

HOBBS TO ROUSSEAU: INEQUALITY, INSTITUTIONS AND DEVELOPMENT*

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This article studies the endogenous evolution of economic and political institutions and the interdependencies with the process of economic development. Favourable economic institutions in the form of a state of law and absence of societal conflict arise in equilibrium. Democracies are neither necessary nor sufficient to implement a state of law, even if they may be instrumental. Efficient oligarchies can emerge and persist supported by the consensus of all groups. A taxonomy of politico-economic equilibria shows the endogenous evolution of institutions depending on economic inequality and natural resource abundance, implying a non-monotonic relationship between inequality and institutional quality.

The importance of institutions for economic development is well recognised. A vast literature studies the economic consequences of the different political institutions regulating the limits of political power and the aggregation of individual preferences.¹ An important finding is that political institutions affect social interactions, the resolution of conflicts of interests, and play an important role in shaping economic outcomes. On the other hand, there is an increasing awareness that economic and political institutions themselves evolve endogenously and are affected by economic forces and long-term development, see e.g. Acemoglu and Robinson (2000, 2001) and Acemoglu *et al.* (2001) for some early contributions.

In this article we propose a theory which studies the distinctive roles of economic institutions and political systems in the process of development and the role of economic inequality and long-term development as both determinants and outcomes of institutional change. We address the issue by modelling economic and political institutions as intrinsically different but interacting domains. Formally, we provide a dynamic model which relates to the metaphors proposed by Thomas Hobbes (1651) and Jean-Jacques Rousseau (1762). Efficient economic institutions are interpreted as a ‘social contract’, or state of law, characterised by limited conflict in society. Conversely, when society falls into a ‘state of nature’, resources are wasted in economy-wide conflict. In the model we study the conditions under which efficient economies can emerge in equilibrium under different political regimes. In particular, we consider democracy with universal franchise as opposed to limited franchise under oligarchy. In each regime, political power allows the enfranchised population to decide about income

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¹ This includes, among others, investigations of the effects of the political system (democracy or not), the role of voting systems, of the form of government, or of the form of state to name a few, on various governmental activities and economic performance in general. See e.g. Persson *et al.* (2000) as well as the recent book by Persson and Tabellini (2003) for surveys of theories and empirical evidence.

redistribution but without having the ability to commit to policies *ex ante*. Conditional on the political system, the social contract, or the absence of it, is the equilibrium outcome of a simple conflict game played between well-defined social groups. This conflict model is nested in a model in which economic inequality changes over time. At each moment in time, the political and economic institutions emerge as subgame perfect Nash equilibrium of the game played between different groups in society. As a result, good economic institutions, i.e. a social contract, can be sustained if and only if no group has incentives to deviate and invest in arms and conflictual activities. Therefore a social contract can emerge in equilibrium only by mutual agreement of all groups in society. This implies that, unlike most of the previous literature, the model does not assume that democratic regimes are ‘intrinsicly’ better than oligarchies.² Consequently the analysis delivers several new results related to the fact that the implementation of particular political regimes is neither sufficient nor necessary for the emergence of a social contract.

A first novel result is that, if inequality is sufficiently high, the economy can sustain a social contract only under the rule of an oligarchic elite. For this equilibrium to arise, no group may have the incentive to deviate and get involved in open conflict. The intuition behind this result is therefore that, under high inequality, the implementation of a democracy would inevitably trigger social conflict. The observation that large inequality may sustain oligarchic societies is in line with previous theoretical findings in the literature, see, e.g., Acemoglu and Robinson (2000, 2001, 2006) Boix (2003) and Gradstein (2007). However, unlike these previous studies where this result is driven by some assumptions on the superior *de facto* political power by part of the ruling elite that prevents democratisation, in our model this equilibrium is sustained by all groups in society preferring this regime to a democratic one. The emergence of ‘universally accepted oligarchies’ parallels Hobbes’ metaphor of the Leviathan, because all social groups find it optimal to accept this system in the absence of social conflict and even prefer it to a democracy.

This finding also implies that, unlike the previous contributions, oligarchic regimes can be efficient in equilibrium since concentrating power in the hands of a rich ruling elite may represent the only available option to avoid wasteful social conflict.³ The emergence of efficient and universally accepted oligarchies in equilibrium provides a new rationale for the persistence of oligarchic regimes even when the ruling elite lack the *de facto* power needed to prevent democratisation. The persistence of political institutions is based on the possibility of curtailing conflict and preserving good economic institutions.⁴

² Examples for models making this assumption include Lizzeri and Persico (2004) who consider the superior provision of public goods in democracies. Gradstein (2007) studies property rights protection in an environment in which, contrary to the rich oligarchic elite, the poor, once in power, do not suffer from commitment problems, which implies a one to one relation between political regimes and efficiency. Other contributions sharing this feature are discussed below.

³ To the best of our knowledge the only paper in which oligarchies can be efficient is Acemoglu (2008). Unlike our model in which oligarchies can emerge endogenously and be supported by broad consensus, he studies the conditions under which the investment in activities that protect monopoly rents of an exogenously given elite may be efficient.

⁴ The model therefore provides an explanation of regime persistence which is complementary to other studies such as Acemoglu and Robinson (2008), where the elite can stay in power only by investing in *de facto* power, or Acemoglu *et al.* (2007), where the elite set up an inefficient bureaucracy prone to patronage.

A second novel implication of the theory is that democracy is neither necessary nor sufficient for the emergence of a social contract, although it may be instrumental. An implication of this result is that the mere transition to a democracy, imposed, e.g., under the pressure of the disenfranchised population as in Acemoglu and Robinson (2000, 2001, 2006), is not necessarily beneficial in terms of efficiency.⁵ Our model also shows, however, that under some conditions a social contract can be implemented only in a democracy. In particular, if inequality is sufficiently low a social contract can only arise in equilibrium under this regime. This is the case since the deviation to conflict is too wasteful for the people compared to the potential gains from expropriating the rich elite and as, on the other hand, agreeing to the social contract in a democracy is less costly for the elite than avoiding redistribution. Therefore, the model predicts that once inequality is sufficiently small, democracy arises endogenously as an efficient equilibrium.⁶ Earlier theoretical studies by Lizzeri and Persico (2004), Llavador and Oxoby (2005) and Gradstein (2007) have related the process of endogenous institutional change and democratisation to an efficiency gain that implies that the extension of the franchise may also be in the own interest of (part of) the oligarchic elite.⁷ However, while in these contributions democratisation increases efficiency, our model predicts that the prevailing economic conditions are crucial in determining the efficiency properties of oligarchies and democracies.⁸

Taken together, these two results imply that oligarchies are not necessarily inefficient and democracies are not sufficient or necessary to implement efficient economic institutions. Empirical findings by Tavares and Wacziarg (2001) and Glaeser *et al.* (2004) support these results by showing that growth is mainly driven by the existence of efficient economic institutions ensuring property rights protection and widespread education, rather than the mere existence of democracy. Glaeser *et al.* (2004) also remark that efficient protection of property in the sense of a state of law is observed also in oligarchies.⁹ Hence, good economic and political institutions, although causally affecting each other, can, but do not have to, go hand in hand. The ambiguous role of political institutions for the implementation of good economic policies is also in line with evidence by Mulligan *et al.* (2004).¹⁰

⁵ In these papers, social conflict is seen as the main force leading to democratic transitions: oligarchic elites facing substantial opposition and a threat of revolution release political power to larger parts of the population in a controlled way. See also the discussion in Acemoglu *et al.* (2004). Related studies that investigate extensions of the franchise by the elite as an instrument to avoid conflict are Bertocchi and Spagat (2001) and Conley and Temimi (2001).

⁶ This prediction is broadly in line with empirical evidence as discussed below.

⁷ In these contributions, democratic regimes always allow to improve efficiency by facilitating, or giving higher incentives for, the accumulation of growth-enhancing human capital, by facilitating the provision of public goods, or by solving commitment problems and setting limits to rent-seeking and corruption with the consequence of better protection of property rights. Related contributions in this vein include Bourguignon and Verdier (2000), Bertocchi and Spagat (2004).

⁸ The consideration of the different roles of conflict and efficiency gains for democratic transitions and the subsequent development path is beyond the scope of this article. For a model that investigates these issues see Cervellati *et al.* (2006a).

⁹ See also Glaeser and Shleifer (2002), Rigobon and Rodrik (2005) and Rodrik *et al.* (2004) for evidence emphasising the crucial role of property rights protection for economic well-being.

¹⁰ The exact channels for causality underlying the correlation between democracy and economic development is still a matter of debate in the empirical literature, as discussed below.

A third novel result is the characterisation of the conditions under which neither democracy nor oligarchy can avoid societal conflict and implement efficient institutions. The equilibrium outcome is then a Hobbesian 'State of Nature'. In particular, the model shows that for intermediate levels of inequality a state of nature, characterised by widespread conflict, can represent the unique equilibrium. This equilibrium emerges because, on the one hand, the cost of redistribution associated with a democracy is too large for the elite and, at the same time, getting involved in active conflict represents the best option for both groups, either for defensive reasons as in the case of the elite, or to expropriate the rich in the case of the poor people. In fact, a state of nature can be avoided only if social conflict is overly wasteful.

By linking the emergence of the different equilibria to the prevailing conditions in terms of inequality the model delivers a taxonomy of politico-economic equilibria. In previous studies like Boix (2003) or Acemoglu and Robinson (2006), the implementation of democracy and good economic institutions is linked monotonically to an underlying fundamental like inequality, wealth or political power. In contrast, the results of our model imply that the effect of inequality on economic efficiency, via the implementation of different political systems, may be non-monotonic. Efficient oligarchies emerge for very large levels of inequality while efficient democracies are the unique equilibrium if inequality is sufficiently small. For intermediate levels of inequality, however, inefficient equilibria characterised by widespread conflict may prevail irrespective of the political regime in place. This non-monotonic relationship is in line with cross-country evidence, as discussed below.

Our analysis ends with a characterisation of the dynamic evolution of the economy and the endogenous emergence of different equilibria overtime. By considering a process of endogenous skill-biased technological change the analysis delivers further dynamic implications. The increasing importance of human capital as compared to natural resources induces a structural change in the economy, shifting labour from traditional, resource intensive sectors of production to modern, human capital intensive sectors. The change in the relative remuneration of different factors of production leads to a reduction of the importance of natural resources such as land and, consequently, of income inequality, which is related to the unequal ownership of natural resources. The evolution of inequality eventually leads to a transition from oligarchy to democracy. However, the transition to democracy is preceded by a period in which a state of nature materialises and society experiences a phase of widespread conflict. This conflictual phase of development can be avoided only if conflict is sufficiently destructive to induce all groups to refrain from arming. Efficiency is re-established only with the transition to democracy. The duration of this conflictual period has negative effects on the level of development later on in time. Since income inequality is related to natural resource abundance, the distribution of natural resources and the level of technological development, the model therefore allows one to study the importance of natural resources and initial inequality for the realisation of uneven development paths affecting the timing of the transitions from the different regimes, in particular the timing of democratisation.

In the last part of the article we consider a simple extension of the model in which government intervention improves the production possibilities of the economy, similar to, e.g., Lizzeri and Persico (2004). Since, in equilibrium, democracies are characterised

by larger government this creates a differential in the maximum level of efficiency in oligarchies and democracies. We show that the interplay of political and economic institutions may explain episodes of a reversal of fortunes. In particular, countries that are abundantly endowed with natural resources but where these resources are unequally distributed among the population, can be overtaken in terms of income and growth by initially poorer but more equal countries. Natural resource abundance affects long-term development prospects negatively if it prevents a social contract and instead leads to poor economic institutions. This is more likely the larger the inequality in the distribution of its ownership. In this respect the article complements the findings of Mehlum *et al.* (2006), who show that the quality of economic institutions, i.e. the quality of the state of law and property rights enforcement, is crucial for the occurrence of a resource course.¹¹ This last result is also in line with the historical discussion of development in the Americas by Engerman and Sokoloff (2001).¹²

The model has direct implications for the empirical debate about the direction of causality between economic development and political, in particular democratic, institutions, which goes back to the seminal work of Lipset (1959). While the model emphasises the mutual interactions between these domains it delivers predictions on both directions of causality. The model delivers two clear predictions concerning the determinants of democracy, which appear in line with an emerging consensus in the literature. First, the model implies that income does not directly lead to democracy. Earlier empirical contributions like Barro (1999) and Wu and Davis (1999) found a positive effect of economic development on the likelihood of democracy. But the more recent findings of Przeworski (2004) and Acemoglu *et al.* (2008) cast doubt on the causal effect of economic development on democracy. Our model is consistent with the findings of the latter line of research. Second, inequality, or equivalently the relative importance of human capital versus natural resources as factor of production, is the actual driving force behind institutional change and democratisation in our model. This is consistent with growing empirical evidence provided by Easterly (2001), Boix and Stokes (2003) and Boix (2003). It is also in line with the historical analysis of Huber *et al.* (1993) who argue that capitalist development reduced the importance of land resources and therefore eroded the economic and political power of the landlord class.

The predictions of the model, concerning the role of democracies for development as well as the empirical findings, are less clear cut. The empirical debate on the causal effect of democratisation and democracy on economic outcomes has not yet reached a consensus. In the model, oligarchies are not necessarily inefficient and democracies are not necessarily efficient since a state of law can be observed in both regimes. In line with the model predictions, there is little evidence for a direct causal effect of

¹¹ This mechanism is also complementary to that considered by Doepke and Eisfeldt (2007), where resource abundance can generate a reversal of fortune in context of armed conflict between colonialists and native populations, and to that studied by Strulik (2008) who shows how inequality and costs for appropriation of resources determine societal conflict and growth.

¹² Our focus on the role of land ownership for the emergence of efficient equilibria is shared with the complementary theories of Galor *et al.* (2008), who study the emergence of human capital promoting institutions and Bertocchi (2006), who investigates the consequences of the disappearance of primogeniture laws, which sustained the concentration of natural resources in large estates. Unlike these papers we focus attention on the role of land abundance and inequality in precipitating social conflict.

democracy on growth, see e.g., Tavares and Wacziarg (2001). As argued above, the predictions are also in line with the findings of Glaeser *et al.* (2004), who, particularly, emphasise the role of human capital and the state of law. Looking at the effects of democratisation rather than of the existence of democracy, Papaioannou and Siourounis (2008), Rodrik and Wacziarg (2005) and Persson and Tabellini (2006) provide evidence that democratic transitions are associated with an increase in growth, that is potentially somewhat lagged.¹³ The model provides a rationalisation for this finding by showing that democratisation can lead to an end of wasteful conflict. Moreover, the empirical evidence suggests that democracies are likely to improve economic well-being indirectly through channels other than the state of law, see, e.g., the findings of Tavares and Wacziarg (2001). The extended version of the model, which considers the effect of state of law together with benefits of government intervention on human capital, illustrates the model's capability to reconcile these findings.

The article is organised as follows. Section 1 introduces the institutional and economic environment under which the members of a society live and make their decisions. The politico-economic equilibria of the model are investigated in Section 2. Section 3 studies the endogenous evolution of the politico-economic environment of the economy over time. Section 4 concludes.

1. Theoretical Framework

1.1. *Institutional Environment: A Social Contract View*

The first component of the institutional environment is the political system. For simplicity, we concentrate on two extreme political systems, oligarchy and democracy, which differ in the formal allocation of political power. The difference between the two systems is given by the degree of enfranchisement: in democracy, all members of society have the right to vote, while in oligarchy some people are excluded and the constituency is restricted to a leading class of oligarchs, the elite.¹⁴ This implies that the decisive agent for political decisions in the two systems differs as well. Consequently, if the interests of the decisive agents in oligarchy and democracy do not coincide, then different actual policies are implemented in the two systems.

The second component of the institutional environment are the rules governing all economic and social interactions. In this respect, we discriminate between state of nature and state of law established under a social contract, reflecting the views of Thomas Hobbes and Jean-Jacques Rousseau. A universally accepted social contract, or a state of law, is characterised by the existence of universally known, accepted and enforced rules that govern all social interactions. Alternatively, the absence of a social contract is reflected by a state of nature. The state of law is more efficient than the state of nature, because individuals face no uncertainty concerning the appropriability of their investments or permanent threat of being expropriated.

¹³ Evidence reported by Przeworski *et al.* (2000) and Persson and Tabellini (2006) that economic development tends to stabilise democracies points at a reinforcing effect.

¹⁴ In our model, there is no need to distinguish between *de jure* and *de facto* political power, since both always coincide, as will become clear below. The restriction to two regimes is made for simplicity. See e.g. Gradstein (2007) and Jack and Lagunoff (2006) for models that allows for intermediate levels of enfranchisement.

Following the views of Thomas Hobbes, under the state of nature...

'every man will and may lawfully rely on his own strength and art, for caution against all other men. (...) For being distracted in opinions concerning the best use and application of their strength, they [i.e. all men] do not help, but hinder one another, and reduce their strength by mutual opposition to nothing: (...) also, when there is no common enemy, they make warre upon each other, for their particular interests.' (Hobbes, 1651, Part 2 Ch. 17, pp. 128–9)

Our modelling of the politico-economic environment is in line with this view. Individuals face an allocative problem on how to use their 'strength' (i.e. income in our model) in the most beneficial way. They decide whether or not to get involved in costly 'arming', i.e. conflictual activities. We consider well-defined social groups, elite and the people and study the conflict of interest between these groups. If both groups engage in conflict, neither one will be successful: their attempts cancel each other leading to a mere destruction of income, they 'reduce their strength by mutual opposition to nothing': this is the source of inefficiency associated with the state of nature.¹⁵

Alternatively the different groups can adhere to a social contract and implement a state of law by abstaining from getting involved in arming activities. According to Jean-Jacques Rousseau the crucial attribute of a society is whether a state of law exists, or whether the state of nature rules:

'I therefore give the name 'Republic' to every State that is governed by laws, no matter what the form of its administration may be. (...) I understand by this word [Republic] not merely an aristocracy or a democracy, but generally any government directed by the general will, which is the law.' (J.J. Rousseau, 1762, *The Social Contract*, Book 2 Ch. 6, pp. 39–40)

In Rousseau's view, a social contract can arise under very different political systems. In the following, we investigate the possibility of sustaining a social contract in the different political regimes as well as the efficiency features of these equilibria.

1.2. *The Model*

We next present a model that operationalises this institutional environment, in particular the concepts of economic and political institutions, in a parsimonious way.

1.2.1. *Individuals*

Consider an economy, which is populated by an infinite sequence of overlapping generations of individuals. A given generation consists of a continuum of adult individuals i , representing generation t , and a continuum of young individuals i , who represent the adults of generation $t + 1$. Each individual has a single parent and a single offspring, so the size of the population, which is normalised to one, is constant

¹⁵ The model can be extended by also considering within group conflict that has to do with the distributional struggle arising if one group successfully expropriates the other, reflecting that individuals 'make warre upon each other, for their particular interests'. Such an extension, e.g. along the lines of Olson (1965) with internal conflict being more easily resolved in smaller groups, would leave the qualitative results unaffected.

across generations. We use i interchangeably to denote an individual or the dynasty to which he belongs. The population is divided in two groups. The first group constitutes the minority, making up for a fraction $\gamma < 1/2$ of the population. This group is called the elite, and denoted by E .¹⁶ The remaining fraction $(1 - \gamma)$ of the population is called the people, P . All members of a particular group are identical, they face the same decision problems and so we can interchangeably speak about a (representative) member of the group or the entire group.

Agents derive utility only from consumption so that maximisation of income is a necessary and sufficient condition for utility maximisation. Consumption is financed from the income individuals derive from supplying factors of production to the market. During their youth individuals acquire human capital h_t which is produced using only time. Since the human capital of any given generation, $H_t = h_t$, is embodied in people it fully depreciates when the generation dies.¹⁷ While childhood is devoted to the acquisition of human capital, income production and consumption take place during adulthood. Every individual is endowed with one unit of labour, which he inelastically supplies during his adult life. Apart from labour and human capital, a fraction γ of individuals, the elite, are endowed with natural resources such as land. This land is equally distributed among the members of the elite, each one owning $n^E = N/\gamma$, and it is passed-on from generation to generation. The landless people, $i \in P$, own no land, so $n^P = 0$. Land, unlike human capital, does not depreciate, so that $N_t = N$. We denote *per capita* variables by lower case letters and aggregate variables by upper case letters, i.e. $y_t = Y_t/L$, $h_t = H_t/L$, and $n = N/L$. Individuals derive incomes from supplying their factor endowments and are given by $y_t^i = w_t + r_t h_t + \rho_t n^i$, where wages on labour and human capital, w_t and r_t , respectively, and the rent on land ρ_t are determined in equilibrium. Since only members of the elite own land, individual incomes differ between the two groups, with $y_t^E > y_t^P$.

1.2.2. Production

The economy is fully competitive and all resources are employed in the production of a single final commodity Y , which is used for consumption. Production takes place in an traditional, natural resource intensive sector and in a modern, human capital intensive sector. The output of the economy in period t is given by,

$$Y_t = Y_t^T + Y_t^M. \quad (1)$$

The production technology in both sectors exhibits constant returns to scale, and is of a Cobb-Douglas form. Denote by L_t^T and L_t^M the respective amounts of labour employed in the two sectors, such that

$$Y_t^T = N^\alpha L_t^{T1-\alpha}, \quad (2)$$

¹⁶ For later use we assume that members of this group possess some initial political power, enabling it to constitute an oligarchic regime. For example, this power derives from the possession of particular resources, such as land, or other peculiar attributes, like nobility. Alternatively, we could assume an income or wealth requirement for political participation.

¹⁷ In an extension we consider the possibility that the acquired human capital may be affected by the provision of a public good which for simplicity is modelled as an externality.

$$Y_t^M = (A_t H_t)^\alpha L_t^{M1-\alpha}. \quad (3)$$

In addition to the inputs, production in the modern sector is affected by a productivity index A_t , which reflects the level of technology available for production in the modern sector and which is assumed to be human capital augmenting.¹⁸ The term $A_t H_t$ can be interpreted as effective human capital.

The technological environment evolves endogenously depending on the total stock of human capital available in the economy. Technological innovations in the form of changes in A arrive with the birth of a new generation and build on the available stock of human capital. As a result, we observe steady technological innovations which improve the production possibilities of the economy,

$$\frac{A_t - A_{t-1}}{A_{t-1}} = f(H_{t-1}) \quad (4)$$

with $f'(\cdot) > 0$. This formulation of endogenous skill biased technological change follows the endogenous growth literature and implies that the human capital acquired by one generation exerts an externality on productivity of the next generation, and is therefore the engine of growth, while technical progress is biased in favour of augmenting the productivity of the human capital intensive sector.¹⁹ At the same time, these two features imply that the available stock of human capital in a given generation indirectly makes human capital a more important source of income for future generations.

1.2.3. Conflict game

Conditional on the political system in place, the distribution of disposable income is the result of a conflict game played between the different groups. Each group can decide to either 'arm' or 'not arm'. The strategic form of the game is depicted in Figure 1. Whenever one group arms, a wasteful conflict arises. For simplicity we assume

People	Arm	Not Arm
<i>Elite</i>		
Arm	gy_t^E, gy_t^P	$y_t \frac{g}{\gamma}, 0$
Not Arm	$0, y_t \frac{g}{1-\gamma}$	$\tilde{y}_t^E, \tilde{y}_t^P$

Fig. 1. *The Conflict Game*

¹⁸ The assumption of technology only affecting the modern sector is made for simplicity. The productivity index essentially reflects relative productivity in the two sectors.

¹⁹ This assumption is without consequence, all results can be obtained with exogenous technological change that affects relative productivity in the two sectors. Assuming that the productivity of land relative to human capital decreases following technological change is consistent with historical evidence from England that suggests that productivity growth in agriculture was modest if existent at all before and during the Industrial Revolution, see Clark (2001, 2002). Any alternative formulation implying a positive relationship between human capital and technological progress is equivalent for the results.

that such a conflict implies that a share $(1 - g)$ of total available income is lost, representing the cost of conflict. If only one group chooses to arm and go to conflict, we observe a transfer of income from the non-armed to the armed group. Without loss of generality, we assume that all income in the economy net of the waste implied by conflict is appropriated by the armed group. This is illustrated in the off-diagonal panels of Figure 1. If both groups arm the result is mutual opposition to nothing so that both groups burn a fraction $(1 - g)$ of their own income without being able to appropriate anything in addition.²⁰ This situation is depicted in the top-left panel and essentially constitutes a society living under a state of nature with everybody struggling against everybody while foregoing part of their income. Only if both groups abstain from arming, is conflict avoided and no income is burned. If this is the case the society is characterised by a social contract. A social contract may stipulate redistribution of income which, by not going to conflict, is implicitly agreed across groups. The disposable income available to the members of the two groups under a social contract is denoted by \tilde{y}_i^P and \tilde{y}_i^E , respectively. This case is reflected in the lower right panel of the Figure. The extent of taxation and income redistribution across groups results from a political process that is studied next.

1.2.4. Political system and income redistribution

Under oligarchy, the political power is in the hands of the elite who can offer their preferred social contract $(\tilde{y}_i^P$ and $\tilde{y}_i^E)$. The group in power cannot commit to any action, however. This implies that the elite could e.g. announce a particular redistribution scheme and *ex post* implement a different one, or announce that they will 'not arm' but eventually do arm in order to expropriate the people. In terms of the game introduced earlier, this absence of commitment implies a timing in which the elite always moves after the people. In turn, the defining characteristic of a democracy is that that everybody participates in the process of political decision making. In the current setting, the people represent the majority in the society so that the pivotal agent is a member of the people under democracy. In terms of the extensive form of the game, this implies that in oligarchy the elite moves last while the opposite is true in democracy. The political system is therefore represented by the sequence of decisions and, in any regime, the group in power has no possibility to commit to fiscal redistribution or arming behaviour. The regime is determined in equilibrium by mutual consent among all groups of society.

Fiscal redistribution, implemented under any social contract, mirrors the preferences of the group which has political power. For convenience (and realism) we restrict the policy space in both political systems such that there is a maximum extent of regressivity and progressivity. To be more concrete, we assume that under any political system, the tax system can stipulate at most either no redistribution from

²⁰ This game can be interpreted as an extreme form of a contest game with a non-convex conflict technology in which a threshold expenditure $(1 - g)$ is needed to make the investment effective and where the probability of winning the contest is one if only one group arms and is zero if both groups arm. The assumption that the cost of conflict is the same if both groups or only one group arms does not affect the qualitative results because the off-diagonals will turn out to be out of equilibrium events.

rich to poor or full redistribution and equalisation of incomes.²¹ We denote by G_t the total size of fiscal revenues, which also reflects the extent of the redistribution scheme. Since the people are poorer than the elite, the equilibrium outcome of a voting over taxation under democracy leads to maximum (progressive) redistribution. This means that the only feasible and credible tax and redistribution scheme under democracy involves a social contract where all members of society receive the same income: $\tilde{y}_t^E = \tilde{y}_t^P = y_t$.²² Under oligarchy, on the other hand, the elite has no incentive to implement a social contract involving progressive redistribution. Therefore, the social contract in an oligarchy implies no redistribution $\tilde{y}_t^E = y_t^E$ and $\tilde{y}_t^P = y_t^P$. This reflects the conventional view that the social contract exhibits more progressive redistribution in democracies than in oligarchies, which goes back to De Tocqueville (1835).²³ This view is also in line with empirical and historical evidence.²⁴ The extensive form of the arming game under oligarchy and democracy is depicted in Figures 2(a) and 2(b), respectively.

1.2.5. *Timing of events*

We first investigate the decisions of the members of the different groups under the different systems. Depending on whether the economy is characterised by oligarchy or democracy, the groups therefore play either the game depicted in Figure 2a or in Figure 2b. The timing of events within a generation's lifetime is as follows.

- 1 Birth and period of youth with human capital acquisition h_t^i ;
- 2 Adulthood, with
 - (a) production and income generation, $w_b, \tau_b, \rho_b, y_t^i$;
 - (b) realisation of conflict decisions;
 - (c) redistribution and realisation of disposable incomes;
 - (d) consumption and death.

A new generation is born when its parent generation enters adulthood and its grandparent generation dies. This completes the framework, whose dynamic properties are analysed in the following Sections.

²¹ This assumption is made for simplicity. In fact, we only need much weaker restrictions on the policy space. In particular, as long as the policy space is restricted such that, under any political system, both groups get at least a positive income net of taxes, the equilibria discussed in the next Section are feasible.

²² Notice that, as investigated below, taxation is distortionary in the sense that it may lead to a state of nature by inducing arming. Under a state of law, taxation does not distort income production so that maximum redistribution can induce full equalisation of post-tax income.

²³ See also Meltzer and Richard (1981). Voting over linear-progressive tax schedules with distortions could be introduced without changing the main results. This would lead to the 'median voter hypothesis', under which taxation increases with inequality. A similar argument is made in the model by Bourguignon and Verdier (2000), where the poor people cannot commit not to expropriate the rich elite once democracy is established. Also, allowing for regressive redistribution in oligarchies would not change the result. What is crucial for our argument is merely the higher progressivity of the redistribution scheme under the democratic social contract.

²⁴ In a historical discussion of economic and political development in Britain, Justman and Gradstein (1999) argue that democratisation was the prime factor that led to declining inequality in the aftermath of the Industrial Revolution beginning in the second third of the nineteenth century. In particular, the extension of the franchise led, according to their discussion, to the replacement of regressive indirect taxes by progressive taxes on incomes, land and inherited wealth. Analysing historical episodes and cross-country data, Gradstein and Milanovic (2000) and Gradstein *et al.* (2001) find a robust positive correlation between democratisation and income equality.

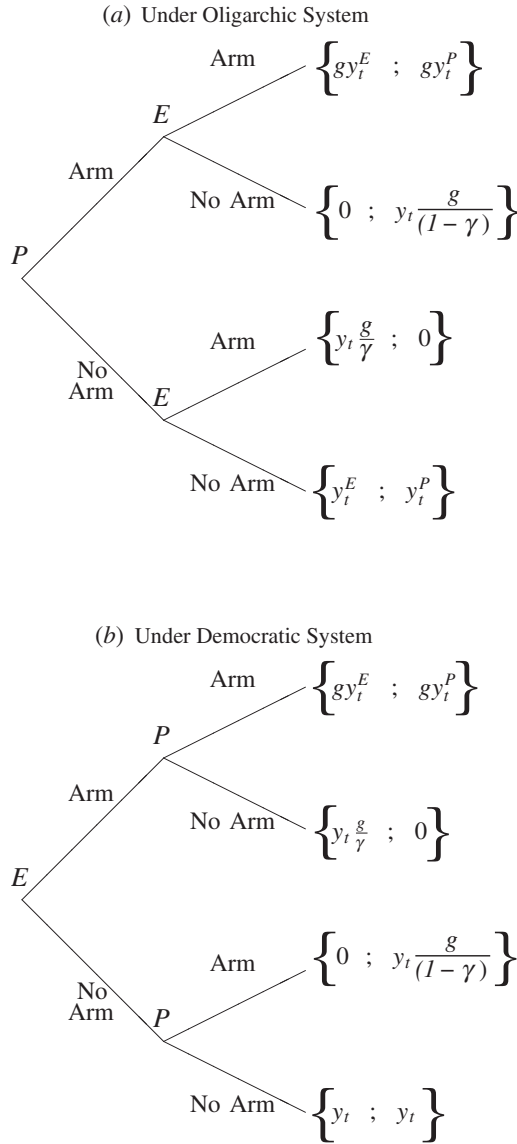


Fig. 2. Extensive Form of the Conflict Game

2. Intra-generational Equilibria

In this Section, we characterise the political environment that arises endogenously as equilibrium. A politico-economic equilibrium is characterised by a political system, a redistribution scheme under this system, the arming behaviour of the two groups, and the resulting factor incomes and consumable incomes of all members of society, such that all decisions constitute a subgame perfect Nash equilibrium.

2.1. Factor Price Equilibrium and Individual Income

The economy is competitive and all factors are remunerated according to their marginal products.²⁵ The quantity of labour employed in the two sectors is given by $L_t^T = (1 - \theta_t)L_t$ and $L_t^M = \theta_t L_t$, respectively, where θ_t is the share of total labour employed in sector M . Labour moves freely across sectors to equalise wages. This implies that for any t there exists a unique equilibrium share of labour supplied to the modern sector θ_t^* such that $w_t^P(\theta_t^*) = w_t^M(\theta_t^*) = w_t$. Using marginal products of labour in both sectors, the equilibrium partition of labour can be computed as

$$\theta_t^* = \frac{A_t H_t}{N + A_t H_t} = \frac{A_t h_t}{n + A_t h_t}, \quad (5)$$

where $\partial\theta_t/\partial N < 0$, $\partial\theta_t/\partial H_t > 0$ and $\partial\theta_t/\partial A_t > 0$.²⁶ Equilibrium factor prices in terms of labour wages, returns to human capital and land rents are therefore given by,

$$w_t^T = w_t^M = w(h_t, A_t, n) = (1 - \alpha)(A_t h_t + n)^\alpha, \quad (6)$$

$$r_t = r(h_t, A_t, n) = \alpha(A_t h_t + n)^{\alpha-1} A_t, \quad (7)$$

$$\text{and } \rho_t = \rho(h_t, A_t, n) = \alpha(A_t h_t + n)^{\alpha-1}. \quad (8)$$

For notational convenience, denote the *effective stock of human capital* available per member of generation t in the economy as \tilde{h}_t , with $\tilde{h}_t \equiv A_t h_t$. Using this notation, and substituting with the expressions for equilibrium factor prices given by conditions (6), (7) and (8), income of individual i , $i \in \{E, P\}$, can be expressed as

$$y_t^i = w_t + r_t h_t + \rho_t n^i = (\tilde{h}_t + n)^\alpha \left[(1 - \alpha) + \frac{\alpha \tilde{h}_t}{\tilde{h}_t + n} + \frac{\alpha n^i}{\tilde{h}_t + n} \right]. \quad (9)$$

Average per capita income is given by $y_t = (\tilde{h}_t + n)^\alpha$. Also, for later use we denote individual income relative to average per capita income by, $\lambda_t^i \equiv y_t^i/y_t$ with $i \in \{E, P\}$ where incomes of members of the elite and the people differ because of the different land endowments. Denote the income of members of the elite relative to that of people as $\lambda_t \equiv y_t^E/y_t^P$.

2.2. The Politico-economic Equilibrium

The goal of this Section is to determine under which conditions a social contract can be supported as equilibrium. By their own arming decisions, members of the different groups determine whether they live under a state of nature, or adopt a state of law. In

²⁵ Evidence supports this assumption. Historically, different sectors were competing for factors and factor prices reflected productivity, even before or at early stages of the industrial revolution, see e.g. Magnac and Postel-Vinay (1997).

²⁶ Note also that $\lim_{A_t \rightarrow \infty} \theta_t = 1$ and $\lim_{A_t \rightarrow 0} \theta_t = 0$.

this sense, a social contract can only arise with mutual consent of all members of society, which justifies the term.²⁷ This Section focuses on static equilibria, so we suppress generation indices t as long as there is no possibility of confusion. The analysis of the dynamic evolution of the economy and the endogenous emergence of different equilibria is postponed to the next Section. Three different types of equilibria, denoted as State of Nature, Oligarchic Republic and Democratic Republic, can arise.

2.2.1. *State of nature*

The state of nature is characterised by a situation in which all groups invest in arming. This state arises in equilibrium if at least one group does not have incentives to adhere to the social contract, and therefore deviates by investing in arming activities. Such an equilibrium can be the outcome of social interactions under any political regime. Recall that, as stated above, we assume that the respective group in power cannot commit to any decisions about arming and policies (redistribution). This implies that under oligarchy the elite moves last, after having observed the people's arming decision. Likewise, under democracy the people have the last move. Notice also that for the group that is not in power and therefore has the first move, the best option is to arm in the case where it is anticipated that the group in power will arm. A direct implication of this observation is that a state of nature materialises in equilibrium whenever the group in power, at the moment of making its move, has incentives to go to conflict and arm. Recall that the absence of commitment to public policies implies that the social contract in democracies (oligarchies) stipulates maximum (minimum) progressive redistribution. Under oligarchy, if the elite arm and the people abstain from doing so, all income in the economy, net of the cost associated to arming and conflict, is appropriated by the ruling elite. The elite therefore has an incentive to arm *ex post* if the *per capita* income (net of the cost of conflict) that each member of this group can appropriate by arming is larger than their initial income. Comparing the respective payoffs from the conflict game in an oligarchic system depicted in Figure 2(a) this is the case if, and only if,

$$\frac{y}{\gamma}g > y^E. \quad (10)$$

Symmetrically, in a democratic regime a state of nature arises if the people have the incentive to arm *ex post*. This is the case if the people earn a larger income by arming than by adhering to the social contract which would allow them to obtain, at most, full equalisation of incomes. From the payoffs of the extensive form of the conflict game in a democratic system depicted in Figure 2(b), this is the case if

$$\frac{y}{1-\gamma}g > y. \quad (11)$$

But even if the people do not have an incentive to deviate from the social contract in democracies, a sufficiently rich elite can find it optimal to arm. This is the case if

²⁷ Also here, the definition follows Rousseau's description: 'To find a form of association which defends and protects the person and property of each member with the whole force of the community, and where each, while joining with all the rest, still obeys no one but himself, and remains free as before.' This is the fundamental problem to which the social contract provides the answer.' (Rousseau, 1762, part 1 ch. 6, pp. 14–5).

the cost of redistribution is sufficiently large for the elite to induce them to prefer to pay the cost of arming. Notice that by arming the elite would induce the people to do the same and therefore lead to a mere destruction of income in the absence of any redistribution between groups. If the cost $(1-g)$ is inferior to the cost of fiscal redistribution, the elite may prefer to trigger open conflict.²⁸ This is the case if

$$y^E g > y. \quad (12)$$

The economic outcome under state of nature, i.e. in the absence of economic institutions under which individuals optimally abstain from arming and without a social contract with $G_t = 0$ and no income being taxed, is the same regardless of the political system. Hence we have the following,

PROPOSITION 1 (STATE OF NATURE) *The politico-economic equilibrium state of nature is characterised by societal conflict with all individuals investing in arms and $G_t = 0$. For any $\{A_t, N, H_t, \gamma\}$, the state of nature equilibrium emerges if, and only if, condition (10) holds under oligarchy, while under democracy a state of nature arises if either (11) or (12) holds.*

The emergence of a state of nature depends on the level of inequality prevalent in the economy at each moment in time as well as on the degree of inefficiency associated with arming. Deviations from the social contract are less likely if arming is substantially distorting. In fact, for any degree of inequality it is possible to identify an upper bound on the wastefulness of conflict above which the social contract can always be implemented, i.e. the state of nature cannot arise in equilibrium.

LEMMA 1 *For any $\{A_t, N, H_t, \gamma\}$ there always exists a level $\underline{g}(\gamma) \in (0, 1)$ such that for any*

$$g < \underline{g}(\gamma)$$

the state of nature cannot emerge in equilibrium.

Proof. In the Appendix.

A social contract can only emerge if it represents a subgame perfect Nash-equilibrium of the game depicted in Figure 2(a) for the case of oligarchy and in Figure 2(b) for the case of democracy. In order to investigate conditions under which a social contract can emerge in equilibrium in a non-trivial way, for the moment we restrict attention to the case in which a state of nature can actually arise in equilibrium, i.e. $g > \underline{g}(\gamma)$.²⁹

Proposition 1 states the first result of the article. The political regime, in particular, democracy, does not represent a sufficient condition for the implementation of a state of law.

²⁸ Notice that in this case arming can be also interpreted as an investment in private property rights protection since it also serves the role of not being subject to fiscal redistribution.

²⁹ Alternatively, if the costs of arming and conflict are exceedingly large, the equilibrium is always characterised by a social contract. For expositional convenience we discuss this case in the Appendix.

2.2.2. *Oligarchic republic*

In an oligarchy, political power is restricted to the members of the elite who cannot commit *ex ante* to their actions. Nevertheless, in equilibrium it is possible to sustain a social contract if the elite find it optimal not to arm *ex post*, provided that the people also refrain from arming. From the payoffs associated to these strategies, see Figure 2(a), and analogously to condition (10), this is the case if and only if the cost of conflict is larger than the benefit obtained by expropriating the people, that is

$$\frac{y}{\gamma}g < y^E. \quad (13)$$

If this condition holds, the elite obtain a higher disposable income in the absence of conflict than they could obtain by arming and fully expropriating the people. Also notice that under these conditions an oligarchic republic is the elite's strictly preferred regime.

Consider now the preferences of the people. Since they move first under an oligarchic system, they rationally anticipate that if they arm, they would induce the elite to do the same, leading to an equilibrium with a state of nature associated with wasteful and useless conflict. To identify the conditions under which a conflict free social contract can emerge in an oligarchy notice that with $g > \underline{g}(\gamma)$ whenever (12) is satisfied then the elite would arm under a democracy. In fact in this case, the implementation of a democratic system inevitably leads to an equilibrium with state of nature where the people are worse off than under an oligarchic republic in which, by leaving the power in the hands of the elite, no arming is possible in equilibrium. Hence, under condition (13) a social contract can be sustained in equilibrium.

PROPOSITION 2 (OLIGARCHIC REPUBLIC) *For any $\{A_t, N, H_t, \gamma\}$ and $g > \underline{g}(\gamma)$, the politico-economic equilibrium is an oligarchic republic, characterised by a political franchise which is restricted to the elite, $G_t = 0$, and no arming, if and only if condition (13) holds. In this equilibrium, both the elite and the people strictly prefer an oligarchy to a democracy.*

Condition (13) is more likely to be satisfied, *ceteris paribus*, the richer the elite is compared to the people and the more wasteful is the conflict. Rearranging, one obtains $\lambda^E > g/\gamma$. The larger the income of the rich group relative to the average, and the larger the cost of conflict (i.e. the smaller g), the more easily this condition is satisfied as the elite has less to gain from arming. This implies that conflict must not be overly wasteful and inequality must not be too low.

This result implies that in some cases oligarchy may represent the preferred available option for all individuals because only oligarchic structures allow them to achieve an efficient allocation. Under the conditions stated in Proposition 2, the oligarchic republic is the preferred political regime for all individuals in the economy: all groups agree that leaving the power in the hands of the elite is the best possible option, and there is no conflict of interest concerning the choice of the political regime. This

equilibrium resembles Hobbes' idea of a Leviathan.³⁰ The result also implies that implementing a democracy is not necessarily a pre-requisite for implementing a social contract. Under some conditions, however, the rule of law under democracy the sole regime as shown next.

2.2.3. *Democratic republic*

We now study the conditions under which a social contract can be sustained under a democratic regime. This democratic republic equilibrium is feasible only if the people are credible in sticking with the social contract, without arming and expropriating the elite. Hence, for a democratic republic to be feasible it must hold that the people have incentives not to arm. Comparing the payoffs in Figure 2(b), and symmetrically to condition (11) it must hold that

$$y \frac{g}{(1-\gamma)} < y. \quad (14)$$

In this case, the income that the people can get through full redistribution is higher than the income they could obtain by investing in arms and appropriating also the elite's factor incomes.

On the other hand, for this equilibrium to emerge, the elite must obey to the system, and not, by arming in order to protect their incomes, break the social contract. Symmetrically to condition (13) this is the case only if the cost of arming is larger than the cost of fiscal redistribution so that,

$$y^E g < y. \quad (15)$$

In other words, the income that the members of the elite receive after full redistribution must still be larger than the income they could obtain from protecting their incomes from taxation by way of arming. This is most likely the case if inequality is sufficiently low, implying that the cost of being taxed for redistributive purposes is lower than the cost of arming to avoid taxation.

Hence, while being less attractive than an oligarchic republic, from the elite's point of view a democratic system can nevertheless be the best available option. This is the case whenever a social contract can only be implemented under a democracy which in turn is strictly preferred to a state of nature. If $g > \underline{g}(\gamma)$ then condition (10) holds implying that a democracy is the preferred regime by all groups in society and consequently emerges as politico-economic equilibrium.

PROPOSITION 3 (DEMOCRATIC REPUBLIC) *For any $\{A_i, N, H_i, \gamma\}$ and $g > \underline{g}(\gamma)$, the politico-economic equilibrium is a democratic republic, characterised by universal franchise, progressive redistribution with $G_i = y_i$, and no arming if, and only if, conditions (14) and (15) hold. In this equilibrium, both the elite and the people strictly prefer a democracy to an oligarchy.*

³⁰ Hobbes' idea of a Leviathan implies that everybody would gain by giving all power in the hands of a small elite, or one person: 'The only way to erect such a Common Power, as may be able to defend them (...) from the injuries of one another, and thereby to secure them in such sort as by their owne industrie, and by the fruites of the Earth they may nourish themselves, and live contentedly; is to conferre all their power and strength upon one Man, or upon one Assembly of men (...) and therein to submit their Wills, everyone to his Will and their Judgements to his Judgement.' (Hobbes, 1651, Part 2, p. 131).

Under these conditions, the elite prefers a democracy with full redistribution to a wasteful state of nature. Rearranging (15) yields $\lambda^E < 1/g$, implying that inequality must be sufficiently low to make the opportunity cost of redistribution bearable for the elite such that members of this group actually prefer democracy to a deviation to arming. Alternatively, the condition holds if the inefficiency associated with the state of nature is sufficiently large. The people have no incentive to deviate and arm once observing the elite's decision only if (14) holds. Rearranging, one obtains $g < (1 - \gamma) \equiv \bar{g}(\gamma)$, which implies that for a democratic republic to arise, the cost of arming must be sufficiently large as to induce the people not to deviate and arm. Therefore we can establish a lower bound on the wastefulness of conflict which is necessary to make a social contract emerge in a democracy in the absence of the possibility for the people to commit to policies and actions.

LEMMA 2 *For any $\{A_t, N, H_b, \gamma\}$ and any degree of income inequality λ_t there always exists a sufficiently low cost of conflict given by $\bar{g}(\gamma) = (1 - \gamma)$ such that for any $g > \bar{g}(\gamma)$ a democracy cannot emerge in equilibrium.*

Proof. The claim follows from rearranging (14) and Proposition 3.

During the life of each generation t the economy is characterised by a unique level of inequality λ_t . By inspection of the conditions for emergence of the different equilibria in Propositions 1, 2 and 3, we have that only one equilibrium can emerge for any given λ_t .

PROPOSITION 4 (TAXONOMY OF POLITICO-ECONOMIC EQUILIBRIA) *For any $\{A_t, N, H_b, \gamma\}$ and given $g \in [\underline{g}(\gamma), \bar{g}(\gamma)]$, the politico-economic equilibrium is uniquely determined by the level of inequality λ_t^E . There exist two thresholds of income inequality $\lambda_{SN} > \lambda_D$ such that:*

- (i) *For $\lambda_t^E > \lambda_{SN}$ the equilibrium is Oligarchic Republic;*
- (ii) *For $\lambda_t^E \in (\lambda_D, \lambda_{SN})$ the equilibrium is State of Nature;*
- (iii) *For $\lambda_t^E < \lambda_D$ the equilibrium is Democratic Republic.*

Proof. Existence of all three types of equilibria follows from condition $g \in [\underline{g}(\gamma), \bar{g}(\gamma)]$ and Lemma 1 and 2. Inspection of the conditions for emergence of the different equilibria in Propositions 1, 2 and 3 makes clear that only one equilibrium can emerge for any given λ_t^E . There is a unique level of income inequality, given by $\lambda_{SN} = g/\gamma$ such that condition (10) holds with equality. From Proposition 2, this implies that an Oligarchic Republic can emerge as equilibrium only if $\lambda_t^E > \lambda_{SN}$. Similarly there is a unique $\lambda_D = 1/g$ such that condition (12) holds with equality so that by Proposition 3 a democratic republic can be implemented in equilibrium only if $\lambda_t^E < \lambda_D$. Notice that if $g > \bar{g}(\gamma)$ then $\lambda_{SN} > \lambda_D$. In this case, if $\lambda_t^E > \lambda_{SN}$, a social contract emerges under oligarchy while if $\lambda_t^E < \lambda_D$, a social contract emerges under democracy. Finally, if $\lambda_t^E \in (\lambda_D, \lambda_{SN})$, then the equilibrium is a state of nature.

The economy can be characterised by three different politico-economic equilibria. All three equilibria can be observed if, on the one hand, the cost of conflict in terms of wasted resources is not too small since otherwise arming would be too

attractive and democracy would not emerge; and if, on the other hand, the cost of conflict is not too large, implying that the state of nature would be prohibitively distortive and therefore never be observed. Proposition 4 also implies that the politico-economic equilibrium is unique no matter which group chooses the political system as long as $g \in [\underline{g}(\gamma), \bar{g}(\gamma)]$. In fact, among all members of society, regardless to which group they belong, there is unanimity about the political system as long as it serves to implement a social contract. A social contract is feasible under oligarchy for sufficiently high levels of inequality since the condition under which the elite does not arm under oligarchy, condition (10), is satisfied for higher levels of inequality than the condition under which the elite prefers democracy, condition (15).

Before proceeding, consider the intuition behind the condition $g \in [\underline{g}(\gamma), \bar{g}(\gamma)]$. In fact, only one part of the conditions can be violated at the same time. As indicated by Lemmata 1 and 2, the main implication of a violation is that one type of equilibrium becomes infeasible. If $g > \bar{g}(\gamma)$, the people have an incentive to deviate from a social contract under democracy, as becomes clear when recalling condition (14). This renders a democratic republic infeasible so that the equilibrium is either an oligarchy or a state of nature. If $g < \underline{g}(\gamma)$, the state of nature is so inefficient to always induce both groups to subscribe to a social contract. Hence, the emergence of the different regimes is crucially related the level of inequality, as is studied in more detail below. In particular, for intermediate levels of inequality a social contract may be feasible under both oligarchy and democracy.³¹

The model so far provides conditions under which a society can implement Rousseau's idea of a social contract under the rule of law. As has been shown, this is possible both under oligarchy, reflecting Hobbes' view of a potentially beneficial Leviathan, as well as under a democratic system. Failure to reach universal obedience to a social contract under either political system, however, inevitably leads to a state of nature. This implies that static efficiency, in the sense of avoiding wasteful conflict, is not confined to a particular political system, that is, democracy is not necessarily inherently 'better' in this respect. The major difference between oligarchy and democracy is the extent of public intervention in the market economy, however. While fiscal revenues are zero under oligarchy, there is taxation and redistribution under democracy. If there are some benefits from a larger intervention of the government in the economy, e.g., through public good provision, however, then these two regimes can be characterised by different development paths of total production, as studied below.

3. Dynamic Evolution of the Economy

We now turn to the dynamic analysis of the model and discuss the conditions under which the political equilibria derived in Section 2 arise endogenously.

³¹ Under certain conditions multiple equilibria can arise, in the sense that society is characterised by a conflict of interest concerning the political system. In this case, each group strictly prefers the equilibrium which grants them larger political power. As is discussed in the Appendix, all qualitative results are unaffected.

3.1. *Development and Politico-economic Institutions*

We first study the evolution of the key state variables, effective human capital \tilde{h}_t , and relative inequality $\lambda_t = \lambda_t^E / \lambda_t^P = y_t^E / y_t^P$. The key parameters are the initial inequality in terms of land resources expressed by γ , the inefficiency associated with arming, g , the process of technological progress, and the total size of land resources, N .

Human capital is acquired by all generations throughout history. Because of the externality of human capital on technology, the effective stock of knowledge that is reflected in the relative productivity of the modern sector, A , grows monotonically and unboundedly over the course of generations.

LEMMA 3 *Productivity A is increasing monotonically overtime and grows unboundedly with $\lim_{t \rightarrow \infty} A_t = \infty$.*

Proof. In the Appendix.

As a result of skill biased technological progress land becomes less and less important in the production process and its role as a source of individual income declines. A larger A_t increases the effectiveness of human capital. From (5) this induces a structural change in the economy leading to a shift of labour force from the traditional to the modern sector of production. As a result the returns to the different factors of production change overtime. In particular, from (6), (7) and (8), a larger A_t increases both the wages and the returns to human capital, but leads to a reduction in the rents from natural resources and in the share of total income appropriated by their owners. While the income share of labour is stable, the income share generated by human capital grows at the expense of the income share generated by land over the course of development.³² In the limit, human capital and labour are the only relevant factors of production while the contribution of land to income production converges to zero. Since the unequal distribution of natural resources is the only source of inequality in incomes, this also implies that income inequality between the groups tends to decrease monotonically over the course of generations and vanishes in the limit.³³ These observations are recorded in

LEMMA 4 *Once the economy is sufficiently developed in terms of productivity, income inequality decreases monotonically over the course of generations and vanishes in the limit, $\lim_{t \rightarrow \infty} \lambda_t^E = \lim_{t \rightarrow \infty} \lambda_t = 1$.*

Proof. In the Appendix.

We are now in a position to study the development path of the economy and the role of inequality for the process of politico-economic development. The qualitative features of the following results go through, as long as natural resources lose importance and eventually human capital is the main factor of income production, implying that in

³² This is in line with historical evidence. See also Acemoglu and Robinson (2003).

³³ Notice that this asymptotic result concerning the relative incomes of landed elite and landless people does not hinge on the assumption of two groups.

the limit inequality in factor endowment loses importance. The monotonic decline in inequality is not necessary for the main results but facilitates the illustration.³⁴ For the sake of illustration and without loss of generality, assume that initial conditions imply a high level of inequality λ_0^E such that the conditions for oligarchic republic are met.³⁵ As becomes clear from the structure of individual incomes displayed in (9), already in the initial period the elite has a higher income than the people, simply by the fact that they own the same labour and human capital endowments but, in addition, land, that is $\lambda_1^P \leq 1 \leq \lambda_1^E$. Note that this is true regardless of which political environment individuals face.

Since oligarchic republic equilibria only vanish with sufficiently low inequality, and since inequality is monotonously decreasing in the level of development, which is reflected in productivity A , it follows from Lemma 3 that there is a unique level of development \underline{A} for which the economy enters the sequence of state of nature equilibria: $\underline{A} : g/\gamma = \lambda_{t(\underline{A})}^E$. From Lemma 3 we know that there is a one-to-one relationship between the level of technology and time in terms of generations t . Hence, denote the generation for which the conditions for oligarchic republic and state of nature bind with equality as $t = t(\underline{A})$. Likewise, once the economy is sufficiently developed, state of nature equilibria disappear, giving rise to democratic republic equilibria. Again, Lemma 4 allows us to denote this level of development by $\bar{A} : \lambda_{t(\bar{A})}^E = 1/g$, and Lemma 3 allows us to translate this into a point in time for which the economy is at the verge of state of nature turning into a democratic republic, $\bar{t} = t(\bar{A})$.

Given this, we can prove the following

PROPOSITION 5 (DEVELOPMENT PATH) *For any $\{A_0, N, \gamma\}$ such that condition (10) holds and, given $g \in [g(\gamma), \bar{g}(\gamma)]$, the dynamic path of the economy is characterised by $\underline{t} < \bar{t}$ implying a sequence of oligarchic republic equilibria during early stages of development, followed by state of nature for intermediate levels of development, and eventually a sequence of democratic republic equilibria.*

Proof. Existence of all three types of equilibria follows from Proposition 4. If inequality is sufficiently high in the early stages of development, $\lambda_t^E > g/\gamma = \lambda_{SN}$, and the politico-economic equilibrium is Oligarchic Republic from Proposition 2. From Lemmata 3 and 4 we have that λ^E declines monotonically and converges to 1. Hence, eventually the only equilibrium becomes a State of Nature once $\lambda_{SN} > \lambda_t^E > \lambda_D$, compare Proposition 1. As development continues, λ^E decreases further. Once $\lambda_t^E < 1/g = \lambda_D$ the unique politico-economic equilibrium is a Democratic Republic, see Proposition 3, because $\lim_{t \rightarrow \infty} \lambda_t^E = 1 < 1/g$.

The condition for which the elite prefers democracy to conflict, condition (15), binds at lower levels of inequality, and thus for later generations, than the condition

³⁴ Accounting for features like differential fertility, credit market imperfections affecting educational outcomes, or heterogeneity in the accumulation of human capital could lead to a non-monotonic change in inequality with intermediate periods of increasing inequality before eventually declining, see e.g. Bertocchi and Spagat (2004) and Galor (2005). A similar comment applies for the consideration of exogenous shocks, like diseases or natural disasters.

³⁵ In the current context, this is equivalent to assuming a sufficiently low initial level of productivity, A_0 .

under which the elite cannot sustain an oligarchic republic by credibly announcing it will not arm, single condition (13). This implies that a democratic republic eventually emerges in equilibrium.

Finally, consider the cases when $g \in [\underline{g}(\gamma), \bar{g}(\gamma)]$ does not hold. Due to Lemma 2, no democracy can be observed if $g > \bar{g}(\gamma)$. In this case, and without the possibility of committing to public policies, the economy is initially characterised by oligarchic republic equilibria, and eventually ends up in a state of nature.³⁶ If, on the other hand, $g < \underline{g}(\gamma)$ then $\underline{t} > \bar{t}$, which implies a direct transition from an oligarchy to a democracy, without a state of nature ever emerging along the development path.

3.2. Inequality, Natural Resource Abundance and Development

Having characterised the overall pattern of development in the economic and political domain, we now turn to the investigation of the properties of the development path in detail. First note that, without loss of generality, we restrict attention to the case in which all three politico-economic equilibria can arise. Recall that \underline{t} and \bar{t} denote the generations for which an oligarchy becomes unsustainable and a democracy becomes sustainable, respectively. We have the following result,

PROPOSITION 6 (NATURAL RESOURCE ABUNDANCE AND INSTITUTIONAL DEVELOPMENT) *For any $\{A_0\}$ and any $g \in [\underline{g}(\gamma), \bar{g}(\gamma)]$, a larger endowment of natural resources (i.e. a larger N given γ) implies:*

- (i) *a later transition from oligarchic republic to state of nature (i.e. a larger \underline{t});*
- (ii) *a later transition from state of nature to democracy (i.e. a larger \bar{t}).*

Proof. In the Appendix.

This Proposition illustrates the crucial role of natural resource abundance in determining the endogenous emergence of politico-economic equilibria. Both types of transition, from oligarchy to state of nature, and from this state of nature to democracy occur later the larger N . The main intuition for the result is that the larger the rents accruing to the elite from the control over natural resources the larger is income inequality over the course of development. This has two important implications for the dynamic evolution of the economy. In the first place the elite can sustain a social contract longer inside an oligarchy since they face a lower incentive to arm and expropriate the disenfranchised people. Second, they also face a larger (shadow) cost of redistribution which delays the transition to a democracy. With respect to the level of inequality in resource endowments, we have the following result.

PROPOSITION 7 (INEQUALITY AND INSTITUTIONAL DEVELOPMENT) *For any $\{A_0\}$ and any $g \in [\underline{g}(\gamma), \bar{g}(\gamma)]$, a larger inequality in the ownership of natural resources (i.e. a smaller γ given N) implies:*

³⁶ This claim is made formally and proven in the Appendix.

- (i) an earlier transition from oligarchic republic to state of nature (i.e. a smaller \bar{t});
- (ii) a later transition from state of nature to democracy (i.e. a larger \bar{t}).

Proof. In the Appendix.

Two effects are at work, the effect of inequality on the timing of the transition to a state of nature implying that the larger inequality in resource endowments, i.e. the smaller γ , the larger the possible range for state of nature equilibria. Larger inequality increases the *per capita* income of each member of the elite, which makes them more credible in not arming. But at the same time the expected returns on arming are higher by decreasing the size of the group that has to share the appropriated incomes. Since the second effect always dominates the first, larger inequality (i.e. smaller γ) implies an earlier transition to the state of nature. Larger inequality also implies a larger (shadow) cost of redistribution, delaying the transition to democracy. Hence, the model implies different roles for resource abundance and inequality in the development path.

These results provide a characterisation of the politico-economic equilibria that can arise along the development path of the economy. So far, however, there is no element in the model that generates dynamic consequences of the respective politico-economic equilibria. From the analysis above we know that both oligarchy and democracy can be effective in avoiding wasteful conflict. In the long-run, however, it is irrelevant how long an economy is characterised by, *e.g.*, a state of nature, since no state variable is affected by the politico-economic environment, and therefore unfolds a compounding effect on the development path. We now show that the model can be easily extended to generate permanent effects of the politico-economic environment.

3.3. Political Regimes and Dynamic Externalities (Extension)

Consider the possibility of financing a public good such as an education system out of the budget for redistribution. Since human capital is the engine of growth, this gives rise to an externality with a higher growth potential under a democratic republic equilibrium. In the context of the model, the amount of fiscal revenues collected by taxation and used for redistribution, which is denoted by G_t , can alternatively be interpreted as a publicly provided good (rather than a monetary payment).³⁷ If this in-kind redistribution is not confined to consumptive payments but has an externality on human capital formation, such as the provision of a public education system, this provides scope for dynamic differences in the income generating process across the different political regimes. In fact, whenever public good provision positively affects the level of human capital, $h_t = h(G_{t-1})$, democracy has a larger growth potential than oligarchy. This dynamic externality is consistent with empirical findings that

³⁷ Note that formally, since population size is normalised to 1, there is no distinction between a publicly provided private good and a pure public good.

democracies foster growth through improved conditions for human capital accumulation, see, e.g., Tavares and Wacziarg (2001) and Wacziarg (2001).³⁸

PROPOSITION 8. *If $h_t = h(G_{t-1})$ with $\partial h / \partial G_{t-1} > 0$, then a transition to a democratic republic implies an acceleration in the development of the economy compared any other politico-economic equilibrium.*

Proof. The claim immediately follows from the formulation of improvements in productivity in (4), since $A_t = f[H_{t-1}(G_{t-2})]$. Because of the time structure, the acceleration of technological progress begins in the generation of grandchildren of the generation experiencing the democratic transition since $G_t = 0$ for every t in an oligarchic republic or state of nature equilibrium.

This implies that democracies may provide a better environment for growth than oligarchies, even in the case in which the latter are statically efficient in the sense that a social contract can be implemented. Hence, the sooner a country democratises the faster it develops.

Notice that these results are obtained by neglecting any dynamic inefficiencies of social unrest under the state of nature. Alternatively, one could imagine that societal conflict and widespread arming has long-run effects apart from the static inefficiency because of the resources wasted in conflict. Examples would be negative effects on investment and the accumulation of factors such as physical or human capital. In this case, each period in which resources are wasted in conflict inflicts a permanent effect on the development path of the economy. If the model were extended in this direction, the implication would not only be that earlier democratic transitions are beneficial. As additional prediction, countries would then develop faster the shorter the period of state of nature and social unrest.

3.4. Discussion

In the context of dynamic externalities, even a relatively small difference in natural resource abundance and inequality can therefore have important implications for the development of the economy. In particular, countries that are initially endowed with a larger, but more unequally distributed stock of natural resources, enter the state of nature sooner and adopt a democratic republic later. The model therefore provides a novel rationale for episodes of growth miracles, overtaking and divergence that is based on a politico-economic mechanism.

The main results are robust with respect to relaxing some crucial assumptions of the model. Given the assumed sequence of events in which redistribution is chosen *ex post*, the group in power will not commit to particular policies. This is an important assumption but considering the absence of commitment is the natural benchmark when dealing with political decisions about fiscal redistribution. Introducing the

³⁸ In principle one could consider the choices of public good provision and redistribution jointly and explicitly, see, e.g. Cervellati *et al.* (2006b). For the purpose of this article we only want to highlight that in democracy there is larger room for public policies since the poor face a lower marginal cost of taxation, which leads to larger governments. Therefore oligarchies and democracies cannot be expected to be equally efficient in general even in the case in which a social contract can be implemented.

possibility of committing to redistribution schemes would make the emergence of a state of nature equilibrium less likely. The assumption of the costs of conflict as a proportion $1-g$ of income that is wasted is made to simplify illustration and has no consequences for the main results. Having non-proportional or group-specific cost specifications would change quantitatively, but not qualitatively, the threshold levels of inequality that characterise the different equilibria and would leave the dynamic evolution of inequality unchanged. The monotonic dynamics and hence the sequence of equilibria, follow from the specification of the technological progress. All the main results could alternatively be obtained with exogenous and biased technological change that affects inequality and therefore the conflict of interest concerning redistribution between the groups of society. Non-monotonic dynamics of inequality would affect the sequence of dynamic equilibria, however. To focus attention on the new politico-economic mechanism, the model concentrates on the role of dynamic externalities and explicitly rules out static distortions from inequality, whose consideration would reinforce the implications concerning the potential reversal of fortunes. In summary, while the assumption of absence of the possibility of commitment is important in determining the emergence of politico-economic equilibria, the other assumptions are mainly made for illustrative convenience.

4. Concluding Remarks

This article presents a theoretical framework for investigating the interactions between political regimes, oligarchy and democracy, and the emergence of a social contract that prevents conflict between different groups of society. The model generates conditions under which an efficient social contract emerges in equilibrium. Efficient oligarchies can emerge and persist in equilibrium if economic inequality is sufficiently large. Under these conditions, in line with Hobbes' metaphor of a Leviathan, all social groups prefer to leave control over policies in the hands of a rich and powerful elite. This equilibrium is preferred by all groups of society to a democratic regime, which would lead to widespread and wasteful conflict under these conditions. The model shows that democracy is not necessary and not sufficient to implement a state of law. However, the model also shows that a social contract can only emerge under a democratic regime if inequality is sufficiently small. For intermediate levels of inequality, both regimes, oligarchy and democracy, fail to implement a state of law, unless conflict is overly wasteful. These results, shed new light on recent empirical findings about the roles of economic and political institutions.

The analytical characterisation of the development path of an economy delivers further new results. During the transition from oligarchy to democracy a period of widespread conflict arises. The duration of this 'state of nature' depends particularly on natural resource abundance and inequality. The model also generates predictions concerning the timing of the endogenous transitions between the different political regimes, as well as their implications for development. As a consequence of the dynamic evolution of economic and political institutions, the model can generate episodes of reversal of fortunes, in which resource abundant but unequal countries are leapfrogged by poorer but more equal countries.

The model delivers predictions in both directions of causality for the correlation between democracy and economic development. On the one hand, inequality and the relative importance of human capital, as compared to natural resources, rather than development *per se*, is the main force behind the end of social conflicts and the emergence of democracy. This prediction appears broadly in line with empirical and historical evidence. On the other hand, both oligarchies and democracies can successfully implement a social contract, a prediction that is supported by some recent empirical evidence about the effective implementations of a state of law under oligarchic structures. In fact, democracy can lead to widespread and inefficient social conflict. Ultimately, the model predicts that political institutions, like democracy, only matter for growth-enhancing institutions in conjunction with economic conditions, like inequality. In a companion paper we use cross-country data to test this prediction. In regressions with institutional quality of a country as the dependent variable, we find evidence for a significant negative effect of inequality, mixed evidence for democratic quality but a significant negative interaction between inequality and democratic quality, see Sunde *et al.* (2008) for details. These results imply that oligarchies do relatively better in terms of economic institutions the higher the inequality within the population, while a reduction in inequality affects institutional quality positively if it is associated with a switch to democracy. A further model implication is that episodes of democratisation are likely to be associated in acceleration in growth rates, in particular if the democratic regimes implement growth-enhancing infrastructure. While the empirical debate on the effects of democratisation is still ongoing, this prediction seems to be in line with recent empirical findings. Overall, the theoretical framework proposed in the article, despite being stylised, delivers a rich set of novel results that are consistent with available evidence and that have potentially important implications for development policy.

Appendix

A.1. Proofs and Supplementary Propositions

Proof of Lemma 1. A necessary condition for the emergence of a state of nature is that the elite cannot refrain from arming under oligarchy. In this case the state of nature arises if a social contract under democracy is not feasible, that is, if either the elite or the people have incentives to arm under democracy. This is the case when (10) holds together with (11) or (12). Conditions (10) and (12) hold simultaneously if

$$yg/\gamma > y^E \wedge gy^E > y \Leftrightarrow g/\gamma > \lambda^E > 1/g$$

$$\text{which implies } g/\gamma > 1/g \Leftrightarrow 1/\gamma > 1/g^2.$$

Hence, (10) and (12) cannot be jointly satisfied if $g < \sqrt{\gamma}$. In this case a state of nature can arise only if the people deviate in democracy, that is, if (11) is not satisfied. This is the case only if $g > 1-\gamma$. But note that (11) is redundant whenever $g < \sqrt{\gamma}$ if $\sqrt{\gamma} < 1-\gamma$. On the other hand, (11) is not redundant if $\sqrt{\gamma} > 1-\gamma$. A state of nature can therefore arise only if $g > (1-\gamma)$. Hence for any $\{A_i, N, H_b, \gamma\}$ we can identify $\underline{g}(\gamma) = \min\{\sqrt{\gamma}, 1-\gamma\}$ such that for any $g < \underline{g}(\gamma)$ the state of nature cannot be an equilibrium.

Proof of Lemma 3. The result follows from (4) and $h_t > 0 \forall t$, implying that $(A_t - A_{t-1})/A_{t-1} > 0 \forall t$. Rearranging condition (4), technological progress is of the form $A_t = [1 + f(H_{t-1})]A_{t-1} = d_{t-1}(H_{t-1})A_{t-1}$ with $d_{t-1}(\cdot) > 1 \forall t > 1$ due to the human capital accumulation process. For any $A_0 > 0$, we can rewrite $A_t = (\prod_{j=1}^t d_{j-1})A_0$, where $(\prod_{j=1}^t d_{j-1}) > 1$ and $\lim_{t \rightarrow \infty} (\prod_{j=1}^t d_{j-1}) = \infty$. This means that the process is autoregressive, positive monotonous and non-stationary. Hence, A_t is strictly increasing generation after generation, with $\lim_{t \rightarrow \infty} A_t = \infty$.

In the following, we characterise the equilibria for the parametric cases complementary to the one of Proposition 4.

PROPOSITION 4a (*Taxonomy of Politico-Economic Equilibria – Alternative Cases*)

For any $\{A_t, N, H_b, \gamma\}$,

- (i) a democratic republic cannot emerge if $g > \bar{g}(\gamma)$. In this case the politico-economic equilibrium is an Oligarchic Republic if $\lambda_t^E > \lambda_{SN}$ or a State of Nature if $\lambda_t^E < \lambda_{SN}$;
- (ii) a state of nature cannot emerge if $g < \underline{g}(\gamma)$, since then $\lambda_D > \lambda_{SN}$. The politico-economic equilibrium in this case is an Oligarchic Republic if $\lambda_t^E > \lambda_D$, a Democratic Republic if $\lambda_t^E < \lambda_{SN}$ and a social contract can be sustained either in an oligarchy or in a democracy if $\lambda_{SN} < \lambda_t^E < \lambda_D$.

Proof.

- (i) Under oligarchy, for any $\lambda_t^E > \lambda_{SN}$ the elite prefers not to arm as implied by Proposition 2. The people agree with an oligarchic republic and do not deviate by arming because of the associated costs, supporting the oligarchic republic equilibrium. Alternatively, when $\lambda_t^E < \lambda_{SN}$, the elite is not credible in refraining from arming, triggering arming by the people as the best reply. Hence, in this case a state of nature arises under oligarchy. Moreover, from Lemma 2, no democratic republic can arise in equilibrium, so the only equilibrium in this case is state of nature.
- (ii) If $g < \underline{g}(\gamma)$ then from Lemma 1 the state of nature never arises in equilibrium. From conditions (10) and (12), $g < \underline{g}(\gamma)$ implies that $\lambda_D = 1/g > \lambda_{SN} = g/\gamma$. In this case for any $\lambda_t^E > \lambda_D > \lambda_{SN}$, the elite chooses to arm under democracy but not under oligarchy. Again, the people do not deviate to arming and hence the equilibrium is an oligarchic republic. For any $\lambda_D > \lambda_{SN} > \lambda_t^E$ the elite arm under oligarchy but not under democracy. Since the people do not deviate either under these conditions, the equilibrium is a democratic republic. Finally, for $\lambda_{SN} < \lambda_t^E < \lambda_D$ both elite and people prefer not to arm under either regime so that a social contract is feasible in both an oligarchy and a democracy. Notice however that in this case the elite would prefer an Oligarchic Republic to a Democratic Republic due to the different redistribution implied by the different social contracts. The opposite is true for the people. Hence in this case the social contract is sustainable under both regimes.

Proof of Lemma 4. For any $\{N, \gamma\}$, the relative income of the elite λ_t^E is given by,

$$\lambda_t^E = \frac{w(A_t, N) + h_t r(A_t, N) + (n/\gamma)\rho(A_t, N)}{w(A_t, N) + h_t r(A_t, N) + n\rho(A_t, N)}, \tag{16}$$

where the factor rents are given by the expressions (6), (7) and (8). Computing the derivative with respect to A_t one gets,

$$\frac{\partial \lambda_t^E}{\partial A_t} = \frac{n(1 - 1/\gamma)[w'\rho - w\rho' + r'\rho - r\rho']}{[w(A_t, N) + h_t r(A_t, N) + n\rho(A_t, N)]^2} < 0$$

with primes denoting partial derivatives with respect to A_t . Negativity follows since $w' = \alpha(1 - \alpha)(A_t h_t + n)^{\alpha-1} h_t > 0$, $r' = \alpha(A_t h_t + n)^{\alpha-1} \left[1 - \frac{(1 - \alpha)}{A_t h_t + n}\right] > 0$ for large A , and $\rho' = \alpha(\alpha - 1)(A_t h_t + n)^{\alpha-2} < 0$ and $\gamma > 1/2$. Monotonicity after a certain level of development follows from the change in sign in r' and Lemma 3. From the fact that $\lim_{A \rightarrow \infty} \rho_t(A, N) = 0$ and noting the definition of λ_t^E in (16) it follows that $\lambda_\infty^E = 1$. Since $n^P = 0$, similar reasoning yields $\lambda_\infty = 1$.

Next, consider the statement of Proposition 5 under the complementary parametric cases:

PROPOSITION 5a (DEVELOPMENT PATH – ALTERNATIVE CASES) *For any $\{A_t, N, H_t, \gamma\}$ the dynamics of the economy is characterised by:*

- (i) *a sequence of oligarchic republic equilibria during early stages of development, followed by a sequence of state of nature equilibria if $g > \bar{g}(\gamma)$;*
- (ii) *a sequence of oligarchic republic equilibria during early stages of development, followed by a sequence of democratic republic equilibria if $g < \underline{g}(\gamma)$.*

Proof.

- (i) A similar reasoning as in the proof to Proposition 5 applies, given that initial inequality is sufficiently high to support an oligarchic republic. But note that it follows from Propositions 3 and 4a that democratic republic is not an equilibrium if $\bar{g}(\gamma) = 1 - \gamma < g$ as the people always have an incentive to deviate and arm in this case. But then, from Lemmata 3 and 4 and condition (11) it follows that the development path is characterised by oligarchic republic in the early stages of development, followed by a sequence of state of nature equilibria in later stages of development.
- (ii) Again, a similar reasoning applies, given that initial inequality is sufficiently high to support an oligarchic republic. However, note that as direct corollary of Proposition 4a, state of nature is not an equilibrium if $g < \underline{g}(\gamma)$ since then $y_t g / \gamma > y_t^E$ and $g y_t^E > y_t$ in condition (10) cannot hold at the same time. Hence, by monotonicity of λ_t^E , the economy experiences a direct transition from oligarchic to democratic republic. The timing of the transition is undetermined in this case as a consequence of the possibility that a social contract can be sustained under both political regimes. If the elite has the power to impose a political system, the democratic transition occurs for lower levels of λ_t^E , and thus during later generations because of Lemma 4, than if the people have the power to impose a political system on the society. All other results concerning the comparative dynamics remain unchanged.

Proof of Proposition 6. Rewrite the conditions that define \underline{t} and \bar{t} in implicit terms as,

$$\lambda_{\underline{t}}^E \gamma - g = 0 \text{ and } \lambda_{\bar{t}}^E - 1/g = 0, \tag{17}$$

respectively. First note that $n = N/L = N/1$ and that

$$\lambda_t^E = \frac{y_t^E}{y_t} = \frac{y_t + n\rho_t(1/\gamma - 1)}{y_t} = 1 + \frac{n\rho_t}{y_t}(1/\gamma - 1).$$

Hence, because $\frac{\partial(n\rho_t/y_t)}{\partial n} = \frac{\alpha A_t h_t}{(A_t h_t + n)^2} > 0 \forall t$ and monotonicity, we know by applying the implicit function theorem that

$$\frac{d\bar{A}}{dn} = -\frac{\partial(\lambda_t^E \gamma)/\partial n}{\partial \lambda_t^E / \partial \bar{A}} > 0 \text{ and}$$

$$\frac{d\bar{A}}{dn} = -\frac{\partial(\lambda_t^E \gamma)/\partial n}{\partial \lambda_t^E / \partial \bar{A}} > 0,$$

and by monotonicity of A in t we have $\text{sign}(d\bar{t}/dn) = \text{sign}(d\bar{A}/dn)$ and that $\text{sign}(d\bar{t}/dn) = \text{sign}(d\bar{A}/dn)$.

A similar reasoning applies for a change of the different timing with respect to inequality γ for a given N .

Proof of Proposition 7. Define \underline{t} and \bar{t} in implicit terms as in the proof of Proposition 6 and note that $\text{sign}(\partial \lambda_t^E / \partial \bar{A}) = \text{sign}(\partial \lambda_t^E / \partial \bar{A}) = \text{sign}(\partial \lambda_t^E / \partial A_t) < 0$. Also note that $\partial[\lambda_t^E \gamma] / \partial \gamma = (w_t + r_t h_t) > 0$ and $\partial \lambda_t^E / \partial \gamma = -(n/\gamma^2)\rho/\gamma < 0$. Moreover, by implicit differentiation we know that

$$\frac{d\bar{A}}{d\gamma} = -\frac{\partial(\lambda_t^E \gamma)/\partial \gamma}{\partial \lambda_t^E / \partial \bar{A}} > 0 \text{ and}$$

$$\frac{d\bar{A}}{d\gamma} = -\frac{\partial(\lambda_t^E \gamma)/\partial \gamma}{\partial \lambda_t^E / \partial \bar{A}} < 0.$$

Finally, by monotonicity of A in t we have $\text{sign}(d\bar{t}/d\gamma) = \text{sign}(d\bar{A}/d\gamma)$ and that $\text{sign}(d\bar{t}/d\gamma) = \text{sign}(d\bar{A}/d\gamma)$, which proves the claim.

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