A THEORY OF STATE FORMATION AND THE ORIGINS OF INEQUALITY (*)

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12 January 2010

(*) Previous versions of this paper were presented at the University of Virginia, the New York meeting of the “September Group” Princeton University, Duke University, Yale University, Stanford University and the University of Chicago. I thank the comments of all their participants, in particular to those of Sam Bowles, Dan Gingerich, Stathis Kalyvas, Carol Mershon, Thomas Romer and Milan Svolik. I am especially grateful to the comments of Alícia Adserà and to Teppei Yamamoto for his research assistance.

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Since its inception and until about 10,000 years ago, mankind lived in small, stateless communities of hunter-gatherers. According to anthropological work on current primitive societies as well as some archaeological evidence, foraging groups display very limited levels of social and economic stratification and similar interpersonal patterns of consumption and individual wealth.\(^1\) From 8,500 B.C. onwards, however, several regions of the world transited to sedentary agriculture. The domestication of plants and animals spurred or at least was correlated with marked inequalities in wealth and income and the advent of the state. Still, the internal structure of emerging states (from a few self-governing communities to the more extended outcome of absolute monarchies) and the extent of social and economic inequality varied considerably across areas and historical periods – until the spread of industrial technologies tended to compress, with a few national exceptions and temporal reversions, the distribution of incomes within countries in the last 150 years or so.

Although relatively extensive, the existing research on both the emergence of states and the origins of inequality still remains underdeveloped and partly disjointed for three reasons. First, most of the literature on state formation, which models the construction of political institutions as the outcome of a deal in which bandits offer their protection to peasants in exchange for some payment or transfer (North 1981; Olson 1993, 2000; Levi 1988; Bates 2001), excludes the possibility of self-governing polities and, with the exception of mostly historical macrosociological accounts (McNeill 1982, Tilly 1990), often brackets the effect of economic and military technologies on the overall process of state formation and on the institutions upon which bandits and producers coordinate. Second, whereas there is a

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\(^1\) This general level of equality comes in some instances with some heterogeneity in status and prestige and some differential access to a few goods (such as sexual partners). However, those differences have little intergenerational persistence. See Clastres (1972, 1974) and his discussion of the hunting-gathering societies of Guayakis; Chagnon (1997) on the Yanomamo. More generally, see Kelly (1995) and Panter-Brick et al. (2001).
burgeoning literature on the effects of inequality on growth (Atkinson and Bourguignon 2000, Lindert 2000, Piketty 2000, Kahhat 2007) and on political institutions and conflict (Boix 2003, Acemoglu and Robinson 2006, Geddes 2007, Boix 2008), much less work has been done on the underlying causes of the evolution of inequality: from a theoretical point of view, most contributions are strict accounting exercises or limit themselves to economic variables such as imperfect credit markets which are in turn left unexplained; from an empirical point of view they have focused their attention to the evolution of income distribution in advanced countries in the last three decades (Gottschalk and Smeeding 1997), suggesting partial yet still heavily contested explanations (Wallerstein 1999, O’Rourke and Williamson 1999, Scheve and Stasavage 2007, Gordon and Dew-Becker 2008). Finally, there is hardly any work that attempts to tackle the choice of political institutions and the distribution of economic assets as jointly determined phenomena – even though that question was a long-standing concern among classical political theorists such as Aristotle ([1988], IV, 11), Machiavelli (1531 [1970], I, 55) or Rousseau (1755 [1973]).

Accordingly, this article offers a joint theory of state formation and the origins of inequality. The first section develops a model in which there are two kinds of agents, both endowed with some economic assets, who may pursue two types of strategies to maximize their income: a productive strategy, which consists in allocating their assets to the production of goods and services, or an extractive or expropriatory strategy, which implies directing their resources to appropriate the assets or returns of other individuals. Although conflict among those individuals may be generalized, the model shows that they tend to coordinate on a stable state of peace ‘spontaneously’, i.e. without permanent political institutions, provided their economic conditions are relatively equal. However, as soon as inequality rises above a certain

2 An exception is Rogowski and McRae (2008).
threshold (as a result of a sufficiently biased technological shock that leads some individuals to acquire better tools to exploit their assets than the rest of the population), their spontaneous coordination around peace becomes unfeasible. In an unequal world, agents sort out into different types – with different payoff functions and different strategies. The economically advantaged individuals have a strong preference for production. Those that do not benefit from the technological shock prefer looting. Hence, to deter the latter, the ‘natural producers’ either offer a transfer to them (in exchange for permanent protection) or invest on constructing and managing some defensive structures (to stop the looters). Both solutions give birth to permanent political institutions, i.e. the state. But each strategy leads to different political regimes (monarchical versus some kind of self-governing or republican system) as well as to distinct distributional outcomes. The nature of the military technology plays a crucial role in determining the prevalence of each political solution.

The second section matches the main traits of the model to the history of the emergence of states: it verifies the ‘exogenous’ character of the agricultural revolution, relates the latter’s success to the formation of the state, and links the internal structure of the latter to the evolution of military technologies. In the following two sections the paper then explores the political and economic determinants of inequality. The third section calibrates the model and shows how economic and military technologies as well as population and the capacity of states shape the final distribution of income. The fourth section brings in empirical evidence (mostly related to the distribution of health patterns) relating the type of political structure to the internal distribution of economic resources.

I. THEORY
I. 1. Set-up
To understand the dynamics that led from equal, primitive economies to complex, unequal historical societies, assume a world populated by two types of agents, 1 and 2, each one with some technological knowledge (for example, some natural abilities to hunt, fight, etc.). These two agents can be thought of as individuals living together or as individuals (or households) populating some territory. They can also be thought of as representative individuals of homogeneous groups, that is, groups formed by agents who, because of their close ‘resemblance’ (in a sense to be made more precise shortly) to each other, can cooperate in a stable, permanent manner.

All individuals have the same time $L$, which they can employ in two different types of activities. On the one hand, they may allocate some fraction of their time $L$ to some ‘productive’ activity (such as hunting) that generates some income $y_i$ in a standard Cobb-Douglas production function $y_i = A_i T_i^\alpha L_i^{1-\alpha}$ for $i = \{1, 2\}$ and where $A$ denotes the state of technology and $T$ stands for a fixed stock of land. On the other hand, they may employ their time to predatory activities, that is, to steal other individuals’ production. In this latter instance, they obtain $(1-1/\theta_L)y_j$, where $y_j$ is the return from the productive activities of individual $j$ (where $j \neq i$) and $\theta_L$ is a technology parameter ($\theta_L > 1$) that measures the effectiveness of the time allocated to extraction. Hence, the income of individual $i$ would be, in principle, that is, in a decision-theory setting:

$$r_i = (1-\lambda) A_i T_i^\alpha L_i^{1-\alpha} + \lambda (1-1/\theta_L) A_j T_j^\alpha L_j^{1-\alpha}$$

where $\lambda$ (with $0 \leq \lambda \leq 1$) is the fraction of time $i$ spends in looting.

Assume that $T$ and $L$ are identical across all agents and define $A = A_n T_n^\alpha L_n^{1-\alpha} / A_j T_j^\alpha L_j^{1-\alpha}$ so that $(A_i T_i^\alpha L_i^{1-\alpha} / A_j T_j^\alpha L_j^{1-\alpha}) = A$ and $(A_j T_j^\alpha L_j^{1-\alpha} / A_j T_j^\alpha L_j^{1-\alpha}) = 1$. Then the previous expression can be rewritten as:

$$r_i = (1-\lambda) A + \lambda (1-1/\theta_L)$$

(1)
Taking $A$ and $\theta_L$ as given, agent $i$ will choose $\lambda$ to maximize her income. Given (1), the Kuhn-Tucker conditions for individual choices imply that the allocation of time by each and every individual will be:

$$
\lambda = \begin{cases} 
0 & \text{for} \quad A > (1-1/\theta_L) \\
[0,1] & \text{for} \quad A = (1-1/\theta_L) \\
1 & \text{for} \quad A < (1-1/\theta_L)
\end{cases}
$$

Now, in a strategic setting in which $i$ and $j$ both choose their optimal strategy simultaneously, the income of $i$ will be (1) only if agent $j$ does not loot ($\lambda_j = 0$). If $j$ has an incentive to loot ($\lambda_j > 0$), the total income of each agent will be reduced by some proportion due to the destructive effects of pillaging. Let us assume, for the sake of simplicity, that a condition of generalized looting (that is, with both $i$ and $j$ looting the other side) results in the destruction of all output not directly consumed by each agent. Hence, agent $i$ will be only able to obtain (in fact, keep) the portion she produces directly or $(1-\lambda)A$. The same logic applies to $j$. Finally, if $i$ only produces (since $\lambda_i = 0$) while $j$ loots, then $i$ keeps $(1-\beta)(1-\lambda)A$ where $\beta$ (with $0 \leq \beta \leq 1$) is a parameter that measures the destructiveness of predation.

I.2. Self-Sustaining Peace under Anarchy

Under what conditions will both agents coordinate on a production strategy? Alternatively, under what conditions will looting prevail? Suppose that they interact over time – with some discount rate $\delta$ (identical for all players). To make the analysis simple (and focused on the question at hand), assume that players have two strategies available to them. They can follow a trigger strategy $PP$, producing always until looting occurs and then responding with looting ever after. Or they can adopt a constant looting strategy $LL$.\(^3\)

\(^3\)Since $(1-\beta)(1-\lambda) < (1-\lambda)$, just producing when looted is not a feasible option. The notation and solution in this subsection partly follows Dixit (2008).
To have sustained peace, the following conditions have to take place. For player \( i \), the value of choosing a production strategy must be larger than looting a producer in the first period and then facing a looting solution always ever after:

\[
\frac{A}{1-\delta} > (1-\lambda)A + \lambda(1 - \frac{1}{\theta_L}) + \frac{\delta}{1-\delta}(1-\lambda)A
\]

Rearranging terms:

\[ A > (1-\delta)(1 - \frac{1}{\theta_L}) \]  

(2)

Similarly, for player \( j \) the following inequality must hold:

\[
\frac{1}{1-\delta} > (1-\lambda) + \lambda(1 - \frac{1}{\theta_L})A + \frac{\delta}{1-\delta}(1-\lambda)
\]

Hence:

\[ \frac{1}{A} > (1-\delta)(1 - \frac{1}{\theta_L}) \]  

(3)

Putting (2) and (3) together, we can conclude that continuous production will be an equilibrium if:

\[
\frac{1}{(1-\delta)(1-1/\theta_L)} > A > (1-\delta)(1 - \frac{1}{\theta_L})
\]

(4)

Inequality (4) shows that, even in a Hobbesian world, that is, in a world where there is no authority in place and players may have incentives to raid others, it is possible for individuals (within a given community) to sustain peace, avoid conflict and engage in productive activities – again without having to resort to any centralized common mechanisms of authority. Nonetheless, that outcome is only possible if there is some fundamental equality of conditions among individuals or across human communities. If \( A \) becomes too large, that is, if agent \( i \) is much more productive (and, hence, better off) than agent \( j \), then the left-hand side
in (4) will not hold. Similarly, if $A$ becomes much lower than 1, then the right-hand side in (4) will not hold either.

The bounds of the level of inequality will vary with the looting technology and the discount rate. As the looting technology becomes more (less) efficient, peace will become less (more) likely even if inequality does not go up. As the players value the future more (and the discount rate $\delta$ declines to 0), peace is more feasible even if inequality grows. (If we make the looting technology (negatively) depend on the feasibility of exit due to asset mobility or non-specificity, then this result has a natural connection with recent work on the basis of political regimes and conflict (Boix 2003, 2008).)

Notice that the solution of the game points to something akin to a ‘nested’ theory of cooperation. At the lowest (individual) level, peace is possible among a subset of actors provided they have sufficiently similar payoffs: when they do they form a stable, orderly tribe, village or neighborhood. Similarly, this social unit can also sustain cooperative relations with other human bands or tribes if the same degree of relative equality (and looting technologies) apply at that level. Peace breaks down at the point (in the continuum of agents) where inequality of conditions becomes ‘excessive’, i.e., inequality (4) does not hold anymore: hence, the model explains why cooperation may exist at some but not other levels of social interactions.

I. 3. Sorting of Agents and Emergence of State Institutions

Besides making the production equilibrium unfeasible, inequality has a sharp discriminating effect among individuals in two senses: it creates some economic heterogeneity among individuals, rearranging their preferences ordering and hence pushing them to adopt different kinds of behavior.
If, overturning an initial state of equality, a biased technological shock (such as the agricultural revolution, which I describe in the following section) increases the returns to production of agent $i$ such that inequality (3) does not hold any longer, agent $j$ has now a preference for looting. By contrast, the economically advantaged agent, $i$, still has an (even stronger) incentive to sustain a production equilibrium since the increase in her income does not lead to the violation of inequality (2).

In response to these new conditions, that is, to the prevalence of looting under anarchy, agents of type $i$, that is, those who are better off under a production equilibrium, may pursue two different strategies. On the one hand, they may offer a transfer (a tribute or payment) to agents of type $j$ such that the latter stop looting. In this instance, the potential looters or bandits (those who have not benefitted from the economic shock) turn to govern and protect the natural producers, particularly against other potential bandits. On the other hand, the ‘natural’ producers (or agents $i$) may decide to make looting a much less rewarding activity (for agents of type $j$) than just following a cooperative, non-violent path. They would do so by setting up some institutions or structures, such as a common army and some stable leadership, that would allow them to defend their assets and lives against any potential bandits. (A caveat is in order here. We do not need to think of bandits as ‘external’ enemies only. The term of looter refers as well to individuals who live in a given community and may try to steal, free ride on others, etc. Individual(s) $i$ will have then an incentive to set up some policing mechanism to dissuade individual(s) $j$ from misbehaving.)

Both cases involve the formation of some organization or structure that controls the monopoly of violence over a given territory – that is, they involve the construction of a “state”. But the mechanisms underpinning each solution are different. The first road to peace, which we
may refer to as a “monarchical solution”, follows Olson’s insight on the emergence of the state as “roving bandits” become “stationary bandits” or landlords (Olson 1993, 2000).  

The second strategy, which has received no attention in the modern institutionalist literature on state formation, leads instead to the construction of a state in which the “natural” producers also double as defenders and rulers. We may wish to call the second strategy an instance of a “self-governing” polity or of a republican settlement. Notice that a system in which the community of producers sets aside some portion of its income to hire an army or leader to protect its members (while governing themselves through republican institutions) does not constitute a case of self-government or republicanism. Since the hired leader cannot credibly commit to preserve the terms of the contract once he has been appointed and takes control of the army, such a solution ends in (or is equivalent to) the subjection of the producers to a leader-monarch. In short, we should think of a stable republican solution as one in which citizens have ultimate control over the means of defense.

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4 Writing from an anthropological perspective, Carneiro (1970) also offered a theory of state formation that emphasizes the interaction of violence and exit options (the latter in turn deriving from population density). Exit strategies and density are, however, not endogenized in his paper. As in Olson, he focuses on the emergence of autocratic states. See Wright (1977) for a review of state formation theories in anthropology and archaeology.

5 Olson’s (and in fact most neoinstitutionalist accounts’) unique solution explains why his explanation about democratic transitions is ad hoc and unconvincing. He claims that democracy emerges when there is a vacuum of power in an already-formed state in which a set of notables have roughly equal claims to power (see Olson 2000: 28 ff.). But this state of things (i.e. the existence of balance of power) could be equally predicated for stateless societies.

6 For a discussion of the moral hazard problems of hiring an external captain or condottiero in late Medieval Italian cities, see McNeill (1982). The mechanisms through which citizens (or some subset of citizens) can control defense – and so limit exploitation – are multiple. For a formal analysis of how institutions may limit executive power, even in the context of non-democratic systems, see, for example, Boix and Svolik (2009).
I. 4. Monarchical Settlement versus Self-Governing Solution

Let me now characterize each political solution separately and then solve for the conditions under which one should prevail over the other. (All this discussion clears the way to examine analytically (in Section 3, after I explore the historical validity of the model) the ways in which those alternative paths of state formation have different consequences for income distribution and inequality: with the monarchical solution implying some redistribution from producers to the lord and the eventual rearrangement of income rankings within society.)

**Monarchical Settlement.** In a ‘monarchical’ settlement, where agents of type $i$ make a transfer to agents $j$ to buy their protection, agent $i$’s payoff will be:

$$\frac{(1 - \varepsilon)A}{1 - \delta}$$

where $\varepsilon$ denotes the transfer extracted by agent $j$, with $0 \leq \varepsilon \leq 1$, and all time is now devoted to production.

In turn, in a monarchical regime agent $j$ receives, if he follows a peaceful strategy (which now includes an effort to protect individuals of type $i$ against other potential bandits), a transfer from the producer in proportion to the time $\lambda$ spent governing (as well as any payoff from his own production, if any):

$$\frac{(1 - \lambda) + (\varepsilon - \gamma)\lambda A}{1 - \delta},$$

where $\gamma$ is the portion that the bandit-lord spends in governing and protecting the producer and $0 < \gamma \leq \varepsilon$.

Notice that in a monarchical state the bandit has the monopoly of force. Thus, since those that are ruled do not retain any armed force to resist the ruler, the extraction rate $\varepsilon$ will be...
set by the monarch at the level that maximizes his income. In other words, individuals of type $j$
cannot credibly commit to any lower $e$ than their optimal choice.

**Self-Governing Institutions.** As discussed before, in a self-governing system the
producers themselves take steps to defend their assets and lives against bandits. This means
that the producer will have to spend some fraction of her time to set up a military or defense
structure (such as building a wall or a watchtower to observe the horizon). That amount of time
will depend on the efficiency with which it is employed to deter any looter $j$ from pillaging the
producer. That efficiency will be a function of the military technology in the hands of the
producers (relative to the military technology of the looters). Therefore, we should represent
the payoff of those agents of type $i$ (or a community with individuals $i$ such that all have an
incentive to cooperate) that decide to defend themselves as:

$$\frac{(1-(\lambda_i/\theta_D))A}{1-\delta}$$

here $\lambda$ is the time spent in defense and $\theta_D$ is the efficiency of the technology with which
producer $i$ defends himself against potential bandits – and where $0\leq\lambda\leq1$ and $\theta_D>\lambda$. Agents $i$
keep the fraction of production not spent in defense. As $i$’s defensive capabilities increase, the
producer will be able to spent more time generating $Y=A_iT_i^\alpha L_i^{1-\alpha}$.

Looked at from the point of view of the potential looter, the purpose of creating a
defense structure is equivalent to the principle of inflicting some cost on $j$ to push the latter into
peaceful behavior. In other words, agent $i$ has to choose a parameter of defense $\theta_D$ such that
individual $j$ has no incentive to exploit the producer. Hence, the payoff of $j$ under a successful
self-governing or republican regime will be $I$, that is, $j$ will devote all his time to production
and none to looting.
Choice of Institutions. Once the level of inequality disrupts the possibility of spontaneous coordination around peace, the natural producers choose between establishing a self-governing state, giving up their rights to a tyrant (a ‘stationary bandit’) or engaging in a looting strategy. In turn, agents $j$ must decide whether to abide by the political settlement or to simply loot.

Under what conditions will each solution prevail?

1. In the first place, a state will only emerge if the payoffs under stable institutions (either a tyrant or a republican structure) exceed the payoffs that come from looting the other side in the first period and then slipping into a situation of permanent conflict. Let us start by examining each alternative separately, that is, the value of a republican solution versus straightforward looting and the value of monarchy versus looting.

1. A. The ‘natural’ producers (agents $i$) would rather have a republican structure than looting (provided they prefer the republican solution over the monarchical settlement) if:

$$\frac{(1-\lambda/\theta_L)\Lambda}{1-\delta} > (1-\lambda)A + \lambda(1-\frac{1}{\theta_L}) + \frac{\delta}{1-\delta}(1-\lambda)A$$

Rearranging the terms of this inequality gives us:

$$A > (1-\delta)(1-\frac{1}{\theta_L})$$  \hspace{1cm} (5)

Thus, the incentives of any agent $i$ to move to a republican solution will increase when the alternative option of looting becomes less attractive: either because the looting technology $\theta_L$ declines in efficiency, the defensive technology $\theta_D$ improves or the production technology, denoted by $A$ increases.
In turn, agent $j$ will accept the self-governing structure set up by $i$ if just producing leaves he better off than trying the looting strategy:

$$\frac{1}{1-\delta} > (1-\lambda) + \frac{A}{\theta_D} \lambda + \frac{\delta}{1-\delta} (1-\lambda)$$

Rearranging this inequality then:

$$\frac{\theta_D}{1-\delta} > A$$

(6)

Putting (5) and (6), a republican settlement is feasible whenever:

$$\frac{\theta_D}{1-\delta} > A > (1-\delta) \frac{(1-1/\theta_L)}{(1-1/\theta_D)}$$

(7)

In addition to (7), self-government will only be feasible if peace without transfers is not an equilibrium. This condition takes place, following (3), when $A > 1/(1-\delta)(1-1/\theta_L)$.

1. B. In the instance in which a monarchical solution is preferred over a republican one, the natural producers will only accept to transfer some resources to a tyrant if that makes them better off than looting:

$$\frac{(1-\varepsilon)A}{1-\delta} > (1-\lambda)A + \lambda(1-\frac{1}{\theta_L}) + \frac{\delta}{1-\delta}(1-\lambda)A$$

Rearranging the inequality:

$$\lambda - \frac{(1-\delta)(1-1/\theta_L)\lambda}{A} > \varepsilon$$

(8)

In turn, $j$ will have an incentive to act as a monarch and not as a bandit if:

$$\frac{(1-\lambda)+(\varepsilon-\gamma)\lambda A}{1-\delta} > (1-\lambda) + (1-\frac{1}{\theta_L})\lambda A + \frac{\delta}{1-\delta}(1-\lambda)$$

Hence:

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7 It is possible to show that there is a broad range of values for which both the latter inequality and (7) hold at the same time.
\[ \epsilon > (1 - \delta)(1 - \frac{1}{\theta_D}) + \gamma \]  

(9)

Putting together (8) and (9), a monarchical settlement will be possible whenever:

\[ \lambda - \lambda(1 - \delta)(1 - \frac{1}{\theta_D}) \frac{1}{A} > \epsilon > (1 - \delta)(1 - \frac{1}{\theta_L}) + \gamma \]  

(10)

As in the case of a republican settlement, in addition to (10), a monarchical settlement will only be feasible if peace without transfers is not an equilibrium.\(^8\)

2. For the space in which a state (either monarchical or republican) may take place (according to the conditions just spelled out in 1.A and 1.B), the producer (agent \(i\)) will prefer a republican over a monarchical solution whenever:

\[
\frac{(1 - \lambda/\theta_D)A}{1 - \delta} > \frac{(1 - \epsilon)A}{1 - \delta}
\]

Simplifying the expression:

\[ \epsilon > \frac{\lambda}{\theta_D} \]  

(11)

In short, a republican solution is more likely as either the extraction rate under a monarchy or the military capability of producers increase.

If the producer sets up a republic, the potential looter \(j\) will abide by the solution since, by definition, a republic is only possible if producers have the actual military capacity to deter looters from pillaging them (and, again, this deterrence strategy still is preferable to any other solution).

If the producers are, instead, better off under a monarchy, agents of type \(j\) will not accept the monarchical settlement if their payoff under a republic is larger than the monarchical transfer \((1 - \epsilon)A\) – with the looting alternative precluded by our assumption that inequality (7) holds. In that case, the producers will have to increase \(\epsilon\) to the point that monarchy becomes feasible.

\(^8\) Again, there is a wide range of values that make these two conditions (and thus a monarchical regime) feasible.
attractive to \( j \) (provided that, even after that increase in the extraction rate, a republic would still leave agents \( i \) worse off than the monarchical solution).

**An Extension: The Possibility of Imperial Republic.** In addition to establishing a self-governing structure to pursue a purely defensive strategy, producers \( i \) may decide to organize themselves to follow an offensive one, both geared toward defending their land and attacking the looters. The offensive strategy costs an extra fraction of \( i \)'s production above the price paid to simply defend their own territory. Therefore, since it implies a lower direct output for \( i \), we can denote the offensive technology parameter as \( \theta_O \) with \( 0 \leq \theta_O \leq \theta_D \).

The use of an offensive strategy implies that agent \( i \) will apply sufficient force to make individuals \( j \) spend their time producing even when they experience some looting from \( i \). (In the defensive republic, \( j \) did not loot but they were able to retain all their output). Thus, for agent \( i \) to pursue an offensive strategy, the following inequality should hold:

\[
\frac{(1 - \frac{\lambda}{\theta_D})A + (\frac{\lambda}{\theta_D})}{1 - \delta} > \frac{(1 - \frac{\lambda}{\theta_D})A}{1 - \delta}
\]

Simplifying the expression shows that the inequality holds if the benefits of looting agents \( j \) are higher that the portion of output lost in upgrading the military strategy from a defensive into an offensive one:

\[
\frac{\lambda}{\theta_D} > (\frac{\lambda}{\theta_D} - \frac{\lambda}{\theta_D})A
\]

\[9\] It seems plausible to think that even when the main endeavor of these agents is production, they still need to pay always some minimum costs of defense \( \theta_D \) to be ready to move to the fully militarized strategy. As a matter of fact, if \( \theta_D \) were equal to 0, then government institutions would only appear when individuals of type \( j \) chose a looting strategy. Otherwise, if individuals of type \( j \) did not loot, everyone would simply cooperate spontaneously with no permanent structure governing them. This does not seem realistic.
The closer the offensive costs $\theta_O$ are to the defensive costs $\theta_D$, the more likely the producers will establish an imperial republic: the expression in the parenthesis becomes closer to 0 (since $\theta_O \leq \theta_D$). In addition, the more productive agents of type $i$ are with respect to agents of type $j$, the less inclined they will be to pursue an offensive strategy – the opportunity costs of the expansion are not compensated by what they obtain in a successful conquest. To put it differently, the more marginal lands and persons are, the less prone their (richer) neighbors will be to attack and subject them.

II. HISTORY

II. 1. Pre-agrarian communities

Until about 8,500 B.C., all mankind lived in relatively equal, stateless, foraging communities. According to existing archaeological evidence and contemporary anthropological research, hunting and gathering communities are small in size – the sum of a few extended families. Although those groups or bands may present some internal heterogeneity in status and prestige as well as some differential access to a few goods (such as sexual partners), their level of social and economic stratification is rather limited. All individuals exhibit similar age-specific patterns of consumption and levels of individual welfare.\(^{10}\) Wealth accumulation is very limited and the intergenerational persistence of wealth inequality is low (Borgerhoff-Mulder et al. 2008).\(^{11}\) Foraging societies lack a well-developed, stable organization (or a group

\(^{10}\) On foragers, see Kelly (1995). On horticulturalists, see Price and Gebauer, eds. (1995). Comparing the Gini coefficients of 3 contemporary hunter-gatherer societies with classical Athens, Bollen and Paxton (1997) conclude that the former are all more egalitarian, particularly with respect to women.

\(^{11}\) The only exception in foraging societies to this pattern of equality appears where the construction and ownership of sophisticated equipment, such as complex fish traps, involves considerable labor (Rowley-Conwy 2001). This is the case of the sedentary fishing communities of northwestern America, which showed considerable social differentiation with chiefs, commoners and even some slaves.
of individuals) holding the monopoly of violence in a given territory. Tribal ‘leaders’ or chiefs act as mere referees among different individuals or families or spend substantial time negotiating with, cajoling or persuading other members of the tribe. And although threats and actual violence are employed within the tribe, they happen in a sporadic or at least non-institutionalized manner (Clastres 1972, 1974).

The structure and underlying dynamics of foraging societies match the model in subsection I.2. A pattern of relative equality in foraging groups underpins the outcome of “spontaneous” cooperation within each tribe or, to employ Clastres’ terms, of “non-state politics”. Of course, as emphasized above, non-institutionalized peace, that is, peace unenforced by any third party, is only one of the possible equilibria of the game. Even under conditions of equality, a fleeting shift in discount rates or in the technology of looting may result in the collapse of cooperation. In fact, we know that generalized violence is endemic among pre-agrarian societies (Gat 2000, LeBlanc 2003). It is also true that foraging bands manage interpersonal conflict through a regular process of fission, with a section of the group seceding and migrating to a new location, where it self-organizes again along the standard patterns of relative equality and non-institutionalized politics (Chagnon 1997).

II. 2. Transition to Agriculture

This scenario of stateless foraging societies changed with the domestication of animals and plants about 11,000 years ago. First, the invention of agriculture increased land productivity: whereas a family of hunters and gatherers may need several square miles to survive, a family of irrigation agriculturalist may live with less than one hectare (Bellwood

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12 On the effect of strong exit options on income distribution and political structures, see Hirschman (1981), chapter 10.
Second, this new technology of land exploitation affected the productivity of land in a non-uniform manner because some territories are more fertile and prone to agrarian exploitation than others. Hence, as agriculture spread out, territories that were initially homogeneous (i.e. they had the same marginal productivity as hunting areas) now acquired a differentiated resource gradient ranging from a ‘core’ of rich lands to a ‘periphery’ of very marginal quality. Those that happened to occupy the core now obtained a much larger income than the rest. In a word, agriculture generated a pattern of inequality across individuals and human communities (and probably within human groups also).

The causes behind the adoption of agriculture have been thoroughly debated among scholars. A first strand of the literature explained the domestication of plants and animals as a response to the declining marginal productivity of hunting and the related Malthusian constraints faced by growing populations of hunters and gatherers (Flannery 1965; Binford 1968; Cohen 1977). A second set of researchers have seen agriculture as a technological improvement that happened as a result of a long process of learning (Rindos 1980). A third line of research traces it back to a momentous change in cultural norms among foraging societies (Bender 1978). Yet, regardless of the ultimate causes of the agricultural revolution, it is apparent that the transition to agriculture only took place in those areas that were characterized by rather precise geographical, environmental and climatic conditions. As pointed out by Diamond (1997), the agricultural revolution materialized in those regions of the world that had enough plants and animals suitable for domestication and the proper climate to exploit those species.

Following up on seminal empirical work by Hibbs and Olsson (2004) and Olsson and Hibbs (2005), Table 1 shows that most of the variation in the time at which different parts of

the world transited to agriculture was indeed related to the set of biological and geographical conditions of each of those areas. In other words, the causes of the transition that led to the economic and political consequences formalized in Section 1 are exogenous to those outcomes.

The estimations in Table 1 are of two kinds. Models 1 through 3 examine the impact of strict geographical conditions on the number of domesticable plants and animals across the world. Models 4 and 5 estimate the effect of those same geographical conditions on the years it took each geographical unit to transit to agriculture. The units of analysis are those geographical quadrants defined by 10 degrees in latitude and longitude (starting at the intersection of the Equator with the Greenwich meridian) for which there is some land mass. There are 234 such observations – 203 if we exclude the Antarctica.\textsuperscript{14} The number of species suitable for domestication are taken from Olsson and Hibbs (2005) and come for ten separate regions of the world.\textsuperscript{15} The number of domesticable animals ranges from 9 in the Middle East to 0 in Iceland. The number of plants goes from 33 to 0. The years to agriculture are the years it took agriculture to appear since the beginning of the Holocene (9,500 BC). The data is built employing the information gathered in the surveys written by Bellwood (2005) and Parker (2006). For those areas where agriculture has yet to develop I assign a value of 11,500 years (9,500 plus 2,000 years).

The geographical conditions are measured through four variables:

\textsuperscript{14} In the Olsson-Hibbs work, the unit of observation is the contemporary state.
\textsuperscript{15} Those regions are: Near East-Europe-North Africa, East Asia, Southeast Asia, Sub-Saharan Africa, North America, Central America, South America, Australia, Pacific Islands and Iceland.
1. **Climate**, measured following Köppen’s system of climatic classification and ranging from 1 (worst climate for agriculture) to 4 (Mediterranean and West Coast climate). I code each unit of observation by looking at the geometrical center of the quadrant.\(^{16}\)

2. **Latitude** of the geometrical center of each observation. I also add the square of latitude to capture any potential non-linearities in the effects of latitude.

3. **Major axis** of continent, that is, longitudinal degrees between the extreme eastern and western points of the continent divided by the distance in latitudinal degrees between the extreme northern and southern points of the continent. The axis ratio goes from 0.1 (in the Pacific Ocean) to 3 (for Asia).

4. **Island**, that is, whether the unit of observation (or most of it) belongs to an island or not.

Both climate and latitude approximate the environmental conditions most favorable to agriculture. The axis ratio measures the fact that, as emphasized in Diamond (1997), a predominant East-West orientation facilitates the diffusion of agricultural techniques within continents. The dummy island is a second proxy to tap the effects of the sea as a barrier to the diffusion of agriculture.

[Table 1 about here]

The geographical variables of climate, axis and island are statistically significant, behave in the expected direction and explain about 55 percent of the variance in the number of animals (Model 1), plants (Model 2) and a composite of the two (Model 3). A one-point shift in the climate variable changes the number of animals by 0.5 and the total of plants by 1.5. The\(^{16}\) The coding is as follows: 1 for tundra and ice (climates of type E in Köppen’s classification), dry tropical climates (climates of type B) and subarctic climates (Dc and Dd in Köppen’s); 2 for wet tropical (climates of type A); 3 for temperate humid subtropical and continental areas (types Caf, Caw, Da and Db in Köppen’s system); and 4 for dry hot summers and wet winters (types Cb, Cc and Cs).
axis ratio has a strong impact on the number of species that can be domesticated: the maximum value of 3 implies about 11 animals and 24 plants. Being an island reduces the number of domesticable plants and animals by 3 and 10 respectively. Finally, latitude has some effect on the number of plants.

Models 4 and 5 report the impact of the environmental conditions on the time to agriculture – with Model 5 excluding the cases of Antarctica. All the variables are strongly significant and the r-squared is 0.54. A shift in the climate index from the worst to the best conditions leads to the introduction of agriculture 2,800 years earlier. The size of the coefficients for axis ratio and island underscores, in turn, the relevance of diffusion. All other things equal, agriculture spread 2,000 to 2,500 years earlier in Asia than in America. The sea delayed the process of diffusion by 1,500 to 2,250 years. Figure 1 displays the correlation between the time at each agriculture was introduced and the composite index of biogeographical conditions.17

II. 3. State Formation

As modeled in Section 1, the biased technological shock that came about with the invention of agriculture led, in turn, to the formation of stable political institutions. The first historical records attesting the formation of states appeared late in time, at around 3,200 BC, that is, a few thousand years after the domestication of plants and animals, simply because writing was only invented at end of the fourth millennium before Christ. But stable political structures must have emerged earlier in time. In the southern Levant there were several villages with an estimated population in each one of them of three to four thousand inhabitants already

17 The index is an equally weighted average of climate, latitude, axis and island (set at their relative values with respect to the maximum value in each variable).
in the seventh millennium before Christ (Kuijt 2000). The city of Jericho had defensive walls and a temple shrine by 6,500 BC (Finer 1997).

The first documented states invariably formed in those areas that had first transited to agriculture. At the end of the fourth millennium BC there were a few city states, with several thousands of inhabitants, a centralized political authority and fortified walls, in southern Mesopotamia. Egypt became unified under a single monarch at around 3,000 BC. By the end of the third millennium several palaces were built in Crete, spawning the Minoan civilization. A few hundred years later continental Greece witnessed the emergence of several monarchies within what has been called the Mycenaean civilization. The Harrapan culture, with large urban agglomerations and fortified structures, flourished in the Indus valley in the middle of the third millennium BC. The first firm evidence of a state structure in East Asia has been put at around 1,850 BC with the Shang dynasty governing northeastern China. In America, urban settlements and state structures developed in the two main cradles of agriculture: in Measoamerica about two thousand years ago and in the Andean area around AD 500-700 (or perhaps earlier).

Table 2 estimates the timing of the transition to agriculture to the formation of states in each unit of observation. A state is defined by the existence of a specialized and organization with the quasi-monopoly of coercion over a well defined territory. I code an area as having a state if there are contemporary writing materials that report the existence of those structures or if, absent writing records, there are sufficiently large fortified structures that point to the existence of armies and states. I employ the information provided in Kinder and Hilgeman (1974), Mann (1986) and Finer (1997) and several regional histories to date the approximate century at which political institutions formed. In coding the emergence of states I take a conservative approach: for example I date the emergence of states at around 3,000 BC in Mesopotamia and the Near East (when writing records appear for the first time) even though Jericho seemed to have had some fortified structures a few thousand years earlier. Pacific
islands are not coded because it is unclear whether (and when) complex tribal chiefdoms were born before Europeans explored that area.

Models 1 and 2 estimate the impact of biogeographical conditions on the birth of states – with and without Antarctica correspondingly. All the variables are strongly significant and operate as expected. Models 3 and 4 examine the relationship between year of transition to agriculture and year of birth of political institutions (again with and without Antarctica). The relationship is extremely strong with and $r^2$ around 0.6. Since one can claim that diffusion effects may be important the process of state formation, Model 5 simply looks at those cases where political institutions formed ‘originally’ in each area. The explained variance is about the same. Figure 2 displays the relationship between transition to agriculture and transition to states (the abbreviations correspond to the contemporary country that matches the geometrical median of the area).

[Table 2 and Figure 2 here]

Notice that besides linking the formation of states to technological shocks that increase the output of particular communities over others, the model developed in this article gives us clear predictions about the origins and direction of violence. As the agricultural revolution unfolds, the poor, non-agricultural populations will try to loot the technologically advanced, sedentary societies that emerged after the domestication of plants and animals. As a matter of fact, that prediction constitutes a very strong regularity in human history. Populations in peripheral, less rich lands have tended to breed much more war-prone populations than fertile lands. Ancient Mesopotamia and Egypt, the first centers of agriculture in the Middle East, withstood successive waves of invaders originating in the Caucasus and the Asian steppes such as the Hurrians in the third millennium and the Hyksos in the late second millennium. The Roman Empire fell under the pressure of Germanic tribes. Medieval Europe endured the attacks of periphery populations such as the Vikings, Slavs, Turks and Mongols.
II. 4. Military Technology and Type of Political Institutions

As modeled before, there are two possible political paths to order and peace: a monarchical settlement and a ‘self-government’ or republican solution. Which solution will prevail will crucially depend on the general costs of war for both producers and looters. If both types of individuals are relatively equal (in strength and resources), producers will be able to defeat and kill any predator or set of predators and therefore will be able to organize in relatively small human communities, where decisions are made in a consensual manner or were, at least, broad section of the population had some impact over politics. Otherwise, that is, if looters acquire some strong comparative advantage in the use of force, monarchical regimes will become the prevalent form of government.

The costs of war will vary as a function of military technology, geographical conditions and the structure of competition among looters. Producers will be able to defend themselves whenever the production and use of the existing military technology does not require much specialization. However, as soon as it grows in sophistication, that is, as soon as soldiers rely on weapons such as swords or chariots that require considerable training and expertise, the production of violence turns into a rather specialized activity. The opportunity costs of self-defense among peasants escalate. By contrast, those individuals that engage in predatory activities gain in power and effectiveness. Bandits ‘professionalize’. They invest substantial time and effort in mastering weapons, looting and razing territories and populations in a systematic manner. They form a separate caste of warriors that encroaches upon the self-governing institutions preferred by the producers and that establishes strong and centralized states imposing highly extractive fiscal systems. All these transformations result in the formation of rather unequal societies.
The impact of technological revolutions on the nature of states is well attested in the historical literature. The foundation of the first big states in Mesopotamia around 3,000 BC came hand in hand with the invention of bronze weapons. The introduction of two-wheeled chariots around 1,800 B.C. increased the costs of war and led to the formation of a set of ‘feudal’ states with a narrow aristocracy of warriors exercising full control over their subjects (McNeill 1982). As emphasized by Rogowski and McRae (2008), medieval feudalism followed the introduction of the stirrup (and the strengthening of the cavalry) and absolutism was equally related to the 16th-century revolution associated with the use of cannons and standing armies.

Likewise, whenever there have organizational and mechanical changes in the production of violence that have reduced existing imbalances between warriors (and rulers) and producers (and subjects), there has been a corresponding broadening of the political base of government (to the point of ‘democratizing’ institutions) and the re-equalization of the distribution of income. In the second half of the second millennium before Christ, the discovery of how to make weapons out of iron cheapened war, allowed a “relatively large proportion of the male population [to] acquire metal arms and armor” (McNeill 1982: 12) and gave way to more egalitarian political and social structures. In its Politics, Aristotle already notes that “when the country is adapted for cavalry, then a strong oligarchy is likely to be established” whereas “the light-armed and the naval element are wholly democratic” (Book 6, Part 7). More recently, Levi has emphasized the impact of modern war and general military mobilization of the extension of political rights (Levi 1997) and several authors have linked the occurrence of modern war to higher levels of taxation and redistribution (Peacock and Wiseman 1961, Scheve and Stasavage 2009).

The costs of defense will also vary with geographical conditions. They will also be more likely in territories with geographical conditions, such as sea barriers and mountainous
terrains, that deter bandits and protecting producers. Hence, other things being equal, one should see less oligarchical institutions in islands, valleys and poorly communicated regions.

Finally, higher levels of competition among looters also reduce the costs of self-defense for producers. A bandit-lord who has to fend off the assault of other agents of his same type will have fewer resources left to enslave other communities of producers. As emphasized by Hansen (2000), many (if not most) of the thirty city-state systems that he has identified emerged in the margins of empires or kingdoms with insufficient means to exercise complete control over their nominal territories. For example, after the collapse of the Carolingian empire, the exercise of political authority was substantially weak in the decentralized areas of the Lotharingia: that may explain why European cities emerged mostly in the axis Flanders-North Italy already in the early Middle Ages (Dhondt 1976).

III. DISTRIBUTIONAL CONSEQUENCES OF POLITICAL SETTINGS

Each political solution has different distributional consequences. In a nutshell, and other things being equal, the level of intrastate inequality is higher under a monarchical system than under a self-governing system. (The ‘ceteris paribus’ caveat is important because, as noted above, the process of technological change also shapes (through a strict economic mechanism) the distribution of income: in other words, there may be considerable variance in the distribution of wealth even within the universe of self-governing communities – from villages of relatively equal farmers to republican cities endowed with a rich commercial class.) Moreover, the number of rulers affects the final distribution of income. And, finally, the extraction rate (determined by the efficiency of rulers and by the nature of assets of the producers) also shapes the distribution of income.

Regime Type
Before the state is established (and institutionalized peace is in place), each individual receives an income $y_i$ and there is no inequality beyond the (relatively bounded) one determined by the productivity $A_i$ of each individual. In a monarchical system, instead, the ruler siphons off a share $\varepsilon$ of every individual to himself (and his servants and allies) and hence gets $(\varepsilon-\gamma)y_iN$ with $N$ denoting the number of subjects while each subject keeps $(1-\varepsilon)y_i$ in each period. (For any minimal number of subjects, this process of redistribution always increases inequality.) By contrast, in a republican or self-governing polity every citizen keeps $(1-1/\theta_D)y_i$ and inequality does not vary with respect to the pre-shock world. (For the sake of simplicity I will assume $\lambda=1$ throughout this section).

[Table 3 here]

To examine the effects of different political institutions on the distribution of income, let us first consider the impact of any technological shock on population. Following the literature on pre-industrial economies, assume that net population growth ($\Delta L$) tracks the rate of technological change ($\Delta A$). That assumption implies that population adjusts so that output per person equals some subsistence income $\hat{y} = Y/L$. This fits two key features of pre-industrial societies. First, the level of material welfare in pre-industrial societies is not very different, at least in terms of vital statistics: food consumption per capita, life expectancies and health profiles have been found to be similar across foraging and agricultural societies (Clark 2007: 40-70, 91-111). Second, population densities are much higher in technologically ‘advanced’ (agrarian) societies than in hunting-gathering territories. In the latter, population densities fluctuate, mostly depending on climate and land conditions, between 2 (in a few cases) to less than 0.5 persons per square kilometer (Kelly 1995). By contrast, recent archaeological studies suggest a density of about 90 persons per square kilometer in the first Neolithic villages in the Levant about 8,000 to 9,000 years ago (Kuijt 2000).
To calculate the population growth rate (and hence the size of the population) given the level of technology, take the previous function, solve for \( Y \) and equalize to the production function introduced in Section I.1 so that \( \hat{Y}L = A_i T_i L_i^{1-\alpha} \). Solving for \( L \) gives us:

\[
L = (\frac{1}{\hat{Y}})^{\frac{1}{\alpha}} A_i^{\frac{1-\alpha}{\alpha}} T_i
\]

(12)

Since \( T \) and \( \hat{Y} \) are constant, the growth rate of \( L \) is \((1-\alpha)/\alpha\) times the growth rate of \( A \).

Given (12) and assuming that the share of the land factor in total output (with no other output than the one from agricultural activities) was about 2/5 (\( \alpha=0.4 \)) (Clark 2007: 138), Figure 3.A displays the evolution of the population (in relative terms) in both foraging and agrarian communities as the technology changes for the latter one. As soon as the technical know-how doubles, the agricultural population becomes two and half times larger than the foraging population. For a technology ten times more advanced, the agricultural population becomes over thirty times larger than the hunting one (for the same unit of land).

For the proper parameters (i.e. relative high looting gains), the shock makes the spontaneous peace equilibrium across communities unfeasible. Once the \( j \)-individuals organize and have a better military technology than producers, the former impose a monarchy and extract some of the producers’ income – the extraction rate slightly declining on the technology in the hands of producers.\(^{18}\) With these results in hand I simulate the post-extraction (per capita) income of individuals \( i \) and \( j \), the proportion of total income in the hands of the top ten percent and the Gini index. I display those results in Figure 3.B. Just to discuss one measure of inequality, the Gini index goes up to around 0.29 if the productive individuals double their output and the ruling class in a monarchical system imposes the corresponding highest feasible extraction rate, that is, 48 per cent. As the technological shock grows, the Gini rises to about 34 percent.

\(^{18}\) The parameters assumed are \( \delta=0.7 \), \( \theta_D=0.6 \), \( \lambda=0.5 \).
Changes in Size of Ruling Clique and Level of Extraction

As I indicated before, holding the feasible rate of extraction constant, the smaller the number of rulers relative to the population of the country, the more unequal the distribution becomes. Figure 3.C reduces the size of the ruling group while holding the extraction rate fixed (at 0.6). The Gini index goes from less than 0.1 to around 0.6.

Figure 3.D also shows that, besides the costs of defense, the type of regime and the final distribution of income depend on the extraction rate $\varepsilon$. For the same proportion of rulers, the Gini index increases from 0.17 to 0.44 as the extraction rate climbs up to 70 percent.

Given that the bandit-lord is unable to commit to a lower extraction rate than the one that maximizes his income, the extraction rate will vary as a function of two factors. First, it will increase with the ‘administrative’ efficiency of the state. Second, it will also vary with the tax elasticity of output and with asset specificity (Boix 2003): the higher the mobility of assets, the less punitive the level of extraction by the lord. Hence, predation and social and economic difference will be sharper in agrarian economies than urban settings (for identical distributions of technologies across individuals).

Monarchies versus Republics

Figure 4 compares the income distribution under a monarchical and republican regime. To make the analysis richer, the baseline distribution of income is slightly different than in Figure 3. Instead of two types, the shock differentiates the population into ten segments or
deciles. The tenth decile does not experience any shock \( (y_{10} = 1) \) – it corresponds to the type-\( j \) individuals of Figure 3. The other deciles experience an increase in productivity – but the extent of the raise varies across them. However, the increase is bounded so that they have an incentive to cooperate among them. (The lowest increase, the one experienced by the first decile, is big enough to make it impossible for those individuals that do not get any increase (those in the 10th decile) to maintain a cooperative relationship with the rest of the population.) In Figure 4 the post-shock income ranges from 2 for the first decile to 3.58 for the ninth decile (the tenth decile keeps receiving 1).

[Figure 4 here]

Figure 4 compares the pre-political distribution (after the shock) with a republican and a monarchical system. A republican system reduces the initial distribution slightly – as a result of the tax burden to defend the human settlement. A monarchical system leads to a strong redistribution of income. The tenth decile becomes the richest one: it has a per capita income that is about nine times larger than the poorest decile’s and it controls almost 39 percent of all the wealth. The Gini index more than doubles to 0.35 under a monarchy. Under an “imperial republic” (where the tenth decile is expropriated by the majority), inequality does not increase by much: even with the highest extraction rate, the Gini index inches up from 0.14 to 0.19.

Although I do not consider the following point in the simulation, the distribution of income may be also shaped by the way in which rulers extract their resources or, in other words, what kinds of alliances they form with different strata of producers. The distribution of

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19 This differentiation is done by assumption. The assumption can be justified as follows: consider the case in which different segments experience different technology shocks and choose the same population growth rate, unlinked to the technological growth rate (in contrast to expression (12) where both were functionally related).
income becomes highly skewed when the rulers ally with the richest fraction of the population (this would be equal to imposing a lower extraction rate $\varepsilon$ on them than on other groups) or where the ruling elite simply replace the existing segment of wealthy individuals. By contrast, the ruling elite may favor a more equalized structure of income within the producers’ population. These different outcomes, resulting from different institutional (and distributive) choices, are particularly manifest in processes of repopulation and colonization. After the Christian kingdoms of Northern Spain took over most of the Southern half of the Iberian Peninsula in the 13th century, they differed markedly in their strategies of land redistribution: Castile and Portugal favored the formation of large landholdings; Catalans settled in Valencia through small farms (Vicens Vives 1957). Similarly, the conquest of America followed very divergent paths: farming communities settled in the Northeastern seaboard and in Quebec; the Caribbean basin and Central and South America were dominated by landowners (Engerman and Sokoloff 2002). In all those cases the distribution of land partly responded to economic considerations, such as the supply of labor. But it was strongly affected by the way in which the ruling elites decided to structure the distribution of assets – and that was probably related to the prevailing political institutions and societal conditions back in the conquering countries.

IV. EMPIRICAL EVIDENCE ON DISTRIBUTION OF INCOME

From an empirical point of view, the simulated extraction rates and Gini indexes do not seem farfetched. Consider the evidence gathered by Milanovic et al. (2007) and reproduced in Table 3. In almost all pre-industrial regimes the Gini index fluctuates around 0.40 and in most cases the top 10 percent of the distribution controls more than two fifths of total income. Bourguignon and Morrisson (2002) offer similar data across the world in 1820, at the dawn of the industrial revolution.
Given the lack of reliable data on income distribution before the 19th century, one possible strategy to understand the welfare consequences of regimes is to employ height as a proxy for access to resources, health status and general welfare. As discussed in Steckel (1995), height and individual income seem to be strongly correlated and, as a result, the distribution of heights should provide us with clues about how that society distributed its resources, at least in human communities living under conditions of scarcity.20 In fact, we know that insufficient nutrition was widespread and that the access to food was biased across social strata in pre-industrial economies: for example, in England in 1790 whereas the top decile consumed 4,329 kg cal per day; the bottom decile consumed 1,545 kg cal per day (Fogel 1994).

Table 4 summarizes a more extensive discussion of data reported in Boix and Rosenbluth (2006) on the level of variance in height across times and within different societies. Inequality is low within tribal, pre-agrarian groups. With the transition to a fully agricultural society with complex political institutions, heights vary strongly with the type of political regime. In ancient kingdoms and absolute monarchies, there is considerable differentiation among individuals: the height gap between nobles and peasants goes from 7 to 9 cm. Using fitted models between log income (in constant dollars of 1985) and height (Steckel 1995), this difference translates into an income ratio of 5 or 6 to 1 between both groups.21 By contrast, more democratic settings show a much more compressed height structure.

V. CONCLUSION

20 For a critique, particularly directed at cross-country or cross-ethnic group comparisons, see Eaton (2007).
21 This ratio matches the ratio of the 95th centile/50th centile in the data Bourguignon and Morrisson (2002) offer for several (46) world areas in 1820.
Broadly speaking, the distribution of income in human societies has been characterized by the following pattern. First, primitive (stateless, pre-agrarian) societies displayed (and still display wherever they exist) relatively equal distributions of income and certainly very low level of intergenerational transmissions of wealth. Second, the agricultural revolution came hand in hand with the emergence of marked inequalities of income (across individuals and over generations) and the formation of the state. Third, the level of inequality has varied considerably across historical communities since the invention of agriculture.

This paper develops a theoretical model to explain the transition away from relatively equal pre-agrarian societies. After the end of the last glacial period, a process of learning and experimentation resulted in territorially differentiated technological shocks that generated inequality (within but mostly across human bands). That inequality made spontaneous cooperation unfeasible. That opened the way to both political institutions and further shifts in income distribution. In response to the productivity growth, less productive individuals responded by creating protection institutions in exchange of systematic payments from more productive sectors. Alternatively, the latter could choose to devote part of their income to deter bandits. Both outcomes (‘monarchical’ and ‘republican’), strongly driven by the evolution of military technologies, had distinctive effects on the distribution of resources – with monarchical regimes generating and sustaining much higher levels of inequality than republican systems. The theoretical results match the existing descriptive work as well as broader empirical work compiled in Boix and Rosenbluth (2006).

Understanding the sources of states institutions and of income inequality is in fact important to explain economic development and the contemporary process of democratization. The emergence of the state had a considerable stabilizing effect on the distribution of income over time. As discussed in Boix (forthcoming), authoritarianism, economic stagnation and inequality came together in an overwhelming majority of Ancien Régime polities -- income
inequality only started to trend downward in a systematic fashion after the industrial revolution. That was a direct outcome of the incentive structure of their ruling elites. The latter’s final income depended, directly, on the returns to their assets and, indirectly, on the extraction rate embodied on the existing political institutions, themselves endogenous to the prevailing income distribution. Hence, those governing had a direct interest in protecting the status quo and in blocking any process of economic and political liberalization.
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### TABLE 1. ESTIMATING THE CAUSES OF THE AGRICULTURAL REVOLUTION

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
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<tbody>
<tr>
<td>Dependent Variable</td>
<td>Animals</td>
<td>Plants</td>
<td>Animals And Plants</td>
<td>Years to Agriculture</td>
<td>Years to Agriculture</td>
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<td>Constant</td>
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<td>-5.214** (2.506)</td>
<td>-24.474*** (7.273)</td>
<td>11,252.226*** (455.150)</td>
<td>11,140.786*** (461.598)</td>
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<td>1.540** (0.665)</td>
<td>5.148*** (1.9292)</td>
<td>-830.410*** (120.751)</td>
<td>-959.365*** (125.037)</td>
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<td>Latitude</td>
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<td>0.0781*** (0.020)</td>
<td>0.169*** (0.058)</td>
<td>8.056** (3.614)</td>
<td>-27.554*** (7.992)</td>
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<td>(Latitude)$^2$</td>
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<td>0.0080 (0.042)</td>
<td>-0.061 (0.120)</td>
<td>73.574*** (7.531)</td>
<td>131.756*** (13.869)</td>
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<td>EW Axis / NS Axis</td>
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<td>8.690*** (1.283)</td>
<td>33.461*** (3.723)</td>
<td>-1,479.413*** (233.010)</td>
<td>-1,169.922*** (243.907)</td>
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<td>Island</td>
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<td>-9.946*** (1.842)</td>
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<td>2,299.943*** (334.573)</td>
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<td>R-squared</td>
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<td>0.4693</td>
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<td>0.5485</td>
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Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
### TABLE 2. ESTIMATING THE EMERGENCE OF STATES

<table>
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<th>Dependent Variable</th>
<th>Emergence of State -------------------------------</th>
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<tbody>
<tr>
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<td>(Original &amp; Derivative)</td>
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<tr>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3</td>
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<td>Constant</td>
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<td>2,474.894***</td>
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<td></td>
<td>(211.439)</td>
<td>(218.471)</td>
</tr>
<tr>
<td>Climate</td>
<td>-260.769***</td>
<td>-311.078***</td>
</tr>
<tr>
<td></td>
<td>(54.822)</td>
<td>(57.753)</td>
</tr>
<tr>
<td>Latitude</td>
<td>4.693***</td>
<td>-9.436**</td>
</tr>
<tr>
<td></td>
<td>(1.682)</td>
<td>(3.758)</td>
</tr>
<tr>
<td>(Latitude)$^2$</td>
<td>22.853***</td>
<td>45.736***</td>
</tr>
<tr>
<td></td>
<td>(3.443)</td>
<td>(6.455)</td>
</tr>
<tr>
<td>EW Axis / NS Axis</td>
<td>-928.002***</td>
<td>-792.815***</td>
</tr>
<tr>
<td></td>
<td>(112.164)</td>
<td>(119.894)</td>
</tr>
<tr>
<td>Island</td>
<td>706.341***</td>
<td>448.982***</td>
</tr>
<tr>
<td></td>
<td>(155.587)</td>
<td>(171.475)</td>
</tr>
<tr>
<td>Year of Transition</td>
<td>0.327***</td>
<td>0.324***</td>
</tr>
<tr>
<td>To Agriculture</td>
<td>(0.016)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Observations</td>
<td>229</td>
<td>198</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.449</td>
<td>0.454</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
**TABLE 3. SOME INEQUALITY STATISTICS**

<table>
<thead>
<tr>
<th></th>
<th>Gini</th>
<th>Top 10 percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roman Empire ca. 14 AD (a)</td>
<td>0.36</td>
<td>0.44</td>
</tr>
<tr>
<td>Byzantium 1000 (a)</td>
<td>0.41</td>
<td>0.46</td>
</tr>
<tr>
<td>England/Wales 1688 (a)</td>
<td>0.45</td>
<td>0.38</td>
</tr>
<tr>
<td>Moghul India 1750 (a)</td>
<td>0.39</td>
<td>0.35</td>
</tr>
<tr>
<td>Mexico 1790 (a)</td>
<td>0.64</td>
<td>0.61</td>
</tr>
<tr>
<td>Naples 1811 (a)</td>
<td>0.28</td>
<td>0.35</td>
</tr>
<tr>
<td>Brazil 1872 (a)</td>
<td>0.39</td>
<td></td>
</tr>
<tr>
<td>France 1780 (b)</td>
<td></td>
<td>0.56</td>
</tr>
</tbody>
</table>

(a) Milanovic et al. (2007).
(b) Morrisson 2000
**TABLE 4. POLITICAL SETTINGS AND DIFFERENCES IN MALE HEIGHTS**

<table>
<thead>
<tr>
<th>INSTITUTIONS, PLACE</th>
<th>MEAN (IN CM.)</th>
<th>DIFFERENCE (IN CM.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-State Societies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zuni Pueblos (before 1680 AD.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height at 90th centile</td>
<td>165.8</td>
<td></td>
</tr>
<tr>
<td>Height at 50th centile</td>
<td>161.1</td>
<td>4.7</td>
</tr>
<tr>
<td><strong>Monarchical/Authoritarian</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ancient Egypt (New Kingdom)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Royal family</td>
<td>174</td>
<td></td>
</tr>
<tr>
<td>Commoners</td>
<td>166</td>
<td>8.0</td>
</tr>
<tr>
<td><strong>Mycenae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Royal</td>
<td>172.5</td>
<td></td>
</tr>
<tr>
<td>Commoners</td>
<td>166.1</td>
<td>6.4</td>
</tr>
<tr>
<td><strong>Poland – 17th cent.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noble</td>
<td>170.6</td>
<td></td>
</tr>
<tr>
<td>Rural Non-Jewish</td>
<td>165.2</td>
<td></td>
</tr>
<tr>
<td>Jewish</td>
<td>162.9</td>
<td>7.7</td>
</tr>
<tr>
<td><strong>Democratic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ohio Recruits, Mid 19th Century</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laborers</td>
<td>173.3</td>
<td></td>
</tr>
<tr>
<td>Skilled Workers</td>
<td>174.0</td>
<td></td>
</tr>
<tr>
<td>Farmer</td>
<td>174.7</td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td>175.5</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Figure 1. Transition to Agriculture and Biogeographical Conditions

Figure 2. Transition to Agriculture and Birth of State Institutions
Figure 3.C. Change in Size of Monarchical Class with Fixed Extraction Rate

Figure 3.D. Change in Extraction Rate
Figure 4. Income Comparison of Monarchy and Republican Structures

Per Capita Income for Each Decile

Decile

Income after shock without state
Income under Monarchy
Income under Republic
Income under Imperial Republic