Institutions: Why are They Persistent and Why Do They Change?*

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Abstract

This paper presents a model of institutional choice over time, where institutional arrangements arise endogenously in response to the need for protection of property. Variable returns to investment in new technology create technological inequality between households, which in turn influences what institutional arrangement is chosen. The type of institution chosen in one period then affects subsequent economic outcomes in a way that tends to reinforce the existing institutional arrangement in the next period. This feedback effect makes institutions persistent over time. A change in the prevailing institution occurs only when particular realizations of the technological development process happen to counteract the institutional feedback effect. The longer a particular institution is in place, the less likely it is that this feedback effect can be overcome.

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1 Introduction

This paper examines two important questions regarding the nature and dynamics of institutions; why are institutions persistent and why do they change? On the one hand, historical observation seems to suggest that institutions broadly defined tend to become entrenched in society for long periods of time. For example, many democracies in North America and Western Europe have been democracies for centuries. Acemoglu, Johnson and Robinson (2001) find a strong correlation in former European colonies between existing institutions and those institutions that were originally put in place by colonizers, often hundreds of years earlier. Glaeser and Shleifer (2002) examine the economic effects of legal origins, exploiting the fact that legal systems in many countries today can be linked either to English common law or French civil law that was formed back in the 12th and 13th century.

On the other hand, there are historical examples suggesting that these same institutions are subject to infrequent, radical change. The last century alone has seen economic and political change ranging from communist revolution in Russia, China and Cuba, to dramatic land reform in South Korea, to a wave of democratization in Latin America.

In their discussion of institutions as the fundamental cause of long run growth, Acemoglu, Johnson and Robinson (2004) state that, '...though we know that institutions, both economic and political, persist for long periods of time, often centuries (and sometimes millenia), we do not as yet have a satisfactory understanding of the mechanisms through which instiutions persist. Second, and closely related, although institutions do generally persist, sometimes they change.'

How to reconcile both of these stylized facts about institutions in a single model is not immediately obvious. On the one hand, imposing exogenous lock-in effects or large set up costs can generate institutional persistence, but not infrequent change. On the other hand, allowing the institutional arrangement to be a costless choice variable can generate lots of change but not much persistence. This paper presents a model of both endogenous institutional persistence and infrequent change, where two groups of agents (households) can choose between alternative institutional arrangements to protect private property.

Because of the possibility of theft, the two households must continually spend resources to protect their property from each other. The particular method (institution) by which this is achieved can be chosen each period, and in general depends on two factors: the current technology levels of the two households (in absolute terms) and the technology gap between them. Both households invest resources in discovering new technology in each period, but because of the uncertain nature of this innovation process, even the same investment by both households can yield different returns. Hence over time the two households can have divergent paths of technological development, which in turn can affect the institution chosen in any given period.

The endogenous persistence of institutions in the model arises from the fact that an institution chosen in one period affects subsequent economic outcomes in a way that reinforces the existing institutional arrangement in the next period. For example, under an institution that promotes equality between the two households, both households make the same investment in discovering new technology. This in turn increases the probability that the households will remain relatively equal, so that they will choose the same equality-promoting institution in the same period. On the other hand, under an instiution that promotes inequality, one household is able to invest more in discovering new technology than the other. This reinforces (or even increases) the existing inequality such that the same inequality-promoting institution is chosen in the next period.

Even though this institutional feedback effect contributes to the persistence of the prevailing institution, change can still occur because of the uncertain return associated with the innovative process by which new technology is acquired. Because of this variability, it is still possible for the relative technologies of the two households to diverge under an institution that promotes equality and to converge under an institution that promotes inequality. Hence a change in the prevailing institution occurs only when a particular realization of the technological development process is able to counteract the institutional feedback effect. However as we show, the longer a particular institution is in place the less likely it is that this feedback effect can be overcome.

In addition to characterizing endogenous institutional choice, persistence and infrequent change, our model also incorporates other key features of institutions that have been addressed in the literature. The first of these key features is that institutions of all varieties are costly. For example, consider a comparison between different political institutions. Autocracies can create opportunities for those with economic and political power to expropriate resources from other agents, creating deadweight loss and a climate that discourages investment and growth. But Acemoglu (2004) argues that democracies may be used to engage in costly and inefficient redistribution activities. Democracies also must incur substantial costs for conducting elections and maintaining various checks and balances on power. The fact that both types of political institutions are costly may help to explain why Barro (1997) finds no clear evidence that democracy (or any particular political institution) is best for growth. In keeping with this idea, we model institutions as cost parameters. Households can choose alternative institutions that protect private property, but never at zero cost. We assume not only that institutions are costly, but that certain costs must be incurred on a continual basis. Here we emphasize the fact that the true cost of institutions is in their enforcement rather than a one-time setup cost.

A second important feature highlighted in Acemoglu, Johnson and Robinson (2004) is that institutional choice is rooted in social conflict. Following from North (1981), those in government (those who hold political power) are self-interested, seeking to maximize their own welfare rather than the collective welfare of all agents in the society. This awareness leads to a power struggle among different groups to hold political power in order to establish their preferred institutions. In our model, each household prefers the particular institutional arrangement that maximizes its own expected utility. Given a sufficient divergence in technology, the two households will prefer different institutions, creating social conflict that is resolved either by compromise or by unilateral action on the part of one household.

One of the implications of this social conflict view of institutions is that vested interests who hold political power will often choose to maintain sub-optimal institutional arrangements for their own private gain. Acemoglu et al. relate the example of ruling monarchs in Russia and Austria-Hungary who saw industrialization as a threat to their power and hence took action to prevent it. In a similar vein, within our model one household may seek to maintain a costly inefficient institutional arrangment that reinforces its dominance over the other household. In this case, the dominant household engages in wasteful expropriation behaviour to maximize its own welfare and at the same time reinforce existing inequality between the two households.

Related to this point, the primary cause of social conflict over alternative institutional arrangements is the simple fact that different institutions lead to different distributions of resources. This implies that inequality is important for understanding institutional choice. Engerman and Sokoloff (1997) for example, argue that inequality is a key factor in both the determination and stability of institutions. For example, in the Latin American colonies, the geographic and climatic conditions were such that agriculture (production of cash crops) was most efficient on large scale farms. This resulted in a large wedge between an elite of wealthy land owners and a poor, landless majority. This inequality was reinforced by the immigration policies of Spain (which controlled many of these Latin American colonies), which restricted immigration to the colonies to its wealthiest citizens. In contrast, the geographic and climatic conditions in the North American colonies gave rise to crop production which did not benefit greatly from economies of scale, leading to an abundance of small and middle size family farms. Since the immigration policies of Britain and France also encouraged migration of the middle class to the colonies, a strong middle class emerged in North America. Engerman and Sokoloff point to these differences in equality as key to explaining the divergent paths of institutions in the two sets of colonies that persist to this day.

Inequality also plays a key role in Acemoglu and Robinson's (2001) theoretical model of political determination and transition between democracy and autocracy. A key factor that determines the political outcome in their model is the level of inequality between rich and poor agents. In a democracy, the poor agents (who are more numerous) set the tax rate. A greater level of inequality means that in a democracy there will be a greater degree of redistribution from rich to poor. As a result, the rich elite will be more likely to hold on to power (or gain power through a coup) in order to prevent democracy from taking root.

In our model, inequality plays a crucial role both in institutional choice and persistence. Regarding choice, technological inequality affects the relative costs of alternative instiutional arrangements, which in turn affects which institution is adopted by the two households. Regarding persistence, technological inequality is the mechanism by which economic outcomes feed back into the existing institutional arrangement, creating a tendency for the current institution to be adopted in the following period. Given this feedback effect alone, institutions in our model would almost always persist forever. However because of the uncertainty inherent in technological advance, it is possible for the level of technological inequality between the two households to change counter to the what would otherwise be implied by the existing institution. It is exactly this possibility that opens the door to institutional change in our model.

Acemoglu et al. point to the development of property rights in England as an example of how institution persistence was overturned by changes in the presiding level of inequality. For centuries English monarchs maintained political and economic dominance, providing general property rights (when convenient) while at the same time expropriating resources for their own purposes. This ability to expropriate reinforced the inequality between the monarchy and the citizenry, which in turn entrenched the dominant position of the monarchy. However, with the rise of Atlantic trade in the 16th and 17th century, the economic power of landowners and merchants began to rise, independent of the power of the monarchy. Because of this new economic power, the expropriative power of the monarchy was no longer sufficient to maintain existing inequality, so that the dominance of the monarchy began to decline. Eventually, relative inequality fell enough that landowners and merchants were able to challenge the power of the monarchy and establish new institutions that would reinforce equality rather than inequality.

The rest of the paper is set out as follows: section 2 presents the basic model, while sections 3 and 4 examine institutional choice and persistence respectively. Section 5 concludes.

2 Model

2.1 Description of Households

To begin, suppose that there are two households who both inhabit a fixed region of land M that can be used for food production. Each household has a constant population N (normalized to 1) in all time periods t, where each time period denotes a generation. Household members are identical and live for two periods, so that a member of generation t is born and raised in period $t-1$ and then lives as an adult in period t. Household members only make economic decisions in their adult life. In each generation, household wealth is defined as $a_{it}M$, where a_{it} is the technology of household i in period t. Hence increases in technology raise household wealth by increasing the productive capacity of its land.

The defining characteristic of a household is that the protection of private property within the household is given. For example, if household members are closely related (ie, there are no 'strangers') then mutual trust and accountability could conceivably provide a sufficient enforcement mechanism to protect property and maintain standards of conduct within the household. However while there may not be strangers among members of the same household, members of different households are always strangers. Because mutual trust, accountability and social pressure cannot apply to strangers, there is no possibility for the two households to coexist without some mechanism to protect private property.

In each generation, a household has both a desire to consume and a bequest motive. Household i's utility at time t is given by

$$u_{it} = (1-\gamma)\log(c_{it}) + \gamma\log(a_{i,t+1}M) \tag{1}$$

where $\gamma \in (0,1)$, c_{it} is the consumption of the household (which is split evenly among all household members) and $a_{i,t+1}M$ is the wealth of the household passed on to the next generation. Consumption is derived directly from agricultural production, which depends on labour and the value of land holdings according to

$$y_{it} = L_{it}^{1-\alpha}(a_{it}M)^{\alpha}$$

Each member of household i is endowed with a unit of time in his adult life which can be put towards the following activities:

(i) agricultural labour (L_{it});

(ii) development of better technology (ϕ_i^a); and

(iii) fulfilling institutional requirements (τ_{it}).

The exact form of the institutional cost τ_{it} will depend on the institutional arrangement chosen by the two households, which we describe in detail below. It is important to note at this point that all possible institutions are costly to the household, and that these costs are incurred in every period. This implies that economic considerations will determine which institution is chosen, creating an important feedback effect from economic outcomes back into existing institutions.

Following from the time limitation described above, agricultural production is subject to the constraint

$$L_{it} + \tau_{it} + \phi_i^a \leq 1$$

With no utility from leisure, household members will use all of their time endowment in every period. Hence we have that production is given by

$$y_{it} = (1 - \tau_{it} - \phi_i^a)^{1-\alpha}(a_{it}M)^{\alpha}$$

and that the (expected) utility of household i in period t is given by

$$u_{it} = (1 - \gamma)\log(c_{it}) + \gamma \log(a_{i,t+1}M) \tag{2}$$

where

$$c_{it} = y_{it} = (1 - \tau_i - \phi_i^a)^{1-\alpha}(a_{it}M)^{\alpha}$$

Given an investment in acquiring new technology ϕ_i^a, the technology passed on to the next generation is given by

$$a_{i,t+1} = (\epsilon_{it}A_t\phi_i^a)^{\mu}(a_{it})^{1-\mu} \tag{3}$$

where $\mu \in (0, 1)$ and A_t is some exogenous measure of the technological frontier, taken as given by both households in each period.

The factor ϵ_{it} is an idiosyncratic shock that reflects the uncertainty that is inherent in the development of new technology. We assume that ϵ_{it} is uniformly distributed on the interval $[\epsilon_L, \epsilon_H]$ with $E(\epsilon_{it}) = \bar{\epsilon}$. Households know the expected value of the shock when they make their investment decisions, but ϵ_{it} is realized only after these decisions are taken. Realizations of the shock are independent across time and across the two households, so that even if both households invest the same amount of time in technological improvement ϕ_i^a, their technology levels can advance at different rates.

Note that a household will always choose a positive level of investment in new technology since $\phi_i^a = 0$ leads to $a_{i,t+1} = 0$. Keeping in mind that each period t is a generation, the idea here is that part of ϕ_i^a includes time spent educating the younger generation. At the extreme then, $\phi_i^a = 0$ would imply that a totally uneducated younger generation would be unable to produce any output from the household's land.

2.2 Timing

The timing of the model is as follows. At the beginning of period t, the generation of children in household i enters adulthood, observes the state of the world and makes decisions accordingly. It is important to note that there is no state uncertainty at the time when the household members make their decisions.

Each period is divided into 3 stages.

Stage 1: Having observed the state of the world, the two households choose an institutional arrangement I_t from a set of institutional choices $\{D_t, P_t, T_t, W_t\}$. We describe each of these institutional choices in detail in the next subsection.

Stage 2: Taking into account the time commitment associated with the prevailing institutional arrangement chosen in stage 1, household i chooses ϕ_i^a in order to allocate its remaining endowment of time optimally between agricultural labour and investment in new technology.

Stage 3: The two households consume c_{it} from their agricultural output y_{it}. At this point the realization of ϵ_{it} is known, the new stock of technology $a_{i,t+1}$ is passed on to the next generation and the current adult generation dies.

2.3 Institutional Choices

Here we present the details of each institutional alternative available to the households.

Private Defense (D)

We suppose that the most basic institutional arrangement is to have no arrangement at all. In this case, the institutional cost faced by a household will consist only of the amount of time required to defend its land holdings from the rival household. This defense cost, which we denote by τ_{it}^d is assumed to be increasing in the value of a household's land, $a_{it}M$. Higher land values imply higher protection costs because with larger output yields, more output must be protected from the rival household.

This institutional cost can be paid either by all household members devoting a fraction of their time to land defense, or by the household designating certain members to be full-time defenders.[1] We assume that $\tau_{it}^d = \{0, \tau^d(a_{it}M)\}$, so that the household must either defend all of its land effectively or not defend it at all (in other words, it cannot choose to defend some positive fraction of its land.) If household i chooses $\tau_{it}^d = 0$, its agricultural production can be stolen by household j (at no cost to household j), yielding zero consumption and negative infinite utility to household i. Hence given no institutional arrangement between the two households in period t, $\tau_{it} = \tau^d(a_{it}M)$ for household i.

Driven by the bequest motive in utility, households will choose to invest time in developing new technology in order to pass new wealth onto the next generation. However, because the cost of defending land $\tau^d(a_{it}M)$ is increasing in the value of land holdings, households will face ever increasing costs as members are forced to divert larger and larger amounts of time away from productive activities like agricultural labour in order to defend their land from the opposing household. This implies that as technology and land values increase over time, the cost of private property protection becomes sufficiently high that the two households will eventually seek alternative institutional arrangements.

Power Sharing (P)

In a formal power sharing arrangement, each household agrees to pay one half of the costs required to set up and enforce a legal system which ensures the protection of private property, both within a household, and across households. The total cost of this system (including maintenance and enforcement costs) is τ^p, so that institutional cost paid by a single household under this arrangement is $\tau_{it} = \frac{\tau^p}{2}$. As with the cost of private defense, the cost of enforcing the formal property rights system can either be split evenly among household members or can be delegated to certain individuals (eg. to create a full-time police force and justice system.)

In this institutional setting, the two households share power equally, and the legal system in place prevents any abuse of power either by an individual member or by an individual household. In other words, τ^p includes the cost of various checks and balances on power

[1] Since all household members are assumed to be identical, distinguishing between these two cases is unimportant.

that are necessary to prevent one household from cheating the other out of property or resources.

Takeover (T)

In a takeover arrangement, the two households enter an unequal power sharing arrangement where one household dominates the other. In this case, the dominant household incurs all of the costs required to set up and enforce a system of law and property rights, denoted by τ^T. However, because only one household is in control of the property rights system, there is no costly self-enforcement or checks or balances on power for the dominant household. We therefore assume that $\tau^T < \tau^p$. At the same time, in order to ensure that a household may prefer either power sharing or takeover, we assume that $\tau^T > \tau^p/2$.

Not only is the property rights system in this case less costly, but it is also of lower quality. This is because without checks and balances on power there is no guard against expropriation of resources. Since the dominant household holds all of the power of enforcement, the members of the dominated household have little protection against unilateral action against their property and resources. Suppose (without loss of generality) that household i dominates j under this arrangement. Then let β be the endogenous fraction of labour effort that household i can expropriate from household j. For simplicity, we assume that labour effort is the only resource that i can extract from j (technology and land belonging to household j cannot be expropriated.)

The expropriation activity of household i is costly in itself, so that for time β extracted from household j, the additional time available to household i is $\beta(1-q_{it})$, where $q_{it} \in (0,1)$ is the cost of expropriation. This expropriation cost is decreasing in the technological gap between the two households $\frac{a_{it}}{a_{jt}}$, so that it is less costly for a dominant household to expropriate resources the larger is its technological advantage.

With household i as the dominant household, we have then that under a takeover arrangement, the institutional cost paid by household j is $\tau_{jt} = \beta$ and the institutional cost paid by household i is $\tau_{it} = \tau^T - \beta(1 - q_{it})$. Both households have full information about each other, and so household i is able to extract the highest possible transfer. Formally, we have that

$$\beta^* = \min\{1/2, \beta^{\max}\}$$

By assumption, household i can extract a maximum of 50% of the resources of household j in a given period. Conditional on being below 50%, $\beta^{\max}$ is the value of the transfer such that household j is just indifferent between the takeover arrangement and its outside option, which is to fight a war.

War (W)

The final institutional option available to both households is to fight a war. In this case, both households devote a fraction τ^w of their time to fight each other. This fraction of time is exogenous and constant across the two households. Here we assume only that $\tau^w < \frac{\tau^p}{2}$.

At the end of the war in period t, the winning household is able to consume and bequest wealth to the next generation in the same way as under other institutional arrangements. The losing household on the other hand, while still able to consume its agricultural production from the current period, suffers a loss in technology. As a result it can bequest only $a_L M$ to generation $t+1$, where $a_L = (\epsilon_{it} A_t \phi_i^a)^\mu (a_0)^{1-\mu}$, with a_0 denoting some initial base level of technology available in period 0. After the bequest takes place, the $t+1$ generation of the losing household is subsequently terminated (either killed or absorbed into the winning household.)

Given that the two households have the same population, and that both make the same investment τ^w in the war, the only factor that determines the probability of winning a war is the relative technology of the two households. Let $p_i(\frac{a_{it}}{a_{jt}})$ be the probability that household i wins a war with household j during time period t. We then assume that $p_i(1) = 1/2$ and that $p_i(\frac{a_{it}}{a_{jt}})$ is increasing in the technology gap $\frac{a_{it}}{a_{jt}}$.

When a war is fought it is always decisive, so that $p_{it} + p_{jt} = 1$ (ie, there are no stalemates.) The outcome of the war is not decided until stage 3 of the period. Hence, in the case of war, a household's expected utility can be written as

$$u_{it}^W = (1-\gamma)\log(c_{it}) + \gamma[p_{it}\log(a_{i,t+1}M) + (1 - p_{it}\log(a_L M))] \tag{4}$$

2.4 Optimal Time Investment

Recall from the discussion of the timing of the model that each period can be divided into 3 stages. Before we analyze the optimal institutional choice that occurs in stage 1, we first look at the optimal time investment decision in stage 2, taking the institutional arrangement as given. Substituting for c_{it}, and $a_{i,t+1}$ in the utility function, we have

$$u_{it} = [\alpha(1-\gamma) + (1-\mu)\gamma]\log(a_{it}) + [\alpha(1-\gamma)+\gamma]\log(M)$$

$$+(1-\alpha)(1-\gamma)\log(1-\tau_{it}-\phi_i^a) + \mu\gamma(\log\phi_i^a + \log(A_t)) + \mu\gamma E_t[\log\epsilon_{it}] \tag{5}$$

At the beginning of stage 2, the new adult generation chooses how much time to invest in new technology (ϕ_i^a) in order to maximize household utility, subject to the constraint that each household member has $1-\tau_{it}$ units of time to devote to either agricultural labour or development of new technology. From the first order condition for ϕ_i^a we have that

$$\phi^{a*} = \frac{\mu\gamma(1-\tau_{it})}{(1-\alpha)(1-\gamma)+\mu\gamma} \tag{6}$$

And the optimal fraction of time spent in agricultural labour is therefore

$$1-\tau_{it}-\phi_i^{a*} = \frac{(1-\alpha)(1-\gamma)(1-\tau_{it})}{(1-\alpha)(1-\gamma)+\mu\gamma}$$

Substituting back into the utility function gives

$$u_{it}^* = K_{it} + k\log(1-\tau_{it}) \tag{7}$$

where $k = (1-\alpha)(1-\gamma)+\mu\gamma$ and

$$K_{it} = [\alpha(1-\gamma)+(1-\mu)\gamma]\log(a_{it}) + [\alpha(1-\gamma)+\gamma]\log(M) + \mu\gamma\log(A_t) + \mu\gamma E_t[\log\epsilon_{it}]$$

$$+(1-\alpha)(1-\gamma)\log[\frac{(1-\alpha)(1-\gamma)}{(1-\alpha)(1-\gamma)+\mu\gamma}] + \mu\gamma\log[\frac{\mu\gamma}{(1-\alpha)(1-\gamma)+\mu\gamma}]$$

Since K_{it} does not depend on the specific institutional cost incurred by the household, it is a common element in the expected utility of household i under every institutional possibility. If we then define $u_{it}^I = u_{it}^* - K_{it}$ as the *relative* payoff to household i for a given institutional arrangement, then the relative payoff under private defense is

$$u_{it}^D = k\log(1-\tau^d(a_{it}M)) \tag{8}$$

The relative payoff under power sharing is

$$u_{it}^{P} = k\log(1 - \frac{\tau^{p}}{2}) \tag{9}$$

The relative payoff given war is

$$u_{it}^{W} = k\log(1 - \tau^{w}) - (1-\mu)\gamma(1-p_{it})\log(\frac{a_{it}}{a_{i0}}) \tag{10}$$

where the last term is a relative adjustment that results from the fact that with probability $1 - p_{it}$ the household suffers a technology loss. Note that this technology loss is increasing in the level of current technology a_{it}.

Finally, the relative payoff under takeover is

$$u_{it}^{T} = k\log(1 - \tau^{T} + \beta^{*}(1 - q_{it})) \tag{11}$$

Given that the relative payoff to household j (the less dominant household) under takeover is $u_{jt}^{T} = k\log(1-\beta)$ we have that

$$\beta^{*} = \min\{1/2, 1 - \exp(\frac{u_{jt}^{W}}{k})\} \tag{12}$$

3 Optimal Institutional Choice

In this section we examine how in stage 1 of a period the two households make decisions about what institutional arrangements (if any) should exist between them. First, we define I_{it} and I_{jt} as the respective institutional preferences of households i and j. Then let I_t denote the actual institutional arrangement that is implemented between the two households in period t. I_{it}, I_{jt} and I_t are all drawn from the set $\{D_t, P_t, T_t, W_t\}$. Without loss of generality, we assume that household i is the more technologically advanced household at time t (ie, $a_{it} \geq a_{jt}$.)

When the institutional preferences of household i and j fit together, then the prevailing institutional arrangement is obvious. The key then to fully characterizing stage 1 is to understand what happens when the preferences of the two households do not agree. To do this, we first classify each institutional choice as either a unilateral or bilateral action.

Assumption 1:

(i) A declaration of war (W_t) by either household is a unilateral action.

(ii) Instituting a power sharing arrangement (P_t) between the two households is a bilateral action. One household cannot impose power sharing on the other.
(iii) Takeover of household j by household i (T_t) is a unilateral action. In such a case, war is the only alternative response available to household j.
(iv) In the absence of any unilateral actions by one household, both households can choose private defense (D_t).

Next we make two additional assumptions regarding the cost of private property defense for a household. Assumption 2 rules out the case where the two households always choose to fight a war in the first generation. Assumption 3 rules out the case where the two households never choose to fight a war at any time.

Assumption 2:
Let a_0 denote some initial level of technology for both households in period 0. The cost of private property defense given this initial level of technology is sufficiently small such that $\tau^d(a_0 M) < \tau^w$.

Assumption 3:
The cost of private property defense τ^d is always sufficiently responsive to changes in technology such that

$$\frac{\partial \tau^d(a_{it}M)}{\partial a_{it}} \geq \frac{(1-\tau^d(a_{i0}))(1-\mu)\gamma}{2k(a_{i0})^2}$$

Now we are in a position to begin to characterize the institutional choices of the households. As a first step we have the following proposition.

Proposition 1: *Given two households i and j where $a_{it} \geq a_{jt}$, and given assumptions 1 and 2, the institutional arrangement between the two households in any period t (I_t) always reflects the preferences of household i (I_{it}) where:*
(i) I_{it} is drawn from the set $\{D_t, P_t, T_t, W_t\}$ when $\tau^d(a_{jt}M) \geq \tau^p/2$;
(ii) I_{it} is drawn from the set $\{D_t, T_t, W_t\}$ when $\tau^d(a_{jt}M) < \tau^p/2$.

Proof: See Appendix.

As a consequence of proposition 1, we can confine the analysis of institutional choice to the choices made by household i in each generation. The only complicating factor that can arise with this simplification is when $I_{it} = P_t$ but $I_{jt} = D_t$. In this case, because power sharing is a bilateral action, household i cannot impose it without the agreement of household j. Hence the choice set for household i does not include P_t in case (ii).

Using proposition 1, we can define I_t to be a function of the state of the world from household i's perspective. The state of the world at time t is given by $(a_{it}, a_{jt}, \bar{W})$, where $\bar{W}$ is an indicator which takes the value of 1 if war has been fought in a past period, and 0 otherwise. Recall that a war is always decisive, so that $\bar{W} = 1$ means that the dominant household is the only remaining household. In this case there is no property rights problem and the household's decisions are trivial. For the rest of the paper we ignore this uninteresting case and assume that $\bar{W} = 0$.

It is important to note that with the exception of $\bar{W}$, no institutional details appear as state variables. This reflects the fact that there is no exogenous institutional persistence, and that the prevailing institution is a choice variable for the households in every period.

At this point we partition the analysis into two separate stages: initial development and later development. We do this by noting that there exists some critical level of technology a^{dp} such that $\tau^d(a^{dp}M) = \tau^p/2$. At this critical level of technology, households are just indifferent between private defense and power sharing.

3.1 Phase 1: Initial Development ($a_{jt} < a^{dp}$)

At the beginning of period t, household i (the technologically dominant household) compares the expected relative payoff with no institutional arrangement (private defense) with the expected relative payoffs of takeover and war with household j. Because of household j's low level of technology, it will always prefer private defense to a power sharing arrangement, so that household i's institutional choice set is given by case (ii) in proposition 1.

To determine what institution will be chosen for any given combination of technologies, we first construct the following three functions. First we define a function

$$a_{it}^{dw} = a_{it}^{dw}(a_{jt})$$

such that $u_{it}^D = u_{it}^W$. For any technology level $a_{jt} < a^{dp}$, this function gives the technology level a_{it} such that household i will be just indifferent between private defense and fighting a war. Note that increases in a_{it} decrease the payoff to both private defense and war, but by assumption 3 the payoff to private defense falls faster. Hence, for any technology level above a_{it}^{dw}, household i will prefer war to private defense, and for any technology level below a_{it}^{dw}, household i will prefer private defense to war.

Next we define a function

$$a_{it}^{dt} = a_{it}^{dt}(a_{jt})$$

such that $u_{it}^{D} = u_{it}^{T}$. For any technology level $a_{jt} < a^{dp}$, this function gives the technology level a_{it} such that household i will be indifferent between private defense and takeover. Note that for $a_{it} > a_{it}^{dt}$, the payoff to private defense will fall and the payoff to takeover will rise. Hence, household i will prefer takeover to private defense above a_{it}^{dt} and similarly will prefer private defense to takeover when below a_{it}^{dt}.

Finally, define a function

$$a_{it}^{tw} = a_{it}^{tw}(a_{jt})$$

such that $u_{it}^{T} = u_{it}^{W}$. In other words, for any technology level $a_{jt} < a^{dp}$, this function gives the technology level a_{it} such that household i will be indifferent between takeover and war. Note that for $a_{it} > a_{it}^{tw}$, the payoff to both institutions will rise. However, because of an increase in the technology gap, there is a negative level effect on the payoff to war. This means that household i must prefer takeover to war above a_{it}^{tw} and similarly will prefer war to takeover when below a_{it}^{tw}.

Using the critical values described above leads us to the following proposition.

Proposition 2: *When $a_{jt} < a^{dp}$, assumptions 1 - 3 hold, and a war has not occurred in any previous period, then the institutional arrangement between households i and j in period t is given by*

$$I_t = \begin{cases} T_t & a_{it} > a_{it}^{dt}, a_{it}^{tw} \\ W_t & a_{it}^{dw} < a_{it} < a_{it}^{tw} \\ D_t & otherwise \end{cases} \tag{13}$$

Proof: See Appendix.

Proposition 2 is illustrated in Figure 1. Since by assumption household i is always the technologically dominant household, only the region above the 45 degree line is relevant. Also, since in the initial development case $a_{jt} < a^{dp}$, we map out only the region of possible technologies below this critical value.

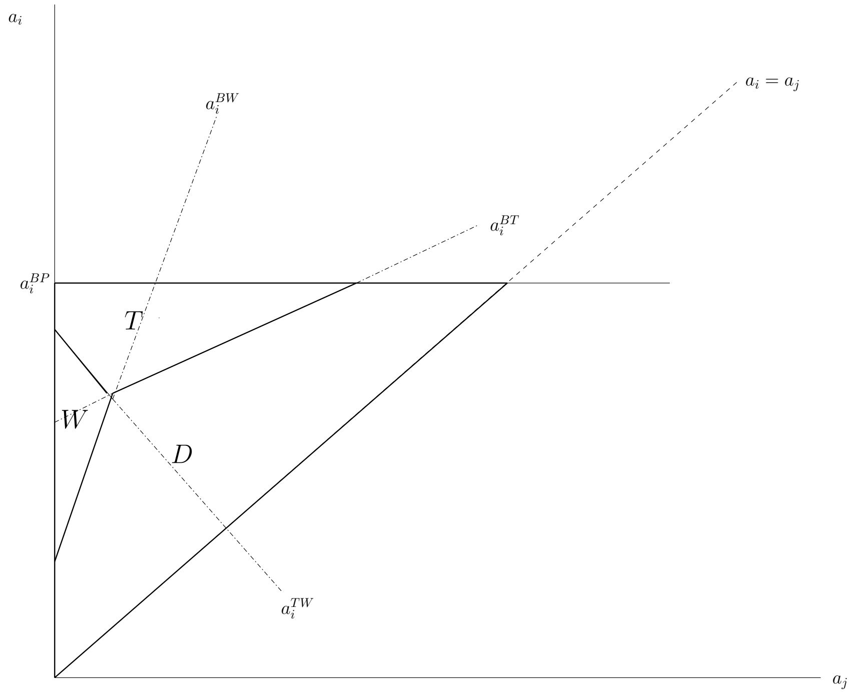

Figure 1: Institutional Choice in Initial Development

The important result of proposition 2 and figure 1 is that the institution chosen depends on both the technology levels of the two households and the technology gap between them. In general, private defense continues as the institution of choice when the technology gap is small. War occurs when the technology gap becomes large at a low level of technological development. Household i chooses to takeover household j in the intermediate case, when technology is reasonably advanced and there is a sufficiently large technology gap.

3.2 Phase 2: Later Development ($a_{jt} \geq a^{dp}$)

Once both households' technology reaches the level a^{dp} or greater, a power sharing arrangement will always be preferred to private defense. In this case, power sharing becomes the benchmark against which war and takeover are compared.

First we define a function

$$a_{it}^{pw} = a_{it}^{pw}(a_{jt})$$

such that $u_{it}^{P} = u_{it}^{W}$. For any technology level $a_{jt} \geq a^{dp}$, this function gives the technology level a_{it} such that household i will be just indifferent between power sharing and fighting a war. Note that increases in a_{it} decrease the payoff to war. Hence, for any technology level above a_{it}^{pw}, household i will prefer power sharing to war, and for any technology level below a_{it}^{pw}, household i will prefer war to power sharing.

Next we define a function

$$a_{it}^{pt} = a_{it}^{pt}(a_{jt})$$

such that $u_{it}^{P} = u_{it}^{T}$. For any technology level $a_{jt} \geq a^{dp}$, this function gives the technology level a_{it} such that household i will be just indifferent between power sharing and takeover. Note that for $a_{it} > a_{it}^{pt}$, the payoff to takeover will rise while the payoff to power sharing is unchanged. Hence, household i will prefer takeover to power sharing above a_{it}^{pt} and similarly will prefer power sharing to takeover when below a_{it}^{pt}.

Using these two critical values described above leads us to proposition 3.

Proposition 3: *When $a_{it}, a_{jt} \geq a^{dp}$, assumptions 1 - 3 hold, and a war has not occurred in any previous period, then the institutional arrangement between households i and j in period t is given by*

$$I_t = \begin{cases} T_t & a_{it} > a_{it}^{pt}, a_{it}^{tw} \\ W_t & a_{it}^{pw} < a_{it} < a_{it}^{tw} \\ P_t & otherwise \end{cases} \tag{14}$$

Proof: See Appendix.

Proposition 3 is illustrated in Figure 2. Once again the institution chosen depends on both the technology levels of the two households and the technology gap between them. In general, power sharing is the institution of choice as long as the technology gap is small. Takeover on the other hand occurs when the technology gap becomes sufficiently large. In the particular case shown in figure 1, war is never chosen in the later development stage. This is because a^{dp} is so large that war is never optimal for household i no matter how large the technology gap is.

Figure 3 combines propositions 2 and 3 by putting both the initial and later development cases together. Note that all four institutions can be chosen depending on the absolute and relative technology levels of the two households. However, beyond a certain level of development, only power sharing and takeover are possible institutional options. In general

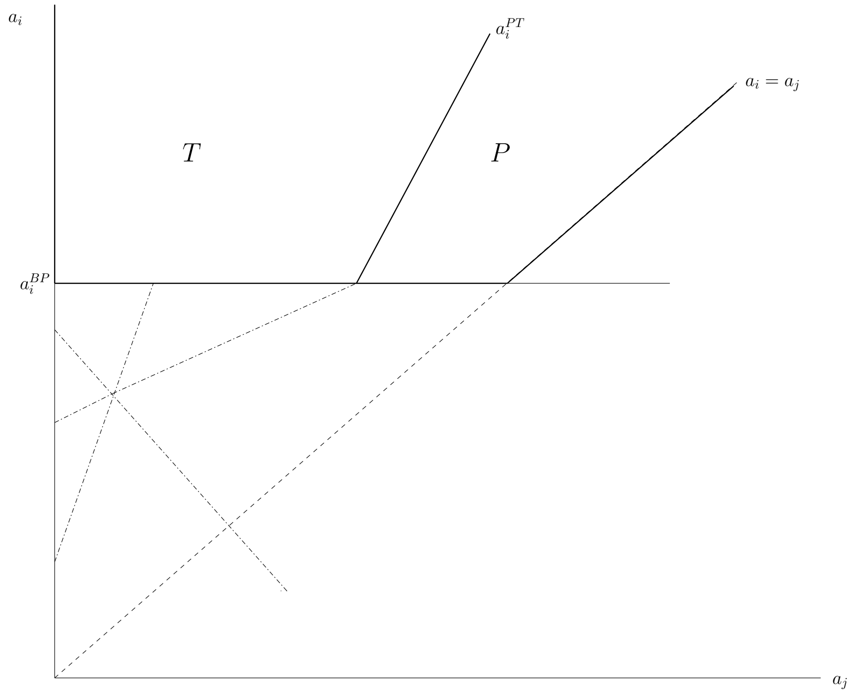

Figure 2: Institutional Choice in Later Development

we have that:

1. Private defense will be chosen given low levels of technological development and a small technology gap.

2. Power sharing will be chosen given high levels of technological development and a small technology gap.

3. War will be chosen given low levels of technological development and a large technology gap.

2. Takeover will be chosen given high levels of technological development and a large technology gap.

4 Institutional Persistence

In this section, we examine the persistence of institutions over time, in the absence of exogenous lock-in effects or large switching or setup costs associated with institutions. Specifically, we are interested to know under what conditions power sharing or takeover will persist

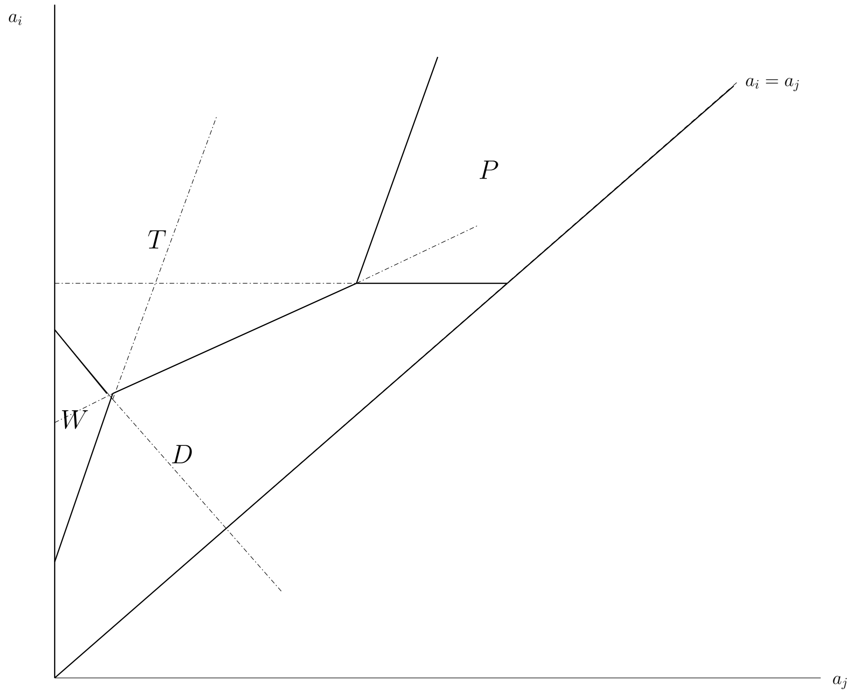

Figure 3: Institutional Choice in Both Stages of Development

over time, even if every successive generation of households has the opportunity to reevaluate the prevailing institutional arrangement. Upon finding persistence of institutions over time, we are then interested to know under what (if any) conditions a prevailing institution may change. In this section we consider two possible cases: joint technological development and independent technological development.

4.1 Joint Technological Development

In this case, we suppose that if two households enter into an institutional arrangement (P_t or T_t) then the research effort of both households in the current period is connected in the following way:

$$\epsilon_{it} = \epsilon_{jt} = \max\{\epsilon_{it}, \epsilon_{jt}\}$$

In other words, suppose that both households operate a laboratory of sorts where technological development takes place in each period. Under the above assumption, both households can conduct research at both laboratories, and then take the return on research from the more successful of the two laboratories. In this case the technological development of the two households is connected, but not the same. Even with the same return to innovation both households maintain their individual technology levels.

An important implication of this joint connection in technological development is that if both households invest the same amount of time in technological research ($\phi_i^a = \phi_j^a = \phi^a$) then the technology gap between the two households will decrease over time since

$$\frac{a_{it}}{a_{jt}} = \frac{(\epsilon A_t \phi^a)^\mu (a_{i,t-1})^{1-\mu}}{(\epsilon A_t \phi^a)^\mu (a_{j,t-1})^{1-\mu}} = (\frac{a_{i,t-1}}{a_{j,t-1}})^{1-\mu} < \frac{a_{i,t-1}}{a_{j,t-1}} \tag{15}$$

Note that this is not a special feature of the particular function governing the evolution of technology in this model. Rather it is simply that a given distance between two technology levels becomes less important as the levels themselves rise. This implication leads to the following proposition.

Proposition 4: *If there is joint technological development between the two households under an institutional arrangement (power sharing or takeover) as described above then we have that:*
(i) Power sharing is persistent over time. If $I_t = P_t$ for any period t, then $I_{t+s} = P_{t+s}$ for all $s > t$.
(ii) Takeover is persistent over time given the following sufficient condition: if $I_t = T_t$ for any period t, and

$$\frac{1 - \tau^T + \beta^*(1 - q_{it})}{1 - \beta^*} \geq \frac{a_{it}}{a_{jt}}$$

then $I_{t+1} = T_{t+1}$.
Proof: See Appendix.

The qualifying condition in (*ii*) ensures that the technology gap increases (or stays constant) under takeover, which will in turn increase (or maintain) its attractiveness to household i relative to power sharing.

A key component of persistence in this case is the feedback between economic and institutional outcomes. Under power sharing, technology levels converge, which in turn reinforces power sharing, which then leads to further technological convergence etc. Under takeover, (given the sufficient condition described in proposition 4) technology levels diverge, which in turn reinforces takeover, which then leads to further technological divergence.

Note that under joint technological development, there is no other process that can counteract this institutional feedback effect. Hence the prevailing institution will persist over time, with little or no chance of an institutional change.

4.2 Independent Technological Development

Now consider the case where the technological development in each household remains subject to idiosyncratic shocks regardless of what (if any) institutional arrangement exists. In other words, each household can now only use its own research laboratory. In this case, the evolution of the technology gap depends both on the relative investment levels of the households and on the idiosyncratic shocks ϵ_{it} and ϵ_{jt}. As a result, it is possible that the particular realizations of the two household specific shocks could counteract the institutional effects on relative investment levels. In this case institutional persistence is not guaranteed.

For simplicity, we examine the long run, where technology accumulates to the point where war is so unattractive that household i will always be able to extract the maximum resources from household j ($\beta^* = 1/2$) under takeover. At this stage, the tradeoff between P_t and T_t is governed by the relative institutional costs faced by household i. Define $(\frac{a_i}{a_j})'$ such that

$$\tau^p/2 = \tau^T + \frac{1}{2}(1 - q((\frac{a_i}{a_j})') \tag{16}$$

In words, $(\frac{a_i}{a_j})'$ is the critical level of the technology gap such that household i is just indifferent between power sharing and takeover.

For values of the technology gap close to $(\frac{a_i}{a_j})'$, the two households may oscillate between P_t and T_t based on successive realizations of the technology shocks. For example, if $I_t = P_t$, then $\phi_i^a = \phi_j^a$, which (as shown earlier) drives $\frac{a_{i,t+1}}{a_{j,t+1}}$ below $\frac{a_{it}}{a_{jt}}$, thereby reinforcing power sharing in the next period. However, if $\frac{\epsilon_{it}}{\epsilon_{jt}}$ happens to be sufficiently large, then it is possible that $\frac{a_{i,t+1}}{a_{j,t+1}} > \frac{a_i}{a_j}' > \frac{a_{it}}{a_{jt}}$, so that the technology gap does not fall, but instead rises enough to cause a takeover arrangement to be chosen in the next period.

On the other hand suppose that $I_t = T_t$, so that $\phi_i^a > \phi_j^a$, which tends to drive $\frac{a_{i,t+1}}{a_{j,t+1}}$ above $\frac{a_{it}}{a_{jt}}$, thereby reinforcing takeover in the next period. If $\frac{\epsilon_{it}}{\epsilon_{jt}}$ is sufficiently small, then it is possible that $\frac{a_{i,t+1}}{a_{j,t+1}} < \frac{a_i}{a_j}' < \frac{a_{it}}{a_{jt}}$, so that the technology gap does not rise, but rather falls enough to cause a power sharing arrangement to be chosen in the next period.

In both of the above scenarios, institutional change occurs only when the idiosyncratic shocks in the technological development process happen to outweigh the institutional effect by a sufficient degree. However, because there is no persistence in the ϵ shocks over time, remaining under one institutional arrangement for an extended number of periods will tend to move the households away from $(\frac{a_i}{a_j})'$. In other words, over a number of periods the idiosyncratic shocks that both households experience will average out over time, hence the investment levels of the two households will be the dominant factor in determining long run movements in the technology gap. As seen in the joint technological development case, time spent under power sharing will reduce the technology gap further and further below $(\frac{a_i}{a_j})'$. But this in turn reduces the probability of either a single combination of shocks $\{\epsilon_{it}, \epsilon_{jt}\}$ or a series of shocks that would be sufficient to bring the technology gap above $(\frac{a_i}{a_j})'$, thereby causing the households to switch to a takeover arrangement.

On the other hand, (if condition (ii) of proposition 4 holds) time spent under takeover will tend to increase the average technology gap over time, eventually converging to a value of $(\frac{a_i}{a_j})'' = \frac{1}{2}[1 - \tau^T + \frac{1}{2}(1 - q((\frac{a_{it}}{a_{jt}})''))]$. Here we denote $(\frac{a_{it}}{a_{jt}})''$ as the highest sustainable technology gap given the constraint that $\beta^* \leq 1/2$. Throughout this analysis we have assumed that $(\frac{a_i}{a_j})'' > (\frac{a_i}{a_j})'$, so that a takeover arrangement can exist in the long run. Once again, the further the technology gap rises above $(\frac{a_i}{a_j})'$, the lower the probability that a single set or series of shocks will occur to bring the technology gap low enough that the households would change to a power sharing arrangement.

5 Conclusion

In this paper we present a model of institutional formation, choice and persistence over time. We show that the need for protection of private property and the escalating cost of private defense of this proverty eventually gives rise to institutional arrangements. Exactly what institutional arrangement is chosen depends on the relative paths of technological development of the two households in the model. A high level of development and relative equality will generate a power sharing arrangement, while sufficiently unequal rates of technological development will lead to a takeover arrangement. We find that institutional arrangements are persistent over time because current institutions affect investment decisions in such a way as to reinforce the existing institutions in the future. Certain economic outcomes can overcome institutional effects and cause institutional change, but this possibility becomes less likely the longer that an institution remains in place.

6 Appendix

6.1 Proof of Proposition 1:

Consider the four possible choices that household i can make:

1. Household i chooses W_t:

In this case it does not matter what household j would prefer to do. War is a unilateral action. If one household wants war, then there will be war. Hence if $I_{it} = W_t$ then $I_t = W_t$.

2. Household i chooses T_t:

In this case, by its very design household j will be indifferent between T_t and W_t, and so we assume that when indifferent it will choose T_t. Household j cannot choose P_t, because P_t requires mutual agreement from both households, and in this case household i prefers T_t. Finally, household j cannot choose D_t, because a takeover bid by household i cannot be ignored. A takeover bid is a unilateral action, and the only feasible response (other than surrender to the takeover bid) is to fight a war. Hence if $I_{it} = T_t$ then $I_t = T_t$.

3. Household i chooses D_t:

In this case, household j cannot choose P_t (for the same reason as in 2). Household j will also not choose W_t in this case, because if W_t is more attractive to household j than D_t, then this must also be the case for household i. To see this, note that if household j prefers war then:

$$k\log(1-\tau^w) - (1-\mu)\gamma(1-p_{jt})\log(\frac{a_{jt}}{a_0}) > k\log(1-\tau^d(a_{jt}M))$$

With $a_{it} \geq a_{jt}$, household i prefers D_t to W_t if

$$(1-\mu)\gamma\log(\frac{a_{it}}{a_0})\frac{\partial p_{it}}{\partial a_{it}} < \frac{(1-\mu)\gamma(1-p_{it})}{a_{it}a_0} - \frac{k}{1-\tau^d(a_{it}M)}\frac{\partial\tau^d(a_{it}M)}{\partial a_{it}}$$

but by assumption 3, the right hand side will be less than zero, which is a contradiction since p_{it} is non-decreasing in a_{it}.

Finally, since household j is indifferent between W_t and T_t, it will also prefer D_t to T_t. So, household j will accept D_t. Hence if $I_{it} = B_t$ then $I_t = B_t$.

4. Household i chooses P_t:

Suppose first that $\tau^d(m_{jt}) < \tau^p/2$. In this case household j prefers B_t to P_t and since P_t

requires bilateral agreement, P_t is not an option for household i. This corresponds to case (ii) in the proposition.

Next suppose that $\tau^d(m_{jt}) \geq \tau^p/2$. In this case household j cannot choose T_t for the same reason as in 2. Household j will also not choose B_t because the cost of land defence under B_t exceeds the cost of joint property rights enforcement under P_t. Household j will not choose W_t over P_t, because by assumption 2 this would imply that household i would do the same. Finally, since household j is indifferent between W_t and T_t, it will not choose T_t either. So, household j will accept P_t. Hence if $I_{it} = P_t$ then $I_t = P_t$, which corresponds to case (i) in the proposition.

6.2 Proof of Proposition 2:

Establishing the result first requires us to determine the relative slopes of the functions a_{it}^{dw} and a_{it}^{dt}.

How a_{it}^{dw} responds to changes in a_{jt} depends on how the relative payoffs to private defense and war are affected by changes in the technology gap between the two households. Note that for household i, the payoff to war is increasing in the technology gap while it has no effect on the payoff to private defense. This then implies that an increase in a_{jt} will increase the relative payoff to private defense, which in turn requires an increase in a_{it} (by assumption 3) to maintain equality between the two institutional choices. Hence a_{it}^{dw} is increasing in a_{jt}.

As with war, the payoff to takeover for household i is increasing in the technology gap while it has no effect on the payoff to private defense. This then implies that an increase in a_{jt} will increase the relative payoff to private defense, which in turn requires an increase in a_{it} to maintain equality between the two institutional choices. Hence a_{it}^{dw} is increasing in a_{jt}.

Note that since an increase in the technology gap increases the relative payoff to both war and takeover, a_{it}^{tw} can be either increasing or decreasing in a_{jt}. In general, the slope of a_{it}^{tw} will depend on the relative sensitivities of p_{it} and q_{it} to changes in the technology gap.

To relate a_{it}^{dw} to a_{it}^{dt}, note first that for $a_{jt} = a_{j0}$, $a_{it}^{dw} < a_{it}^{dt}$. This is because an increase in the level of a_{it} decreases the payoff to war and increase the payoff to takeover. Hence relative to private defense, the technology level at which household i is indifferent between war and private defense must be lower than the level at which there is indifference between takeover and private defense.

Next, note that for given increases in a_{jt}, a_{it}^{dw} increases faster than a_{it}^{dt}. This is also because an increase in the level of a_{it} decreases the payoff to war and increase the payoff to takeover. For higher levels of technology, a higher technology gap is required to maintain the desirability of war. In contrast, for higher levels of technology, even a lower technology gap will maintain the desirability of takeover. Hence the slope of a_{it}^{dw} is steeper than the slope of a_{it}^{dt}.

Given the properties of a_{it}^{dw}, a_{it}^{dw} and a_{it}^{tw}

(i) $u_{it}^{T} > u_{it}^{D}$ when $a_{it} > a_{it}^{dt}$ and $u_{it}^{T} > u_{it}^{W}$ when $a_{it} > a_{it}^{tw}$.

(ii) $u_{it}^{W} > u_{it}^{D}$ when $a_{it} > a_{it}^{dw}$ and $u_{it}^{W} > u_{it}^{T}$ when $a_{it} < a_{it}^{tw}$.

(iii) $u_{it}^{D} > u_{it}^{W}$ when $a_{it} < a_{it}^{dw}$ and $u_{it}^{D} > u_{it}^{T}$ when $a_{it} < a_{it}^{dt}$.

6.3 Proof of Proposition 3:

Establishing the result first requires us to determine the relative slopes of the functions a_{it}^{pw} and a_{it}^{pt}.

Note that a_{it}^{pw} and a_{it}^{pt} have the same general properties as a_{it}^{dw} and a_{it}^{dt}. Hence the proof follows the same pattern as above.

Given the properties of a_{it}^{pw}, a_{it}^{pw} and a_{it}^{tw}

(i) $u_{it}^{T} > u_{it}^{P}$ when $a_{it} > a_{it}^{pt}$ and $u_{it}^{T} > u_{it}^{W}$ when $a_{it} > a_{it}^{tw}$.

(ii) $u_{it}^{W} > u_{it}^{P}$ when $a_{it} > a_{it}^{pw}$ and $u_{it}^{W} > u_{it}^{T}$ when $a_{it} < a_{it}^{tw}$.

(iii) $u_{it}^{P} > u_{it}^{W}$ when $a_{it} < a_{it}^{pw}$ and $u_{it}^{P} > u_{it}^{T}$ when $a_{it} < a_{it}^{pt}$.

6.4 Proof of Proposition 4:

(i) Suppose that $I_t = P_t$. In this case ϕ^a is the same for both households. Given the same level of investment, equation (28) holds and the technology gap decreases from $\frac{a_{it}}{a_{jt}}$ in period t to $\frac{a_{it}}{a_{jt}}^{1-\mu}$ in period $t+1$. What then will be the institutional arrangement I_{t+1}? If household i chose P_t over D_t, then with higher wealth in $t+1$, it will certainly choose P_{t+1} over D_{t+1}. Also, if household i chose P_t over W_t in period t, then with higher technology and a lower technology gap relative to household j in period $t+1$, it will then choose P_{t+1} over W_{t+1}. Finally, if household i chose P_t over T_t, then in period $t+1$, with higher technology and a lower technology gap, $u^W_{j,t+1} < u^W_{jt}$, which means that $\beta_{t+1} \leq \beta_t$ and so T_{t+1} will be even less attractive relative to P_{t+1} than T_t was to P_t. Hence $I_t = P_t$ implies $I_{t+1} = P_{t+1}$ for any t.

(ii) Suppose that $I_t = T_t$. Given a technology gap $\frac{a_{it}}{a_{jt}}$ in period t, we have that

$$\frac{a_{it}}{a_{jt}} = \frac{(\epsilon\phi^{aT*})^{\mu}(a_{i(t-1)})^{1-\mu}}{(\epsilon\phi^{aT*})^{\mu}(a_{j(t-1)})^{1-\mu}} = \frac{(\epsilon(1-\tau^T+\beta(1-q)))^{\mu}(a_{i(t-1)})^{1-\mu}}{(\epsilon(1-\beta))^{\mu}(a_{j(t-1)})^{1-\mu}}$$

From this we can see that the technology gap will remain stable or increase over time given the condition

$$\frac{1-\tau^T+\beta(1-q)}{1-\beta} \geq \frac{a_{i(t-1)}}{a_{j(t-1)}}$$

If household i chose T_t over D_t, then with higher wealth in $t+1$, it will certainly choose T_{t+1} over D_{t+1}. Also, if household i chose T_t over W_t in period t, then because a^{tw}_{jt} is declining over time, it will then choose T_{t+1} over W_{t+1}. Finally, if household i chose T_t over P_t, then in period $t+1$, with higher technology and a higher technology gap, T_{t+1} will be even more attractive relative to P_{t+1} since $\tau^T - \beta_{t+1}(1-q_{t+1}) > \tau^T - \beta_{t+1}(1-q_{t+1}) > \tau^p/2$. Hence $I_t = T_t$ implies $I_{t+1} = T_{t+1}$ for any t.

References

[1] Acemoglu, Daron, Simon Johnson and James Robinson (2004), *Institutions as the Fundamental Cause of Long-Run Growth*, MIT Working Paper.

[2] Acemoglu, Daron (2004), *The Form of Property Rights: Oligarchic vs. Democratic Societies*, MIT Working Paper.

[3] Acemoglu, Daron and Simon Johnson (2003), *Unbundling Institutions*, Working Paper.

[4] Acemoglu, Daron, Philippe Aghion and Fabrizio Zilibotti (2004), *Distance to Frontier, Selection and Economic Growth*, Working Paper.

[5] Acemoglu, Daron, Simon Johnson and James Robinson (2001), *The Colonial Origins of Comparative Development: An Empirical Investigation*, **American Economic Review**, vol. 91, no. 5, pp.1369-1401.

[6] Acemoglu, Daron and James Robinson (2001), *A Theory of Political Transitions*, **American Economic Review**, vol. 91, no. 4, pp.938-963.

[7] Acemoglu, Daron and James Robinson (2000), *Why Did the West Extend the Franchise? Democracy, Inequality and Growth in Historical Perspective*, **Quarterly Journal of Economics**, vol. 115, pp.1167-1199.

[8] Banerjee, Abhijit and Andrew Newman (1993), *Occupational Choice and the Process of Development*, **Journal of Political Economy**, vol. 101, pp.274-298.

[9] Barro, Robert (1997), **Determinants of Economic Growth: A Cross-Country Empirical Study**, MIT University Press, Cambridge MA.

[10] Diamond, Jared (1997), **Guns, Germs and Steel: The Fate of Human Societies**. New York: W.W. Norton & Co.

[11] Djankov, Simeon, Rafael LaPorta, Florencio Lopez-de-Silanes and Andrei Shleifer (2003), *Courts*, **Quarterly Journal of Economics**, vol. 118, pp.453-517.

[12] Engerman, Stanley and Kenneth Sokoloff (1997), *Factor Endowments, Institutions and Differential Paths of Growth among New World Economies* in S.H. Haber ed. **How Latin America Fell Behind**, Stanford University Press, Stanford CA.

[13] Galor, Oded, Omer Moav and Dietrich Vollrath (2003), *Land Inequality and the Origin of Divergence in Overtaking the Growth Process: Theory and Evidence*, Working Paper.

[14] Galor, Oded and Joseph Zeira (1993), *Income Distribution and Macroeconomics*, **Review of Economic Studies**, vol. 60, pp.35-52.

[15] Glaeser, Edward and Andrei Shleifer (2002), *Legal Origins*, **Quarterly Journal of Economics**, vol. 117, pp.1193-1230.

[16] Hall, Robert and Charles Jones (1999), *Why Do Some Countries Produce so Much More Output per Worker than Others?*, **Quarterly Journal of Economics**, vol.114, pp.83-116.

[17] Knack, Steven and Philip Keefer (1997), *Does Social Capital have an Economic Impact? A Cross-Country Investigation*, **Quarterly Journal of Economics**, vol.112, pp.1251-1288.

[18] Krusell, Per and Jose-Victor Rios-Rull (1996), *Vested Interests in a Theory of Stagnation and Growth*, **Review of Economic Studies**, vol.63, pp.301-330.

[19] Mankiw, Gregory, David Romer and David Weil (1992), *A Contribution to the Empirics of Economic Growth*, **Quarterly Journal of Economics**, vol.107, pp.407-438.

[20] Murphy, Kevin, Andrei Shleifer and Robert Vishny (1993), *Why is Rent-Seeking So Costly to Growth?*, **American Economic Review**, vol. 83, pp.409-414.

[21] Murphy, Kevin, Andrei Shleifer and Robert Vishny (1989), *Industrialization and the Big Push*, **Journal of Political Economy**, vol.97, pp.1003-1026.

[22] Murphy, Kevin, Andrei Shleifer and Robert Vishny (1989), *Income Distribution, Market Size and Industrialization*, **Quarterly Journal of Economics**, vol.104, pp.537-564.

[23] North, Douglass (1981), **Structure and Change in Economic History**, New York: W.W. Norton and Co.

[24] Parente, Stephen and Edward Prescott (1999), *Monopoly Rights: Barriers to Riches*, **American Economic Review**, vol.89, pp.1216-1233.

[25] Parente, Stephen and Edward Prescott (2004), *A Unified Theory of the Evolution of International Income Levels*, Staff Report 333, Federal Reserve Bank of Minneapolis.

[26] Romer, David (2003) *Misconceptions and Political Outcomes*, **Economic Journal**, vol.113, pp.1-20.