

**Preliminary and Incomplete
Comments Welcomed**

**INSTITUTIONS, APPROPRIATION ACTIVITY,
AND INCOME INEQUALITY**

By

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ABSTRACT: The allocation of society's activity between production and appropriation and the quality of property rights protection are important determinants of income inequality. Expropriation activity generates inequality because of the endogenous emergence of self-regulating restrictive institutions. Such institutions shape the structure of the appropriation sector and screen entry into the expropriation arena; their objective is to mitigate potential defensive measures by output producers and maximize the average expected payoff of appropriators. In equilibrium, weaker property rights protection and more extensive appropriation cause more pronounced income inequality, as well as a lower level of output.

Key Words: Appropriation, Property Rights, Institutions, Income Inequality.

JEL Classification Codes: P48, O, J3.

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1. INTRODUCTION

The degree of income equality in society is an important indicator of economic well-being. A country's economic prosperity is ultimately determined not only by the level of Gross Domestic Product (GDP), but also by the pattern of distribution of total GDP within the population. For this reason, the causes of inequality constitute a popular research topic in economics. Orthodox economic theory mainly attributes income inequality to different levels of talent or human capital among agents and to technological biases towards specific sectors and occupations (Rosen [1981], Acemoglu [1998, 2003], Aghion [2002]). There is no doubt that the orthodox approach makes a vital contribution to economics and can account for some of the inequality we observe in society.

The neoclassical framework, however, is limited in that it takes complete property rights protection for granted. In recent years historians and policy makers have started to depart from the neoclassical paradigm, often associating income inequality with the incompleteness of property rights institutions or with the existence of activities outside the realm of legal protection (De Soto [2000], Sokoloff and Engerman [2000]). For example, the pronounced income inequality in many Latin American and former Soviet block countries is sometimes linked to a prevalent emphasis on appropriation activities that aim at seizing the output of others, rather than on productive activities that create new output. As Hernando De Soto [2000] points out

“Ten years ago, few would have compared the former Soviet block nations to Latin America. But today they look astonishingly similar: strong underground economies, glaring inequality, pervasive mafias, political instability, capital flight, and flagrant disregard for law.”¹

Empirical studies show that appropriation inherently entails a more unequal distribution of income than production (Levitt and Venkatesh [2000, 2001]). In many cases, the wealthiest people in a country accumulate their fortune by expropriating the property of others (Veblen [1899], Baumol [1990]); for example, wealth can be amassed by building political connections and using the government as a medium for rent seeking, by joining the bureaucracy and soliciting bribes, or by becoming involved in outright

¹ De Soto [2000], p. 209.

coercive and criminal activities.² At the same time, the poorest people in society may also tend to engage in appropriation, rather than in production. For instance, urban slums in developing countries often exhibit an extremely high crime rate; in Rio's favelas the murder rates for youngsters are higher than in many actual war zones (Lakshmanan [2006]). Furthermore, even when an economy's poor are employed in the productive sector, they often exhibit a primary aptitude for appropriation, rather than for production (Levitt and Venkatesh [2000, 2001]).

Thus both the wealthiest and poorest groups (as opposed to the middle groups) in an economy often specialize in expropriation; reinforced by the weakness of property rights institutions, appropriation seems to be associated with a more unequal society. Nevertheless, appropriation or weak property rights protection as a source of inequality has received little attention in formal economic theory. Hernando De Soto [2000] characteristically observes that

“[Capitalist thinking] has no comparable analysis or even a serious strategy for reaching the poor in the extralegal sector. Capitalists generally have no systemic explanation of how the people in the underclass got where they are and how the system could be changed to raise them up.”³

This paper provides a simple theoretical framework to illustrate how the presence of appropriation activity or the incompleteness of property rights institutions can be a driving force of income inequality in society. In the model, an agent makes a rational choice as to whether to become either a producer or a predator. Producers develop the ability to produce output, while predators specialize in appropriation, trying to expropriate the property of producers. In the spirit of industrial organization theory, the members of each group — producers or predators — have the opportunity to cooperatively form self-regulating restrictive institutions, monitoring entry into their sector (and thus shaping the structure of their sector).⁴ Furthermore, the government can

² Veblen [1899] uses the term “leisure class” to describe society's upper classes that tend to engage in appropriation.

³ De Soto [2000], p. 213.

⁴ As industrial organization theory points out, doctors, lawyers and accountants are some examples of professional groups that often set up self-regulating restrictive institutions (Carlton and Perloff [2000]). While industrial organization theory examines such institutions in isolated markets, this paper focuses on an analysis at a macroeconomic or country level.

operate property rights institutions that aim at offering producers legal protection against predators. Given that legal protection entails significant administrative costs, property rights institutions are incomplete in equilibrium; a fraction of each producer's output is vulnerable to appropriation. For this reason, each producer supplements the legal protection that he receives from the government with individual efforts to privately hide (and thus protect) his property from predators.

Because predators are in conflict with each other over the distribution of appropriable producer property, they can maximize their expected payoff by cooperatively screening entry into the expropriation arena. In particular, when the intensity of appropriation activity, — i.e., the number of active predators per producer, — is excessive, average predator payoff decreases; producers are induced to spend an excessive amount of time on privately hiding their property from predators. Excessive private defensive measures by producers may to some extent neutralize the appropriation attempts of predators; they may also divert producer time from production and reduce an economy's total output.

The self-regulating restrictive institutions of predators may thus maximize expected predator payoff by excluding some predators from expropriation activities and attaining the optimal (for predators) intensity of appropriation. Producers, on the other hand, are not in conflict with each other because, unlike predators, they focus on creating new output, rather than on seizing existing output. A producer is not negatively impacted by the activities of other producers. As a result, in equilibrium producers do not establish screening institutions to block entry into production. In practice, some examples of restrictive institutions of predators include networks of cronies (cronyism) or relatives (familism) that screen entry into rent seeking activities and the Sicilian and Sicilian-American Mafia Commissions or the various federations of U.S. inner city gangs that screen entry into outright coercive activities.

In the analysis, appropriation leads to an unequal society even when all agents are endowed with exactly the same level of talent by nature. In equilibrium, restrictive institutions generate inequality within the group of predators by limiting the number of active slots in the expropriation arena. Successful access to the arena translates into a very high income, while exclusion translates into a very low income. The poorest

members of society are excluded predators that either resort to trivial (and thus relatively unprofitable) appropriation activities or rely on their inferior productive skills to engage in marginal production (rather than on their superior appropriation skills to engage in expropriation).

In the model, there may be two interior equilibria in aptitude allocation. In a productive equilibrium, the proportion of producers in the population is high, allowing producers to gain political control of the country's government and establish strong property rights institutions. In a predatory equilibrium, on the other hand, the group of predators prevails politically and chooses weak property rights institutions. Because weaker legal protection leaves a higher fraction of total output vulnerable to expropriation, there is more extensive appropriation activity in a predatory than in a productive equilibrium. As a result, in a predatory equilibrium the restrictive institutions of predators play a more pervasive role, leading to a more unequal society and a higher Gini coefficient of income inequality. Further, the level of output is lower in a predatory equilibrium because the skills of predators are less conducive to economic prosperity than the skills of producers.

A historical comparison between the United States and Argentina — two European colonies with relatively similar natural resource endowments — constitutes a good natural experiment that confirms the conclusions of our model. Furthermore, the model has empirical implications that are not captured by existing economic theory. In the analysis, there is more pronounced income inequality within the group of predators than within the group of producers in an economy, which is consistent with the empirical results of Levitt and Venkatesh [2000, 2001]. The model is also consistent with the empirical observation that weaker property rights protection or more corruption is associated with more pronounced income inequality (Chor [2005], Glaeser and Saks [2006]). Further, the result that weaker initial property rights institutions are associated with higher subsequent income inequality (Chor [2005]) may imply that institutional inefficiency may cause income inequality, which is in harmony with our analysis.

The paper most closely relates to the theoretical literature on rent seeking and property rights institutions (Murphy, Shleifer and Vishny [1991, 1993], Acemoglu [1995, 2005], Aghion, Alesina and Trebbi [2004], Acemoglu and Robinson [2006, forth]), which

analyzes in detail the pernicious effects of appropriation and institutional inefficiency on the level and the growth rate of a country's GDP. I extend this literature by focusing on a different issue, namely the impact of appropriation and weak property rights institutions on the degree of income inequality in a country. It is shown that pronounced appropriation and weak property rights protection may inherently lead to an unequal society.

In a different vein, Glaeser, Scheinkman and Shleifer [2003] and Acemoglu, Ticchi and Vindigni [2007] discuss the effects of income inequality on property rights institutions — i.e., the reverse of the question that is examined in our model. They show that glaring income inequality may allow a small elite to capture the political system and set up extractive institutions to expropriate the rest of the population; income inequality is thus path dependent. In this paper, I supplement existing work by focusing on the causes, rather than the effects of inequality; the analysis demonstrates how appropriation activity and incomplete property protection may lead to (rather than stem from) income inequality.

There is a vast literature on inequality which offers several explanations for the sources of income inequality in society.⁵ For example, in addition to technological biases and different levels of talent or human capital accumulation among agents (Rosen [1981], Acemoglu [1998, 2003], Aghion [2002]), income inequality has been attributed to the randomness of investment returns (Aghion and Bolton [1997]) or to increased sorting (Fernandez and Rogerson [2001]). This paper extends the existing literature on income inequality by proposing the novel explanation that it may be the presence of appropriation activity and the incompleteness of property rights institutions that lead to an unequal society.

The paper consists of seven sections. Section 2 describes the basic model that focuses on an economy without property rights. Section 3 solves for the equilibrium of the basic model. Section 4 examines income inequality. Section 5 extends the basic model to incorporate property rights institutions. Section 6 discusses the empirical implications of the analysis. Finally, section 7 presents some conclusions.

⁵ Furthermore, there is a vast literature that examines a society's redistributive tax and welfare policies (e.g., Fishback and Kantor [2000], Alesina and Angeletos [2005], Benabou and Tirole [2006]). In this paper, I abstract from income redistribution and focus on a different issue, namely the causes of inequality.

2. AN ECONOMY WITHOUT PROPERTY RIGHTS

The basic model examines an economy without property rights. The government does not establish any laws and institutions to protect the property of agents; agents can guard their belongings only through private activities. By analyzing the operations of such a rudimentary economy, we can bring out in a clear and straightforward manner the mechanics of inequality. Later on, we will see that the insights of the basic model can be easily extended to an economy where the government formally enforces property rights through its institutions.

In the model, the economy is populated by a continuum of agents whose measure is normalized to 1. All agents are endowed by nature with exactly the same level of talent. By assuming that all agents have the same level of innate ability, we can abstract from natural talent differences as a source of inequality and thus focus on the important role of appropriation activity. The analysis will show that even when all agents are equally talented, appropriation may lead to an unequal society.

I characterize an agent as either a producer (P) or a predator (R). Although both producers and predators aim at maximizing their personal wealth, they use their innate talent (which is equal for everyone) to build up different types of skills, thereby pursuing wealth maximization in different ways. Producers develop the ability to create output, but do not have appropriation skills. Predators, on the other hand, lack the ability to engage in production; instead, they develop an aptitude for appropriation activities, attempting to expropriate the property of producers. For example, appropriation may take the form of coercive encroachment, confiscatory redistribution, or political privilege to use the government as a medium for rent seeking (Hirshleifer [1988]).⁶ The proportion of producers and predators in the population is θ^P and $\theta^R = 1 - \theta^P$ respectively.

The results of the model would be qualitatively similar if each producer also had some inferior appropriation skills (in addition to his superior productive skills) and each predator also had some inferior productive skills (in addition to his superior appropriation skills). Such an extension, however, would unnecessarily complicate our calculations

⁶ 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.

without affecting the conclusions. Thus for simplicity, the basic model assumes that producers and predators specialize solely in production and appropriation respectively. Section 4.2 will discuss an extension where agents can engage in a combination of productive and appropriation activities.

In the analysis, an agent chooses his aptitude type — producer or predator — at the beginning of the game. Agents make their aptitude decisions with perfect foresight, aiming at maximizing their individual expected wealth. The acquisition of skills constitutes a long-term training process that can only start early. For this reason, an agent's aptitude decision at the beginning of the game is irreversible and his particular aptitude type characterizes him for the entire game. The long-term nature of skill development in the model and the rather inflexible agent behavior that logically follows is in the spirit of Stigler and Becker [1977] who point out that long-term skills cause rational agents to commit to a rather rigid course of action. Overall, our model follows the standard game theory methodology of perfect foresight and subgame perfection (Fudenberg and Tirole [1991]). With rational expectations about the simultaneous aptitude decisions of other agents and the future effects of these decisions on his payoff, an agent chooses his aptitude type.

According to industrial organization theory, a common and natural form of interaction among members of the same professional group is the cooperative formation of restrictive institutions that determine whether or not to admit a potential member to the group; a group thus engages in self-regulation (Shaked and Sutton [1981], Carlton and Perloff [2000]). Lawyers, doctors and accountants are good examples of professional groups that often set up such self-regulating restrictive institutions.

In the model there are two aptitude groups, producers and predators. In the spirit of industrial organization theory, each group has the opportunity to form restrictive institutions, shaping the structure of its sector; these self-regulating institutions may screen entry into the activities of the group. The objective of such institutions is to maximize the expected payoff of individual members of the corresponding group. In particular, producers may reach a cooperative decision about the proportion of producers α^P that will be allowed to actively engage in production, where $0 \leq \alpha^P \leq 1$. Similarly, predators may reach a cooperative decision about the proportion of predators α^R that

will be allowed to actively engage in appropriation, where $0 \leq \alpha^R \leq 1$. After α^P and α^R are determined, the specific producers and predators that actually enter the production and appropriation sector are randomly chosen by nature. Given that all producers (predators) have the same innate talent, they have the same probability α^P (α^R) of being allowed to become active. The remaining proportion of producers $1 - \alpha^P$ (of predators $1 - \alpha^R$) is prohibited from participating in any production (appropriation) activities whatsoever.

An active producer utilizes his productive skills to manufacture an output. Furthermore, as in Murphy, Shleifer and Vishny [1993] and Grossman [2001], producers have the opportunity to hide some of their property to prevent its appropriation by predators. An active producer may choose to spend an amount of time e on privately hiding (and thus protecting) his output from predators, where $0 \leq e \leq 1$. Because an active producer has only one unit of time available, he utilizes an amount of time $1 - e$ for productive activities when he spends a time e on property hiding. The output that is manufactured by an active producer is ω per unit of productive time; an active producer thus generates an output that is equal to $(1 - e)\omega$.

The distribution of the economy's output between producers and predators is determined by two parameters, namely the intensity of appropriation activity in society and each producer's private protective measures. The intensity of appropriation activity corresponds to the ratio $(\alpha^R \theta^R)/(\alpha^P \theta^P)$ of active predators to active producers in the population; appropriation is more intense when the number of active predators per active producer is larger. An active producer that takes no private protective measures against expropriation maintains possession of a fraction $s((\alpha^R \theta^R)/(\alpha^P \theta^P))$ of his output, where s is decreasing in $(\alpha^R \theta^R)/(\alpha^P \theta^P)$ and $s(0) = 1$.

Furthermore, an amount of time e that is allocated to hiding efforts allows an active producer to conceal an additional fraction $z(e)$ of his property from predators, where z is increasing in e . To ensure that second-order conditions are met and an interior equilibrium exists, it is also assumed that $\partial^2 z(e)/\partial e^2 \leq 0$. Overall, an active producer successfully protects from predators a fraction $s((\alpha^R \theta^R)/(\alpha^P \theta^P)) + z(e)$ of his output. Given that all active predators that have been allowed into the appropriation arena have

the same innate talent, they each seize an equal share of the remaining fraction $1 - s((\alpha^R \theta^R)/(\alpha^P \theta^P)) - z(e)$ of an active producer's output, which is appropriable.⁷

We have a six-stage game:

Stage 1: Each agent chooses his aptitude type — producer or predator — and begins acquiring the skills relevant for his type.

Stage 2: Producers have the opportunity to cooperatively determine the proportion α^P of active producers by setting up self-regulating restrictive institutions. Similarly, predators have the opportunity to cooperatively determine the proportion α^R of active predators by establishing self-regulating restrictive institutions.

Stage 3: Nature randomly selects the specific producers (who constitute a proportion α^P of all producers) and the specific predators (who constitute a proportion α^R of all producers) that actually become active.

Stage 4: Each active producer chooses the amount of time e that he will spend on privately hiding his property.

Stage 5: Production takes place.

Stage 6: Active predators try to appropriate the output of producers.

For simplicity, I adopt the tie-breaking convention that if an agent is indifferent between becoming a producer and a predator, he becomes a predator.

3. EQUILIBRIUM IN AN ECONOMY WITHOUT PROPERTY RIGHTS

To solve for the subgame-perfect equilibrium, I proceed by backward induction.

3.1 Choice of e by Active Producers

An active producer's payoff is equal to $[s((\alpha^R \theta^R)/(\alpha^P \theta^P)) + z(e)](1 - e)\omega$. An active producer's choice of e thus is

$$e(s) = \arg \max_e [s + z(e)](1 - e). \quad (1)$$

⁷ The assumption that the appropriable property of producers is equally distributed among all active predators is standard in the appropriation literature. See, for example, Murphy, Shleifer and Vishny [1993]

In an interior solution, we have $\partial e(s)/\partial s < 0$. When appropriation activity is intense (i.e., when $(\alpha^R \theta^R)/(\alpha^P \theta^P)$ is high and s is low), an active producer needs to spend more time on privately hiding his property from predators.

Lemma 1: The time e that an active producer privately spends to hide his property is increasing in the intensity of appropriation activity, i.e. $\partial e(s)/\partial s < 0$.

Proof: The proof is in the appendix.

Less intense appropriation activity — a lower $(\alpha^R \theta^R)/(\alpha^P \theta^P)$ and a higher s — translates into a less serious expropriation threat to producers, but also induces producers to reduce their private hiding efforts. Overall, an active producer maintains possession of a higher fraction of his output as appropriation activity becomes less intense, i.e., $\partial[s + z(e(s))]/\partial s > 0$.

Lemma 2: The overall fraction of his output of which an active producer maintains possession is decreasing in the intensity of appropriation activity, i.e., $\partial[s + z(e(s))]/\partial s > 0$.

Proof: The proof is in the appendix.

3.2 Choice of α^P by Producers and of α^R by Predators

Producers never decide to set up restrictive institutions; they always set α^P equal to 1 regardless of the level of α^R . For one thing, a producer is not negatively impacted by the activities of other producers and has no reason to support restrictions on entry into the productive sector.⁸ Also, given that s is decreasing in $(\alpha^R \theta^R)/(\alpha^P \theta^P)$, the payoff of

and Grossman and Kim [2000].

⁸ As industrial organization theory shows, if we examine only an isolated productive profession (e.g., doctors, accountants, etc) at a microeconomic level, members of the profession may sometimes have an incentive to screen entry into their group to raise the price of their product. This paper, however, focuses on general production at a macroeconomic or country level, rather than on isolated professions. At this level, producers are not in conflict with each other and have no incentive to restrict entry into general

an active producer is increasing in the total number of active producers because the intensity of appropriation subsides; appropriation activity becomes more diluted. For this reason, when the number of active producers is larger, an individual active producer maintains possession of a larger fraction (lemma 2) of his now higher output (lemma 1). We thus have

$$\alpha^P = 1. \quad (2)$$

Given that α^P is always equal to 1, an active predator's payoff is $[\theta^P / (\alpha^R \theta^R)][1 - s(\alpha^R \theta^R / \theta^P) - z(e)](1 - e)\omega$. The probability that a predator will become active is α^R , and thus in stage 2 a predator's expected payoff is $\alpha^R[\theta^P / (\alpha^R \theta^R)][1 - s(\alpha^R \theta^R / \theta^P) - z(e)](1 - e)\omega$ or $(\theta^P / \theta^R)[1 - s(\alpha^R \theta^R / \theta^P) - z(e)](1 - e)\omega$. Predators have the opportunity to set up restrictive institutions to attain the level of s that maximizes this payoff. The optimal level of s for predators is

$$\hat{s} = \arg \max_s [1 - s - z(e(s))][1 - e(s)]. \quad (3)$$

The interior solution is given by

$$-1 + e(s) - \frac{\partial e(s)}{\partial s} = 0. \quad (4)$$

As condition (4) implies, predators face a trade-off when they set the level of s . A low level of s (i.e., more intense appropriation activity in the economy) generates two opposing effects:

production. Our macroeconomic insight supplements, rather than contradicts, the industrial organization findings about the existence of entry barriers in some isolated professions. In particular, at a macroeconomic level, a producer can use his productive skills in several different productive occupations. Even if there are restrictive institutions that monitor entry into some isolated professions (but not into country-wide production), a producer can easily choose another productive occupation (or create a new productive occupation as an entrepreneur), instead of being kept out of the general productive sector.

- (a) Appropriation intensity effect: More intense appropriation raises the fraction of a producer's output that is appropriable *ceteris paribus*. This increases the expected payoff of a predator (i.e., $-1 + e(s) < 0$).
- (b) Producers' reaction effect: More intense appropriation induces producers to spend more time on private defensive activities and less time on productive activities. This reduces the overall amount $(1 - e)\omega$ of a producer's output. Increased private defensive activities also counter the appropriation intensity effect to some extent, decreasing the appropriable fraction of a producer's output. Such producer reactions reduce the expected payoff of a predator (i.e., $-\partial e(s) / \partial s > 0$ according to lemma 1).

Predators weigh both effects when they set up their restrictive institutions and choose \hat{s} .

The optimal (for predators) level \hat{s} is attained when the ratio of active predators to producers in the population is equal to $\hat{\theta}$, i.e., $\hat{s} = s(\hat{\theta})$. Thus in stage 2 predators cooperatively select the level of α^R that leads to \hat{s} . We have

$$\alpha^R = \frac{\theta^P}{\theta^R} \hat{\theta}. \quad (5)$$

When, however, the optimal α^R is strictly higher than 1 (i.e., when $(\theta^P / \theta^R) \hat{\theta} > 1$), predators resort to a second-best corner solution where α^R is exactly equal to 1 and s is equal to $s(\theta^R / \theta^P)$ (rather than equal to \hat{s}). In this corner solution, predators set up no restrictive institutions; all predators are allowed to enter the appropriation arena and engage in expropriation activities.

Intuitively, an important difference between predators and producers is that the former are in conflict with each other over the distribution of existing property, while the latter focus on the creation of new output and are thus not in conflict with each other. As a result, unlike producers, predators may have an incentive to self-regulate their disputes

by forming restrictive institutions and by monitoring entry into the expropriation arena. In practice, restrictive institutions are quite common in the appropriation sector. For instance, predators often organize rent seeking activity by allowing some networks of cronies (cronyism) or relatives (familism) to screen the number of agents that can use the government as a medium for appropriation (Desai [2007]). Or, in a rather extreme example, the Sicilian and Sicilian-American Mafia Commissions or the federations of U.S. inner city gangs are self-regulating institutions that carefully monitor entry into outright coercive activities (Gambetta [1993]).

3.3. Agent Type Decisions

In a subgame-perfect equilibrium the expected payoff of a producer is equal to the expected payoff of a predator in stage 1; otherwise, agents would have an incentive to deviate. Provided that the restrictive institutions of predators attain the optimal level \hat{s} in stage 2 — i.e., provided that predators reach an interior solution $\alpha^R = (\theta^P / \theta^R) \hat{\theta} \leq 1$ — the equilibrium proportions of producers and predators in the economy in stage 1 are $\hat{\theta}^P$ and $\hat{\theta}^R$ respectively. We have

$$\hat{\theta}^P = \hat{s} + z(e(\hat{s})), \quad (6a)$$

$$\hat{\theta}^R = 1 - \hat{s} - z(e(\hat{s})). \quad (6b)$$

If, on the other hand, predators are expected to reach a corner solution $\alpha^R = 1 < (\theta^P / \theta^R) \hat{\theta}$ in stage 2, the proportions of producers and predators in the economy that equalize the expected payoffs of the two types are given by

$$\left[s\left(\frac{\theta^R}{\theta^P}\right) + z\left(e\left(s\left(\frac{\theta^R}{\theta^P}\right)\right)\right) \right] = \frac{\theta^P}{1 - \theta^P} \left[1 - s\left(\frac{\theta^R}{\theta^P}\right) - z\left(e\left(s\left(\frac{\theta^R}{\theta^P}\right)\right)\right) \right]. \quad (7)$$

A necessary condition for the existence of an equilibrium in which there is a strictly positive proportion of both producers and predators in the population is

$(\hat{\theta}^R / \hat{\theta}^P) > \hat{\theta}$, i.e., $(\hat{\theta}^P / \hat{\theta}^R) \hat{\theta} < 1$. Thus an equilibrium where there are both producers and predators in the economy exists only when the ratio of predators to producers that equalizes the expected payoff of the two types is sufficiently high for predators to set up restrictive institutions and choose $\alpha^R < 1$ in stage 2. Then, the equilibrium proportions of producers and predators in the economy in stage 1 are $\hat{\theta}^P$ and $\hat{\theta}^R$ respectively.⁹

Lemma 3: A necessary condition for the existence of an equilibrium in which there is a strictly positive proportion of both producers and predators in the population is $(\hat{\theta}^R / \hat{\theta}^P) > \hat{\theta}$.

Proof: The proof is in the appendix.

Intuitively, if $(\hat{\theta}^R / \hat{\theta}^P) \leq \hat{\theta}$ (i.e., if $(\hat{\theta}^P / \hat{\theta}^R) \hat{\theta} \geq 1$), even when the expected payoff of a producer is equal to the expected payoff of a predator in stage 1, predators always have an incentive to deviate from their type and become producers. Because in stage 2 predators are expected to choose $\alpha^R = 1$, — i.e., all predators will be allowed to participate in expropriation activities, — even a single predator is in a position to affect the payoff of producers by deviating and becoming a producer himself; his deviation will lead to a higher s (and thus to a higher payoff for producers according to lemmas 1 and 2). If, on the other hand, $(\hat{\theta}^R / \hat{\theta}^P) > \hat{\theta}$ (i.e., if $(\hat{\theta}^P / \hat{\theta}^R) \hat{\theta} < 1$), predators are expected to choose $\alpha^R < 1$ in stage 2. Then, a single predator is not in a position to affect the payoff of producers by deviating and thus has no incentive to deviate when his expected payoff is equal to the payoff of a producer. If a predator deviates, the restrictive institutions of predators will still attain the optimal (for predators) \hat{s} , leaving the payoff of producers unaffected; only α^R will change.

⁹ Trivially, another necessary condition for the existence of an equilibrium where there is a strictly positive proportion of both producers and predators in the population is $0 < \hat{\theta}^P = \hat{s} + z(e(\hat{s})) < 1$.

Parameter $\hat{\theta}$ is largely independent of $\hat{\theta}^P$ and $\hat{\theta}^R$; $\hat{\theta}$ is determined by the functional form of $s(\cdot)$, while $\hat{\theta}^P$ and $\hat{\theta}^R$ are determined by the functional form of $z(\cdot)$. For this reason, it is straightforward to see that depending on the specific functional forms of $s(\cdot)$ and $z(\cdot)$, condition $(\hat{\theta}^R / \hat{\theta}^P) > \hat{\theta}$ is often met (and an equilibrium with strictly positive proportions of both producers and predators exists). The remainder of the paper will mostly focus on the case where we have $(\hat{\theta}^R / \hat{\theta}^P) > \hat{\theta}$, and there exists an equilibrium with strictly positive proportions of both producers and predators. The coexistence of producers and predators in an economy is the most relevant case from an empirical standpoint.

Lemma 3 implies that in a subgame-perfect equilibrium with both producers and predators in the population, we always have $(\hat{\theta}^R / \hat{\theta}^P) > \hat{\theta}$ (otherwise, if $(\hat{\theta}^R / \hat{\theta}^P) \leq \hat{\theta}$, such an equilibrium does not exist). Then, in stage 2 predators always choose $\alpha^R < 1$, and in stage 1 the equilibrium proportions of producers and predators in the economy are given by (6a) and (6b).

Proposition 1: In a subgame-perfect equilibrium with a strictly positive proportion of both producers and predators in the population, the proportion of producers is $\hat{\theta}^P = \hat{s} + z(e(\hat{s}))$ and the proportion of predators is $\hat{\theta}^R = 1 - \hat{s} - z(e(\hat{s}))$.

Aside from the equilibrium where the proportion of producers is $\hat{\theta}^P$ and the proportion of predators is $\hat{\theta}^R$, we may also have a corner solution where all agents in the population choose to become producers, i.e., $\theta^P = 1$.¹⁰

¹⁰ This equilibrium exists when the limit of the expected payoff of predators as θ^P tends to 1 is lower than the limit of the payoff of producers. In particular, according to L' Hopital's rule, a corner solution exists in three cases. It exists if condition (A1) leads to a strictly positive e or a strictly negative e for $s = 0$ (which translates into a corner solution $e(0) = 0$) and $-\partial s(\alpha^R \theta^R / \theta^P = 0) / \partial(\alpha^R \theta^R / \theta^P) < 1$, or if condition (A1) leads to $e = 0$ for $s = 0$ and $-\partial s(\alpha^R \theta^R / \theta^P = 0) / \partial(\alpha^R \theta^R / \theta^P) [1 + (\partial z(e = 0) / \partial e)(\partial e(s = 1) / \partial s)] < 1$.

4. INCOME INEQUALITY

Let us examine a subgame-perfect equilibrium that entails a strictly positive proportion of both producers and predators in the population. Then, although all agents are endowed by nature with exactly the same level of talent, they experience inequality in their incomes, i.e., in the amounts of output that they possess in the end of the game. In particular, the expected income of an agent (producer or predator) is $\hat{\theta}^P [1 - e(\hat{s})]\omega$. However, because $\alpha^R < 1$ (lemma 3), a proportion α^R of predators generate an income $(1/\alpha^R)\hat{\theta}^P [1 - e(\hat{s})]\omega$, while the remaining proportion $1 - \alpha^R$ are completely excluded from appropriation activities and generate a zero income. The self-regulating restrictive institutions of predators lead to an unequal society. 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).

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 ($i \in \{1, \dots, m\}$), the Gini coefficient is $(1/(2n^2\mu)) \sum_{j=1}^m \sum_{k=1}^m n_j n_k |y_j - y_k|$. In our analysis, in a subgame-perfect equilibrium where there are both producers and predators in the population the Gini coefficient is

$$G = \frac{1}{2}(1 - \alpha^R)\hat{\theta}^R (2 - \hat{\theta}^R) > 0. \quad (8)$$

In a corner solution, on the other hand, where there are only producers in the population, the Gini coefficient is zero. There is no inequality whatsoever because all producers earn exactly the same income.

Proposition 2: In a subgame-perfect equilibrium with a strictly positive proportion of both producers and predators in the population, there is strictly positive income inequality in society, i.e., the Gini coefficient is $[(1 - \alpha^R)\hat{\theta}^R(2 - \hat{\theta}^R)]/2 > 0$.

Intuitively, the source of income inequality in society is the presence of appropriation activity. Because predators are in conflict with each other over the distribution of existing property, they have an incentive to self-regulate their sector to maximize their expected payoff; predators cooperatively establish restrictive institutions that monitor entry into the expropriation arena. By setting up restrictive institutions, however, predators generate inequality among themselves as the income of a fraction $1 - \alpha^R$ of predators is driven to zero. Producers, on the other hand, are not in conflict with each other and have no incentive to monitor entry into the productive sector. It is inequality within the group of predators that leads to an unequal society. Such inequality exists even when all agents are endowed by nature with exactly the same level of talent.

Although the result that excluded predators earn a zero income is rather extreme, it allows us to bring out the mechanics of inequality in a clear and straightforward manner. 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 inferior productive skills (in addition to their superior appropriation skills); excluded predators would then earn a low income by engaging in trivial productive activities. These extensions of the model are discussed in sections 4.1 and 4.2.

4.1. Two-Tier Appropriation Activity

It is straightforward to extend the model to allow for the possibility that restrictive institutions may be unable to totally exclude predators from the appropriation arena; excluded predators may resort to trivial (and relatively ineffective) expropriation. Specifically, the effectiveness of trivial appropriation activities is a proportion β of the effectiveness of standard appropriation activities, where $0 < \beta < 1$. The intensity of

appropriation in the economy is $[\alpha^R \theta^R + (1 - \alpha^R) \beta \theta^R] / (\alpha^P \theta^P)$ or $[(1 - \beta) \alpha^R \theta^R + \beta \theta^R] / (\alpha^P \theta^P)$; the proportion $1 - \alpha^R$ of predators that are excluded from the appropriation arena resort to trivial appropriation. Furthermore, when the appropriable output of producers is distributed among predators, the share of each excluded predator is a proportion β of the share of each included predator.

By following the same procedure as in the basic model, we can see that in stage 2 predators attain the optimal level \hat{s} (which is given by expression (3)) by choosing $\underline{\alpha}^R = (\theta^P \hat{\theta} - \theta^R \beta) / [\theta^R (1 - \beta)]$. Lemma 3 still holds. As in the basic model, in a subgame-perfect equilibrium with a strictly positive proportion of both producers and predators in the population, the proportion of producers is $\hat{\theta}^P = \hat{s} + z(e(\hat{s}))$ and the proportion of predators is $\hat{\theta}^R = 1 - \hat{s} - z(e(\hat{s}))$. Then, there are three income groups in society. A predator with access to the appropriation arena (wealthiest group) generates an income $\{1 / [\beta + (1 - \beta) \underline{\alpha}^R]\} \hat{\theta}^P [1 - e(\hat{s})] \omega$. A producer (middle group) earns an income $\hat{\theta}^P [1 - e(\hat{s})] \omega$. A predator without access to the appropriation arena (poorest group) generates an income $\{\beta / [\beta + (1 - \beta) \underline{\alpha}^R]\} \hat{\theta}^P [1 - e(\hat{s})] \omega$. The Gini coefficient is $(1 - \underline{\alpha}^R) \underline{\alpha}^R (1 - \beta) (2 - \hat{\theta}^R) \hat{\theta}^R / \{2[\beta + (1 - \beta) \underline{\alpha}^R]\} > 0$.

Proposition 3: In the extension of the model with a two-tier appropriation system, in a subgame-perfect equilibrium with a strictly positive proportion of both producers and predators in the population, there is strictly positive income inequality in society, i.e., the Gini coefficient is $(1 - \underline{\alpha}^R) \underline{\alpha}^R (1 - \beta) (2 - \hat{\theta}^R) \hat{\theta}^R / \{2[\beta + (1 - \beta) \underline{\alpha}^R]\} > 0$.

It follows that if we allow for two-tier appropriation activity, we still obtain the same qualitative results as in the basic model. These results, however, take a less extreme form in that members of the poorest group in society (excluded predators) generate a strictly positive income, rather than a zero income as in the basic model.

4.2. Two-Tier Productive Activity

It is straightforward to extend the basic model to allow for the possibility that each agent may have a combination of skills; a predator may have some inferior productive skills (in addition to his superior appropriation skills), while a producer may have some inferior appropriation skills (in addition to his superior productive skills). As we will see, the basic results of the model still hold. Furthermore, this extension brings out a new aspect of income inequality; the income of the poorest agents in society (excluded predators) may be generated through productive activities, rather than through appropriation activities as in the basic model.

As in Murphy, Shleifer and Vishny [1993], in this extension there are two types of production, inferior subsistence production and superior market production. All agents, producers and predators, effortlessly engage in subsistence production and create an output γ . Only producers, however, have the superior productive skills to engage in the creation of market output (in addition to the subsistence output γ that they produce). As in Murphy, Shleifer and Vishny [1993], subsistence output cannot be expropriated, while the market output of producers is vulnerable to appropriation. Market output is equivalent to the standard output of producers in the basic model; when a producer spends a time e on private hiding efforts, he creates a market output $(1-e)\omega$. Overall, a producer successfully protects from predators a fraction $s((\alpha^R\theta^R)/(\alpha^P\theta^P))+z(e)$ of his market output. It would also be easy to allow each producer to have some inferior appropriation skills (as predators have inferior productive skills). However, the presence of such inferior appropriation skills would not affect the conclusions of the analysis, and thus for simplicity, it is assumed the producers have no appropriation skills whatsoever.

By following the same procedure as in the basic model, we can see that \hat{s} and α^R are given by expressions (3) and (5) respectively. Furthermore, lemma 3 and proposition 1 still hold. There are three income groups in society. A predator with access to the appropriation arena (wealthiest group) earns an income $\gamma + (1/\alpha^R)\hat{\theta}^P [1 - e(\hat{s})]\omega$. A producer (middle group) generates an income $\gamma + \hat{\theta}^P [1 - e(\hat{s})]\omega$. An excluded predator

(poorest group) earn an income γ . The Gini coefficient is $[(1 - \alpha^R)\hat{\theta}^R(2 - \hat{\theta}^R)]/2 > 0$ (the same as in the basic model).

Proposition 4: In the extension of the model with a two-tier production system, in a subgame-perfect equilibrium with a strictly positive proportion of both producers and predators in the population, there is strictly positive income inequality in society, i.e., the Gini coefficient is $[(1 - \alpha^R)\hat{\theta}^R(2 - \hat{\theta}^R)]/2 > 0$.

Allowing for two-tier productive activity brings out a new aspect of income inequality. Although in equilibrium the poorest agents in society generate their entire income γ through productive activities, they have developed a primary aptitude for appropriation, rather than for production. In equilibrium these agents depend entirely on production because they have been excluded from the appropriation arena by the restrictive institutions of predators. These agents become the poorest members of society because they have inferior productive skills and can thus only create a low level of output.

5. AN ECONOMY WITH PROPERTY RIGHTS

So far we have examined a rudimentary economy without property rights, which has brought out in a straightforward manner the link between income inequality and appropriation. This section extends the analysis to incorporate property rights institutions; the government sets up laws and institutions to protect the property of agents. As we will see, because property rights are often incomplete in equilibrium, the main insights of the basic model still hold. The incompleteness of property rights gives rise to expropriation activity, which, in turn, generates inequality.

As in the basic model, each group — producers or predators — has the opportunity to screen entry into its sector by setting up self-regulating restrictive institutions. However, I also introduce another type of institutions, namely property rights institutions, which are run by the government, rather than by each individual group; the government establishes institutions and laws that fix the strength of producer

property rights. Strong property rights institutions hinder appropriation, offering greater protection (than weak property rights institutions) to producers against predators. The strength of producer property rights is denoted by d ; each producer is granted legal rights to a fraction d of his output ($d \in [0,1]$), which is absolutely immune from appropriation. A producer, on the other hand, does not have legal property rights to the remaining share $1 - d$ of his output, which is vulnerable to appropriation.

The implementation of society's legal system entails administrative costs and utilizes productive resources; society needs to rely on producer skills to operate the legal and property rights infrastructure.¹¹ Specifically, operating a legal framework that achieves a strength of producer property rights d requires an amount $t(d)$ of each producer's time. We have $\partial t(d)/\partial d > 0$, i.e., administrative costs are increasing in the degree of property protection that the legal system offers. Furthermore, we have $\partial^2 t(d)/\partial d^2 \geq 0$; the convexity of the administrative cost function ensures that second-order conditions are met and is thus necessary for the existence of an interior equilibrium.

Perhaps even more important than society's legal institutions are the private activities in which producers engage to protect their property 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."¹² Similarly to the basic model, active producers have the opportunity to hide some of their output that lacks legal protection to prevent its appropriation. An active producer may spend a fraction e of the time that is available for production and corresponds to his legally unprotected output on privately hiding (and thus privately protecting) this output from predators, where $0 \leq e \leq 1$.¹³ Overall, an active

¹¹ Although the operation of self-regulating restrictive institutions by each group may also entail costs for the group, these costs do not affect the conclusions of our analysis. Thus for simplicity, it is assumed that the cost of operating restrictive institutions is zero (unlike the cost of property rights institutions which is positive).

¹² Grossman [2001], p. 347.

¹³ An active producer's time which is available for production is $1 - t$ (i.e., the time which is not spent on operating property rights institutions). Then, the available time that corresponds to the production of legally protected output and legally unprotected output is $(1 - t)d$ and $(1 - t)(1 - d)$ respectively.

producer successfully protects from predators a fraction $s((\alpha^R \theta^R)/(\alpha^P \theta^P)) + z(e)$ of his legally unprotected output.

Given the very long-term nature of aptitude choices — an agent starts developing the skills that are relevant to his aptitude type at the beginning of the game (a la Stigler and Becker [1977]) — decisions about the legal and property rights system in the model are made after agents have chosen their aptitude types. The two groups — producers and predators — engage in a political battle to gain control of the economy’s government and impose self-serving legal rules for the strength of producer property rights d . Members of the prevailing group cooperatively choose the level of d in the economy, aiming at the maximization of their expected payoff. The government (which is controlled by the politically prevalent group) then requires each producer to spend a time $t(d)$ to complete his institutional assignment.

In the political contest between producers and predators, strength lies in numbers. Specifically, producers determine the economy’s legal system, — i.e., the level of d — if the ratio of predators to producers in the population is below a threshold value $\bar{\theta}$ ($(\theta^R / \theta^P) \leq \bar{\theta}$), where $0 < \bar{\theta} < 1$. If, on the other hand, $(\theta^R / \theta^P) > \bar{\theta}$, the legal system is selected by predators. This process is in the spirit of the social conflict literature (e.g., Acemoglu [2005], Acemoglu and Robinson [2006, forth]), which stresses that an economy’s property rights institutions are determined by the prevalent social group — either the group of producers or predators in our model.¹⁴

Furthermore, the economy may have constraints on the executive. In particular, there may be checks and balances that to some extent restrict the ability of the politically prevalent group to choose any level of property rights protection d it wants, ensuring that the non-prevalent group has some rights. Suppose that d^P is the level of d that maximizes the expected payoff of producers (and is thus the optimal d for the group of producers) and d^R is the level of d that maximizes the expected payoff of predators (and is thus the optimal d for the group of predators). Then, when the group of producers prevails politically, it sets d equal to $(1 - \rho)d^P + \rho d^R$, where $0 \leq \rho < 1/2$. When, on the

other hand, the group of predators prevails politically, it sets d equal to $(1 - \rho)d^R + \rho d^P$. Parameter ρ corresponds to the economy's constraint on the executive; a higher ρ implies that the non-prevalent group has more rights. In an economy with no constraint on the executive whatsoever, we have $\rho = 0$.

We have a six-stage game:

Stage 1: Each agent chooses his aptitude type — producer or predator — and begins acquiring the skills relevant for his type.

Stage 2: Members of the politically prevalent social group (producers or predators) cooperatively choose the degree of legal protection d and set up property rights institutions, requiring each producer to spend a time $t(d)$. Producers have the opportunity to cooperatively determine the proportion α^P of active producers by setting up self-regulating restrictive institutions. Similarly, predators have the opportunity to cooperatively determine the proportion α^R of active predators by establishing self-regulating restrictive institutions.

Stages 3, 4, 5 and 6 are similar to the basic model.

5.1. Equilibrium in an Economy with Property Rights

An active producer's optimization problem regarding the time that he spends on privately hiding his property is described by expression (1), as in the basic model. Also, as in the basic model, producers always set α^P equal to 1 in stage 2. Furthermore, the level of s that maximizes the expected payoff of a predator is the same as in the basic model, i.e., equal to \hat{s} . Specifically, we have

$$\hat{s} = \arg \max_s (1 - d)(1 - t)[1 - s - z(e(s))][1 - e(s)] = \arg \max_s [1 - s - z(e(s))][1 - e(s)]. \quad (9)$$

In stage 2, predators choose the level of α^R that leads to \hat{s} , attaining the optimal (for predators) intensity of appropriation. Furthermore, similarly to the basic model, in a

¹⁴ In practice, the level of political threshold $\bar{\theta}$ is also affected by a country's factor endowments, such as a country's climate and soil conditions. Certain types of factor endowments facilitate the efforts of producers to prevail politically, leading to a higher $\bar{\theta}$ (Sokoloff and Engerman [2000]).

subgame-perfect equilibrium with a strictly positive proportion of both producers and predators in the population, we always have $(\theta^R / \theta^P) > \hat{\theta}$, i.e., the ratio of predators to producers is always sufficiently high for appropriation institutions to choose $\alpha^R < 1$ in stage 2. The proof is the same as in lemma 3.

Provided that $(\theta^R / \theta^P) > \hat{\theta}$ (and thus predators set the level of s equal to \hat{s} in stage 2), the level of d that maximizes an individual producer's payoff $[1-t(d)]\{d+(1-d)[\hat{s}+z(e(\hat{s}))][1-e(\hat{s})]\}\omega$ is

$$d^P = \arg \max_d [1-t(d)]\{d+(1-d)[\hat{s}+z(e(\hat{s}))][1-e(\hat{s})]\}. \quad (10)$$

Furthermore, the expected payoff of a predator is $(\theta^P / \theta^R)(1-d)[1-t(d)][1-\hat{s}-z(e(\hat{s}))][1-e(\hat{s})]\omega$, which is decreasing in d . Specifically, we have

$$[-1+t(d)-\frac{\partial t(d)}{\partial d}(1-d)]\frac{\theta^P}{\theta^R}[1-\hat{s}-z(e(\hat{s}))][1-e(\hat{s})] < 0. \quad (11)$$

As a result, the level of d that maximizes an individual predator's payoff is equal to 0, i.e., $d^R = 0$.

The group of producers prevails politically and determines the strength of the economy's property rights institutions when $(\theta^R / \theta^P) \leq \bar{\theta}$. Then, producers cooperatively set the level of d equal to d^* , where

$$d^* = (1-\rho)d^P. \quad (12)$$

When $\theta^R / \theta^P > \bar{\theta}$, on the other hand, the strength of property rights institutions is chosen by predators. We have

$$d^{**} = \rho d^P. \quad (13)$$

There can be two subgame-perfect equilibria — a productive and a predatory equilibrium — in which there is a strictly positive proportion of both producers and predators in the population. In particular, in a productive equilibrium the proportion of producers is

$$\theta^{P*} = \frac{d^* + (1 - d^*)[1 - e(\hat{s})][\hat{s} + z(e(\hat{s}))]}{1 - (1 - d^*)e(\hat{s})}. \quad (14)$$

The proportion of predators is $\theta^{R*} = 1 - \theta^{P*}$. Then, in stage 2 producers prevail politically and cooperatively set d equal to d^* . The restrictive institutions of predators set α^R equal to $\alpha^{R*} = (\theta^{P*} / \theta^{R*})\hat{\theta}$.

In a predatory equilibrium, on the other hand, we have

$$\theta^{P**} = \frac{d^{**} + (1 - d^{**})[1 - e(\hat{s})][\hat{s} + z(e(\hat{s}))]}{1 - (1 - d^{**})e(\hat{s})}. \quad (15)$$

The proportion of predators is $\theta^{R**} = 1 - \theta^{P**}$. Then, in stage 2 predators gain control of the economy's property rights institutions and set d equal to d^{**} . The restrictive institutions of predators set α^R equal to $\alpha^{R**} = (\theta^{P**} / \theta^{R**})\hat{\theta}$.

Similarly to the basic model (lemma 3), a necessary condition for the existence of a productive and a predatory equilibrium (where there is a strictly positive proportion of both producers and predators in the population) is $(\theta^{R*} / \theta^{P*}) > \hat{\theta}$ and $(\theta^{R**} / \theta^{P**}) > \hat{\theta}$ respectively. Furthermore, parameter $\hat{\theta}$ is largely independent of θ^{P*} , θ^{R*} , θ^{P**} or θ^{R**} ; parameter $\hat{\theta}$ is determined by the functional form of $s(\cdot)$, while θ^{P*} , θ^{R*} , θ^{P**} and θ^{R**} are determined by the functional forms of $t(\cdot)$ and $z(\cdot)$. It is thus straightforward to see that depending on the specific functional forms of $s(\cdot)$, $t(\cdot)$ and $z(\cdot)$, conditions $(\theta^{R*} / \theta^{P*}) > \hat{\theta}$ and $(\theta^{R**} / \theta^{P**}) > \hat{\theta}$ are often met (and both a productive

and a predatory equilibrium exist). The remaining portion of the paper will mostly focus on comparing the productive with the predatory equilibrium and will thus assume that both of these equilibria exist.¹⁵ Moreover, similarly to the basic model, we may also have a corner solution where all agents in the population choose to become producers, i.e., $\theta^P = 1$.

Proposition 5: The proportion of producers in the population is $\theta^{P*} = \{d^* + (1 - d^*)[1 - e(\hat{s})][\hat{s} + z(e(\hat{s}))]\} / [1 - (1 - d^*)e(\hat{s})]$ in a productive and $\theta^{P**} = \{d^{**} + (1 - d^{**})[1 - e(\hat{s})][\hat{s} + z(e(\hat{s}))]\} / [1 - (1 - d^{**})e(\hat{s})]$ in a predatory equilibrium.

The proportion of producers in the population is higher in a productive than in a predatory equilibrium — i.e., $\theta^{P*} > \theta^{P**}$, — because the expectation of stronger property rights institutions induces more agents to become producers, rather than predators. Furthermore, the proportion α^R of predators that are allowed to enter the appropriation arena is higher in a productive than in a predatory equilibrium, i.e., $\alpha^{R*} > \alpha^{R**}$; the restrictive institutions of predators are less exclusive in a productive than in a predatory equilibrium.

Lemma 4: The proportion of producers in the population is higher in a productive than in a predatory equilibrium, i.e., $\theta^{P*} > \theta^{P**}$. A higher proportion of predators are allowed to actively engage in appropriation activities in a productive than in a predatory equilibrium, i.e., $\alpha^{R*} > \alpha^{R**}$.

Proof: The proof is in the appendix.

¹⁵ Another necessary condition for the existence of a productive equilibrium is $(\theta^{R*} / \theta^{P*}) \leq \bar{\theta}$ (i.e., when the proportion of producers is θ^{P*} , property rights institutions are chosen by producers). Similarly, another necessary condition for the existence of a predatory equilibrium is $(\theta^{R**} / \theta^{P**}) > \bar{\theta}$. Furthermore, trivially, there is a strictly positive proportion of both producers and predators in a productive equilibrium when $0 < \theta^{P*} < 1$ and in a predatory equilibrium when $0 < \theta^{P**} < 1$.

In a subgame-perfect equilibrium with both producers and predators in the population, the expected payoff of a producer is equal to the expected payoff of a predator. The expected payoff of an agent is thus equal to $[1-t(d)]\{d+(1-d)[\hat{s}+z(e(\hat{s}))][1-e(\hat{s})]\}w$. Given that d^P maximizes $[1-t(d)]\{d+(1-d)[\hat{s}+z(e(\hat{s}))][1-e(\hat{s})]\}$, that the second-order condition in (10) is negative and that $d^{**} < d^* \leq d^P$ (d^P is closer to d^* than to d^{**}), the expected payoff of an agent (producer or predator) is higher in a productive than in a predatory equilibrium. As a result, an economy's total output is also higher in a productive than in a predatory equilibrium.

Proposition 6: A productive equilibrium leads to a higher economy-wide output and a higher expected payoff for each agent than a predatory equilibrium.

In a productive equilibrium the allocation of skills in the population is more conducive to economic prosperity than in a predatory equilibrium. A larger fraction of producers in the economy leads to a higher level of total output and a higher average agent payoff. Both equilibria are possible, however, because agents make decisions simultaneously in stage 1 and are thus unable to coordinate.

Although all agents have exactly the same level of innate talent, they exhibit inequality in their incomes in both a productive and a predatory equilibrium. Similarly to the basic model, the source of income inequality is the presence of appropriation activity. There are three income groups in society; predators that have been allowed to actively engage in appropriation activities (wealthiest group), producers (middle group) and predators that have been excluded from the appropriation arena (poorest group). The Gini coefficient is G^* in the productive and G^{**} in the predatory equilibrium. We have

$$G^* = \frac{1}{2}(1 - \alpha^{R^*})\theta^{R^*}(2 - \theta^{R^*}) > 0, \quad (16a)$$

$$G^{**} = \frac{1}{2}(1 - \alpha^{R^{**}})\theta^{R^{**}}(2 - \theta^{R^{**}}) > 0. \quad (16b)$$

A predatory economy is more unequal than a productive economy, i.e., $G^{**} > G^*$.

Proposition 7: A predatory equilibrium exhibits strictly higher income inequality than a productive equilibrium, i.e., $G^{**} > G^*$.

Proof: The proof is in the appendix.

Intuitively, it is expropriation activity and the self-regulating restrictive institutions of predators that generate income inequality in society. A productive equilibrium entails stronger property rights protection (than a predatory equilibrium), leaving a lower proportion of the economy's output vulnerable to appropriation. As a result, because a smaller part of the economy operates outside the realm of the law, income inequality is lower.

Overall, in the analysis, low income inequality is associated with a high level of output because they are both driven by an emphasis on production (rather than on appropriation). A productive equilibrium exhibits low income inequality, strong property rights institutions, a high level of economy-wide output and a high expected payoff for each agent. Finally, it is straightforward to extend the model with property rights to allow for a two-tier appropriation or a two-tier production system. The results are similar to those of sections 4.1 and 4.2.

6. HISTORICAL EXAMPLES AND EMPIRICAL IMPLICATIONS

The conclusions of the model are supported by historical evidence. A good historical example that can play the role of a natural experiment is the colonization of the United States and Argentina. Furthermore, the paper has novel empirical implications that are not captured by the existing theoretical literature.

6.1. United States and Argentina

The colonization of two new areas (and eventually the establishment of two new countries), Argentina in the mid-16th century and the United States in the early 17th

century, constitutes a natural experiment that is consistent with the insights of our model. The two areas bore several parallels when they were first colonized. Given that they both had a relatively small indigenous population, they became mostly settled by European immigrants.¹⁶ Furthermore, both countries had similar natural resource endowments and comparative advantages. They were large geographically with abundant land, and farming centered on grains and livestock (Engerman and Sokoloff [1997], Harrison [2000]).¹⁷

Because Argentina and the United States were relatively uninhabited when European settlers arrived, they had no pre-existing patterns of inequality and no pre-existing institutions. They thus constitute a good natural experiment for studying how inequality can arise in a new society — in a society that is a blank slate or *tabula rasa*. In more densely-populated European colonies, on the other hand, European immigrants often inherited social structures and institutions from previous civilizations there. For example, in most of Latin America and India, Europeans simply took over the existing institutions of the Aztecs, Incas and Mughals; these indigenous societies were already extraordinarily unequal when they were colonized (Acemoglu, Johnson and Robinson [2005]).

There is historical evidence that at least in the early stages of each colony's existence, immigrants in the United States had quite different profiles than immigrants in Argentina. The United States mainly attracted immigrants that had an objective to become involved in productive activities, such as agriculture, stock raising and commerce (Harrison [2000], Sokoloff and Engerman [2000]). Argentina, on the other hand, attracted many immigrants whose objective was to plunder and appropriate. As in several other Spanish colonies, European immigrants in Argentina were often characterized by the brutality of conquistador (Estrada [1942], Harrison [2000]). As Estrada [1942] points out, “[their objective] was neither to colonize nor populate ... To farm, to build, to resign oneself, to persevere were all depressing and outside the set of

¹⁶ The United States and Argentina had approximately the same population density in 1500 (Acemoglu, Johnson and Robinson [2005]).

¹⁷ In several other European colonies in the New World, on the other hand, farming centered on cash crops, such as sugar and coffee, which led to considerably different initial conditions than in the United States and Argentina (Engerman and Sokoloff [1997], Sokoloff and Engerman [2000]).

values of conquest and domination ... Thus was born a scale of false values.”¹⁸ The United States adopted stronger property rights institutions than Argentina (Acemoglu, Johnson and Robinson [2005]).

Our model predicts that an economy with more extensive appropriation activity and weaker property rights institutions exhibits more pronounced income inequality. A comparison between the United States and Argentina is consistent with these insights. For example, Argentina adopted a considerably more unequal land tenure system than the United States. In the United States small farmers were encouraged and given incentives to acquire land; small family farms were the rule (Engerman and Sokoloff [1997], Sokoloff and Engerman [2000]). Argentina, on the other hand, adopted the *encomienda* (and later the *estancia*) system, where land was divided into very large tracts and given to a small number of powerful *estancieros* (land owners) (Harrison [2000]). Economic theory notes that land ownership can serve two functions; land can be used for productive activities (agriculture, stock raising) or as a means to control the behavior of others and appropriate (Baland and Robinson [2006]). In Argentina land ownership was often seen as a tool for rent seeking and appropriation, rather than for production. Furthermore, the self-regulating restrictive institutions of predators played a predominant role; the institutions of cronyism and familism were widespread (Fillol [1961], Harrison [2000]).

Argentina thus created a considerably more unequal society than the United States. These inequality patterns persist until today. For example, today Argentina has a Gini coefficient of 0.522 and the United States has a Gini coefficient of 0.408 (Perkins *et al.* [2006]). Income inequality is thus more pronounced in Argentina than in the United States.

6.2. Empirical Implications

The model has empirical implications that are little understood in existing economic theory. The emphasis on appropriation activity and on property rights protection allows us to enhance our understanding of income inequality. For example, in

¹⁸ Estrada [1942], p. 10.

our analysis, the group of predators exhibits a more unequal income distribution than the group of producers (even if some predators are eventually forced to rely on production as in section 4.2). Implication 1 follows.

Implication 1: In an economy, income distribution is more unequal within the group of predators than within the group of producers.

Although there are no empirical studies about the entire group of society's predators (rent seekers, corrupt government officials, cronies, gangsters, common criminals, etc), there are detailed reports about a specific form of appropriation activity, namely outright coercion and common crime. Levitt and Venkatesh [2000, 2001] focus on the operations of U.S. inner city gangs and show that individuals who grow up in gangs (and thus specialize in appropriation) exhibit a much more uneven distribution of income later in their lives regardless of whether they continue to be involved in gang activities or they eventually focus on productive activities. These empirical findings are consistent with our analysis.

For example, Table 1 compares the incomes of residents in a high-rise housing project building in Chicago in 2000 based on whether these residents were gang members or non-gang members ten years earlier, i.e. in 1991. Although the average financial condition (which includes both legitimate and illegitimate income) of gang members does not appear to be very different from the average financial condition of non-gang members, the standard error of estimate for gang members is more than twice as high as the standard error of estimate for non-gang members. Income inequality is thus significantly higher within the group of gang members, as our analysis would predict.

<< INSERT TABLE 1 HERE >>

As Levitt and Dubner [2005] characteristically point out,

“So if crack dealing is the most dangerous job in America, and if the salary was only \$3.30 an hour, why on earth would anyone take such a job? Well, ... they all want to succeed in an extremely competitive field in which, if you reach the top, you are paid a fortune ... The problem with crack dealing is the same as in every other glamour profession: a lot of people are competing for a very few prizes.”¹⁹

Our model suggests that an unfavorable allocation of skills — i.e., an emphasis on appropriation, rather than on production — and weak property rights institutions cause high income inequality in a country. Implication 2 follows.

Implication 2: Countries with weaker property rights institutions and more pronounced corruption tend to exhibit higher income inequality.

Chor [2005] and Glaeser and Saks [2006] estimate that there is a positive correlation between income inequality and corruption or a negative correlation between income inequality and the strength of property rights institutions, which is consistent with our analysis. Although the direction of causality is not examined in most of the empirical work, Chor [2005] estimates that weaker initial property rights institutions are associated with higher subsequent income inequality; this may suggest that weaker property protection causes income inequality, as our analysis would predict.²⁰

7. CONCLUSION

Although the link between income inequality, appropriation activity and property protection inefficiency is emphasized by empirical and anecdotal evidence, it is little understood in economic theory. This paper provides a simple theoretical framework for demonstrating how the incompleteness of property rights institutions and the presence of expropriation activity in a country may be an important cause of income inequality. In an economy with a weak legal system, the restrictive institutions of predators — i.e., the self-regulating institutions that shape the structure of the appropriation sector and screen entry into the expropriation arena — are shown to play a pervasive role, leading to a more unequal society. Overall, higher income inequality is associated with more corruption, weaker property rights protection and a lower level of output.

In practice, income inequality is a very complex phenomenon that is likely to have several different explanations. Many of these causes are discussed in detail in the existing literature. This paper does not intend to contradict the various existing

¹⁹ Levitt and Dubner [2005], p. 94-95.

²⁰ According to Glaeser, Scheinkman and Shleifer [2003] and Acemoglu, Ticchi and Vindigni [2007], a positive correlation between property rights inefficiency and income inequality would imply that income

explanations for inequality; it only aims at suggesting that the extent of appropriation activity and the incompleteness of property rights institutions may account for some of the income inequality we observe in an economy. It will ultimately be up to empirical research to determine which theoretical explanations are the most relevant.

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inequality causes property rights inefficiency. This is the reverse of the issue that is examined in our model.

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APPENDIX

Proof of Lemma 1

When a producer chooses e , his first-order condition is

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

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

$$\frac{\partial e(s)}{\partial s} = \left[\frac{\partial^2 z(e)}{\partial e^2}(1-e) - 2 \frac{\partial z(e)}{\partial e} \right]^{-1} < 0. \quad (\text{A2})$$

Proof of Lemma 2

We have

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

Proof of Lemma 3

Suppose that $(\hat{\theta}^R / \hat{\theta}^P) \leq \hat{\theta}$. Then, the proportions of producers and predators in the population for which the expected payoffs of producers and predators are equal are determined by expression (7). Furthermore, in stage 2 predators are expected to set the level of α^R equal to 1. This, however, cannot be a subgame-perfect equilibrium because predators have an incentive to deviate and become producers in stage 1. In particular, because s is a decreasing function of $\alpha^R \theta^R / \theta^P$ and $\alpha^R = 1$, if a predator deviates and becomes a producer, s will increase. According to lemmas 1 and 2 a higher level of s allows a producer both to raise his output (by spending less time on property hiding) and also to maintain possession of a higher fraction of his (now higher) output. For this reason, a predator can increase his expected payoff by deviating and becoming a producer. Thus if $(\hat{\theta}^R / \hat{\theta}^P) \leq \hat{\theta}$, there exists no subgame-perfect equilibrium where both the proportion of producers and the proportion of predators in the population are strictly positive.

Proof of Lemma 4

We have

$$\frac{\partial \frac{d + (1-d)[1 - e(\hat{s})][\hat{s} + z(e(\hat{s}))]}{1 - (1-d)e(\hat{s})}}{\partial d} = \frac{[1 - e(\hat{s})][1 - \hat{s} - z(e(\hat{s}))]}{[1 - (1-d)e(\hat{s})]^2} > 0. \quad (\text{A4})$$

Given that $d^* > d^{**}$, expression (A4) implies that $\theta^{P^*} > \theta^{P^{**}}$. It also follows that $\alpha^{R^*} = (\theta^{P^*} / \theta^{R^*})\hat{\theta} > \alpha^{R^{**}} = (\theta^{P^{**}} / \theta^{R^{**}})\hat{\theta}$.

Proof of Proposition 7

We have

$$\frac{\partial [\frac{1}{2}(1 - \alpha^R)\theta^R(2 - \theta^R)]}{\partial \theta^R} = (1 - \alpha^R)(1 - \theta^R) > 0, \quad (\text{A5})$$

$$\frac{\partial [\frac{1}{2}(1 - \alpha^R)\theta^R(2 - \theta^R)]}{\partial \alpha^R} = \frac{-\theta^R(2 - \theta^R)}{2} < 0. \quad (\text{A6})$$

Because $\theta^{R^*} < \theta^{R^{**}}$ and $\alpha^{R^*} > \alpha^{R^{**}}$ (lemma 4), it follows that $G^{**} > G^*$.

	Gang Members in 1991	Non-Gang Members in 1991
Average Annual Income in 2000 (If Income > 0)	\$21,031	\$23,966
Standard Error of Estimate	2,391	1,145

Table 1: Incomes of Gang Members and Non-gang Members in a High-Rise Housing Project Building in Chicago in 2000.

Source: Levitt and Venkatesh [2001].