varepsilon_t^{\pi^*})]k)^{1-\alpha}.
\]  

(28)

Thus, the model generates a standard aggregate production function in which the level of the capital stock is determined by the fraction of parasites. In the following analysis we will also be interested in the resources devoted to security. The fraction of output allocated to paying for security (the cost of corruption) is given by

\[
D_t^* = \frac{\pi_t^* \gamma k [1 - F(\varepsilon_t^{\pi^*})]}{Y_t^*}.
\]  

(29)

4 The Equilibrium Dynamics of Insecurity and Development

In this section we detail the evolution of an economy which is always in an insecure equilibrium. To save on notation, we drop the superscript * and assume that all variables take their equilibrium values. Figure 1 illustrates the equilibrium determination of the fraction of parasites diagrammatically in \((\varepsilon_t^c, \pi_t)\) space. The LC curve illustrates the combinations of \( \pi_t \) and \( \varepsilon_t^c \) that are consistent with both incentive compatibility in the capital market (9) and (14), and labor market equilibrium (27), and is given by

\[
\pi_t^{LC}(\varepsilon_t^c; w_{t-1}) = \frac{1}{1 - \rho} \left[ 1 - \frac{r(1 + \frac{\gamma}{1 - \rho})k - rw_{t-1}\varepsilon_t^c}{[1 - F(\varepsilon_t^c)]^{-\alpha} \theta_k + \left( \frac{1}{1 - \rho} - \frac{1}{\rho} \right) \gamma r k} \right],
\]  

(30)

where we also used (5) and (17) to substitute for \( \theta_t^* \) and \( w_t^* \), thereby introducing \( \theta \). The PI curve shows how the degree of insecurity varies with the critical level of labor efficiency units, and is given by

\[
\pi^{PI}(\varepsilon_t^c) = \min \left\{ \frac{F(\varepsilon_t^c)}{1 - F(\varepsilon_t^c)}, 1 \right\}.
\]  

(31)
An increase in the critical labor efficiency level implies that more agents are denied access to the capital market. In a parasite–constrained equilibrium, this increases insecurity. $E_1$ depicts an opportunity–constrained insecure equilibrium, with $\pi_t = 1$. $E_2$ depicts a parasite–constrained insecure equilibrium. As they are drawn, the curves intersect only once where $\pi_t < 1$ and the insecure equilibrium is unique. We ensure that this is the case by imposing the following restriction:

**Assumption A2:**

$$\frac{d\pi^{LC}}{d\varepsilon^c} > \frac{d\pi^{PI}}{d\varepsilon^c}. \quad (32)$$

**Lemma 1:** There exists an $\alpha^0 \in (0, 1)$ such that if the wage elasticity of labor demand is sufficiently large, $\alpha > \alpha^0$, Assumption A2 holds and the insecure equilibrium is unique.

To understand Lemma 1, note that with a Cobb–Douglas production function, the slope of the LC curve increases with the wage–elasticity of labor demand, $1/(1 - \alpha)$. To see this, consider the effect of a decrease in $\varepsilon^c$. The associated expansion in the supply of entrepreneurs, $1 - F(\varepsilon^c)$, raises the demand for labor, drives up the equilibrium wage and reduces profitability. This can be consistent with the incentive compatibility condition only if the degree of insecurity is lower. The greater is the wage elasticity, the larger is this effect. Hence, as long as the wage elasticity of demand is sufficiently large, the slope of LC exceeds that of PI.

Note finally that combining equations (26) and (31) for the case of a parasite–constrained equilibrium generates a minimal degree of insecurity consistent with this sort of equilibrium, given by

$$\pi_t = \frac{\theta_t - r - (1 - \rho)\theta_t}{\theta_t^*}, \quad (33)$$

and an associated minimal critical ability level, $\varepsilon_t^f$, which satisfies

$$F(\varepsilon_t^f) = \frac{\theta_t - r - (1 - \rho)\theta_t}{2\theta_t - r - (1 - \rho)\theta_t}. \quad (34)$$

If the intersection point in Figure 1 falls below $(\varepsilon_t^f, \pi_t)$, equilibria with insecurity cease to exist because it is always better to be a producer.\(^{20}\) In this case, the secure equilibrium would be the unique equilibrium.\(^{21}\)

--- FIGURE 1 ---

\(^{20}\)Since $\theta_t^*$ declines over time, so does the minimum degree of insecurity.

\(^{21}\)Given the parametric assumptions that we have made, a secure equilibrium always exists so that, in principle, the economy could jump to it from the positive insecure growth path described below at any date $t$. However, under certain conditions described below, the economy would then remain in a secure equilibrium thereafter.
4.1 The Era of Rising Diversion

When first-period wages are low, agents must borrow a large amount in order to produce and to pay for private security. For a given rate of interest and profit rate, few agents have sufficient wealth to satisfy the incentive compatibility condition (8) and hence to qualify for a low-interest loan. The remainder are left with a choice between the subsistence income or a life of parasitism. However, the opportunities to gain from parasitism are limited by the small number of potential victims. Since there is a surplus of agents who could be parasites, the degree of insecurity is driven to its maximum level and so also is the interest rate. This reinforces the fact that very few agents are sufficiently wealthy to profitably become entrepreneurs. This opportunity-constrained equilibrium is illustrated in Figure 1, where the LC curve intersects the PI curve at $E_1$.

In the initial period there is little demand for the labor supplied by the subsequent generation, so that the wage they receive is correspondingly low. However, provided that $w_1 > w_0$, a greater fraction of this generation qualifies for a low-interest rate loan than in their parents’ generation, so that the critical ability level declines, $\varepsilon^*_2 < \varepsilon^*_1$, and the rate of enterprise, $1 - F(\varepsilon^*_1)$, and hence aggregate output, both expand. This can be represented in Figure 1 by a leftward shift of the LC curve. So long as the rate of enterprise remains relatively low (i.e. $1 - F(\varepsilon^*_2) < 1/2$), the expansion is not sufficient to draw all agents out of subsistence, and there is a matching increase in the fraction of parasites, $n_2 > n_1$. However, since insecurity is already at its maximum, its level, $\pi_t$, and the lending rate, $r^*_t$, remain unchanged. With decreasing returns to capital at the aggregate level, the aggregate cost of security grows more rapidly than output, so that the share of output allocated to private security grows, $D_2 > D_1$. Despite this, the demand for labor rises and the wages received by the generation born at $t = 2$ grow in the first-order stochastic sense.

The development process continues in this fashion so long as the LC curve is such that opportunity-constrained equilibria continue to obtain. Increases in the wage allow more agents to undertake projects and output expands. However, so also do the opportunities to gain from diversion and the fraction of parasites increases through time. This phase of the development process is thus summarized by the following proposition:

**Proposition 1:** Suppose $w_1 > w_0$. Then there exists a $t^* \in [0, \infty)$ such that for all $t < t^*$

(a) equilibrium wages rise through time, $w_t > w_{t-1}$,
(b) insecurity remains constant at its maximum rate, $\pi_t = \pi_{t-1} = 1$,
(c) the rate of enterprise rises, $\varepsilon^*_t < \varepsilon^*_t_{t-1}$,
(d) the rate of diversion increases, $n_t > n_{t-1}$,
(e) the lending rate remains at its maximum level, $r^*_t = r/\rho$,
(f) aggregate output expands, $Y_t > Y_{t-1}$,
(g) the share of output devoted to protection increase, $D_t > D_{t-1}$.

4.2 The Era of Falling Diversion

Eventually the economy reaches a date $t^*$ in which the inactive subsistence population is exhausted and increments in the rate of enterprise are no longer matched by increased parasitism. A parasite-constrained equilibrium obtains and the next phase of the process begins.

From Proposition 1 we know that $w_{t^*} > w_{t^*-1}$, so that the $t^* + 1$ generation is stochastically wealthier than the previous one. For a given level of insecurity, $\pi_t$, the critical efficiency level falls
(the LC curve shifts to the left) and there is an increase in the fraction of agents who are eligible for a low-interest loan. Now, however, the measure of entrepreneurs exceeds the fraction of agents with first-period income below \( w_{t-1} \varepsilon_t^c \) (i.e. \( 1 - F(\varepsilon_t^c) > F(\varepsilon_t^c) \)), so that the equilibrium fraction of parasites and the insecurity level must decline. Indeed, the effect of the expansion in the supply of producers can now be separated into two components: (1) the supply of parasites contracts so that insecurity falls and the borrowing rate declines, and (2) the demand for labor rises, driving up the equilibrium wage and reducing profits. The net effect of these two forces determines whether expected profits and the rate of enterprise rise in equilibrium. From Lemma 1, however, we know that so long as the wage elasticity of demand is sufficiently large, the second force is relatively small and the first force dominates. The rate of enterprise thus expands until the effect of the decreased profit rate, \( \theta_t \), on the fraction of agents who qualify for a loan just offsets the effect of the reduced borrowing rate (see equation 9).

The increased wage generates a further increase in the rate of enterprise in the next generation and a further reduction in the fraction of parasites. The economy continues to develop in this fashion as long as the parasite-constrained equilibrium continues to exist (i.e. as long as the LC curve intersects the PI curve above \( \pi_f \)). Output expands with the rate of enterprise, but the measure of parasites declines so that the resources used to prevent output appropriation fall. The equilibrium dynamics can therefore be summarized as follows:

**Proposition 2:** There exists a \( t^* \in [0, \infty) \) such that if \( t > t^* \) then

(a) equilibrium wages continue to rise, \( w_t > w_{t-1} \),
(b) insecurity declines, \( \pi_t < \pi_{t-1} \),
(c) the rate of enterprise continues to rise, \( \varepsilon_t < \varepsilon_{t-1} \),
(d) the rate of diversion declines, \( n_t < n_{t-1} \),
(e) the lending rate falls, \( r_t^s < r_{t-1}^s \),
(f) aggregate output continues to expand, \( Y_t > Y_{t-1} \),
(g) the share of resources devoted to protection declines, \( D_t < D_{t-1} \).

Figure 2 illustrates the time paths for the key features of the economy for a parameterized example.\(^\text{22}\) In this example, the economy passes through each phase of the development cycle before converging to a positive parasitism rate. Note that, in addition to the direct cost of resources used to defend property against appropriation, the costs of insecurity also include the loss in output experienced by each generation relative to the secure economy. It is possible for the economy to reach a point at which the equilibrium interest rate becomes so low that the returns to production exceed those from diversion for all agents. At this point the economy necessarily jumps to the secure equilibrium.

--- FIGURE 2 ---

\(^{22}\)Parameter values are \( \alpha = 0.5; H = 0.5; k = 1; r = 1.05; A = 3; \rho = 0.5; \gamma = 0.2. \)

4.3 The Steady State

Figure 3 is useful for understanding the convergence of the economy to its steady-state equilibrium. The WW-curve depicts the relationship between the critical ability level of the old generation and the implied equilibrium wage of the young generation. It is obtained by re-writing (27) to give

$$w_{WW}(c) = \alpha A \left( \frac{1 - F(c)}{H} \right)^{1-\alpha}.$$  

(35)

The EQ-curve depicts the relationship between the equilibrium critical ability level of the old generation and the wage they received in the previous period. Each point on this locus represents the sequence of temporary equilibria described above and is given by combining (30) and (31) to get

$$w_{EQ}(c) = k \frac{1}{\varepsilon} \left[ 1 + \frac{\gamma}{1-\rho} - [1-(1-\rho)\pi(c)] \left( \frac{\theta}{\tau[1-F(c)]} + \frac{\gamma}{1-\rho} \right) \right],$$

(36)

where

$$\pi(c) = \min \left\{ \frac{F(c)}{1-F(c)}, 1 \right\}.$$  

(37)

If these two curves intersect at a value of $c < \frac{c}{\varepsilon}$, then the unique equilibrium is a secure equilibrium.\(^{23}\) However, if they intersect at a value of $c > \frac{c}{\varepsilon}$, then this intersection represents a steady-state insecure equilibrium, that we denote by the vector $\{\tilde{n}, \tilde{\varepsilon}, \tilde{\pi}, \tilde{\bar{w}}, \tilde{X}, \tilde{Z}^n, \tilde{Z}^s, \tilde{r}^n, \tilde{r}^s\}$. The following assumption ensures that, if the steady-state insecure equilibrium exists, it is also unique:

**Assumption A3:**

$$-\frac{dw_{EQ}}{d\varepsilon} > -\frac{dw_{WW}}{d\varepsilon}.$$  

(38)

**Proposition 3:** There exists an $\alpha^1 \in (\alpha^0, 1)$ such that if the wage-elasticity of labor demand is sufficiently large, $\alpha > \alpha^1$, then Assumption A3 holds and the economy converges to a unique steady state insecure equilibrium.

In Lemma 1, a sufficiently high-elasticity of demand, $\alpha > \alpha^0$, effectively implied that the EQ-curve is downward sloping. Here we require a stronger sufficient condition to ensure that it is more steeply sloped than the WW-curve.\(^{24}\)

--- FIGURE 3 ---

\(^{23}\)That they intersect is guaranteed by the fact that

$$\lim_{\varepsilon \to 0} w_{EQ}(\varepsilon) = \infty$$ \text{ and } $$\lim_{\varepsilon \to 2H} w_{EQ}(\varepsilon) = -\infty.$$

\(^{24}\)If Assumption A3 does not hold, then it is possible that the EQ and WW curves intersect more than once, so that there would be multiple steady-state equilibria.
Figure 3 illustrates a situation in which the steady state occurs at a value of $\varepsilon^c$ that is consistent with a parasite-constrained equilibrium. The path towards this steady state is also illustrated. If the initial wage $w_0$ is sufficiently small, the economy passes through the opportunity-constrained region, before entering the parasite-constrained region and converging to the steady state. However, it is also possible that the point of intersection occurs in the opportunity-constrained region, in which case the economy would converge to an opportunity-constrained steady-state. The type of steady state to which the economy converges depends on whether the WW curve and the EQ curve intersect to the left or right of the boundary $\varepsilon^c = H$ (since $F(H) = \frac{1}{2}$):

**Proposition 4:** If

$$\frac{\alpha AH^\alpha k^{1-\alpha}}{2^{1-\alpha}} + (1 - \alpha) \left(\frac{\rho}{r}\right) 2^\alpha AH^\alpha k^{1-\alpha} > (1 + 2\gamma)k,$$

then the economy converges to a parasite-constrained steady-state. Otherwise, the economy converges to an opportunity-constrained steady-state.

The economy will not reach the second phase if the cost of security, $\gamma$, is high or if the effectiveness of private security, $\rho$, is low. However, high productivity, $A$, and a productive labor force, $H$, are factors which will tend to overcome these constraints and allow the economy to reach the phase of declining parasitism rates.

If the point of intersection occurs at a value of $\varepsilon^c$ that is inconsistent with a positive parasitism equilibrium, the unique steady-state is one with no parasite. Note that if the EQ curve intersects the $\varepsilon^c = \varepsilon^c$ boundary at a wage below $\bar{w}$ then, once a secure equilibrium occurs, the economy can never revert back to an insecure equilibrium because the wealth of subsequent generations is sufficiently high to rule out such equilibria.

5 **Policy Implications**

Thus far we have ignored the role of public sector institutions designed to deter diversion, apprehend parasites and impose punishments. In this section, we allow for the possibility that increased public spending may enhance the effectiveness of these institutions. We distinguish between two categories of public policy: (1) punishment — public expenditures that raise the expected cost of being apprehended and/or punished, and (2) prevention — public expenditures that reduce the ex ante probability that diversion is successful in the first place. When occupational choices are partly determined by credit constraints, public spending can have quite different consequences depending on whether it enhances the effectiveness of punishment or prevention. Throughout most of this section we simplify the exposition by focusing on a steady state parasite-constrained equilibrium.

5.1 **Punishment**

We assume that the expected disutility incurred by parasites who are caught and punished is $\mu k$.\textsuperscript{25}

This variable depends on the probability that a parasite is successfully apprehended and prosecuted.

\textsuperscript{25}Expressing this value as a fraction of $k$ simplifies the exposition. Since $k$ is fixed, there is no loss of generality.
ex post, and on the disutility of the punishment incurred (e.g. imprisonment, social sanctions). Becker (1968) argues that harsher punishments or a greater likelihood of prosecution reduces the payoff to diversion, thereby inducing more people to undertake productive activities. However, in the presence of sufficiently severe credit constraints, increasing the expected cost of punishment may have little impact. The reason is that individuals do not choose to become criminals because the payoff is higher than production, but rather because they are constrained from becoming entrepreneurs by their lack of wealth. Such public investment will only have an effect on the equilibrium outcome if the expected punishment is so large that it reduces the expected payoff of a parasite, $X$, below that of an entrepreneur who does not invest in private security, $Z^n$. If it requires significant increases in taxes, then raising the expected cost of punishment may even have a detrimental effect, actually raising rates of diversion and lowering productivity.

To see this more formally, suppose that the government finances its expenditures using a proportional tax $\tau$ on the wages of the young, so that total expenditure at time $t$ is given by

$$T_t = \tau \bar{w}H = \tau \alpha \bar{Y}. \quad (40)$$

This imposition of such a tax reduces the after-tax wealth of agents when they are old and hence effectively reduces the fraction that are able to qualify for a low interest loan. We follow the approach of Sah (1991), and assume that the expected punishment is a function of expenditure per criminal:

$$\mu = \mu \left( \frac{T_t}{n_t} \right) = \mu \left( \frac{\tau \alpha \bar{Y}}{F(\xi^c)} \right). \quad (41)$$

This formulation captures the idea that the greater the resources per parasite allocated to apprehending and punishment (e.g. the costs of more time in prison), the greater the expected cost.

The introduction of the punishment leads to the replacement of (34) by

$$F(\xi^c) = \frac{\theta_t - \tau - (1 - \rho)(\theta_t - \mu)}{2\theta_t - \tau - (1 - \rho)(\theta_t - \mu)}. \quad (42)$$

Given the steady state equilibrium values, increased investment in punishment raises $\mu$ and thereby shifts the boundary $\xi^c = \xi^c$ in Figure 3 to the right. Ceteris paribus, a sufficiently large increase in $\mu$ might therefore eventually push the economy into the secure equilibrium. Unfortunately, there are two factors offsetting this effect. Firstly, the distortion created by the increased taxes required to finance this expenditure cause the $EQ$-curve to shift to the right, reflecting the fact that the after-tax wealth of the young generation is reduced. This causes steady-state equilibrium diversion to rise and entrepreneurial productivity to decline. Secondly, as the steady-state rate of diversion, $F(\xi^c)$, expands and the tax base, $\alpha \bar{Y}$, contracts, expenditure per criminal declines, offsetting the effect on $\mu$ of the increase in $\tau$. It follows that expenditures which increase the probability of conviction and/or the size of sanctions could have detrimental long-run consequences, actually raising the rate of diversion and lowering per capita income.

26Since agents are risk-neutral, there is no need to distinguish between effects of the probability of apprehension and the level of sanction.

27In this sense it does not matter whether the tax is proportional or lump sum. Note further that the follow arguments would go through if we were to consider a tax on entrepreneurial profits - the borrowing constraint would become more binding.

28The exact relationship between $\mu$ and spending per criminal is not important for the following argument.

29Allowing for a distribution of disutilities associated with criminal acts (e.g. varying moral values), say, might
5.2 Prevention

In contrast, public spending which enhances the \textit{ex ante} prevention of successful diversion (e.g. police patrols, public security, gun control laws) can have large effects on the margin. By reducing the probability that appropriation attempts will initially be successful, prevention reduces the \textit{ex ante} cost of private security measures and reduces the interest rate faced by borrowers. This, in turn, reduces the critical wealth level required to qualify for a loan, induces greater legal activity and reduces the rate of diversion.

If public prevention reduces the success probability of a criminal to $1 - \phi$, then the degree of insecurity in the absence of private security measures is $(1 - \phi)\pi_t$. Suppose that expenditures on prevention are again financed by taxes on wage income (40), and that the probability $\phi$ is assumed to be an increasing function of these expenditures per unit of property protected. Then

$$\phi = \phi \left( \frac{T_t}{(1 - \alpha)Y_t} \right) = \phi \left( \frac{\alpha\tau}{1 - \alpha} \right)$$  \hspace{1cm} (43)

This particular formulation is simple because $\phi$ depends only on the tax rate, and not on any endogenous variables. Moreover it seems reasonable to assume that the greater is the wealth that is protected by the public sector, the larger the cost of doing so.\footnote{Again the arguments here do not depend on the exact formulation.} We assume that private and public security measures are complementary, so that the competitive price of private security measures is now $p_t = \gamma(1 - \phi)\pi_t k$, and the $EQ$–curve (36) is replaced by

$$w^{EQ}(\varepsilon; \tau, \phi) = \frac{k}{(1 - \tau)\varepsilon^c} \left[ 1 + \frac{\gamma}{1 - \rho} - \frac{1 - (1 - \rho)(1 - \phi)\pi(\varepsilon^c)}{\tau(1 - F(\varepsilon^c))^\alpha} + \frac{\gamma}{1 - \rho} \right].$$ \hspace{1cm} (44)

The $WW$–curve and $\pi(\varepsilon^c)$ are still given by (35) and (37), respectively.

**Proposition 5:** Suppose the economy initially rests in a parasite–constrained steady–state equilibrium. There exists a $\delta > 0$ such that if the responsiveness of prevention to an increase in the tax rate is sufficiently large, $d\phi/d\tau > \delta$, then greater prevention increases the steady–state rate of enterprise, $1 - F(\varepsilon^c)$, aggregate output, $\tilde{Y}$, and the wage, $\tilde{w}$, and reduces insecurity, $\tilde{\pi}$, and the rate of diversion, $\tilde{n}$.

As described earlier, the increase in $\tau$ causes the $EQ$–curve to shift to the right, so that equilibrium diversion increases. However, the resulting increase in $\phi$ causes the $EQ$–curve to shift to the left, reflecting the fact that for any given rate of enterprise, the degree of insecurity is reduced. Thus, the net equilibrium impact of an increase in public investment in crime prevention depends on whether the increase in $\phi$ is sufficiently large to outweigh the associated increase in $\tau$ and cause the $EQ$–curve to shift down and to the left. This will be the case if $d\phi/d\tau$ is large enough. If it is, then steady–state diversion declines and the long–run level of productivity rises.
6 Concluding Remarks

We have developed a dynamic general equilibrium model linking the process of economic development to the interaction between insecurity and credit market imperfections. We used it to illustrate how and why an economy will tend to go through a phase of rising diversion followed by a phase of falling diversion as it develops. The initial phase corresponds to Adam Smith’s hypothesis that appropriation would tend to rise with the accumulation of wealth, and arises when credit market constraints are particularly severe. The later phase is consistent with the models of Baumol (1990), Murphy, Schleifer and Vishny (1993) and Acemoglu (1995) in which economies with lower rates of diversion tend to be more highly developed. We characterized the convergence of the economy to its long-run steady-state equilibrium and detailed the factors determining the nature of this equilibrium.

As noted in the introduction, the cross-country empirical evidence of Hall and Jones (1999) is suggestive of a positive relationship between economic development and indexes of social infrastructure that are negatively related to diversion. Time-series evidence on broad measures of the degree of insecurity are had to come by. However, one (admittedly imperfect) proxy that is available is the property crime rate. The overall hump-shaped pattern implied by our model is consistent with the empirical and anecdotal evidence on the evolution of property crime during the industrialization of Western Europe. For example, Jones (1982) summarizes the conclusions of Beattie (1974) and Gurr (1976), and Gatrell and Hadden (1972) on the evolution of property crime in Britain as follows:

“... their findings indicate a fairly gentle rise in the eighteenth-century crime rate, with particularly significant increases in the early Hanoverian period and a more sudden upward movement in property offenses in the last three decades. This last rise became spectacular in the years 1815–17, and continued to cause alarm until the critical turning-point of the mid-century .... in the second half of the century, especially after the 1860s, there was a national decline in the number of offences against persons and property until the end of the century, and beyond ... This picture of major long-term changes in criminal behaviour is complemented by much recent research in Germany, France, Sweden and other parts of the western world.” (Jones 1982, pp. 3–4)

Reported crime statistics are notoriously difficult to interpret. The main reason for this is that increases in policing tend to increase the rates of reporting and detection, thereby artificially increasing the measured crime rate. The important point to note here, however, is that the recorded crime rate fell, despite the fact that there was an upward trend in policing during the latter part of the century. Thus, if it is the case that increased policing does artificially raise the measured crime rate, then the true crime rate must have fallen even more precipitously.

What factors are responsible for the patterns observed? Many contemporaries had little doubt about the causes of the initial rise in crime:

“Crimes have increased among men because property and transactions connected with property have increased.” (Wade, 1833, p. 568)

Moreover, although the number of policemen per capita grew in England and Wales during the latter half of the century, there are several reasons to believe that the key causal factor in the
reduction of property crime was the improvement in economic conditions.\footnote{According to Gurr (1976, p. 96) increased policing can only reduce criminal behaviour “when it reinforces improving socio-economic conditions”.} Firstly, increased policing appeared to affect the nature rather than the rate of property crime:

“unless the officers were on the spot at the time robbery, comparatively few criminals were arrested ... It was largely a case of deciding ... whose area and property to protect and of tracking down suspected persons and known criminals ... the police determined the place, character and perpetrators of crime.” Jones (1982, p.177)

Secondly, Gatrell and Hadden (1972) document that prisoners later in the century were drawn from a less educated, hardened criminal class which was relatively less numerous, and less representative of the population as a whole, than was the case earlier in the century. They argue that

“... fewer ‘potentially honest’ people, who earlier in the century might have been driven to commit an offence because of want, were now brought before the courts.”

Thus, as in the model, the critical ability below which agents became parasites fell during the later phases of industrialization.

The model also allowed us to illustrate the implications of the interaction between insecurity and credit constraints for alternative diversion–deterring public policies. In a world with no credit constraints, greater investment in institutions which raise the cost and likelihood of apprehension and prosecution have significant equilibrium effects on insecurity and productivity. However, in the presence of credit market imperfections such policies are likely to be ineffective at best and, if they are costly, may even be detrimental. In such cases, policies that enhance the effectiveness of prevention are likely to be a more cost–effective method for reducing diversion and increasing long run productivity.

Various extensions of our work are possible. For example, there is no engine for sustained long–run per capita income growth in our model. One way to introduce such an engine would be to allow the aggregate efficiency units of labor (i.e. human capital) or total factor productivity to grow endogenously over time. If the costs of protection were to remain constant, then eventually they would become negligible relative to wealth, and the economy would always attain a secure equilibrium in the long run. However, it seems likely that the cost of private security also grows over time, as parasites become more sophisticated and gain access to better technologies for pursuing their objectives. In this case, the economy could converge to a long–run growth path with persistent insecurity.
References


Appendix

Proof of Lemma 1: Differentiating (30) yields

\[ \frac{d\pi}{dz} \bigg|_{LC} = \frac{rw_t-1 + [1 - (1 - \rho) \pi_t] \alpha [1 - F_t]^{-\alpha - \gamma + \gamma - 1]}{2HB(z_t^e)} \cdot \]

where

\[ B(z_t^e) = (1 - \rho) \left( [1 - F_t]^{-\alpha - \gamma + \gamma - 1} - \frac{\gamma}{\rho} \right) \]

Differentiating (31), recalling that \( F(\cdot) \) is uniform, yields

\[ \frac{d\pi}{dz} \bigg|_{Pl} = \frac{1}{2H[1 - F_t]^2} \cdot \]

Let \( |\Pi| = \frac{d\pi}{dz} \bigg|_{LC} - \frac{d\pi}{dz} \bigg|_{Pl} \), then Assumption A2 can be expressed as

\[ |\Pi| = \frac{rw_t-1 \xi^2 [1 - F_t]^2 + [1 - (1 - \rho) \pi_t] \alpha [1 - F_t]^{-\alpha - \gamma + \gamma - 1} - B(z_t^e)}{2HB(z_t^e)[1 - F_t]^2} > 0. \]

Since the denominator is positive, it follows that \( |\Pi| > 0 \) if

\[ rw_t-1 \xi^2 [1 - F_t]^2 + [1 - (1 - \rho) \pi_t] \alpha [1 - F_t]^{-\alpha - \gamma + \gamma - 1} - B(z_t^e) > 0. \]

In a parasite-constrained equilibrium, we know that \( F_t < \frac{1}{2} \) and \( \pi_t < 1 \). Thus \( |\Pi| > 0 \) if

\[ rw_t-1 \xi^2 \left( \frac{1}{2} \right)^2 + \rho \alpha \left( \frac{1}{2} \right)^{-\alpha} \theta k - (1 - \rho) \left( \left( \frac{1}{2} \right)^{-\alpha} \theta k - \frac{\gamma}{\rho} \right) > 0. \]

Also, if a parasite-constrained equilibrium obtains, then

\[ w_{t-1} \geq \alpha A \left( \frac{k}{2H} \right)^{-\alpha} = \left( \frac{\alpha}{1 - \alpha} \right) \left( \frac{1}{2} \right)^{1-\alpha} \theta k. \]

Substituting for \( w_{t-1} \) in (50), it follows that \( |\Pi| > 0 \) if

\[ \left( \frac{1}{2} \right)^{-\alpha} \theta \left[ \left( \frac{\alpha}{1 - \alpha} \right) \left( \frac{\theta}{2(1 - \rho)} \right) + \rho - 2(1 - \rho) \right] + \gamma r \left( 2\rho - 1 \right) > 0. \]

As \( \alpha \to 1 \), the first term in brackets becomes arbitrarily large. Thus, there must exist some \( \alpha^0 \in (0, 1) \) such that \( |\Pi| > 0 \) for all \( \alpha > \alpha^0 \).

Proof of Proposition 1: Consider any time period \( t < t^* \) such that the equilibrium which obtains is an opportunity-constrained equilibrium and \( w_{t-1} > w_{t-2} \). Since \( \pi = 1 \), the impact of a wage increase on \( z_t^e \) can be found by totally differentiating (30), to yield

\[ \frac{dz_t^e}{dw_{t-1}} = \frac{-r z_t^e}{rw_t-1 + \alpha \rho (1 - F_t)(-\alpha - 1) \theta k} < 0. \]
Thus, the critical efficiency level declines: $\varepsilon_i^t < \varepsilon_i^{t-1}$. Since, in an opportunity–constrained equilibrium, $n_t = 1 - F(\varepsilon_i^t)$, it follows that $n_t > n_{t-1}$, and from (28), $Y_t > Y_{t-1}$. From (29) $D_t > D_{t-1}$, since $\pi_t$ remains constant and $Y_t$ rises. Finally, differentiating (27) yields

$$\frac{dw_t}{d\varepsilon_i^t} = -\frac{(1-\alpha)w_t}{2H[1 - F_i]} < 0.$$  (54)

It follows that $w_t > w_{t-1}$. Since, by assumption $w_1 > w_0$, Proposition 1 follows by induction.

**Proof of Proposition 2:** Let $t^* + 1$ be the first time period in which a parasite–constrained equilibrium obtains. From Proposition 1, we know that $w_{t^*} > w_{t^*-1}$. In such an equilibrium $\pi_t$ and $\varepsilon_i^t$ are jointly determined according to (30) and (31). Totally differentiating this system of equations yields

$$\begin{bmatrix} 1 - \frac{\partial \pi^{LC}}{\partial \varepsilon_i} \\ 1 - \frac{\partial \pi^{PC}}{\partial \varepsilon_i} \end{bmatrix} \begin{bmatrix} d\pi_t \\ d\varepsilon_i^t \end{bmatrix} = \begin{bmatrix} \frac{r\varepsilon}{B(\varepsilon_i)} \\ 0 \end{bmatrix} dw_{t-1},$$  (55)

Let $\Pi$ denote the Jacobian matrix on the left–hand side of (55). Lemma 1 implies that $|\Pi| > 0$, so using Cramer’s rule we get

$$\frac{d\pi_t}{dw_{t-1}} = -\frac{1}{|\Pi|} \left( \frac{\partial \pi^{PC}}{\partial \varepsilon_i} \right) \begin{bmatrix} \frac{r\varepsilon}{B(\varepsilon_i)} \\ 0 \end{bmatrix} < 0,$$  (56)

$$\frac{d\varepsilon_i^t}{dw_{t-1}} = -\frac{1}{|\Pi|} \left( \frac{\partial \pi^{PC}}{\partial \varepsilon_i} \right) \begin{bmatrix} \frac{r\varepsilon}{B(\varepsilon_i)} \\ 0 \end{bmatrix} < 0.$$  (57)

It follows that $\pi_{t^*+1} < \pi_{t^*}$ and $\varepsilon_{i_{t^*}+1} < \varepsilon_{i_{t^*}}$. The parasitism rate is now given by $n_t = F(\varepsilon_i^t)$, and so $n_{t^*+1} < n_{t^*}$. Since $\pi_{t^*+1} < \pi_{t^*}$, (10) implies that $r_{t^*+1}^R < r_{t^*}^R$. Since $\varepsilon_{i_{t^*}+1} < \varepsilon_{i_{t^*}}$, (28) implies that $Y_{t^*+1} > Y_{t^*}$. The resource costs of parasitism can be expressed as

$$D_t = \gamma(1 - F(\varepsilon_i^t)) \frac{[1 - F(\varepsilon_i^t)]}{AH^\alpha(1 - F(\varepsilon_i^t))k^{1-\alpha}},$$

$$= \left( \frac{\gamma}{AH^\alpha k^{1-\alpha}} \right) \frac{F(\varepsilon_i^t)}{[1 - F(\varepsilon_i^t)]^{1-\alpha}}.$$  (58)

Since this is increasing in $\varepsilon_i^t$, it follows that $D_{t^*+1} > D_{t^*}$. Finally, from (27), it must be the case that $w_{t^*+1} > w_{t^*}$. Since $w_{t^*} > w_{t^*-1}$, Proposition 2 follows by induction.

**Proof of Proposition 3:** Using (54) and (57), Assumption A3 can be written as

$$|\Pi| \left( \frac{(1-\rho)(1-F_i)^{-\alpha}qk - \left(\frac{1-\rho}{\rho}\right)\gamma Rk + \gamma Rk}{r\varepsilon_i^t} \right) > \frac{(1-\alpha)\alpha A}{(1-F_i)} \left( \frac{(1-F_i)k}{H} \right)^{1-\alpha}.$$  (59)

This simplifies to

$$|\Pi| \left( (1-\rho)(1-A)A + \left[ \gamma R - \left(\frac{1-\rho}{\rho}\right)\gamma R \right] \left[ \frac{(1-F_i)k}{H} \right]^\alpha \right) > \frac{(1-\alpha)\alpha ARe_i^t}. \quad (60)$$

Since in a parasite–constrained equilibrium, $\varepsilon_{i_{t^*}} < \frac{1}{2}$ and $F(\varepsilon^c) < \frac{1}{2}$, a sufficient condition is

$$|\Pi| \left( (1-\rho) + \frac{1}{(1-A)A} \left[ \gamma R - \left(\frac{1-\rho}{\rho}\right)\gamma R \right] \left[ \frac{(1-F_i)k}{H} \right]^\alpha \right) > \alpha r.$$  (61)
As \( \alpha \to 1 \), the left–hand side becomes arbitrarily large. Hence there must exist an \( \alpha_1 \in (0, 1) \) such that the condition holds for all \( \alpha > \alpha_1 \).

**Proof of Proposition 4:** The steady state occurs in the parasite–constrained region if

\[
 w^{\text{WW}}(H) > w^{\text{EQ}}(H). \tag{62}
\]

Using (35) and (36), this condition may be written as

\[
 \alpha A \left( \frac{k}{\bar{H}} \right)^{1-\alpha} \left( \frac{1}{2} \right)^{1-\alpha} > \frac{k}{\bar{H}} \left( 1 + 2\gamma - \frac{2\alpha \rho \bar{\theta}}{r} \right). \tag{63}
\]

Noting that \( \theta k = AH^{\alpha}k^{1-\alpha} \) yields

\[
 \alpha A \left( \frac{k}{\bar{H}} \right)^{1-\alpha} \left( \frac{1}{2} \right)^{1-\alpha} > \frac{k}{\bar{H}} (1 + 2\gamma) - \frac{\rho(1-\alpha)A}{r} \left( \frac{k}{\bar{H}} \right)^{1-\alpha}. \tag{64}
\]

Rearranging gives (39).

**Proof of Proposition 5:** A steady–state crime equilibrium is a vector \((\bar{\pi}, \bar{w}, \bar{v}^c)\) solving (35), (43) and (37). Totally differentiating this system of equations yields

\[
 \begin{bmatrix}
 J_{11} & J_{12} & 1 \\
 J_{21} & J_{22} & 0 \\
 J_{31} & 0 & -1
 \end{bmatrix}
 \begin{bmatrix}
 d\bar{v}^c \\
 d\bar{w} \\
 d\bar{\pi}
 \end{bmatrix}
 =
 \begin{bmatrix}
 J_{1\phi} & J_{1\tau} \\
 0 & 0 \\
 0 & 0
 \end{bmatrix}
 \begin{bmatrix}
 d\phi \\
 d\tau
 \end{bmatrix}, \tag{65}
\]

where

\[
 J_{11} = -\frac{r(1-\tau)\bar{w}}{(1-\phi)\bar{B}} < 0, \tag{66}
\]

\[
 J_{12} = \frac{r(1-\tau)\bar{v}^c}{(1-\phi)\bar{B}} < 0, \tag{67}
\]

\[
 J_{21} = -\frac{1}{2H} \bar{w}^{\frac{1}{1-\alpha}} < 0, \tag{68}
\]

\[
 J_{22} = -\frac{(1-\bar{F})^{\frac{2}{1-\alpha}}}{(1-\alpha)} < 0, \tag{69}
\]

\[
 J_{1\phi} = \frac{1}{(1-\phi)^2} \left\{ 1 - \frac{\left[ 1 + \frac{\gamma}{1-\rho} \right] \frac{r k - r(1-\tau)\bar{w}\bar{v}^c}{B} }{1-\rho} \right\} > 0, \tag{70}
\]

\[
 J_{1\tau} = -\frac{r \bar{w} \bar{v}^c}{(1-\phi)\bar{B}} < 0, \tag{71}
\]

\[
 \bar{B} = (1-\rho) \left[ (1-\bar{F})^{-\alpha} \theta k + \frac{1}{1-\rho} \frac{(\gamma k)}{\rho} \right] > 0, \tag{72}
\]
and where

$$J_{31} = \begin{cases} 
0, & \text{if } \bar{e}^c > H, \\
1/2H(1 - \bar{P})^2, & \text{if } \bar{e}^c < H.
\end{cases}$$  \hspace{1cm} (73)$$

Let $J$ denote the $3 \times 3$ matrix on the left hand-side of (65). Assumption A3 implies that $|J| < 0$. It is then possible to obtain that

$$\frac{\partial \bar{e}^c}{\partial \phi} = \frac{-J_{1\phi}J_{22}}{|J|} < 0, \quad \frac{\partial \bar{e}^c}{\partial \tau} = \frac{-J_{1\tau}J_{22}}{|J|} > 0,$$

$$\frac{\partial \bar{w}}{\partial \phi} = \frac{J_{1\phi}J_{21}}{|J|} > 0, \quad \frac{\partial \bar{w}}{\partial \tau} = \frac{J_{1\tau}J_{21}}{|J|} < 0,$$

$$\frac{\partial \bar{n}}{\partial \phi} = \frac{-J_{1\phi}J_{22}J_{31}}{|J|} \leq 0, \quad \frac{\partial \bar{n}}{\partial \tau} = \frac{-J_{1\tau}J_{22}J_{31}}{|J|} \geq 0,$$ \hspace{1cm} \hspace{1cm} (74), \hspace{1cm} (75), \hspace{1cm} (76)

where for the degree of insecurity $\bar{n}$, the weak inequality is replaced by an equality for an opportunity-constrained equilibrium, and by a strict inequality for a criminal-constrained equilibrium. The impact on an endogenous variable $x$ of a decrease in $\phi$ financed by an increase in $\tau$ is given by

$$\frac{dx}{d\tau} = \frac{\partial x}{\partial \tau} + \frac{\partial x}{\partial \phi} \frac{d\phi}{d\tau}, \quad x = \bar{e}^c, \bar{w}, \bar{n}.$$ \hspace{1cm} (77)

Using equations (74), (75), and (76), it can be seen that $\bar{e}^c$ decreases, $\bar{w}$ increases, and $\bar{n}$ does not increase, if and only if $J_{1\tau} + J_{1\phi}d\phi/d\tau > 0$, or if

$$\frac{d\phi}{d\tau} > -\frac{J_{1\tau}}{J_{1\phi}}.$$ \hspace{1cm} (78)

That is, if $d\phi/d\tau$ is sufficiently large and positive. Since a decrease in $\bar{e}^c$ increases steady-state aggregate output, $\bar{Y}$ and reduces the crime rate, $\bar{n}$, Proposition 5 follows.
Figure 1: Opportunity–Constrained ($E_1$) and Parasite–Constrained ($E_2$) Equilibria
Figure 2: The Equilibrium Dynamics of Insecurity and Development
Figure 3: Convergence to a Steady–State Insecure Equilibrium