Predator or Prey?
Parasitic enterprises in economic development

Halvor Mehlum, Karl Moene and Ragnar Torvik

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2Frisch Centre, Department of Economics, University of Oslo P.O. Box 1095, Blindern
N-0317 Oslo, Norway. E-mail: halvor.mehlum@econ.uio.no.
3Department of Economics, University of Oslo P.O. Box 1095, Blindern N-0317 Oslo,
Norway. E-mail: k.o.moene@econ.uio.no.
4Department of Economics, Norwegian University of Science and Technology, N-7491
Trondheim, Norway. E-mail: ragnar.torvik@svt.ntnu.no
Abstract

In many developing and transition economies Mafia-like activities are rampant. Extortion and other forms of predation lower profitability in private businesses and distort investment incentives. Incorporated in a model of industrialization, bimodal club convergence may result. Economies may get stuck in a Predators’ Club characterized by a vicious circle of poverty and predation. Societies with a low flow of new entrepreneurs are especially vulnerable to predation and never get out of this club. Poor societies with high flow of new entrepreneurs, however, may grow out of the trap and join the rich Producers’ Club.

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JEL: O1, O4
1 Introduction

The state should have monopoly of legitimate violence with priorities of protection, taxation and law enforcement. In many societies, however, this Weberian ideal is not fulfilled. Violent gangs and criminal entrepreneurs not only extort and steal, but also provide protection, enforce contracts, and mediate disputes. "Problem solving" that normally belongs to the realm of the state, is undertaken by violent entrepreneurs and bandit gangs for money. Tributes are paid to avoid damage as criminals extort productive enterprises. Partnerships apply force on a commercial basis to collect debt and reduce transaction costs. As Konrad and Skaperdas (1998) observe, even in the most industrialized countries one find such backward forms of illegal activities, known as organized crime. The Sicilian Mafia and the American Mafia (Cosa Nostra) are well known examples. Similar rent seeking activities are also prevalent in developing countries and in the Eastern European transition economies.

Most often, however, rent seeking is thought of as activities directed towards an influential public sector where regulation and taxation invite wasteful influence activities by private businesses. We explore the opposite pole where weak public governance provides little protection of property rights. Inefficient law enforcement of this kind easily gives rise to unproductive rent seeking actions towards the business community itself.

In developing countries bandits not only control and protect small-scale informal enterprises such as street sellers and sweat shops. The surplus from large-scale modern firms are also dissipated by organized middlemen and professional plunderers. In some instances former youth gangs or rebel groups are transformed to criminal enterprises feeding on private businesses (Collier 2000). In other instances, political insiders set up their own firms that private sector companies have to consult and remunerate in order to have certain contracts signed. The latter type of activities, called straddling, constitute important forms of rent seeking in Africa. In Kenya, for example, president Moi allows extensive straddling among politicians and bureaucrats in exchange for loyalty to the government (Bates 1983, Bigsten and Moene 1996).

In Eastern Europe predatory enterprises belong to the growing shadow economy (Campos 2000). The institutional vacuum created by the collapse of communism has opened the scene for extortion by commercial parasites. Illegal enforcement partnerships have become routine in Russian business activities. As Volkov explains:

Before signing formal business contracts, companies acquire information on each other’s enforcement partners (‘whom do you work with?’) and arrange a meeting between enforcement partners (strelka). Besides that, each of the participating sides would check whether the others really work with the group they claim to and would seek additional information about the real power (reputation as well as actual firepower) of that group. (Volkov 1999 p.746)

Both Eastern Europe and parts of the developing world seem to be trapped in a vicious circle of high crime and low growth. According to the Russian Ministry of Internal Affairs, criminal gangs in 1994 controlled 40000 Russian businesses (Volkov 1999).
In this paper we investigate the causes and consequences of such a vicious circle driven by criminal predation. Whether the predatory enterprises are best described as firms or as feudal kings, lords, and emperors, is debated.\textsuperscript{1} Some Mafia organizations act like mini states that tax and protect commercial activities. Other types of parasitic enterprises are smaller and operate more like conventional firms. Common to all of them, however, is the profit motive. In our model the predators are profit seekers. We focus on the behavior of entrepreneurs who can run either parasitic enterprises or productive firms. Those who become parasites extort productive firms but do also (as in the model of Konrad and Skaperdas 1998) provide protection against extortion by other parasites.

In order to identify the harm of predation on economic development in poor countries we embed predatory activities within a dynamic general equilibrium model of industrialization. The basic model follows Murphy, Shleifer, and Vishny (1989) where the degree of industrialization depends on the size of the market, and the size of the market depends on the degree of industrialization. We extend the model in two directions. First we include predation that lowers profitability of producers. Predation becomes particularly harmful when production and predation compete for scarce entrepreneurial resources. We therefore study the mechanism that allocates a limited number of entrepreneurs between the two activities. In this respect our approach relates to the seminal papers on the misallocation of talent to unproductive activities by Usher (1987), Baumol (1990), Murphy, Shleifer, and Vishny (1991 and 1993), and Acemoglu (1995).\textsuperscript{2}

The second extension to Murphy, Shleifer, and Vishny (1989) is to incorporate explicit dynamics to the flow of new entrepreneurs. Here we apply an economics twist to the well known predator-prey mechanism. Unlike in biology, entrepreneurs can choose whether to enter as predator or prey. A newborn cub cannot choose whether to become a fox or a rabbit, but a novice entrepreneur can decide whether to go into predation or production.

One may think that it is a dominant strategy of entrepreneurs to enter into production with modern technologies when the number of entrepreneurs is low. This intuition is not generally true. With few entrepreneurs the size of the market becomes small which again limits the profits from entering production. To enter predation, however, normally involves lower fixed costs and therefore becomes relatively more tempting at low levels of development. Thus, when productive entrepreneurship is most needed, it may be most difficult to achieve it.

As a result an underdevelopment trap may emerge. A low level of development may, on the one hand, make venal activities within the business community relatively attractive for profit seeking agents. On the other hand, growth and development may be retarded by high (initial) levels of venal practices within the business community. Accordingly the economy can get stuck in a trap where a high number of predatory enterprises undermine the profitability of productive entrepreneurship. As a result, production is stagnating at a low level. Whether an economy ends up in the trap or not, depends on the degree of predation at the initial level of development. Within


\textsuperscript{2}See also Andvig (1997), Grossman (1998), Chand and Moene (1999), and Baland and Francois (2000).
the trap what is good for production is also good for predation, which may explain why it is so difficult to get rid of parasitic enterprises.

Like other models with multiple equilibria ours explain how otherwise equal societies may find themselves in quite unequal situations due to differences in initial conditions. Unlike other models, however, ours explains how the underdevelopment trap may be overcome by the endogenous entry of entrepreneurs. The different economies of scale in production and predation makes the trap disappear when the total number of entrepreneurs is high enough. Once this threshold of entrepreneurship is reached even countries that were caught in the trap will escape it. Hence, when the growth in the number of entrepreneurs is sufficiently strong the economy’s multiple equilibria property disappears and only the no predation equilibrium remains.

The feature of multiple equilibria that may transform into a unique equilibrium at higher levels of development has interesting implications for economic convergence across countries. In poor societies with relatively much predation, modernization evolves slowly and economic growth is low. If the flow of new entrepreneurs is low these countries end up relatively poor irrespective of their initial income levels. Societies that start their modernization with a lower number of unproductive rent seekers within the business community, are likely to grow faster and end up richer. Some relatively poor countries join the ranks of the rich, while some rich countries transit to being relatively poor. Thus our model generates dynamics where countries may go both from poor to rich and from rich to relatively poor. Initially poor countries may grow fast and outperform richer countries. One may end up in a polarized distribution where some countries are rich and some are poor, also denoted club-convergence or twin peaks dynamics (Quah 1996a,b). In our case, we label the twin peaks Predators’ Club and Producers’ Club.

If the flow of new entrepreneurs is sufficiently high, however, all countries end up in the Producers’ Club. Societies that start modernization with many predators, experience a first phase where predation activities expand together with new modern activities. In the second phase the development trap is overcome and predation vanishes as modernization continues. Thus, due to endogenous club switching the Producers’ Club is the absorbing state.

The root of the development problem that we study is weak law enforcement by the state. As neatly analyzed by Dabla-Norris and Freeman (1999) an inefficient legal system may in itself be explained by underdevelopment at the same time as underdevelopment is caused by insecure property rights. Except for a brief discussion in Section 4 we abstract from variations in law-enforcement.

The rest of the paper is organized as follows: Section 2 presents the basic model of the productive and predatory activities, and derives the allocation of entrepreneurs between activities. Section 3 discusses best response entry of entrepreneurs and dynamic implications. Section 4 concludes with a discussion of possible extensions.

2 The economy

2.1 The productive sector

All goods are produced within the productive sector of the economy. With some modifications, our description of the productive part of the economy is that of Murphy, Shleifer, and Vishny (1989). There is a given number, \( M \), of different
goods. Each good can be produced in a modern firm or in a competitive fringe with free entry. The fringe has a constant returns to scale technology where one unit of labor produces one unit of the good, fixing the real wage to unity. A modern firm produces \( y \) with the increasing returns to scale production function

\[
y = \alpha (l - F) \quad ; \alpha > 1
\]

where \( l \) is employment and \( F \) is a fixed cost in labor units. Assuming equal expenditure shares in consumption, unitary demand elasticity and Bertrand price competition it follows that: (i) all \( M \) goods have a price equal to one and are produced in equal quantities \( y \). (ii) each good is either produced entirely by the fringe or entirely by one single modern firm. To see this, observe that the fringe can always supply at a price equal to one. Price competition a la Bertrand implies that the price is set just below the marginal cost of the second most efficient competitor. A single modern firm in a industry only competes against the fringe and the price is set equal to one. With more than one modern firm in the same industry competition drives the price further down (to the lower marginal cost of modern firms). Hence, when two or more modern firms compete all of them get negative profits, implying that only one firm will enter each branch of industry.

Each modern firm has a profit margin \( \gamma = 1 - 1/\alpha \) and profits before predation is taken into account are therefore

\[
\pi = \gamma y - F
\]

The production, \( y \), of each of the \( M \) goods depends on the size of the market, represented by the total income of the economy, \( Y = yM \). Total income is the sum of profit and wage income. Since firms in the fringe earn no profit, aggregate profits are \( n_a\pi \) where \( n_a \leq M \) denotes the number of productive modern firms. Since all workers, \( L \), earn the same wage equal to one, total wage income is \( L \). In general equilibrium total spending is equal to total income. Hence,

\[
Y = yM = n_a\pi + L
\]

By solving for \( y \) from (2) and (3) we get

\[
y = \frac{Y}{M} = \frac{\alpha (L - n_aF)}{\alpha (M - n_a) + n_a} = \frac{L - n_aF}{M - \gamma n_a} \equiv y(n_a)
\]

If there are no modern firms, total income and production \( Y \) is equal to \( L \). With full industrialization, \( n_a = M \), total production equals \( \alpha(L - MF) \). We assume that production (value added) in a modernized economy is higher than in a backward economy, i.e.

\[
\alpha (L - MF) > L \iff \gamma L - MF > 0
\]

Note that (4) and (5) imply that demand for each good is increasing in the number of modern producers, \( y(n_a) > 0 \). It also follows that modernization generates higher...
profits. From (2) and (4) profits per modern enterprise (before predation) is

\[ \pi = \frac{\gamma L - MF}{M - \gamma n_a} > 0 \]  

(6)

Where the inequality follows from (5). Observe that \( \pi \) is increasing in the number of other modern firms \( n_a \). As firms modernize they generate positive profits, pushing up demand and profits in all modern firms. Our model would, without predation, lead to full modernization.\(^3\) However, as we shall see by incorporating predatory actions of extortion and protection in our model, productive entrepreneurs cannot expect to keep all profits for themselves and a development trap result may result.

2.2 The predatory sector

Predation against productive firms takes many forms. Extortion and protection are obvious examples in societies where law enforcement is weak. While extortion implies use or threat of violence to obtain illegal rents, the economic gains from providing protection are compensation for defensive measures against other gangs. There are \( n_b \) predatory entrepreneurs. Hence the total number of entrepreneurs, predators and producers, is

\[ n = n_a + n_b \leq M \]  

(7)

The latter inequality is imposed as we concentrate on development problems where there is a scarcity of entrepreneurial talent, \( n \), relative to industrial opportunities, \( M \). This implies that there is never congestion among productive entrepreneurs.

In case the firm is approached by a predatory enterprise, it chooses what is the cheapest of paying protection money and paying for self defence. Self-defence requires a constant marginal cost of \( \phi \) per unit of production \( y \). Knowing this, a parasite preempt by asking for \( \phi y \) in protection money. As a consequence self-protection is not chosen.

The probability of being approached by a parasite is denoted by \( \mu \). The expected profits net of protection money is thus given by

\[ \pi_a = \pi - \mu \phi y = (\gamma - \mu \phi) y - F \]  

(8)

The probability \( \mu \) can be defined as the number of extortion cases \( x \) divided by the number of productive firms. As in other matching processes \( x \) depends on the number of productive firms \( n_a \) and the number of predators \( n_b \). At each point in time each predatory enterprise approaches only one productive firm. (The mechanisms are also easily extended to the case where each predator can extort more than one productive firm.) Assuming full information and no friction, \( x \) is then the lowest of \( n_a \) and \( n_b \), and the probability \( \mu = x/n_a \) simply becomes

\[ \mu = \min [m, 1] \]  

(9)

where \( m = n_b/n_a \) is the predation intensity in the economy.

\(^3\)The poverty trap in Murphy, Shleifer, and Vishny (1989) follows from their assumption about a wage premium in modern firms.

29th March 2001
Like ordinary business operations parasitic activities require entrepreneurial

effort and organizational skills. Unlike productive business operations, however,
predation requires hardly any investment in physical capital in contrast to the fixed
cost $F$ in production. Parasites specialize in protection and may utilize efficient but
illegitimate methods. They can therefore produce protection at a lower unit cost
compared to the cost of self defence. These characteristics are captured in the model
by setting both fixed and marginal costs in predation to zero. Moreover, we also
set the predator’s probability of being punished equal to zero. Law enforcement is
briefly discussed in Section 4.

The predator who is first to approach a productive firm is able to collect the
protection money. The probability of being the first is equal to the number of
extortion cases $x$ divided by the number of predators $n_b$. This probability can also
be expressed as $\mu/m$. The expected profits to a predator can now be defined as

$$\pi_b = \frac{\mu}{m} \phi y$$

The fraction $\mu/m = x/n_b$ also measures the congestion among the predators.
There is no congestion and each predator can extort its productive firm without
competition, $x = n_b$, when there are few predatory enterprises, ($m < 1$ and
$\mu/m = 1$). When $n_b$ exceeds $x$ ($m$ exceeds one), congestion sets in, and $\pi_b$
goes to zero as $m$ goes to infinity. In case there are more predatory enterprises
than productive firms, some productive firms are approached by more than one
predator. In that case the protection becomes effective and more protection money
need not to be paid. When there are fewer predatory than productive firms, each
predator captures the whole amount paid in protection money. When there are
more predatory enterprises than productive firms, some predators end up in conflict
with others. In (10) we assume that they do not waste resources in this conflict.
Combining (8) and (10) it follows that

$$\pi n_a = \pi_a n_a + \pi_b n_b$$

Hence, the gross profits are distributed to productive and predatory entrepreneurs
without any loss.

The results of the model do not depend on the exact assumptions made above.
One essential feature of the model is that profits to predatory enterprises go to zero
when the predation intensity $m$ is high. Several alternative specifications would
yield this result. If the predatory enterprises had to fight over $\phi y$, predators’ profits
would still go to zero - only faster. For example, if protection of each productive
firm is monopolized, new predatory enterprises have to fight for a footing or wait
for a productive firm without protection to show up. Compared to (10), both
these alternatives would lower expected profits to an entering predatory enterprise
without changing the qualitative results. Taking account of the use of labor beyond
entrepreneurial skills in the predatory sector would just strengthen the negative
effect of predation on production.

Since a productive firm always has the option to close down, the fraction of
extortion money $\phi$ must be sufficiently low to ensure that the productive firm receives
positive profits also after protection money is paid. The necessary condition for

29th March 2001
positive profits of an approached producer for all relevant levels of production \( y \), is

\[ \gamma > \frac{F}{L/M} + \phi \]  

This follows since the profit of an approached producer is \( (\gamma - \phi) y - F \) and the lowest level of \( y \) is \( y(0) = \frac{L}{M} \).

### 2.3 Allocation of entrepreneurs without entry and exit

What are the equilibrium allocations of a given number of entrepreneurs and what are the conditions for the existence of a development trap caused by predation?

To answer these questions observe that a feasible equilibrium implies an allocation of \( n_a \) and \( n_b \) such that either profits are the same in both activities

\[ \pi_a = \pi_b \]  

or that production is more profitable than being the only predator

\[ \pi_a > \pi_b \text{ and } n_a > 0 = n_b \]  

To describe these equilibria we draw the profit curves (8) and (10) as in Figure 1 and Figure 2 where \( n = n_a + n_b \) determines the width of the diagram. The profit curves \( \pi_a \) and \( \pi_b \) intersect twice, once (as a tangency) or not at all. Let us first consider the case where they cross twice as in Figure 1.

In Figure 1 the number of productive firms, \( n_a \), are measured from left to right while the number of predatory enterprises, \( n_b \), are measured from right to left. Let us start from the left. With only one productive firm and \( n = n - 1 \) predatory enterprises, \( m \) is high while \( \mu = 1 \). As a result profits to a predatory enterprise are approximately zero. Profits to the productive firm are positive in accordance with the participation constraint (12). As the number of productive firms increases and the number of predatory enterprises declines, production goes up and profits increase in both activities. As long as \( n_a < n_b \) (and therefore \( m > 1 \)) the predatory enterprises enjoy an additional gain as the congestion among the predators gets less severe. At the point where \( n_a = n_b \) (and thus \( m = 1 \)), the congestion among predatory enterprises disappears. The profit curve of the predators levels out, as they only benefit from increased production. For the producers, however, the profit curve becomes steeper at \( n_a = n_b \). Further increases in \( n_a \) implies that \( \mu \), the probability
of being approached by a predatory enterprise, starts to decline in tandem with \( m \), giving an additional boost to profits in production.\(^4\) In Figure 1 condition (13) is satisfied in \( e_2 \) and \( e_3 \) while condition (14) is satisfied in \( e_1 \). Assuming that entrepreneurs flow to the most profitable activity:

\[
\pi_a > \pi_b \Rightarrow \dot{n}_a > 0 \text{ and } \dot{n}_b < 0 \\
\pi_a < \pi_b \Rightarrow \dot{n}_a < 0 \text{ and } \dot{n}_b > 0
\]

(15)

Thus in Figure 1 \( e_1 \) and \( e_2 \) are locally stable equilibrium points while \( e_3 \) is an unstable tipping point. If the economy starts out to the right of \( e_3 \) it ends up in \( e_1 \). If the economy starts out to the left of \( e_3 \) it ends up in \( e_2 \). As the level of modernization and income is lower in \( e_2 \) than in \( e_1 \) we label \( e_2 \) a development trap. The segment between \( e_2 \) and \( e_3 \), where the economy moves towards \( e_2 \), is denoted the poverty funnel. This discussion can be summarized as follows:

**Proposition 1** For any number of entrepreneurs \( n \) there is either one or two locally stable equilibria. i) \( m = 0 \) is always an equilibrium. ii) If (and only if) \( \pi_a < \pi_b \) for \( m = 1 \), there is also one locally stable equilibrium for \( m > 1 \)

**Proof.** When \( m = 0 \) (and therefore \( n_a = n \)) it follows from (8)-(10) and (12) that \( \pi_a = \gamma y(n) - F > \phi y = \pi_b \), which proves part i). Part ii) is proven in an appendix.

In the Proposition part i) refers to \( e_1 \) in Figure 1, while ii) refers to the poverty trap \( e_2 \) in the figure. In \( e_2 \) the equilibrium condition (13) holds and there is congestion among the predators, \( m > \mu = 1 \). Inserting \( \mu = 1 \) in (8) gives us the following expression for the common profit in \( e_2 \)

\[
\pi_a = \pi_b = (\gamma - \phi) y - F
\]

(16)

From (16) it follows that in \( e_2 \) profits in both activities increase when the extortion share, \( \phi \), declines or when the markup rate, \( \gamma \), increases. Hence we have

**Proposition 2** In the predation trap improved efficiency in production (\( \gamma \) up or \( F \) down) and lower extortion (\( \phi \) down) increase profitability both in production and extortion

It may be counter-intuitive that a lower extortion share implies higher profits to predatory enterprises. The reason is that a lower \( \phi \) raises profits from production relative to predation, inducing entrepreneurs to move from predation to production. Hence, production increases and profits to each producer go up. The number of producers grows at the expense of predators until profits from predatory activities become as high as in production. To slightly rephrase Usher (1987 p.241): Whatever harms the thief is beneficial both to the producer and the thief.

\(^4\)With increasing returns in self-defence, in the sense that \( \phi \) is decreasing in \( y \), \( \pi_a \) would be steeper for all \( n_a \), while \( \pi_b \) would become less steep. The qualitative features illustrated picture in Figure 1 would not be changed.
As stated in part ii) of Proposition 1 the predation trap does not always exist. If $\pi_a > \pi_b$ for $m = 1$ there is no trap. By using (8), (10), and (4) inserting for $n_a = n/2$ it follows that there is no trap if and only if

$$F < \frac{(\gamma - 2\phi)L}{M - \phi n}$$

(17)

When $F$ is sufficiently small relative to demand it is always more profitable to produce than to predate. Thus economic expansions with a higher $n$ can shift the economy out of the vicious predation circle. The case with the trap is already illustrated in Figure 1 where $\pi_a$ and $\pi_b$ cross twice. The alternative case, where $\pi_a$ and $\pi_b$ do not cross, is illustrated in Figure 2.

Whether (17) holds or not depends on the total number of entrepreneurs $n$. We denote the highest number of entrepreneurs that can support dual equilibria $\hat{n}$. This threshold can be derived from (17) as

$$\hat{n} = \frac{FM - L(\gamma - 2\phi)}{F\phi}$$

(18)

There is a predation trap only if $0 < n < \hat{n}$. Hence, if $\hat{n} < 0$ there can never be a predation trap. If $\hat{n} > M$ it follows from (7) that the economy may be captured in the trap for all feasible $n$. If $0 < \hat{n} < M$ there exists a predation trap for low levels of $n$, but not for high values of $n$. The threshold $\hat{n}$ is an increasing function of $\phi$. Observe from (18) that

$$\phi = \frac{(\gamma L - FM)}{(2L)} \equiv \tilde{\phi} \quad \Rightarrow \quad \hat{n} = 0$$

$$\phi = \frac{(\gamma L - FM)}{(2L - FM)} \equiv \tilde{\phi} \Rightarrow \hat{n} = M$$

(19)

By using (19) the following proposition follows.

**Proposition 3** If the extortion share $\phi$ is low, $\phi < \tilde{\phi}$, there is never a predation trap. If $\phi$ is high, $\phi > \tilde{\phi}$, there is always a predation trap. For intermediate values of $\phi$, where $\tilde{\phi} \leq \phi \leq \hat{\phi}$, there is a predation trap for low $n$ that disappears for high $n$.  

29th March 2001
A description of the equilibria for different \( n \) is given in Figure (3). For each \( n \)

\[
\text{Figure 3: Predator or prey - equilibria}
\]

there is a downward sloping 45 degree line, \( n_b = n - n_a \). The \( E_2 \) and \( E_3 \) curve are all combinations of \( n_a \) and \( n_b \) that solves the equilibrium condition (13). The \( E_2 \) curve represents the set of stable interior equilibria \( e_2 \), while the \( E_3 \) curve represents the set of unstable tipping points \( e_3 \). Finally, the no-predation corner solutions \( e_1 \) from (14) apply along the horizontal \( E_1 \) curve where \( n_a = n \) and \( n_b = 0 \).

Along the \( E_2 \) curve in Figure (3) the predation intensity \( m \) is a decreasing function of \( n_a \) expressed as \( m_2 (n_a) \). The reason why \( m \) decreases as \( n_a \) goes up is increasing returns to scale in modern production. If the total number of entrepreneurs increases entrepreneurs must flow out of predation and into production in order to equalize profitability. Along the \( E_3 \) curve in Figure (3), however, \( m \) is a decreasing function of \( n_a \) expressed as \( m_2 (n_a) \). In fact, \( m_3 (n_a) = 1/m_2 (n_a) \). To see all this we combine (9), (8), and (10) into the equilibrium condition (13) to obtain

\[
m_2 (n_a) = \frac{\phi}{\gamma - \phi} - \frac{F}{g(n_a)} \tag{20}
\]

\[
m_3 (n_a) = \frac{\gamma - \phi - \frac{F}{g(n_a)}}{\phi} \tag{21}
\]

In Figure (3) the \( E_2 \) and \( E_3 \) curves eventually converge (for \( m = 1 \)). For values of \( n \) larger than \( \bar{n} \) there is no poverty trap. The arrows in the figure indicate the dynamics in (15).

### 3 Growth with entry and exit

#### 3.1 The basic dynamics

In order to investigate the dynamics and the long run development path we specify in more detail the mechanism underlying the simple dynamic assumption in (15). Our approach is inspired by the predator-prey models (e.g. Lotka-Volterra, see Lotka 1956) where the flow of novice entrepreneurs is \( \theta \), while the exit rate of entrepreneurs
is δ:

\[ \dot{n} = \theta - \delta n \]  (22)

To simplify the presentation we make three assumptions that are relaxed Section 3.2.

1. \( \theta \) and \( \delta \) are exogenous. In 3.2 we derive the implications when entry and exit depend on income and profitability.
2. The entrepreneurs’ choice of which sector to enter is made once and for all. In 3.2 we consider the possibility of cross-overs at later stages.
3. Profit expectations are myopic. In 3.2 we consider forward looking expectations.

When \( \theta \) and \( \delta \) are exogenous, the limit of expansion of entrepreneurs, \( n^* \), is determined by the growth relative to the death rate, \( \theta/\delta \). New entrepreneurs choose whether to go into productive or predatory activities depending on what activity that yields the highest profit. Thus, we add best response entry to the predator-prey model. Hence, if \( \pi_a \geq \pi_b \) all new entrepreneurs go into productive activity. If \( \pi_a < \pi_b \), however, all new entrepreneurs go into predation. The assumption about a best response choice of activity produces completely different dynamics from Neher’s (1978) Predator-Prey modelling of muggers and mugees. In Neher’s model the growth of both types depends only on the absolute profitability of the respective activities. He gets high growth in the number of predators even when it’s much more profitable to enter as prey.

The best response dynamics is

\[
\begin{align*}
\pi_a \geq \pi_b & \Rightarrow \dot{n}_a = \theta - \delta n_a \quad \text{and} \quad \dot{n}_b = -\delta n_b \\
\pi_a < \pi_b & \Rightarrow \dot{n}_a = -\delta n_a \quad \text{and} \quad \dot{n}_b = \theta - \delta n_b
\end{align*}
\]  (23)

which is consistent with the aggregate dynamics in (22). The phase diagram following from (23) is illustrated in Figure 4. The movement is to the southeast except in the poverty funnel where the movement is north-west. Outside the poverty funnel profits are higher in legal than in illegal activity. All new entrepreneurs start as productive firms, while the number of predators decreases by rate \( \delta \). In the poverty funnel profits are lower in productive activity than in predation, and all new entrepreneurs choose to enter as predators. The number of predatory enterprises thus increases while the number of productive firms decreases.

We focus our attention on situations with an initial number of entrepreneurs below the steady state number \( n^* \) implying a development process with a growing number of entrepreneurs. Condition (7) implies that \( n^* = \theta/\delta \leq M \). Figure 4 illustrates the case where the flow of new entrepreneurs \( \theta \) is low relative to the death rate \( \delta \), causing the limit of expansion \( n_1 \) to be lower than the threshold \( \bar{n} \). Figure 4 also captures the essence of the case where \( \bar{n} > M \) and where the existence of a trap is unavoidable.

Once captured in a development trap, the economy remains trapped. For example, an economy starting out in B (country B) ends up in the trap C in the long run. From B, the new entrepreneurs enter into both activities. Thus, the
number of producers as well as predators increases until the steady state number of entrepreneurs is reached. In country A, that starts to the right of the poverty funnel, however, all new entrepreneurs enter into productive businesses while predatory entrepreneurs gradually die out. Eventually country A ends up in D, a long run equilibrium without predation.

According to (4) total production $Y$ is increasing in the number of productive entrepreneurs. Knowing the path for productive entrepreneurs, the path for $Y$ can be derived as in Figure 5. The total number of entrepreneurs is the same in country A and B. Because of the different initial predation rates, production in A is higher than in B. Furthermore, because B is in the predation trap it converges to a lower long run income level, $Y_C$, than country A, that asymptotically approaches $Y_D$. Country A both starts out and ends up with a higher income level than country B.

Consider next country $B'$ in Figure 4 that starts out with a higher number of productive entrepreneurs, and thus a higher income level, than both A and B. As this country is also in the predation trap it converges to $Y_C$, in spite of the high initial income level. Note that country A over time outperforms country $B'$. The reason is that A starts out free of the predation trap and therefore has a higher growth potential than country $B'$. Thus we have club convergence. Countries of type B and $B'$ both end up at low income levels. They constitute the Predators’ Club. Countries of type A, however, end up with high production and constitute the Producers’ Club.

In the Predators’ Club there is a vicious circle of underdevelopment. Firms make low profits, production is low, and average income is low. Once the economy is in this bad equilibrium, predation hampers development and a low level of development invites predation. An entrepreneur does not take into account that by entering the productive sector, aggregate demand increases, shifting profit in favor of productive activities. Hence, predation creates externalities in addition to the demand externality in the basic model.

In the Producers’ Club there is a virtuous circle of development. Firms make high profits, production is growing and the average income is rising. Once the
economy is on this good equilibrium path, predation is too low to prevent a beneficial development. Two positive externalities fuel the modernization. Entry of productive firms expand the market and boost the profitability of productive firms relative to predatory enterprises. As a consequence the number of predatory enterprises declines which further enhance profitability in production.

As illustrated in Figure 4, whether a country ends up in the Predators’ Club or the Producers’s Club cannot be predicted by initial income alone. The initial predation intensity is equally important. Any country, starting out below $E_3$, goes into the Producers’ Club. From (21) it follows that along $E_3$ the predation intensity $m$ is an increasing function of $y$ and $n_a$. Hence, the following proposition:

**Proposition 4** The highest predation intensity $m$ that an economy can tolerate without slipping into the Predator’s Club is higher the richer the economy.

According to the proposition poor countries are more vulnerable to initial predation levels than richer countries.

In the cases considered so far the predation trap can be avoided but not escaped once captured. This is not always the case. When the flow of new entrepreneurs $\theta$, relative to the death rate $\delta$, is sufficiently high, the limit of expansion $n^*$ is higher than $\bar{n}$, and the economy eventually grows out of the trap. One example is provided in Figure 6 where country B escapes the trap when the number of entrepreneurs has grown to a level beyond the poverty funnel. From this point all new entrepreneurs in country B enter productive businesses and the country ends up in the no-predation equilibrium $G$. The development trap is therefore only temporary. Unlike earlier models with multiple equilibria, such as those of Murphy, Shleifer, and Vishny (1993) and Acemoglu (1995), the economy may thus endogenously grow out of a development trap.

Expanding economies may escape the predation-induced development trap because the profit in production is increasing in the scale of the productive economy, while predation has no such scale advantage. This difference in scale effects are even stronger when we take account of the reasonable assertion that law enforcement is
more efficient in rich compared to poor countries. We return to the question of law enforcement below.

Time paths for country A, B, and B' are provided in Figure (7). All countries eventually approach the same equilibrium income level, but the speed of convergence is different. Country A is the fastest grower. The reason is that in country A all new entrepreneurs become producers from the start, while country B and B' starts out in an interior equilibrium where, for an interval of time, only a fraction of new entrepreneurs become producers. Country A starts out and remains in Producers’ Club. Country B' has a better performance than country B, as B' starts from a high level and soon shifts from Predators’ Club to Producers’ Club. Country B remains in Predators’ Club for a longer time, but eventually shifts club. In the long run Producers’ Club is the absorbing state for all countries. Yet country A and country B diverge for a while until convergence sets in. Thus we have long run convergence with endogenous club switching. We can summarize these results in the follow proposition:

**Proposition 5** With a sufficiently high flow of new entrepreneurs the economy will eventually move into the Producers’ Club, irrespective of initial conditions. The transition is fastest if the economy starts out entirely free of the poverty trap.

This prediction may appear overly optimistic. Note, however, that two conditions needs to be fulfilled in order for Proposition 6 to hold: First, as discussed in Section 2, in order to avoid the trap \( \tilde{n} \) must be below \( M \). Second, the growth of new entrepreneurs must be high (that is \( n^* = \theta/\delta > \tilde{n} \)) If these conditions are not met, it is not possible to escape the Predators’ Club.

### 3.2 Law enforcement and alternative dynamics

In this section we consider some alternative assumption in order to check the robustness of the derived results. We also show that realistic extensions easily can be incorporated in the model.

29th March 2001
Law enforcement

Effective law enforcement obviously reduce the profitability of predation. Law enforcement can be captured by letting $\phi$ be a decreasing function of expenses for law enforcement $Z$. Further, let $Z$ be financed by a tax $t$ on income in the modern sector, $Z = tyn_a$. The markup $\gamma$ in the model is then replaced by $\gamma - t$, lowering profits from productive activities in (8) and where $t = Z/(ym_a)$. Hence, the required tax for a given quality of law enforcement is decreasing in the size of the modern sector. That $t$ is decreasing in $n_a$ and $y$ gives additional reasons why there may be a development trap caused by predation. Efficient law enforcement in poor countries may require such a high tax rate $t$ that the profitability of production gets too low to outperform predation. In a rich economy the tax base is higher, making law enforcement relatively cheaper. (Dabla-Norris and Freeman 1999 provide an alternative discussion). In our context adding endogenous law enforcement implies decreasing returns in predation as the size of the market expands.

Endogenous entry and exit parameters

One way of making the entry parameter $\theta$ endogenous is to take into account that richer societies generate a higher flow of new entrepreneurs as education for the potential entrepreneurs is better. This can be captured by assuming that $\theta = \theta(y)$ where $\theta'(y) > 0$. Furthermore, in line with the gist of the original predator-prey models, the exit rate of entrepreneurs may go down as profits increase. Hence $\delta_a = \delta(\pi_a)$ and $\delta_b = \delta(\pi_b)$ where $\delta'(\cdot) < 0$. These modifications are rather innocuous for the qualitative results. In the phase diagrams the new specification is mainly reflected in the shape of the limit of expansion of entrepreneurs

$$\theta(y) = \delta(\pi_a)n_a + \delta(\pi_a)n_b$$

(24)

As $y$, according to (4), is an increasing function of $n_a$, equation (24) implicitly defines $n_b$ as a function of $n_a$. This limit of expansion curve is neither linear nor
necessarily everywhere downward sloping in the $n_a$-$n_b$ plane.\textsuperscript{5} In other respects the phase diagram is not affected. Thus, the essential dynamics are not changed. Yet, the movements along the transition paths are of course affected by the endogeneity of the parameters. Consider, for example, country A and B in Figure 6 and Figure 7, which by construction have the same total number of entrepreneurs. As country B is in the development trap it has lower initial growth than country A. When the entry of entrepreneurs depends on income this initial growth differential widens. In addition the transition towards the full modernization equilibrium is faster as the expected economic lifetime of predators is lower than that of producers.

Cross-overs So far we have assumed that entrepreneurs choose their line of business once and for all. One modification is to allow one-way mobility only, in the form of a predation ratchet: Productive entrepreneurs may at any point in time switch from production to predation, but not the other way around. To go from predation to production is difficult when there is a stigma attached to illegal or amoral businesses. The inclusion of one-way mobility in the model is innocuous. When $\pi_b \leq \pi_a$, the predation ratchet is effective and the dynamics are as discussed above. When $\pi_b > \pi_a$, however, entrepreneurs instantly shift from productive to predatory businesses. Hence, countries that start in the poverty funnel instantly jump to the predation trap. From then on the dynamics are as already discussed.

The highest flexibility is obtained when there is frictionless movement of entrepreneurs in and out of any business activity. In this case the economy is always on either the $E_2$ or the $E_1$ curve. If the economy starts out to the left of the curve $E_3$ it jumps to $E_2$ while if it starts out to the right of $E_3$ it jumps to $E_1$. Otherwise the dynamics are as discussed in Section 3. Thus, allowing some degrees of flexibility in cross-overs do not alter the main results, but may cause jumps in the transition path. With full mobility of entrepreneurs a good start yields an even better performance as the predators instantly switch to productive activities.

Expectations Above we assumed myopic entry decisions among new entrepreneurs. Some degree of forward-looking or model based expectations lead to interesting modifications. Consider the case of a temporary development trap as country B in Figure 6. In that case there is only one long run equilibrium; the one without predation. Productive entrepreneurs take this into account, even from the outset. Some entrepreneurs therefore choose productive businesses also in cases where the instant return to predation is higher. Thus, the area of the poverty funnel shrinks and a positive development is more likely. With sufficient weight on future gains combined with a long expected life (low $\delta$) the poverty funnel may

\textsuperscript{5}With endogenous parameters the limit of expansion has the slope

$$\frac{dn_b}{dn_a} = \frac{\delta (\pi_a) - \theta' (y) \frac{\partial y}{\partial n_a} - G_1}{\delta (\pi_b) + G_2}$$

$$G_1 = -\delta' (\pi_a) n_a \frac{\partial \pi_a}{\partial n_a} - \delta' (\pi_b) n_b \frac{\partial \pi_b}{\partial n_a} \geq 0$$

$$G_2 = \delta' (\pi_a) n_a \frac{\partial \pi_a}{\partial n_b} + \delta' (\pi_b) n_b \frac{\partial \pi_b}{\partial n_b} \geq 0$$

Hence $dn_b/dn_a$ may be positive for some values of $n_a$ and $n_b$. In Section 3, with exogenous parameters, the limit of expansion curve is linear as defined by $\theta = \delta [n_a + n_b] = \delta n^*$.  

29th March 2001
vanish all together, and the temporary predation trap disappears.

Allowing for degrees of optimism and pessimism, forward-looking behavior may give rise to self-fulfilling prophecies. Consider the case with two long run equilibria. If all entrepreneurs are optimistic and anticipate a long-run movement towards the no-predation equilibrium this may lift the economy out of the predation trap, making the expectations self-fulfilling. Hence, again the poverty funnel shrinks. If entrepreneurs are generally pessimistic, however, we may end up in a self-fulfilling predation trap. Consider country A in Figure 4, that with myopic expectations ends in the no-predation equilibrium D. If entrepreneurs are forward looking and anticipate a movement to the development trap C, they may choose predation even when productive entrepreneurship is relatively more profitable in the short run. Hence, the economy moves into the long-run predation trap due to self-fulfilling pessimism. This implies that the poverty funnel expands with pessimistic expectations.

Combined with a one-way predation ratchet, however, the potential problem of self-fulfilling pessimism disappears. New entrepreneurs now always go into productive activities as long as the immediate return to producers are higher than the return to predators. One way mobility adds an option value on productive activities and may indeed help forming self-fulfilling optimism as entrepreneurs are not likely to choose productive activities if they attach a positive probability on productive businesses being the most profitable choice in the long run.

The complete dynamics In the preceding discussion we have focused on the reasonable case where the initial number of entrepreneurs is below $n^*$. For completeness we here also look at some possible cases when the economy starts out with a number of entrepreneurs above the steady state value. In Figure 8 we consider the case of a absolute poverty trap and consider the dynamics as described by (23) enriching Figure 1. Note first that there is net reduction in the number of entrepreneurs everywhere beyond $n^*$. Note also that beyond the dotted line (where $n_a > n^*$) both $n_a$ and $n_b$ declines. The income dynamics starting out from $F_1$ shows increasing income until the predation equilibrium is reached, then income goes down

29th March 2001
until the economy is stuck in steady state predation equilibrium C. Starting further to the right, in $F_2$, the economy goes clear of the predation trap and income grows steadily towards steady state D. Lastly starting even further to the right, in $F_3$, the number of producers is higher than the sustainable level $n^*$ and production declines until D is reached.

4 Concluding remarks

The assumption that all entrepreneurs choose the business that yields the highest profits may also be modified. Including a moral cost for those who enter into predation would work as a downward shift in profits from predation. More interesting is the situation where entrepreneurs can be divided into three groups where, in addition to the opportunistic entrepreneurs, there are some completely honest and some completely dishonest entrepreneurs. Whether this modification changes anything depends on the relative size of these groups and on which group that contains the marginal entrepreneur. When some entrepreneurs are completely dishonest also the high income equilibrium would contain predators. In the development trap, however, the equilibrium allocation could well remain unaffected. As long as there are opportunists both among the parasites and the producers the equilibrium allocation is not affected.
A Appendix Proof of Proposition 1 part ii

We shall prove the following result: *If and only if* \( \pi_a < \pi_b \) for \( m = 1 \), *there is one locally stable equilibrium for* \( m > 1 \).

Assume that there are interior equilibria. Let \( K \) indicate the number of interior equilibria and let \( k = 1 \ldots K \) indicate the sequence of interior equilibria ranked according to the corresponding value of \( n_a \). From (12) it follows that \( \pi_a \) is above \( \pi_b \) both when \( n_a = 0 \) and when \( n_a = n \) and from (8) and (10) it follows that \( \pi_a \) and \( \pi_b \) both are continuous and everywhere increasing. Two facts follow:

- \( K \) is an even number
- In the equilibrium \( k = 1 \) we have \( \partial \pi_b / \partial n_a - \partial \pi_a / \partial n_a > 0 \). Hence this equilibrium is locally stable. In the equilibrium \( k = K \) we have \( \partial \pi_b / \partial n_a - \partial \pi_a / \partial n_a < 0 \). Hence this equilibrium is unstable.

Assume that there is an equilibrium for \( m > 1 \). Using (4), (8), (10), and the equilibrium condition \( \pi_a = \pi_b \) it can be shown that in any equilibrium where \( m > 1 \)

\[
\frac{\partial \pi_b}{\partial n_a} - \frac{\partial \pi_a}{\partial n_a} = \frac{\phi n (\alpha (M - n) + \phi n + n)}{(n - n_a)^2 (\alpha (M - n_a) + n_a)} > 0
\]

The inequality follows as \( M > n_a \) by definition. Hence, \( \pi_a \) can only cross \( \pi_b \) once for \( m > 1 \). Similarly, assume that there is an equilibrium for \( m < 1 \). Using (8), (10), and the equilibrium condition \( \pi_a = \pi_b \) it can be shown that in any equilibrium where \( m < 1 \)

\[
\frac{\partial \pi_b}{\partial n_a} - \frac{\partial \pi_a}{\partial n_a} = \frac{-\alpha n L}{n_a^2 (\alpha (M - n_a) + n_a)} < 0
\]

Hence, \( \pi_a \) can only cross \( \pi_b \) once for \( m < 1 \) and it follows that: a) The maximum value of \( K \) is 2, b) When \( K = 2 \) there is one and only one stable interior equilibrium which is found for an \( m > 1 \), and c) \( K = 2 \) if and only if \( \pi_b > \pi_a \) in the point where \( m = 1 \).

QED

29th March 2001
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29th March 2001


29th March 2001