PRODUCTION, APPROPRIATION, AND BARRIERS TO ENTRY

By

Chris Stefanadis*

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* Finance Dept, University of Pireaus, cstefana@unipi.gr.

ABSTRACT

The paper examines the nature of self-regulatory entry barriers. It shows that the presence of appropriation activity — which seeks to seize output from productive sectors through non-economic means (brute force, coercion, government taxation and redistribution to cronies, etc) — may be a driving force in the erection of such barriers. Only agents in the appropriation sector — agents that have generated predatory capital — have the incentive to set up entry barriers into their activities. On the other hand, agents in productive sectors, — agents that have generated human or physical capital (laborers or capitalists) — have no incentive to deliberately restrict entry into their market. Thus the maximization of non-economic transfers toward predators, rather than the attainment of pricing power in productive industries, is the main motive of self-regulatory entry barriers. The accommodation of self-regulatory entry barriers by the government is the socially optimal policy; dismantling self-regulatory barriers would lead to a Pareto deterioration in the economy.

In particular, because predators exert both positive and negative externalities on each other, they can maximize their expected payoff by cooperatively screening entry into the expropriation arena. When the intensity of appropriation activity is excessive, average predator payoff decreases; productive agents (laborers, capitalists) are induced to dissipate an excessive amount of output on private hiding their property from predators. Thus the self-regulatory entry barriers that are erected by predators may maximize expected predator payoff by attaining the optimal (for predators) intensity of appropriation. In this way, appropriation may lead to an unequal society even when all agents are endowed with exactly the same level of talent by nature. Entry barriers may generate inequality within the group of predators by limiting the number of active slots in the expropriation arena.

Greater economies of scale in production reduce the optimal intensity of appropriation for predators; predators are more reluctant to prevent the realization of scale economies or to induce productive agents to divert resources from production to property protection. Greater economies of scale increase the proportion of productive agents in the population.

1. INTRODUCTION

Coming soon …

2. THE MODEL

The economy is populated by a continuum of agents whose measure is normalized to one. There are a large number of firms that each manufactures a homogeneous product and utilizes two inputs, namely labor and physical capital. I assume that each firm has a Cobb-Douglas production function. As is well-known in macroeconomics, Cobb-Douglas functions are widely considered a good empirical approximation of how the actual economy turns labor and physical capital into output (Mankiw [2003]). Section will explain how our basic results may be extended to more general functions. We have

$$q(k,l) = Ak^{\alpha}l^{1-\alpha}, \tag{1}$$

where q is the amount of output that is manufactured by a firm, A ($A > 0$) corresponds to the level of technology, α is a parameter between zero and one ($0 < \alpha < 1$) and k and l are the amounts of physical capital and labor that are used.

All agents are endowed by nature with the same level of talent. An agent may choose between three occupations; he may become a laborer, a capitalist or a predator. Each laborer, capitalist and predator utilizes his talent to generate one unit of human, physical and predatory capital, respectively. Laborers and capitalists are productive agents in that they contribute to manufacturing. A laborer receives a wage by providing firms with labor — i.e., with human capital. Similarly, a capitalist receives a payment for selling his physical capital to firms.

Predators, on the other hand, lack the ability to produce; instead, they develop predatory capital, attempting to expropriate the output that is manufactured by firms.[1] Appropriation may take several forms (Olson [2000], Acemoglu and Johnson [2005]). For example, it may happen through brute force, theft or coercive encroachment.

[1] Murphy, Shleifer and Vishny [1993], Acemoglu [1995] and Grossman and Kim [2000], among others, also construct models where there are both producers and predators in the population.

Predators may also use the government as a means of appropriation; the government may seize output through extractive policies or taxation and redistribute it to predators (who may be government cronies). The proportion of laborers, capitalists and predators in the population is θ^L, θ^K and θ^R, respectively, where $\theta^L + \theta^K + \theta^R = 1$. Our results would be qualitatively similar if each productive agent — laborer or capitalist — also had some predatory capital and each predator also had some productive — human or physical — capital as long as productive agents had more productive and less predatory capital than predators.

According to industrial organization theory, a natural form of interaction among members of the same professional group is the deliberate formation of entry barriers that determine whether or not to admit a potential member to the group; a group thus engages in self-regulation of entry (Shaked and Sutton [1981], Carlton and Perloff [2000]).[2] Such self-regulation may be formal, — occurring through official bodies or associations, — or informal, — taking place through unofficial social interaction or networks. Furthermore, a profession may often be able to transform its internal self-regulatory rules into government regulations; government regulations are often acquired by a profession and designed for its benefit (Stigler [1971]).

In the model there are three occupations, laborers, capitalists and predators. Each group has the opportunity to shape the structure of its sector and form entry restrictions; these self-regulatory barriers may screen entry into the activities of the group. The objective of such barriers is to maximize the expected payoff of individual members of the corresponding group. Furthermore, in the spirit of Posner [1975], when self-regulation imposes restrictions on entry, it may create incentives for agents to use some of their capital to circumvent these restrictions. Thus when a group sets entry barriers, each agent may allocate his individual capital — human, physical or predatory — between *ex ante* and *ex post* activities, i.e., between seeking entry into his sector and operating within his sector after (and if) he successfully enters.

In particular, laborers may reach a decision about the level of entry barriers into the labor market, namely about x^L. Then, when a laborer spends an amount of human

[2] In industrial organization theory, self-regulation may be either socially beneficial (e.g., by ensuring product quality or correcting market failures) or socially harmful (e.g., by eliminating competition).

capital ω ($\omega \in [0,1]$) on attempting to gain access to the labor market, he has a probability $(1/x^L)p(\omega)$ of being allowed to actually sell his labor to firms, where $\partial p(\omega)/\partial\omega > 0$ and $\partial^2 p(\omega)/\partial\omega^2 < 0$. We have $x^L \in [p(0),\infty)$. If the entry barrier x^L is infinite, entry into the labor market is impossible. If, on the other hand, x^L is equal to $p(0)$, entry is completely free and a laborer can effortlessly enter (i.e., by spending zero human capital). Each laborer chooses a level of x^L in the interval $[p(0),\infty)$ and votes for this level. Then, the profession of laborers adopts the level of entry barriers with the most votes. Such a voting process can be interpreted either literally, — for example, as each laborer voting in formal union or association elections, — or metaphorically — for example, as each laborer supporting an alliance in a political struggle. Because a laborer has only one unit of labor — i.e., of human capital — available, he sells firms an amount of labor $1-\omega$ when he spends an amount ω on attempting to achieve entry.

Similarly, capitalists and predators may decide about the level of entry barriers into the capital market and the appropriation sector, respectively, i.e., about x^K and x^R, where $x^K, x^R \in [p(0),\infty)$. Each profession adopts the level of entry barriers with the most votes. When a capitalist spends an amount of physical capital ω on attempting to gain access to the market for capital, he has a probability $(1/x^K)p(\omega)$ of being allowed to actually sell his capital to firms. Furthermore, when a predator spends an amount of predatory capital ω on attempting to gain access to the appropriation arena, he has a probability $(1/x^R)p(\omega)$ of being allowed to actively engage in expropriation.

Firms transform labor and physical capital into output. A standard assumption in general equilibrium theory is that firms are owned by consumers; owning a firm is an effortless activity. I thus assume that any productive agent — laborer or capitalist — that succeeds in circumventing the barriers of his profession — x^L or x^K — and entering his market has the opportunity to establish and own a firm.

Society has laws and institutions that fix the strength of property rights to output. The strength of property rights in the economy is d ($d \in (0,1)$); each firm is guaranteed legal rights to a fraction d of the output that it manufactures. The law, on the other hand, does not offer protection to the remaining share $1-d$ of a firm's output, which is appropriable. The implementation of society's legal system entails administrative costs and utilizes productive resources. Operating the legal framework expends a fraction t ($t \in (0,1)$) of each firm's output. Parameter t is immaterial for our conclusions, and thus for simplicity, I assume that t is zero.

In our model, property rights institutions constitute a rigid parameter that already exists at the beginning of the game. This is in the spirit of Djankov, McLiesh and Shleifer [2007] and Balas, La Porta, Lopez-de-Silanes and Shleifer [forth] who stress the inflexible and persistent nature of institutions. As, for example, Glaeser and Shleifer [2002] and Acemoglu, Johnson and Robinson [2005] point out, institutions may stem from a historical accident at a critical juncture.[3] Abstracting from the formation of institutions allows us to focus on different issues — in particular, on the nature of entry regulation and income inequality.

Firms also engage in private activities to hide their appropriable output — their output that lacks legal protection — from predators (Murphy, Shleifer and Vishny [1993], Grossman [2001]). As, for example, Grossman [2001] points out, "even with an advanced modern state and legal system, the single most important action that one takes to secure property is probably the purely private activity of locking one's doors."[4] Private hiding activities, however, are costly; some output is dissipated in the hiding process. Attaining a level $z(e)$ of hiding leads to the dissipation of a fraction e ($e \in [0,1]$) of a firm's appropriable output. In addition to hiding, another important parameter is the intensity of appropriation in the economy — i.e., the total amount R of predatory capital that circumvents entry barrier x^R and enters into the appropriation arena.

Overall, a firm maintains possession of a fraction $s(R) + z(e)$ of its legally unprotected (i.e., appropriable) output that is not dissipated in the private hiding process. We have $\partial z(e) / \partial e > 0$ and $\partial^2 z(e) / \partial e^2 < 0$; the concavity of the hiding function is a standard assumption. It is also assumed that $\partial^3 z(e) / \partial e^3 > 0$, which ensures the

[3] For example, the adoption of a common law or a civil law system constitutes an especially rigid parameter. Common law is often viewed as offering greater protection of property rights (Acemoglu, Johnson and Robinson [2005]).
[4] Grossman [2001], p. 347.

convexity of the cost function $e(s)$. Furthermore, it is assumed that $\partial s(R)/\partial R < 0$ and $s(R) \in [\underline{s}, \overline{s}]$, where $0 < \underline{s} < \overline{s} < 1$.

The remaining fraction $1 - s(R) - z(e)$ of a firm's non-dissipated appropriable output is seized by active predators — i.e., by predators that have succeeded in entering the appropriation sector. This output is distributed among active predators based on the amount of predatory capital that each active predator has after he enters the appropriation arena. A predator obtains a share of this output that is equal to the ratio of his predatory capital to the total amount *R* of predatory capital that is active in the appropriation sector.

An agent chooses his aptitude type — laborer, capitalist, or predator — at the beginning of the game, aiming at maximizing his expected payoff. In the spirit of Stigler and Becker [1977], the acquisition of a specific type of capital or skills constitutes a long-term process that can only start early. An agent's occupational choice at the beginning of the game is thus irreversible and his particular type characterizes him for the entire game. Because of the long-term nature of aptitude choices, decisions about the entry barriers are made after agents have chosen their aptitude types.

We have a five-stage game:

Stage 1: Each agent chooses his occupational type — laborer, capitalist or predator — and begins acquiring the capital — human, physical or predatory — relevant for his type.

Stage 2: Self-regulation takes place. Each occupation has the opportunity to determine the level of its entry barriers.

Stage 3: Each agent chooses the amount of capital that he will spend on attempting to gain access to his sector.

Stage 4: Manufacturing takes place. Each firm chooses the level $z(e)$ of its private hiding activities. Laborers and capitalists have the opportunity to sell their labor and physical capital, respectively, to firms.

Stage 5: Active predators try to appropriate the output of firms.

Overall, our model follows the standard game theory methodology of rational expectations and subgame perfection. With rational expectations about the simultaneous decisions of other agents and the future effects of these decisions on his payoff, an agent chooses his strategy in each stage of the game. For simplicity, I adopt the tie-breaking convention that in stage 2, in the case of a tie in an agent's voting choices — i.e., in the case an agent expects his vote to be non-pivotal (and thus indifferent) — the agent votes for his most preferred entry barriers.[5]

3. EQUILIBRIUM OF THE MODEL

To solve for the subgame-perfect equilibrium, I proceed by backward induction. Suppose that the amount of human, physical and predatory capital that entered the economy in stage 3 is *L*, *K* and *R*, respectively. Then, in stage 4, a fraction *e* of each firm's appropriable output is dissipated in the private hiding process. Therefore, each firm maintains possession of a fraction $d+(1-d)(1-e)[s(R)+z(e)]$ of its gross output. A firm's optimal choice of *e* is

$$e(s)=\arg\max_{e}[s+z(e)](1-e)\,. \tag{2}$$

As the appendix shows, maximization problem (2) has a unique argument of the maximum. Conditions (A4a), (A4b) and (A4c) ensure that the unique solution is interior.

In equilibrium, when appropriation is less intense, — i.e., when *s* is greater, — firms need to engage in less private hiding activities. Overall, less intense expropriation allows firms to maintain possession of a larger fraction of their non-dissipated appropriable output. We summarize this in lemma 1.

<u>Lemma 1:</u> In equilibrium in the stage 4 subgame, the extent *e* of a firm's private hiding activities is increasing in the intensity of appropriation, i.e., $\partial e(s)/\partial s<0$. The overall fraction of its non-dissipated appropriable output of which a firm maintains possession is decreasing in the intensity of appropriation, i.e., $\partial[s+z(e(s))]/\partial s>0$.

Proof: The proof is in the appendix.

In stage 4, there are a large number of perfectly competitive firms that earn zero profits. A laborer's wage rate is equal to the marginal revenue product of labor — the

[5] Alternatively, we could assume that agents could coordinate in voting a la Bernheim, Peleg and Whinston

marginal product of labor that a firm is able to maintain possession of. The wage rate w^L for one unit of labor is thus equal to $\{d+(1-d)(1-e)[s(R)+z(e)]\}A(1-\alpha)(K/L)^{\alpha}$. Similarly, the price w^K for one unit of physical capital is $\{d+(1-d)(1-e)[s(R)+z(e)]\}A\alpha(L/K)^{1-\alpha}$. Since each firm's production function $Ak^{\alpha}l^{1-\alpha}$ exhibits constant returns to scale, the size and number of firms is immaterial for the wage rate or the price of capital. Regardless of the share β ($\beta \in (0,1)$) of the total amount of labor and physical capital that a firm employs, — which leads to a gross firm output of $A\beta K^{\alpha}L^{1-\alpha}$, — the firm's marginal revenue product of labor and physical capital is w^L and w^K, respectively.

The total output that is expropriated by predators is $(1-d)(1-e)[1-s(R)-z(e)]AK^{\alpha}L^{1-\alpha}$. An active predator that maintains an amount $1-\omega$ of predatory capital in stage 4 — i.e., an active predator that has spent an amount ω of predatory capital in trying to gain access to the appropriation sector — seizes a proportion of this output that is equal to $(1-\omega)/R$, i.e., equal to the ratio of his predatory capital to the total amount of predatory capital that has entered the appropriation arena.

The output that an agent — laborer, capitalist, or predator — earns in stage 4 is proportional to the amount of capital — human, physical, or predatory — that he maintains.[6] Suppose that an agent expects to earn an output y per unit of capital that he maintains after (and if) he enters the market. Then, in stage 3 an agent maximizes his expected output $(1/x^j)p(\omega)(1-\omega)y$, where $x^j \in \{x^L, x^K, x^R\}$. An agent's optimal choice of ω is

$$\hat{\omega} = \arg\max_{\omega} p(\omega)(1-\omega) . \tag{3}$$

[1987].

[6] Because the economy's population is large, an individual agent's human or physical capital has a negligible effect on the wage rate or the price of capital, which are viewed as exogenous parameters by an agent. Similarly, an individual agent's predatory capital has a negligible effect to the total amount R of

Since $p(\omega)(1-\omega)$ is continuous and concave in the closed interval $\omega \in [0,1]$, maximization problem (3) has a unique argument of the maximum on $\omega \in [0,1]$. It is assumed that the unique solution to (3) is interior, i.e., $0 < \hat{\omega} < 1$. Furthermore, an agent's probability of entry cannot be strictly greater than one. Thus if $x^j < p(\hat{\omega})$ — i.e., if $(1/x^j)p(\hat{\omega}) > 1$, — we have a corner solution $\omega(x^j)$ so that the probability of entry $(1/x^j)p(\omega(x^j))$ is exactly equal to 1, i.e., $\omega(x^j) = p^{-1}(x^j)$.

In stage 2, the expected payoff of a laborer is maximized when x^L is set equal to $p(0)$ — i.e., when entry into the labor market is completely free. Then, a laborer has a probability one of gaining access to the labor market without spending any capital in stage 3, i.e., $\omega(p(0)) = p^{-1}(p(0)) = 0$. The increase in the wage rate that may be caused by entry barriers — i.e., by making labor a scarcer input — is not sufficient to compensate laborers for the reduction in the amount of labor that they sell to firms. Similarly, the expected payoff of a capitalist is maximized when x^K is set equal to $p(0)$. Thus in equilibrium in the stage 2 subgame, all laborers and capitalists vote for a level $p(0)$ of entry barriers into their sector. As a result, self-regulation among laborers and capitalists leads to complete freedom of entry into both professions in equilibrium, i.e., $x^L* = p(0)$ and $x^K* = p(0)$.

<u>Proposition 1:</u> In a subgame-perfect equilibrium, laborers and capitalists impose no barriers to entry into the labor and physical capital market, respectively, i.e., $x^L* = p(0)$ and $x^K* = p(0)$.

Proof: The proof is in the appendix.

Intuitively, a Cobb-Douglas production function $Ak^{\alpha}l^{1-\alpha}$ implies that a constant share $1-\alpha$ of the economy's output of which firms maintain possession goes to labor,

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active predatory capital in the economy. Thus the output that an agent earns in stage 4 is proportional to his own capital.

while a constant share α goes to capital.[7] When entry barriers reduce the amount of labor in the economy, total output — a constant share of which goes to labor — decreases; it follows that total laborers' income also decreases. A laborer's expected payoff is thus maximized when there is complete freedom of entry into the labor market. Similarly, a capitalist's expected payoff is maximized when there are no barriers of entry into the market for physical capital.

The total payoff of all predators — i.e., the total output that is seized by predators — is $(1-d)(1-e)[1-s(R)-z(e)]AK^{\alpha}L^{1-\alpha}$. If each predator spends an amount $\hat{\omega}$ (or $\omega(x^R)$ in a corner solution) of capital to enter into the appropriation sector in stage 3, the total amount of predatory capital R that is active in the appropriation arena is $\int_{\theta^R}(1/x^R)p(\hat{\omega})(1-\hat{\omega})=\theta^R(1/x^R)p(\hat{\omega})(1-\hat{\omega})$ (or $\theta^R[1-\omega(x^R)]$ in a corner solution). A predator has a probability $(1/x^R)p(\hat{\omega})$ (or one in a corner solution) of gaining access to the appropriation sector; once he gains access he obtains a fraction $(1-\hat{\omega})/R$ (or $[1-\omega(x^R)]/R$ in a corner solution) of the total output that is captured by predators. Thus in stage 2, the expected payoff of a predator is $(1-d)(1-e)[1-s(R)-z(e)]AK^{\alpha}L^{1-\alpha}/\theta^R$.

The level of s that maximizes the total output that is expropriated, as well as each individual predator's expected payoff, is

$$\hat{s}=\arg\max_{s}[1-s-z(e(s))][1-e(s)]. \tag{5}$$

The first-order condition is

$$-1+e(s)-\frac{\partial e(s)}{\partial s}=0. \tag{6}$$

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[7] The Cobb-Douglas production function has been devised on the basis of the empirical observation that the division of national income between labor and capital tends to remain constant over long periods of time (Mankiw [2003]).

As the appendix shows, there is a unique argument of the maximum in maximization problem (5). Conditions (A8a) and (A8b) ensure that the unique solution to (5) is interior.

The optimal (for predators) level $\hat{s}$ corresponds to an optimal amount of active predatory capital $\widehat{R}$, i.e., $\hat{s} = s(\widehat{R})$ or $\widehat{R} = s^{-1}(\hat{s})$. In stage 2, when the proportion θ^R of predators in the population is lower than $\widehat{R}$, expected predator payoff is maximized when there no barriers to entry into the appropriation arena, i.e., when x^R is set equal to $p(0)$. Any barriers to entry would reduce active predatory capital, moving further away from the optimal level $\widehat{R}$. Then, in equilibrium in the stage 2 subgame, all predators vote for a level $p(0)$ of entry barriers.

When, on the other hand, θ^R is strictly higher than $\widehat{R}$, predators can increase their expected payoff by imposing barriers to entry into the appropriation sector, so that $\widehat{R}$ is attained. The optimal intensity of appropriation $\widehat{R}$ is attained when predators set the level x^R of entry barriers into the appropriation arena equal to $[(1-\widehat{\omega})p(\widehat{\omega})\theta^R]/\widehat{R}$ if $\theta^R \geq \widehat{R}/(1-\widehat{\omega})$ and equal to $p((\theta^R - \widehat{R})/\theta^R))$ if $\widehat{R} < \theta^R < \widehat{R}/(1-\widehat{\omega})$. In equilibrium in the stage 2 subgame, all predators vote for their optimal level of entry barriers.

Lemma 2: In equilibrium in the stage 2 subgame, predators set the level x^R of entry barriers into the appropriation sector equal to $p(0)$ if $\theta^R \leq \widehat{R}$, equal to $p((\theta^R - \widehat{R})/\theta^R))$ if $\widehat{R} < \theta^R < \widehat{R}/(1-\widehat{\omega})$ and equal to $[(1-\widehat{\omega})p(\widehat{\omega})\theta^R]/\widehat{R}$ if $\theta^R \geq \widehat{R}/(1-\widehat{\omega})$.

Proof: The proof is in the appendix.

Intuitively, predators exert both positive and negative externalities on each other. As lemma 1 implies, a greater amount of active predatory capital allows predators to seize a greater proportion $1 - s(R) - z(e)$ of the economy's appropriable output that is not dissipated in private hiding activities. This increases the expected payoff of a predator (i.e., $-1 + e(s) < 0$ in condition (6)). At the same time, a greater amount of active predatory capital induces producers to engage in more intense private hiding activities, dissipating more appropriable output. This decreases the expected payoff of a predator (i.e., $-\partial e(s)/\partial s > 0$ in condition (6)). Predators trade off these opposing effects when they determine the optimal amount $\hat{R}$ of active predatory capital. Then, when $\theta^R > \hat{R}$, predators impose barriers to entry into the appropriation arena to exclude some predatory capital and attain $\hat{R}$.

In a subgame-perfect equilibrium the expected payoffs of laborers, capitalists and predators are equal in stage 1; otherwise, agents would have an incentive to deviate from their occupation. The expected payoff of a laborer is equal to the expected payoff of a capitalist — i.e., w^L is equal to w^K — when a proportion $1-\alpha$ of all productive agents (of all non-predators) are laborers, while a proportion α are capitalists. Then, the expected payoff of a productive agent — laborer or capitalist — is $A\alpha^{\alpha}(1-\alpha)^{1-\alpha}E\{d+(1-d)(1-e)[s(R)+z(e)]\}$. The expected payoff of a predator is $[(1-\theta^R)/\theta^R]A\alpha^{\alpha}(1-\alpha)^{1-\alpha}E\{(1-d)(1-e)[1-s(R)-z(e)]\}$. It follows that the expected payoffs of productive agents and predators are equalized when the proportion θ^R of predators in the population is $E\{(1-d)(1-e)[1-s(R)-z(e)]/[1-(1-d)e]\}$.

As Lemma 2 explains, predators impose entry barriers into the appropriation arena when $\theta^R > \hat{R}$. To bring out the differences between productive and predatory sectors in a clear and straightforward manner, we focus on the case where x^R has an interior, rather than a corner, solution — i.e., on the case where predators have an incentive to choose a level x^R of entry barriers strictly higher than the lower boundary $p(0)$.[8] It is thus assumed that

$$\forall s \in [\underline{s},\bar{s}],\ (1-d)(1-e)[1-s-z(e)]/[1-(1-d)e] > \hat{R}. \tag{7}$$

Then, there exists a unique subgame-perfect equilibrium, in which the proportion of laborers, capitalists and predators is

[8] Otherwise, productive agents (laborers, capitalists) and predators make identical entry barrier choices, maintaining complete freedom of entry into their sectors.

$$\theta^{L}* = \frac{(1-\alpha)\{d+(1-d)[1-e(\hat{s})][\hat{s}+z(e(\hat{s}))]\}}{1-(1-d)e(\hat{s})}, \tag{8a}$$

$$\theta^{K}* = \frac{\alpha\{d+(1-d)[1-e(\hat{s})][\hat{s}+z(e(\hat{s}))]\}}{1-(1-d)e(\hat{s})}, \tag{8b}$$

$$\theta^{R}* = \frac{(1-d)[1-e(\hat{s})][1-\hat{s}-z(e(\hat{s}))]\}}{1-(1-d)e(\hat{s})}. \tag{8c}$$

Since $\theta^{R}* > \hat{R}$ (condition (7)), predators always impose entry barriers that restrict entry into the appropriation arena, i.e. $x^{R}* > p(0)$. We summarize this in proposition 2.

<u>Proposition 2:</u> There exists a unique subgame-perfect equilibrium in which the proportion of laborers, capitalists and predators in the population is $\theta^{L}*$, $\theta^{K}*$ and $\theta^{R}*$, respectively. In equilibrium, predators set the level $x^{R}*$ of entry barriers into the appropriation arena equal to $p((\theta^{R}*-\hat{R})/\theta^{R}*)) > p(0)$ if $\hat{R} < \theta^{R}* < \hat{R}/(1-\hat{\omega})$ and equal to $[(1-\hat{\omega})p(\hat{\omega})\theta^{R}*]/\hat{R} > p(0)$ if $\theta^{R}* \geq \hat{R}/(1-\hat{\omega})$.

Proof: The proof is in the appendix.

Propositions 1 and 2 imply that all self-regulatory entry barriers in an economy are present in the appropriation sector. In equilibrium, the motive for imposing entry barriers is the maximization of non-economic transfers towards predators, rather than the attainment of price power in productive industries. Specifically, productive agents — laborers and capitalists — always maintain complete freedom of entry into their occupations. Predators, on the other hand, may deliberately erect self-regulatory entry barriers to reduce the amount of predatory capital in operation and reach the optimal (for them) intensity of appropriation. When appropriation is excessive, firms dissipate a large amount of output in private hiding activities, diminishing the payoff of predators.

4. ENTRY REGULATION AND INCOME INEQUALITY

So far we have derived the subgame-perfect equilibrium of the game, which finds that only predators may erect barriers of entry into their sector. The maximization of non-economic transfers, rather than the realization of price power, is the driving force behind entry barriers in equilibrium. We will now further examine the determinants and implications of such self-regulatory entry barriers.

Laborers and capitalists always impose no entry restrictions — setting x^L* and x^K* equal to $p(0)$ — regardless of the strength d of society's property rights institutions. Parameter d, however, impacts the level x^R* of entry barriers that is chosen by predators. Stronger property rights institutions lead to less restrictive entry barriers into the appropriation arena.

<u>Proposition 3:</u> An increase in the strength d of society's property rights institutions reduces the equilibrium level x^R* of entry barriers into the appropriation sector, i.e., $\partial x^R*/\partial d < 0$.

Proof: The proof is in the appendix.

Stronger property rights institutions allow firms to maintain possession of a larger fraction of their output. This gain is passed on to productive agents — i.e., laborers and capitalists — in the form of a higher wage rate and price of capital. At the same time, stronger institutions reduce the fraction of the economy's output that is vulnerable to expropriation by predators. In this way, a stronger institutional framework causes an aggregate shift of talent toward production and away from appropriation, reducing the proportion of predators in the population. As a result, predators need to impose less restrictive entry barriers into the appropriation arena to reach the optimal level of active predatory capital.

In practice, a government may sometimes have the ability to dismantle the self-regulatory entry barriers that are formed in a sector. To examine this possibility, let us suppose that in stage 2 of the game, the government has the opportunity to dismantle — or refuse to accommodate — any entry restrictions that are erected by laborers, capitalists or predators, setting the level of entry barriers equal to $p(0)$. Furthermore, let us suppose that the government's objective is to maximize total social welfare. Then, it is straightforward to see that the government never takes a non-accommodating course of action in equilibrium; dismantling entry barriers would lead to a Pareto deterioration in the economy.[9]

Proposition 4: In a subgame-perfect equilibrium, the government never decides to dismantle any self-regulatory entry barriers in stage 2.

Proof: The proof is in the appendix.

Intuitively, in equilibrium, only predators restrict entry into their profession. Dismantling these self-regulatory entry barriers would increase the amount of predatory capital in the appropriation arena, intensifying appropriation and decreasing the payoff of productive agents. It would also reduce the payoff of predators by causing them to deviate from their most preferred intensity of appropriation. Thus in our analysis, the accommodation of self-regulatory entry restrictions is Pareto optimal.

4.1. Income Inequality

Although all agents are endowed by nature with exactly the same level of talent, they may experience inequality in their incomes, i.e., in the amounts of output that they possess in the end of the game. The source of income inequality is the appropriation sector. According to proposition 2, if $\theta^R* \geq \widehat{R}/(1-\widehat{\omega})$, the level x^R* of entry barriers into the appropriation arena is $[(1-\widehat{\omega})p(\widehat{\omega})\theta^R*]/\widehat{R}$, which implies that the probability $(1/x^R*)p(\widehat{\omega})$ of entry into the appropriation arena is strictly less than one.[10]

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[9] Proposition 4 would still hold if the government was controlled by a specific social group (laborers, capitalists or predators), aiming at maximizing the group's welfare (rather than total social welfare).

[10] If, on the other hand, $\widehat{R} < \theta^R* < \widehat{R}/(1-\widehat{\omega})$, the level of entry barriers is not sufficiently high to completely exclude any predator from the appropriation arena. Although predators still need to expend some capital to gain access to their sector, they always succeed in entering.

Thus, if $\theta^R* \geq \widehat{R}/(1-\widehat{\omega})$, there are three income groups in the economy; predators with access to the expropriation arena (wealthiest group), producers (middle group) and excluded predators (poorest group). Specifically, the expected income of an agent — laborer, capitalist or predator — is $A\alpha^{\alpha}(1-\alpha)^{1-\alpha}\{d+(1-d)[1-e(\widehat{s})][\widehat{s}+z(e(\widehat{s}))]\}$. Laborers and capitalists always earn exactly this level of income. However, the proportion $(1/x^R*)p(\widehat{\omega})<1$ of predators who succeed in becoming active in appropriation earn a higher income $[x^R*/p(\widehat{\omega})]A\alpha^{\alpha}(1-\alpha)^{1-\alpha}\{d+(1-d)[1-e(\widehat{s})][\widehat{s}+z(e(\widehat{s}))]\}$, while the remaining proportion $1-(1/x^R*)p(\widehat{\omega})$ of predators are completely excluded from appropriation activities and generate a zero income. In this way, the self-regulatory entry barriers of predators lead to an unequal society.

A measure of income inequality that is widely used by economists is the Gini coefficient. The Gini coefficient takes the difference between all pairs of incomes in society and totals the absolute differences. If, for example, the mean income in a population is μ, the number of agents is *n*, and there are n_i agents that generate an income y_i ($i \in \{1,...,m\}$), the Gini coefficient is $(1/(2n^2\mu))\sum_{j=1}^{m}\sum_{k=1}^{m} n_j n_k \left|y_j - y_k\right|$. In our analysis, when $\theta^R* \geq \widehat{R}/(1-\widehat{\omega})$, the Gini coefficient $\widehat{G}$ is strictly positive, i.e., we have[11]

$$G* = \frac{1}{2}[1-(1/x^R*)p(\widehat{\omega})]\theta^R*(2-\theta^R*) > 0. \tag{9}$$

Stronger property rights institutions — a greater *d* — lead to a more equal society, i.e., $\partial G*/\partial d < 0$.

<u>Proposition 5:</u> In a subgame-perfect equilibrium, when $\theta^R* \geq \widehat{R}/(1-\widehat{\omega})$, there is strictly positive income inequality in society, i.e., the Gini coefficient is $G* > 0$. An increase in the strength d of property rights institutions reduces income inequality in society, i.e., $\partial G^* / \partial d < 0$.

Proof: The proof is in the appendix.

In the analysis, income inequality is voluntary. Predators deliberately set up self-regulatory entry barriers to maximize their *ex ante* expected payoff; these barriers may lead to *ex post* income inequality in the appropriation sector. It follows that the degree of income inequality in society depends on the strength of property rights institutions. Stronger institutions leave a lower proportion of the economy's output vulnerable to appropriation. As a result, since the appropriation sector (which is the driving force of income inequality) accounts for a smaller fraction of economic activity, income inequality is less pronounced.

We could obtain the same qualitative conclusions in a less extreme way by allowing, for example, excluded predators to engage in trivial appropriation activities (rather than in no appropriation activities at all) and earn a low income (rather than a zero income). Alternatively, we could allow predators to have a small amount of productive — human or physical — (in addition to their predatory capital); excluded predators would then earn a low income by selling the small amount of their productive capital. In the latter extension, although in equilibrium the poorest agents in society generate their entire income by selling productive capital, they are predators. The reason these agents become the poorest members of society is that they have focused on the generation of predatory capital and can thus sell only a small amount of productive capital if they are excluded from the appropriation arena.

4.2. Economies of Scale

Coming soon …

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[11] If, on the other hand, $\hat{R} < \theta^R * < \hat{R} / (1 - \hat{\omega})$, the Gini coefficient is zero; all agents earn the same income.

4.3. General Production Functions

Coming soon …

4.4. Product Variety

Coming soon …

5. EMPIRICAL IMPLICATIONS

Coming soon …

7. CONCLUSION

Coming soon …

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APPENDIX

Proof of Lemma 1

The first-order condition that stems from expression (2) is

$$\frac{\partial z(e)}{\partial e}(1-e)-[s+z(e)]=0\,. \tag{A1}$$

From (A1), we derive $\partial e(s)/\partial s$ through implicit differentiation. We have

$$\frac{\partial e(s)}{\partial s}=[\frac{\partial^2 z(e)}{\partial e^2}(1-e)-2\frac{\partial z(e)}{\partial e}]^{-1}<0\,. \tag{A2}$$

We also have

$$\frac{\partial[s+z(e(s))]}{\partial s}=1+\frac{\partial z(e)}{\partial e}\frac{\partial e(s)}{\partial s}=\frac{\frac{\partial^2 z(e)}{\partial e^2}(1-e)-\frac{\partial z(e)}{\partial e}}{\frac{\partial^2 z(e)}{\partial e^2}(1-e)-2\frac{\partial z(e)}{\partial e}}>0\,. \tag{A3}$$

The expression $[s+z(e)](1-e)$ is continuous and concave in the closed interval $e\in[0,1]$. As a result, there exists a unique argument of the maximum $e(s)$ on $e\in[0,1]$. To ensure that unique argument of the maximum constitutes an interior solution (i.e., $e(s)\in(0,1)$) for all $s\in[\underline{s},\bar{s}]$, I assume that

$$e(\underline{s})<1\,, \tag{A4a}$$

$$e(\bar{s})>0\,, \tag{A4b}$$

$$\bar{s}+z(e(\bar{s}))<1\,. \tag{A4c}$$

Proof of Proposition 1

In stage 4, the total payoff of all laborers is equal to Lw^L, i.e., equal to $[1-t(d)]\{d+(1-d)(1-e)[s(R)+z(e)]\}A(1-\alpha)K^{\alpha}L^{1-\alpha}$. The derivative of total laborers' payoff with respect to L is strictly positive:

$$[1-t(d)]\{d+(1-d)(1-e)[s(R)+z(e)]\}A(1-\alpha)^2(K/L)^{\alpha}>0\,. \tag{A5}$$

Suppose that in stage 2 laborers impose an entry barrier x^L which induces each laborer to spend an amount ω of human capital in his attempts to gain access to the labor market in stage 3. Then, in stage 4 the total amount L of labor is $\theta^L(1/x^L)p(\omega)(1-\omega)$. It follows that that the total payoff of laborers is maximized when there are no entry barriers into the labor market, i.e., when x^L is set equal to $p(0)$. Then, all available human capital θ^L is sold to firms, maximizing L. Furthermore, given the symmetry of the model, in stage 2, the expected payoff of a laborer is $E(Lw^L)/\theta^L$. A laborer's expected payoff is thus maximized when laborers' total expected payoff $E(Lw^L)$ is maximized (or when L is maximized), i.e., when x^L is set equal to $p(0)$.

Similarly, the derivative of total capitalists' payoff with respect to K is strictly positive:

$$[1-t(d)]\{d+(1-d)(1-e)[s(R)+z(e)]\}A\alpha^2(L/K)^{1-\alpha}>0. \tag{A6}$$

Thus in stage 2 a capitalist's expected payoff is maximized when x^K is set equal to $p(0)$.

Proof of Lemma 2

The second-order condition of (5) is

$$[\frac{\partial^2 z(e)}{\partial e^2}(1-e)-2\frac{\partial z(e)}{\partial e}]^{-1}\{1+[\frac{\partial^2 z(e)}{\partial e^2}(1-e)-2\frac{\partial z(e)}{\partial e}]^{-2}[\frac{\partial^3 z(e)}{\partial e^3}(1-e)-3\frac{\partial^2 z(e)}{\partial e^2}]\}<0. \tag{A7}$$

The expression $[1-s-z(e(s))][1-e(s)]$ is thus continuous and concave in the closed interval $s\in[\underline{s},\bar{s}]$. As a result, there exists a unique argument of the maximum $\hat{s}$ on $s\in[\underline{s},\bar{s}]$. To ensure that unique argument of the maximum constitutes an interior solution (i.e., $\hat{s}\in(\underline{s},\bar{s})$), I assume that

$$-1+e(s/s=\underline{s})-\frac{\partial e(s/s=\underline{s})}{\partial s}>0, \tag{A8a}$$

$$-1+e(s/s=\bar{s})-\frac{\partial e(s/s=\bar{s})}{\partial s}<0. \tag{A8b}$$

Suppose that $\theta^R\le\hat{R}$. Then, predators maximize their payoff by imposing no entry barriers, so that the amount of active predatory capital is as close to $\hat{R}$ as possible. Predators thus set the level x^R of entry barriers equal to $p(0)$. Suppose now that $\theta^R>\hat{R}$. If predators choose a level of x^R that is higher than $p(\hat{\omega})$, the amount of predatory capital that enters into the appropriation arena is $(1/x^R)p(\hat{\omega})(1-\hat{\omega})\theta^R$. This amount is equal to $\hat{R}$ when x^R is $[p(\hat{\omega})(1-\hat{\omega})\theta^R]/\hat{R}$. Predators thus choose this level of x^R if $\theta^R\ge\hat{R}/(1-\hat{\omega})$ (i.e., if x^R is indeed higher than $p(\hat{\omega})$). If, on the other hand, predators choose a level of x^R that is lower than $p(\hat{\omega})$, the amount of predatory capital that enters into the appropriation arena is $[1-\omega(x^R)]\theta^R$. This amount is equal to $\hat{R}$ when $\omega(x^R)$ is $(\theta^R - \hat{R})/\theta^R$, i.e., when $p(\omega(x^R))$ is $p((\theta^R - \hat{R})/\theta^R)$, or x^R is $p((\theta^R - \hat{R})/\theta^R)$. Predators thus choose this level of x^R if $\hat{R} < \theta^R < \hat{R}/(1-\hat{\omega})$ (i.e., if x^R is indeed lower than $p(\hat{\omega})$).

Proof of Proposition 2

As section 3 explained, the expected payoffs of all agents are equalized when the proportion of predators in the population is $E\{(1-d)(1-e)[1-s(R)-z(e)]/[1-(1-d)e]\}$, the proportion of laborers is $(1-\alpha)E\{\{d+(1-d)(1-e)[s(R)+z(e)]\}/[1-(1-d)e]\}$, and the proportion of capitalists is $\alpha E\{\{d+(1-d)(1-e)[s(R)+z(e)]\}/[1-(1-d)e]\}$. Assumption (7) implies that agents always expect the level of s to be set equal to $\hat{s}$ in stage 2. It follows that the unique proportions of laborers, capitalists and predators that equalize the payoffs of the three types are $\theta^L *$, $\theta^K *$ and $\theta^R *$, respectively. Furthermore, the level $x^R *$ of entry barriers follows directly from lemma 2. Since $\theta^R * > \hat{R}$, we have $x^R * > p(0)$.

Proof of Proposition 3

We have

$$\frac{\partial \theta^R *}{\partial d} = -\frac{[1-e(\hat{s})][1-\hat{s}-z(e(\hat{s}))]}{[1-(1-d)e(\hat{s})]^2} < 0 . \qquad \text{(A9)}$$

It follows that

$$\frac{\partial x^R *}{\partial d} = \frac{\partial p(\omega / \omega = \dfrac{\theta^R * - \hat{R}}{\theta^R *})}{\partial \omega} \frac{\partial \theta^R *}{\partial d} \frac{\hat{R}}{\theta^R *^2} < 0 \quad \text{if } \hat{R} < \theta^R * < \frac{\hat{R}}{1-\hat{\omega}}, \qquad \text{(A10a)}$$

$$\frac{\partial x^R *}{\partial d} = \frac{\partial \theta^R *}{\partial d} \frac{(1-\hat{\omega})p(\hat{\omega})}{\hat{R}} < 0 \quad \text{if } \theta^R * \geq \frac{\hat{R}}{1-\hat{\omega}} . \qquad \text{(A10b)}$$

Proof of Proposition 4

In equilibrium in stage 2, only the group of predators decides to impose entry restrictions. If the government dismantles these entry barriers, setting x^R equal to $p(0)$, all predators enter into the appropriation arena. The amount of active predatory capital becomes $\theta^R * > \hat{s}$. Then, as lemma 1 implies, the fraction e of the economy's appropriable output that is dissipated increases, while $s + z(e)$ decreases. As a result, the payoff $\{d+(1-d)(1-e)[s+z(e)]\}A(1-\alpha)(K/L)^{\alpha}$ of a laborer and the payoff $\{d+(1-d)(1-e)[s+z(e)]\}A\alpha(L/K)^{1-\alpha}$ of a capitalist decreases. Furthermore, the payoff $(1-d)(1-e)[1-s-z(e)]AK^{\alpha}L^{1-\alpha}/\theta^R$ of a predator decreases because

$(1-e)[1-s-z(e)]$ is maximized when s is set equal to $\hat{s}$ (which would be attained if entry barriers maintained). It follows that dismantling the entry barriers x^R* reduces the payoff of all agents, leading to a Pareto deterioration.

Proof of Proposition 5

If $\theta^R* \geq \hat{R}/(1-\hat{\omega})$, the level x^R* of entry barriers into the appropriation arena is equal to $[(1-\hat{\omega})p(\hat{\omega})\theta^R*]/\hat{R}$ (proposition 2). It follows that the probability $(1/x^R*)p(\hat{\omega})$ of entry into the appropriation arena is $\hat{R}/[(1-\hat{\omega})\theta^R*] < 1$ and the Gini coefficient $G*$ is $(1/2)[1-(1/x^R*)p(\hat{\omega})]\theta^R*(2-\theta^R*) > 0$. Since $\partial\theta^R*/\partial d < 0$ (condition (A9)), we also have

$$\frac{\partial G*}{\partial d} = \frac{\partial \theta^R*}{\partial d}\{[1-\frac{\hat{R}}{(1-\hat{\omega})\theta^R*}](1-\theta^R*) + \frac{\hat{R}}{2(1-\hat{\omega})\theta^R*^2}\theta^R*(2-\theta^R*)\} < 0 . \quad \text{(A11)}$$