

The Coevolution of Economic and Political Development from Monarchy to Democracy

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Abstract

This paper establishes a unified political economy model to analyze the democratization process from monarchy to oligarchy and then to democracy with full suffrage in the context of dynamic economic development. As the predominant source of wealth evolves from land to physical capital and finally to human capital, the relative economic and hence coercive power of land owners, capitalists, and workers shifts accordingly, inducing the transition of the political system where political power is expanded from the owners of land to the owners of capital and then to the owners of labor. A smooth transition through political compromise facilitates efficient allocation of savings in physical capital followed by efficient investment in human capital. Failure to expand political power to support expanding investment would lead to the retarding of economic development. These results are broadly consistent with historical evidence in Western Europe.

JEL: O10, O40, P16, N10.

Key Words: Democratization, Factor Composition, Monarchy, Oligarchy, Democracy, Suffrage Extension, Human Capital.

1 Introduction

The main storyline of human history may be driven by the dynamic interactions between cooperative economic activities leading to greater aggregate wealth and political conflicts over its distribution. The current paper attempts to formalize this idea in a simple model of long-run economic and political development: As the main source of growth shifts from land to physical capital and then to human capital, the relative

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economic and hence coercive power of landlords, capitalists, and workers shifts accordingly, inducing the transition of the political system from monarchy to oligarchy (of landowners and capitalists) and finally to democracy with full suffrage. Every new political regime, by extending political power to the owners of the new form of capital and thus increasing their future economic gains from investment, speeds up economic progress. In other words, a smooth expansion of political power from the owners of land to the owners of capital and then to the owners of labor facilitates a smooth transition in investment, allowing for efficient allocation of savings in physical capital followed by efficient investment in human capital. Failure to expand political power to support expanding investment would lead to the retarding of economic development. These results are broadly consistent with historical evidence in Western Europe, especially England and France where the full time line in the model has been realized through autonomous transitions.¹

The sequence of the economic development path is mainly determined in the model by the distinct technical features of production factors: land is endowed by nature and difficult to create or destroy; physical capital, in contrast, has to be produced endogenously by investment; the raw labor is endowed by nature, but human capital beyond this basic level has to be acquired through endogenous investment. The exogenous endowment of land and raw labor makes it beneficial to invest in physical capital first when savings become available, while the ever increasing stock of physical capital will eventually trigger human capital investment when the return to it becomes large enough (Galor and Moav 2004, 2006).

The division of outputs among production factor owners is determined by the political system, where the ruler may exploit ruled agents through taxes and confiscation. The establishment and transition of political regimes is mainly driven by the assumption of *might-is-right*, that is, the political *right* of any group has to be obtained and secured by their coercive *might*, which is determined by the joint incomes and coordination effectiveness of its members.² This chain of economic strength, coercive might, and political right is the engine that pulls the coevolution train of dynamic economic and political development across different historical stages.³

Specifically, the transition of political regime is modeled as an equilibrium outcome in a political game

¹The model abstracts from international interactions such as colonization and thus may not be directly applicable to late-comers in development that were colonized or conquered. As Olson (1993) pointed out, although “there are a fair number of democracies, there have not been many spontaneous and entirely autonomous transitions from autocracy to democracy.” England and France are arguably the main exceptions.

²This is in line with North’s (1981, p. 21-22) theory of state, in which the key to understanding the state involves the potential use of violence to gain control over resources: “The contract theory assumes an equal distribution of violence potential amongst the principals. The predatory theory assumes an unequal distribution.”

³Note that the coercive might is similar to the *de facto* power used by Acemoglu and Robinson (2006a), while political power has some similarity to the *de jure* power. From this perspective, an innovation of the current paper is modeling the *dynamic* links between the *de facto* and *de jure* power.

between the incumbent ruler and the challenging group, where the latter may choose either to obey the ruler or revolt, and then in response to revolt, the ruler may choose either to compromise or to repress. A smooth transition to a new political regime occurs under compromise, in which the ruler extends political power to the challenging group. If the ruler chooses to repress and the challenging group continues to revolt, an open fight breaks out, which may in a probabilistic manner lead to either repression or revolution depending on the balance of coercive power. In the equilibrium, the challenging group revolts only when its coercive power becomes large enough. The main focus of this paper is on the smooth transition case through compromise, which is more likely to occur in equilibrium when the cost of fighting is higher, when the stake of political power (as represented by the net tax rate) is smaller, and when the incumbent's repressive apparatus is less effective.

The model economy starts from the agricultural era when there is no capital investment. The initial political regime is monarchy, where the exogenous and fixed supply of land makes it possible for an individual to capture and hold enough land to possess dominant coercive power over others and become the monarch.⁴ The balance of economic and coercive power would remain stable under monarchy for a long time until the endogenous capital accumulation becomes an important source of economic growth. In sharp contrast to land or other natural resources, the new form of wealth, namely physical capital, cannot be easily centralized or controlled by the monarch through coercion, since its ultimate source (capitalists' entrepreneurial skills or technical know-how) is inherently dispersed among individual capitalists and difficult to capture by force.⁵ As the stock of physical capital increases over time, it would eventually replace the relatively fixed land as the predominant source of wealth, and enable its owners to collectively acquire enough coercive power to obtain political rights and protect their capital returns. As the same logic applies to human capital beyond raw labor, workers as the owners of human capital will also gain political rights when their coercive power becomes sufficiently large. Thus the endogenous accumulation of physical capital and human capital is the fundamental driving force underlying the democratization process from monarchy to oligarchy and then to democracy, along which the exploitative political rent gradually dissipates until all factor owners share political power and earn competitive market returns.

⁴Such a technical feature of land also applies to natural resources, which seems to be the ultimate cause for the natural resource curse (Ross 1999, Boix and Stokes 2003, Lagerlof and Tangeras 2007).

⁵Factories and machines may be confiscated by others, but the most important assets of capitalists in capital accumulation, such as their entrepreneurial skills, technical know-how, and business networks, are usually intangible and difficult to capture by force. Nor are these special talents of capitalists readily accessible to everyone in the population. Even at the present time, how to become a successful entrepreneur still eludes most people. The standard human capital, such as the skills to read, write, and calculate, in comparison, can be systematically acquired through education.

The model has several useful implications concerning the relationship between economic growth and political development. First, the more fundamental force underlying democratization is not the income level *per se*, but the changing factor composition (where the predominant factor for economic growth shifts from land to physical capital and finally to human capital), since the latter determines the changing economic and coercive power of different factor owners. In other words, the production factor composition is the common element that affects *both* the income level and the nature of the political regime. This accounts for why both in history and current times, most democracies have industrialized economies where human capital is the dominant source of growth, while in countries with natural resources as the main form of wealth, authoritarian political regimes are more likely to occur.⁶

The second implication is that political transition often makes a breakthrough in a short period of time, although the groundwork, by means of economic development, usually takes a long time. This is consistent with the findings of Acemoglu et al. (2008), which cast doubt on the short-term causal effect of income on democracy after World War II, but find evidence that such a relationship may exist in a much longer horizon. Similarly, Boix and Stokes (2003) argue that it is the prewar period—from the late nineteenth century to the end of World War II—in which the impact of income on democracy is most powerful.

Third, economic growth is a necessary but insufficient condition towards political development, since the ultimate political outcome is affected by the balance of coercive power, the cost of fighting and the probability of winning during the crucial transitional periods, which may depend on geopolitical, religious, ideological, and other ultra-economic elements. For example, a country with faster economic growth but a strong ruler with higher repressing capacity may end up in repression, while another country with slower growth but a weak ruler may make the political transition first.

This paper proceeds as follows. The main contributions of this paper to the related literature are discussed in the next section. The basic elements of the political economy model are introduced in Section 3, and the analysis of the model is in Section 4. The robustness of this paper's main results is checked against alternative modeling choices in Section 5. Related historical evidence is collected in Section 6 and some concluding remarks are offered in the final section. All proofs are relegated to the Appendix.

⁶For evidence of such correlations see Lipset (1959), Huber et al. (1993), Burkart and Lewis-Beck (1994), Londregan and Poole (1996), Przeworski and Limongi (1997), Ross (1999), Boix (2003), and Epstein et al. (2006), among others, in the large modernization literature.

2 Contributions to Related Literature

This paper belongs to a broad literature connecting growth, development, and institutions in a long-term perspective.⁷ Its primary contribution is using a unified political economy framework to analyze the democratization process from monarchy to oligarchy and, finally, to democracy with full suffrage in the context of dynamic economic development. This framework appears to be very useful in uniting scattered results and reconciling conflicting views in a systematic way. To a certain extent, the model suggests that the history of human society is, in essence, an integrated democratization process in which each country, though following unique routes, moves within the same broad historical trend shaped by the changing predominance of land, physical capital, and human capital in the economy.

Owing to its immense importance and complexity the democratization process has been a major subject in comparative history. In a landmark study, Moore (1966, p. 429) found that “getting rid of agriculture as a major social activity is one prerequisite for successful democracy” and robust capitalist development is crucial in achieving this end. Moore’s conclusion on the role of the bourgeoisie as the primary agent of democracy, although widely shared by the orthodox Marxist and liberal social science view, is challenged by Rueschemeyer et al. (1992, p. 270). They, instead, conclude that “a key actor in the development of full democracy almost everywhere” is not capitalists but the organized working class, and the widely believed association of capitalist development with democracy is mainly because it strengthens the working class.

These seemingly conflicting conclusions are, however, consistent with and neatly reconciled by the main results of the current paper: The focus of Moore is on the first political transition from monarchy to oligarchy (or, in more conventional terms, parliamentary democracy), while that of Rueschemeyer et al. is mainly on the second political transition from oligarchy to full democracy. Distinguishing these two transitional stages helps to clarify the crucial role of capitalists in breaking the absolute power of monarchy and initiating the parliamentary democracy at an earlier historical occasion, and the role of the working class, strengthened during the industrialization process, in pushing for further franchise expansion at a later time. To be sure, these two democratization stages inherently share some common features, which are also obvious in the model; distinguishing them analytically, however, seems to bring more insights than does ignoring their critical differences in the historical timing and economic bases (of physical capital and human capital, respectively).

The formal analysis of democratization started only recently in economics, with relatively few studies

⁷See Bertocchi (2006b) for a survey of related literature.

focusing on the first political transition from monarchy to oligarchy. Olson (1993) argues that, compared with anarchy, a tax-collecting monarch brings substantial benefits to the people and “permits a considerable development of civilization.” North and Weingast (1989) discuss the emergence of parliamentary democracy in the seventeenth century England and the corresponding improvement of property rights security after the Glorious Revolution. DeLong and Shleifer (1993) provide evidence which shows that absolutist princes, in comparison to representative governments, slowed down economic growth, especially in cities. Bertocchi (2006a) models the evolution of the land inheritance system from primogeniture to partition when landed estates are replaced by capital as the primary source of wealth. These results are consistent with findings in the current paper, which shows that the large inequality of land under monarchy is necessary to maintain a stable political rule and to facilitate capital investment, while the growing strength of capitalists will eventually replace monarchy by oligarchy that promotes industrial and commercial interests.

There are a number of studies on how the voting franchise is further expanded from oligarchy to full suffrage. In a seminal study by Acemoglu and Robinson (2000), franchise expansion is used by the ruling elites to mitigate the revolutionary threat from workers. Following the same theme of conflict resolution, Bertocchi and Spagat (2001) find that the elites may want to co-opt a subset of the challenging group. In contrast, an alternative rationale for suffrage extension suggests that the elites may do it voluntarily in their own best interests (Lee 2003, Lizzeri and Persico 2004, Jack and Lagunoff 2006). Both views find support in historical evidence, either in different countries or at different times, which prompts further research to characterize conditions that give rise to distinct transition paths (Justman and Gradstein 1999, Boix 2003, Engerman and Sokoloff 2005, Llavador and Oxoby 2005, Cervellati et al. 2006, Gradstein 2007, Cervellati, Fortunato and Sunde 2008). The current paper contributes to this stream of literature by establishing a unified analytical framework where the *same* fundamental forces can account for the gradual suffrage extension from absolute monarchy to oligarchy by landlords and capitalists and, finally, to full democracy; it shows that this general historical trend of political power being shared among more people over time is ultimately driven by dynamic economic development in which the predominant source of wealth evolves from land to physical capital and later to human capital.

The long-term growth literature⁸ typically abstracts from the political conflict that is the focus of the democratization literature. The economic development path in the current paper builds on the important insight of Galor and Moav (2006) that the complementarity between physical and human capital would eventually eliminate the class distinction between capitalists and workers. In a related study, Galor and Moav

⁸See Galor (2005) for a survey of the unified growth theory.

(2004) examine the endogenous replacement of physical capital accumulation by human capital investment as a prime engine of economic growth in the transition from industrial sectors to modern growth based on services, while Galor and Weil (2000) as well as Hansen and Prescott (2002) emphasize the effects of technological progress in moving the economy from agricultural to industrial production methods. The current paper contributes to this literature by formally modeling the evolving composition of main production factors during the economic growth process, and highlighting the important role of political transitions in shaping distinct economic development paths across countries.

Another strand of related literature studies the effects of institutions on long-run growth. North (1981) proposes a dynamic framework of political economy and substantiates it by rewriting Western history in its light. He recognizes not only the influence of technology advancement on institutions, especially property rights, but also the effects of political institutions on future technological and economic development. In some sense, the current paper is an attempt to formalize this dynamic framework in a simple model; it may thus shed light on current debates on whether technology or institutions are more important for long-run growth. Acemoglu et al. (2005) argue that institutions are the fundamental cause of long-run growth, while Glaeser et al. (2004) demonstrate that the level of human capital is more fundamental than institutions. In fact, both claims can be true in the chain of dynamic interactions between the economic fundamentals and political institutions shown in the current paper, depending on which specific segment is chosen for investigation. Among countries with similar institutional backgrounds, the initial gap in economic fundamentals may become the ultimate cause of their later divergence since institutions may evolve endogenously.⁹ On the other hand, between countries with similar economic fundamentals, different institutions caused by exogenous factors may account for their later economic development gaps.¹⁰

To the extent that the cooperative and conflicting sides of human interactions are treated simultaneously, this paper is connected with Hirshleifer (1994), Grossman and Kim (1995), and Grossman (2002) among others. While the paper's analysis of the political conflicts among factor owners is similar to the Marxist approach of class struggles (Marx and Engels 1848), there is a major difference: The class conflicts are

⁹Consistent with results in the current paper, Galor et al. (2009) find that the inequality of land ownership, although beneficial in earlier development, can be a major hurdle in the emergence of human capital promoting institutions, and hence negatively affect future economic performance. Similar views are also expressed by Engerman and Sokoloff (1997) and Rajan and Zingales (2009).

¹⁰In this paper, the same economy with different fighting costs during the political transition periods may generate distinct political outcomes, which will affect the economic development path afterwards. This is similar in spirit to the findings of Acemoglu and Robinson (2006b) that the political security of the incumbent elites may determine whether they would block technological and institutional innovations that potentially undermine their incumbency advantages. In a related work along this line, Rodrik et al. (2004) find that conventional measures of geography have a strong indirect effect on incomes by influencing the quality of institutions.

embedded here in the cooperative context of economic activities and eventually resolved under democracy where political rents disappear and each factor earns its competitive market returns. This result echoes Polany’s (1944) view that a competitive market economy was brought forth *together* with political democracy for the first time in human history by the industrialization process. He observed that both harmony and conflicts are inherent in the economy, and they often lead to each other in a dynamic world. On this point, the current paper further suggests that the cooperative side dominates historical progress in the long run, although the conflicting side may change historical paths for some time and often in a stagnant direction.

3 The Political Economy Model

3.1 The Economy

There are overlapping generations in the economy with a fixed population size.¹¹ Each individual lives for two periods, accumulating human capital in childhood and participating in production at adulthood.

Preferences. Individuals are identical in preferences, which are represented by a log-linear utility function $u_{ti} = (1 - \beta) \log c_{ti} + \beta \log(z + b_{ti})$, where c_{ti} is the adulthood consumption of individual i in generation t , b_{ti} is his bequest for offspring,¹² $\beta \in (0, 1)$ indicates the relative weight of bequest in utility, and $z > 0$ is a constant. The budget constraint is $c_{ti} + b_{ti} \leq I_{ti}$, where I_{ti} is individual i ’s income at adulthood.

As a result of utility maximization, the individual’s optimal bequest is $b_{ti} = \max\{\beta(I_{ti} - Z), 0\}$ where $Z \equiv z(1 - \beta)/\beta$. That is, only when an individual’s income is higher than a certain level Z , would there be any resources left as bequest;¹³ this is a reasonable result given that the model economy starts from the agricultural era where many people live at the subsistence level and may not afford any savings. The total bequest in society B_t is then

$$B_t = \sum_i b_{ti} = \sum_i \max\{\beta(I_{ti} - Z), 0\}. \tag{1}$$

¹¹In an earlier version of the paper the population size was set to follow the broad demographic trends in history as in Hansen and Prescott (2002); the main results were the same.

¹²This bequest motive from the “joy of giving” is commonly adopted in the recent literature on income distribution and growth. See Altonji, Hayashi and Kotlikoff (1997) for related empirical evidence. This particular utility function is also used in Galor and Moav (2006) and Fishman and Simhon (2002) among others.

¹³The implication that the rich save more is consistent with empirical evidence (Dynan, Skinner and Zeldes 2004). If a homothetic utility function is used instead, individuals will leave positive bequests regardless of how low their incomes are, which does not seem to be reasonable in the context of this paper where the model starts from the agricultural period with subsistence levels of incomes. And furthermore, it will not change the main results because the economic development path is determined mainly by the distinct features of the three production factors.

Final Output Production. In every period the economy produces a single homogeneous good that can be used for consumption and investment. The production function at time t is

$$Y_t = A_t(L + K_t)^{1-\alpha} H_t^\alpha.$$

The knowledge stock A_t grows at an exogenous speed $g > 0$ so that $A_{t+1} = A_t(1 + g)$, which is the ultimate growth engine.¹⁴ The quantity of land L is fixed over time, while the stocks of physical capital K_t and human capital H_t depreciate fully after one period, which corresponds to one's adulthood (about 20 to 30 years).

This production function is adopted only to simplify the exposition, since the main results are the same whether using a more general production function that allows complementarity between land and physical capital or using a detailed two-sector general equilibrium model, both of which are analyzed in Section 5.

Endowment. The initial endowment of land L is exogenously distributed among N_l landowners. There are N_c identical capitalists who are endowed with skills to generate physical capital K_t using final outputs.¹⁵ The majority are N workers each endowed only with raw labor. The initial state of the model economy corresponds to a time when agriculture is the dominant production method, the physical capital stock is zero, and people are not educated.

Production Functions of Physical and Human Capital. The aggregate physical capital $K_t \equiv N_c m_t^k$ is produced by N_c identical capitalists, where m_t^k denotes the amount of final output used in generating physical capital. With an education expenditure m_t^h , an individual may acquire human capital h_t according to

$$h_t = f(m_t^h), \tag{2}$$

where $f' > 0$, $f'' \leq 0$, and $\lim_{m_t^h \rightarrow +\infty} f' = 0$. We assume $f(0) = 1$ so that a worker is endowed with a basic unit of human capital, namely the raw labor, even without any education expenditure; to acquire human capital above the basic level, however, a positive amount of output is needed. And furthermore, $f'(0) = \gamma < +\infty$ holds so that the human capital production function has a finite slope at zero investment.¹⁶

¹⁴In a more general setting, the knowledge stock should be allowed to increase in the aggregate physical or human capital; this will speed up capital investment and thus political transitions, but will not change the main results. The assumption of a slowly growing knowledge stock even when there is no human capital is also made by Galor and Weil (2000) and Hansen and Prescott (2002). Note that the exogenous growth rate g , though positive, can be arbitrarily close to zero in the model, which is not inconsistent with the almost zero growth rate found in the Malthusian era.

¹⁵Alternatively one may think of capitalists as emerging from either the landed class or workers; that is, with a certain exogenous probability $N_c/(N_l + N)$ an individual is endowed with physical capital production skills. Though it is more realistic to allow families to change class, as long as such incidents are relatively few compared with those who remain in the same class, the assumption of fixed class lines serves as a reasonable approximation.

¹⁶The typically assumed Inada condition (i.e. γ is infinite) is designed to simplify the exposition by avoiding a corner solution,

Capital Investment. An individual may invest his bequest in physical capital or human capital for the next generation. There is no credit market for human capital investment, which can only be financed by public education or by parental bequest. To simplify the exposition, the option of private schooling is not considered in the model.¹⁷ The public education expenditure M_t^h is financed through tax revenues by the ruler to maximize its own benefits, where an endogenously determined tax rate τ_t^{h*} is imposed on parental bequests so that $M_t^h = \tau_t^{h*} B_{t-1}$.¹⁸ Individuals then invest their disposable savings in the capital market, and thus the total amount used in producing physical capital is $M_t^k = (1 - \tau_t^{h*}) B_{t-1}$.

Note that only capitalists have the skills to produce physical capital; landowners and workers, however, may supply their savings $b_{t-1,i}$ to capitalists through the capital market to gain a return $\widehat{\delta}_t b_{t-1,i}$, where $\widehat{\delta}_t \geq 0$. Each capitalist borrows resources from the capital market at the rate $\widehat{\delta}_t$ to produce physical capital k_t and then rent it to the final output producers to get a return $r_t k_t$, where r_t is the rental rate of physical capital. Since capitalists as a group act as a monopolist in producing physical capital, and since the exact value of $\widehat{\delta}_t$ is not important for the main results, $\widehat{\delta}_t = 0$ is assumed in the basic model.¹⁹ So the aggregate physical capital is equal to

$$K_t = (1 - \tau_t^{h*}) B_{t-1}.$$

The sequence of the economic development path is mainly determined by the distinct technical features of these three factors of production, where land and raw labor are endowed by nature, while physical capital and human capital have to be produced endogenously. The exact timing of the economic development stages, however, is also affected by institutional elements such as the political structure discussed below.

3.2 The Political Structure

The division of outputs among production factor owners is determined by the political system, where the ruler may exploit ruled agents through taxes and confiscation. The establishment and transition of political regimes are shaped by the balance of political powers, which may experience fundamental changes during the economic development process. Consistent with the horizon of economic decisions in the overlapping

but it is not necessarily a realistic assumption for human capital production given that individuals are already endowed with a unit of human capital.

¹⁷Although mass education by private financing is possible in principle (Bertocchi and Spagat 2004), in history it has not been the typical case due to the subsistence level of wages and the imperfection of credit markets (see Galor and Moav (2006) for more evidence).

¹⁸Imposing tax on bequests is equivalent to directly taxing incomes beyond the threshold Z because $b_{ti} = \max\{\beta(I_{ti} - Z), 0\}$.

¹⁹The case for $\widehat{\delta}_t = \delta > 0$ is formally analyzed in Section 5. Note that the entrepreneurial skills of capitalists are crucial and indispensable in transforming savings to physical capital, and thus capitalists get the main proportion of capital returns while the capital market suppliers receive theirs as interest returns. This is in line with recent endogenous growth models where capitalists run firms producing intermediate goods in monopolistic competition (Acemoglu 2008).

generation model, the length of an individual’s adulthood, which corresponds to one period in the model, is also used as the horizon for political decisions.²⁰

Coercive Capability. The coercive capability of a group of N_j individuals is

$$v_t = \psi(N_j, e_t) \sum_{i=1}^{N_j} I_{ti}. \quad (3)$$

The total income $\sum_{i=1}^{N_j} I_{ti}$ of the group members indicates the overall economic strength of the group, which can be transformed to coercive power through supply of weapons and soldiers, for example. $\psi(N_j, e_t)$ is the group’s organizing effectiveness, which increases with e_t , the group-average capability to coordinate, but decreases with group size N_j due to free-riding and information problems; that is, $\psi_1 < 0$ and $\psi_2 > 0$. For simplicity, we assume $e_t = h_t$ for workers and $e_t = \bar{e} > 1$ for landlords and capitalists,²¹ where $\psi(1, \bar{e}) = 1$ holds by normalization.

Political Transition. The initial political regime is established based purely on *might-is-right*, where the dominant group becomes the first ruler and imposes tax on others. The highest possible tax rate $\tau \in (0, 1)$ is determined by an individual’s ability to hide his income, and the tax collecting cost is $(1 - \eta) \in (0, 1)$ of the tax revenue. Note that this tax is purely exploitative and represents the economic benefit of possessing political power.

The transition of political regimes follows the political game illustrated in Figure 1. In each period, a challenging group may choose either to obey the current political order or to revolt. In response to revolt, the incumbent ruler has two options: One is to repress the revolting group, the other is to compromise. When compromise is proposed and accepted,²² the ruler will extend political power to the challenging group so that no exploitative tax is imposed on their incomes, and this will lead to a peaceful transition to a new and more democratic political regime.

When the ruler chooses to repress, the challenging group may either surrender immediately so that the old regime continues as before, or continue to revolt so that an open fight breaks out, where the result of fighting is determined by the two fighting parties’ coercive capabilities as given by (3). Let $v_t^C \equiv \psi_t^C I_t^C$ and

²⁰Allowing longer horizons may alter the timing but not the qualitative results of the transition process. Acemoglu and Robinson (2006b), for example, find similar results for the political transition problem in a more abstract setting with infinite horizons. Due to the extremely long period (often in the magnitude of hundreds of years) the model covers, it is not realistic to assume that agents can take into consideration all of the future economic and political changes when they make decisions. For example, Moore (1966, p. 30) observed that “it is unlikely that more than a very few people had any but the haziest notions as to ... what kind of a society might lie over the horizon.” Moreover, most European monarchies were insecure, which prevents kings from taking a long view (DeLong and Shleifer 1993).

²¹The skills of landlords and capitalists are exogenously given in this paper; they are formally analyzed in Huang (2011).

²²Since accepting compromise always leads to a higher payoff than other alternatives for the challenging group, which is to be formally proved in Proposition 1, the game ends when compromise is chosen by the ruler in order to simplify the exposition.

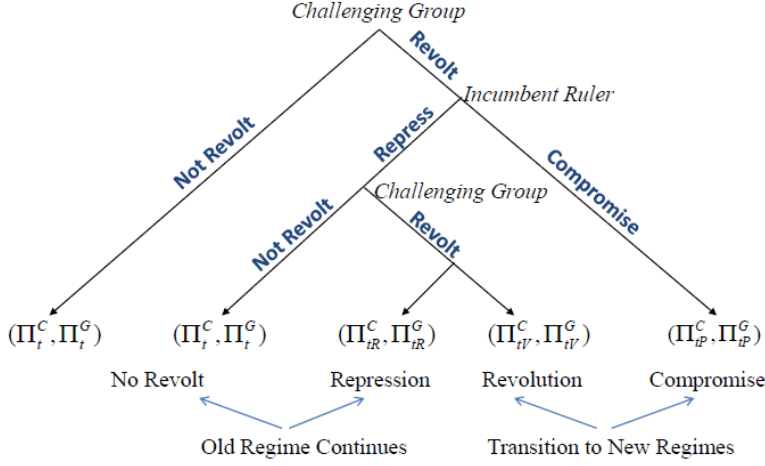


Figure 1: The Political Game between Challenging Group and Incumbent Ruler

$v_t^G \equiv \psi_t^G I_t^G$ denote the coercive capability of the challenging group and the ruler, respectively, where I_t^C and I_t^G are their before-tax incomes. Then the relative coercive power of the challenging group is denoted by

$$x_t \equiv v_t^C / v_t^G = \psi_t^C I_t^C / \psi_t^G I_t^G.$$

The probability of the ruler winning the fight and preserving the current political regime with repression is determined by a standard contest function (Tullock 1980, Skaperdas 1992):

$$\frac{\chi v_t^G}{\chi v_t^G + v_t^C} = \frac{1}{1 + \chi^{-1} x_t} \equiv q(x_t),$$

where $\chi > 1$ indicates the effectiveness of the ruler's repressive apparatus, which is also a form of incumbency advantage since it increases the incumbent's winning probability in the fight beyond its coercive capability v_t^G . Note that $q'(x_t) < 0$ holds, implying that the ruler is less likely to win when the challenging group's relative coercive power is higher.²³ When the ruler loses, which happens with probability $1 - q(x_t)$, such revolution leads to a violent transition to a new political regime where the challenging group becomes the new ruler imposing tax on others.

²³Since this property is also true for alternative contest functions (Besley and Persson forthcoming), the main qualitative results of political transition are robust.

Equilibrium. While the exact payoffs in the game are derived in the next section, some general features of the game can be discussed here. Let I_t^O denote the before-tax joint income of the neutral group, which is composed of all the other individuals outside the challenging and ruling groups. Under the current political order, the challenging group has to pay tax τI_t^C , while the incumbent ruler receives a net tax revenue $\eta\tau(I_t^C + I_t^O)$, and so their payoffs under no revolt are their after-tax incomes $(\Pi_t^C, \Pi_t^G) = ((1 - \tau)I_t^C, I_t^G + \eta\tau I_t^C + \eta\tau I_t^O)$.

When compromise is achieved, the challenging group gains political power; this means it stops paying the exploitative tax τI_t^C , and in addition, it will share the total tax revenue $\eta\tau I_t^O$ with the ruler, where the sharing rule is based on its relative economic power. Specifically, their payoffs under compromise are $(\Pi_{tP}^C, \Pi_{tP}^G) = (I_t^C + \eta\tau I_t^O \frac{I_t^C}{I_t^C + I_t^G}, I_t^G + \eta\tau I_t^O \frac{I_t^G}{I_t^C + I_t^G})$.

When the revolt is repressed, the two groups' incomes are $(\Pi_{tR}^C, \Pi_{tR}^G) = (\Pi_t^C/\theta, \Pi_t^G)$, where $\theta > 1$ indicates the fighting cost. Fighting is costly because it consumes resources and disturbs routine production, and for simplicity, we assume that the loser has to pay the fighting cost.²⁴ When the revolt succeeds, the challenging group gains political power while the incumbent group loses it, so that their incomes are $(\Pi_{tV}^C, \Pi_{tV}^G) = (I_t^C + \eta\tau I_t^G + \eta\tau I_t^O, (1 - \tau)I_t^G/\theta)$.

The outcomes of Subgame Perfect Nash Equilibrium (SPE) are characterized in the following proposition.

Proposition 1 *when $x_t \leq x_t^*(\theta)$ holds, the current political order continues [(Not Revolt, Not Revolt), Repress) is the SPE], where*

$$x_t^*(\theta) = \omega_0 - \eta \left(1 + \frac{I_t^O}{I_t^G}\right) \frac{\psi_t^C}{\psi_t^G},$$

$\omega_0 = \chi \left(\frac{1}{\tau} - 1\right) \left(1 - \frac{1}{\theta}\right)$, and $x_t^{*'}(\theta) > 0$.

When $x_t > x_t^(\theta)$ holds, the challenging group revolts, and compromise is realized [(Revolt, Revolt), Compromise) is the SPE] if $\theta \geq \theta_t^*(\eta, \tau, \chi)$ is true, where*

$$\theta_t^*(\eta, \tau, \chi) = \frac{1 - \tau}{1 - \eta\tau \left(1 + \frac{\chi\psi_t^G/\psi_t^C - 1}{1 - I_t^O/Y_t}\right)},$$

otherwise an open fight occurs [(Revolt, Revolt), Repress) is the SPE], which leads to either repression or revolution, where the probability of revolution increases in x_t .

This proposition says that the current political regime continues peacefully when the challenging group is still relatively weak (that is, when x_t is smaller than the threshold $x_t^*(\theta)$); when it becomes strong

²⁴As long as the loser has to bear a large proportion of the fighting cost, which is often the case because the winner can always demand compensation, the results go through.

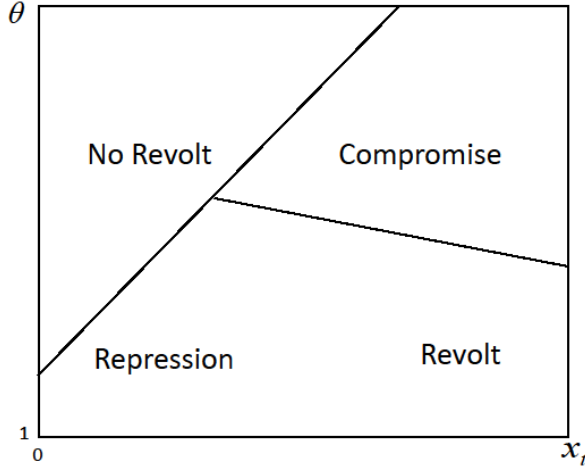


Figure 2: Subgame Perfect Equilibrium Outcomes

enough, however, the old political regime may not be able to sustain any longer. The transition to a new political order can be either smooth or violent. When it is too costly to engage in fighting (that is, when $\theta \geq \theta_t^*(\eta, \tau, \chi)$), compromise between the ruler and the challenging group is the equilibrium outcome, where a smooth transition of political regime is achieved by extending political power to the challenging group. In this case, the change of coercive power (or *de facto* political power) is consolidated by the change of (*de jure*) political power without interrupting economic development, which is the main focus of this paper.

Such an ideal situation of smooth political transition, however, is not achievable in equilibrium when it is not so costly to fight (that is, when $\theta < \theta_t^*(\eta, \tau, \chi)$). In this case, the ruler and the challenging group will engage in an open fight for political power. If the ruler wins, then the old regime continues by repressing revolts; if the challenging group wins, revolution occurs that leads to a violent transition to a new political regime. The fight is more likely to end up with revolution when the challenging group is more powerful, which is not surprising.

Figure 2 illustrates these equilibrium outcomes in the space of the fighting cost θ and the challenging group's relative coercive power x_t . Given that $x_t^*(\theta)$ is increasing in θ , a stable political regime with no revolt is more likely to continue in places where the coercive power of the challenging group is still small or where it is more costly to fight. The fact that $\theta_t^*(\eta, \tau, \chi)$ is increasing in $\eta\tau$ and χ implies that compromise is more

likely to arise when the stake of political power (represented by the net tax rate $\eta\tau$) or when the incumbent's repressing capacity χ is smaller. In other words, among countries with the same fighting cost θ , those with lower tax rates and weaker repressive apparatus have a larger likelihood to reach political compromise.

4 The Economic and Political Development Path

Until modern times, the peasant is an “object of history,” over which “historical changes pass but which contributes nothing to the impetus of these changes” (Moore 1966, p. 453). To be consistent with such historical evidence, $|\psi_1|$ and ψ_2 are assumed to be large enough so that workers lack enough coercive might to gain political rights by themselves before human capital investment starts, and they will not be invited to join any challenging group by other factor owners. The underlying reason is that the large size and low coordination skills of workers may reduce the coercive capability of any group including them.²⁵

4.1 Land and Monarchy: $[0, t_k]$

In the beginning of the model economy, agriculture is the dominant production method. The productivity is so low that no saving is available for capital accumulation, and thus capitalists are not distinguishable from the worker group.²⁶ The initial political regime is monarchy where a dominant landowner with land L_m is the ruler, who imposes tax τ on landowners and workers. A landlord i owns land L_i and employs N_{ti} workers taking wage w_t as given,²⁷ where $\sum_{i=1}^{N_t} L_i = L$ and $\sum_{i=1}^{N_t} N_{ti} = N + N_c$.

Lemma 1 *The optimal profit for a landlord i with land L_i is $I_{ti} = \lambda A_t L_i$, where $\lambda \equiv (1 - \alpha)(\frac{N + N_c}{L})^\alpha$. The monarch's total income $I_{tm} = \lambda A_t [(1 - \eta\tau)L_m + \frac{\eta\tau}{1 - \alpha}L]$ includes his land profit and tax revenues from other landlords and workers.*

Since the coercive power of landowners is proportional to land size, the fixed amount of land implies that no landlords are able to challenge monarchy as long as the monarch owns large enough land.

Proposition 2 *When land is the main source of wealth, monarchy continues without any revolt as long as*

$$L_m \geq \omega_1 L, \text{ where } \omega_1 \equiv \frac{1 + \eta\alpha / (1 - \alpha)}{1 - \eta + \omega_0 / \psi(N_t - 1, \bar{e})}.$$

²⁵The exact conditions can be formally derived in all relevant cases, which are omitted because they do not contribute additional insights.

²⁶The assumption that capitalists do not emerge from landowners is consistent with historical evidence, although it has no effect on the qualitative results. Doepke and Zilibotti (2007), for example, show that the crucial characteristics of capitalists, such as patience and work ethic, were initially cultivated in certain working families but not in the landed class.

²⁷Though receiving the market wage w_t , workers still have to pay an exploitative tax τ that makes it essentially equivalent to receiving a forced wage $(1 - \tau)w_t$.

This proposition suggests that the overwhelming power of the monarch, which is derived from his dominant land size L_m , enables him to enforce a stable political order without challenge from others. Since the monarch is the richest person and his income I_{tm} increases over time, a society starts to have positive bequests when I_{tm} reaches the threshold income Z in period t_k , which is uniquely determined by

$$I_{t_k,m} = A_0\lambda[(1 - \eta\tau)L_m + \frac{\eta\tau}{1 - \alpha}L](1 + g)^{t_k} = Z. \quad (4)$$

It is obvious that t_k arrives earlier when L_m , L , and $\eta\tau$ are larger. Since the large inequality of land ownership under monarchy shortens the time for society to begin capital investment, monarchy facilitates economic development when land is the main source of wealth.

4.2 Physical Capital and Oligarchy: $(t_k, T_k]$

With surpluses available in society after t_k , capitalists start to use their special skills to produce physical capital. The *endogenous* supply of physical capital marks its fundamental difference from land. Such a change in the economic arena will induce corresponding adjustment in the political system.

To be consistent with historical evidence, we focus on the case where public education for workers is not provided under monarchy, which happens when γ is sufficiently small (see Proposition 4). The total physical capital stock is thus $K_t = B_{t-1}$ in any period t under monarchy. Individual landowners choose the optimal demand for capital and labor to maximize their profits, taking as given the capital rental rate r_t^* and wage w_t^* , which clear the capital and labor markets in equilibrium. Capitalists also have to pay τ proportion of their income to the monarch.²⁸

The ever increasing stock of physical capital induces faster growth in total output than before. The monarch benefits from capital accumulation through increased tax revenues and capital returns. Economic development, however, would gradually build up pressure to challenge the monarch's absolute power because the joint income of the elites (capitalists and landowners) grows faster than that of the monarch and so does their coercive power. When the burgeoning capitalists join force together with landowners in their fight against the monarch, the political transition may arrive faster than it would if they had acted alone; this is indeed true when N_l is small or when L/L_m is large enough.²⁹

²⁸An endogenous tax rate on capitalists is considered in Section 5.

²⁹The coalition between capitalists and landowners seems more likely to happen than the co-optation alternative in which the monarch divides the elites by co-opting either landowners or capitalists (Bertocchi and Spagat 2001). When compromise would have been reached in the political game analyzed here, the co-optation payment to landowners or capitalists must be at least as large as their tax payment to the monarch, otherwise they should reject it and ally with each other; it must, however, be smaller than the joint tax revenue paid by both groups, otherwise the monarch would not benefit from co-optation. But then

Proposition 3 *After t_k , the elites' relative coercive power $x_t = \varphi(\frac{L+K_t}{L_m} - 1)$ goes up over time because K_t keeps increasing. In the political game between monarch and the elites, monarchy continues with no revolt before T_k , where T_k is determined by*

$$K_{T_k} = \omega_2 L_m - L \quad (5)$$

with $\omega_2 \equiv \frac{1-\eta+\omega_0/\varphi}{1+\eta\alpha/(1-\alpha)}$. Revolt occurs at $t \geq T_k$, which leads to compromise and a smooth transition to oligarchy when $\theta \geq \theta_{t_k}^*$ holds, where

$$\theta_{t_k}^* \equiv \frac{1-\tau}{1-\eta\tau(\chi/\varphi-\alpha)/(1-\alpha)},$$

otherwise to an open fight that may result in either repression or revolution, where revolution (a violent transition to oligarchy) is more likely to happen as time goes by due to x_t increasing.

This proposition makes it clear that the driving force of the increasing coercive power of the elites is the ever increasing physical capital K_t , and when it becomes large enough at T_k , the elites are capable of challenging the monarch. Note that $\varphi \equiv \psi(N_c + N_l - 1, \bar{e})$ is the coordination effectiveness of the elites, and when it is higher, the threshold K_{T_k} is smaller. Condition (5) also shows that when L_m is bigger, the political transition time T_k is reached later, although physical capital accumulation begins earlier (as t_k in (4) is smaller). It implies that an economy with higher inequality in the initial land distribution will start to accumulate physical capital earlier, but its political transition to oligarchy may be relatively late because the monarch is too powerful. Such a reversal of fortune is not uncommon in history.

This proposition suggests that the smooth transition of political regime from monarchy to oligarchy tends to take place when the fighting cost is larger than the threshold $\theta_{t_k}^*$; in this case, it is not worthwhile for either group to resort to violent means and thus mutually beneficial compromise is reached. The following analysis assumes that this smooth transition is achieved at T_k so that landlords and capitalists share political power and impose no tax on themselves from period T_k onwards; discussions of other outcomes are collected in Section 4.5.

4.3 Human Capital and Democracy: $(T_k, T_h]$

During the initial periods under the elite rule, workers are still raw labor and their after-tax wages are not high enough to have bequests. The elites, however, may find it beneficial to start investing in human capital

the group that is not co-opted can bribe the other group by offering a transfer up to their tax payment. Thus co-optation of one group is, at least weakly, dominated by the coalition between capitalists and landowners in the compromise case. Co-optation may delay the open fight but cannot prevent it because the relative coercive power of the elites is increasing over time.

through public education in some period when the physical capital stock becomes so large that the return of investing more in it is relatively low. The following proposition provides the specific condition under which human capital is not invested under monarchy, and characterizes the first period t_h that human capital investment starts and the optimal tax rate τ_t^{h*} for public education.

Proposition 4 *Human capital investment does not start under monarchy if $\gamma < \frac{N(\xi-\alpha)}{\alpha\omega_2L_m}$, where $\xi \equiv [1 + (1-\alpha)(1/\eta\tau - 1)/\omega_2]^{-1}$. It starts under oligarchy in period t_h that is determined by*

$$K_{t_h} = \frac{(1-\alpha)N}{\alpha\gamma} - L. \quad (6)$$

In any period $t \geq t_h$, the optimal tax rate τ_t^{h} for public education is determined by*

$$\alpha(L + K_t^*)h_t^{*'} - (1-\alpha)Nh_t^* = 0, \quad (7)$$

where $K_t^ = (1 - \tau_t^{h*})B_{t-1}$ and $h_t^* = f(\tau_t^{h*}B_{t-1}/N)$. The public education expenditure $M_t^{h*} = \tau_t^{h*}B_{t-1}$ is strictly increasing in B_{t-1} .*

This proposition suggests that the tax rate for public education τ_t^{h*} is optimally chosen by the ruling elites to balance the marginal returns of investing in physical and human capital. Human capital investment starts later when the number of workers N is larger and when the return of initial investment γ is smaller. After t_h , public education begins, and its expenditure keeps increasing over time, which drives up the human capital level for workers and their coordination effectiveness. As a result, the collective coercive power of workers will eventually reach the threshold in some period and trigger a change of equilibrium outcome in the political game.

Proposition 5 *After t_h , the relative coercive power of workers $x_t = \frac{\alpha\psi(N, h_t)}{(1-\alpha)\psi(N_c + N_t, \bar{e})}$ goes up over time because h_t is increasing. In the political game between elites and workers, oligarchy continues with no revolt before T_h , which is uniquely determined by*

$$\psi(N, h_{T_h}) = \omega_3\psi(N_c + N_t, \bar{e}), \quad (8)$$

where $\omega_3 \equiv \omega_0 \left(1 + \frac{\eta\alpha}{1-\alpha}\right)^{-1}$. Revolt occurs at $t \geq T_h$, which leads to compromise and full democracy when $\theta \geq \theta_{th}^$ holds, where*

$$\theta_{th}^* = \frac{1-\tau}{1 - \frac{\alpha}{(1-\alpha)x_t}\eta\tau\chi}$$

and $\partial\theta_{th}^/\partial x_t < 0$, otherwise to an open fight that may result in either repression or revolution, where revolution (a violent transition to the rule of workers) is more likely to happen as time goes by due to x_t increasing.*

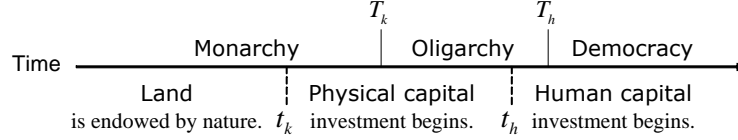


Figure 3: The Time Line of Economic and Political Development

Similar to the transition from monarchy to oligarchy, mutual compromise is reached between the elites and workers when it is too costly to fight; in this case, the elites extend political power to workers in a smooth transition of political regime from oligarchy to full democracy, where no tax is imposed on wages, and as a result each factor earns its competitive return and the exploitative tax disappears. It turns out that under democracy the optimal tax rate τ_t^{h*} for public education is also determined by equation (7), since the elites' joint income under oligarchy is proportional to the aggregate income.

4.4 The Smooth Development Path: Summary

The development path in the model is driven by the technical features of different production factors and political conflicts among factor owners in dividing the outputs, while the effects of many elements (such as geography, culture, religion, ideologies, wars, and colonization) that bestow much richness to the actual history are mainly reflected by differences in parameters related to tax collecting (η, τ) , cost of fighting (θ) , repressing capacity χ , and the effectiveness of groups in transforming incomes to coercive power $(\psi(N_j, e_t))$. If at both transition times T_k and T_h the cost of fighting is higher than the corresponding threshold, a smooth economic and political development path as illustrated in Figure 3 is to be taken, where the political regimes adjust smoothly to the evolving factor composition of land, physical capital and human capital; England seems to be such a case, where political compromises were reached at these crucial moments. This type of coevolution path is summarized by the following proposition.

Proposition 6 *Compromise between the incumbent ruler and the challenging group is reached at both transition times T_k and T_h when it is too costly to fight ($\theta \geq \max\{\theta_{t_k}^*, \theta_{t_h}^*\}$), and the political economy evolves as follows. Physical capital accumulation starts at period t_k while human capital investment starts at t_h . Monarchy continues before T_k , after which it is replaced by oligarchy of landowners and capitalists, and finally, after T_h , workers also gain political rights and hence full suffrage is realized. The endogenous time path $t_k < T_k < t_h < T_h$ suggests that economic development leads to political transition, which in turn facilitates future economic development. The evolution of the total output $\{Y_t\}_{t=1}^{+\infty}$ is characterized by the increasing*

amount of total saving $\{B_{t-1}\}_{t=1}^{+\infty}$ in the economy, where $B_{t-1}^{MK} < B_{t-1}^{OK} < B_{t-1}^{OH} < B_{t-1}^{DH}$ in Table 1 holds and thus the economic growth rate keeps increasing due to knowledge accumulation, new capital investment, and expansion of political right.

Table 1. The Smooth Development Path

The Political Transition					
Time	$t \leq T_k$		$t \in (T_k, T_h]$		$t > T_h$
Political Regime	Monarchy		Oligarchy		Democracy
The Ruler	Dominant Landowner		Landowners & Capitalists		All Factor Owners
Exploitative Tax	τ		τ on workers, 0 on others		0
Education Tax	0		0 in $t \leq t_h$, $\tau_t^{h*} > 0$ after t_h		$\tau_t^{h*} > 0$

The Economic Growth					
Time	$t \leq t_k$	$(t_k, T_k]$	$(T_k, t_h]$	$[t_h, T_h]$	$t > T_h$
Physical Capital K_t	0	B_{t-1}^{MK}	B_{t-1}^{OK}	$(1 - \tau_t^{h*})B_{t-1}^{OH}$	$(1 - \tau_t^{h*})B_{t-1}^{DH}$
Human Capital H_t	$N + N_c$	N	N	$Nf(\frac{\tau_t^{h*} B_{t-1}^{OH}}{N})$	$Nf(\frac{\tau_t^{h*} B_{t-1}^{DH}}{N})$
Growth $\frac{Y_{t+1}/A_{t+1}}{Y_t/A_t}$	1	$\frac{(L+K_{t+1})^{1-\alpha}}{(L+K_t)^{1-\alpha}}$	$\frac{(L+K_{t+1})^{1-\alpha}}{(L+K_t)^{1-\alpha}}$	$\frac{(L+K_{t+1})^{1-\alpha} H_{t+1}^\alpha}{(L+K_t)^{1-\alpha} H_t^\alpha}$	$\frac{(L+K_{t+1})^{1-\alpha} H_{t+1}^\alpha}{(L+K_t)^{1-\alpha} H_t^\alpha}$

Note: t_k , t_h , T_k , T_h and τ_t^{h*} are determined by (4), (6), (5), (8), and (7) respectively.

As shown in Table 1, the exploitative tax τ is imposed on all three production factors under monarchy because only the dominant landowner, the monarch, has political power. This tax is waived for both land and physical capital under oligarchy, and finally waived for workers' human capital under full democracy. Such sequential elimination of exploitative tax is driven by the corresponding change of coercive power of factor owners and made permanent by the gradual extension of political power; it reduces the waste of resources associated with tax collecting, and thus increases incentives for more capital investment.

The efficiency gain is reflected in Figure 4 by the ever increasing economic growth rate along the path. Before t_k , the economy grows at an exogenous rate g that may be close to zero as is routine in the Malthusian era, which is represented by the first point in the graph at y_{t_k} . Once investment in physical capital starts, however, the economic growth rate becomes higher, $\frac{(L+K_{t+1})^{1-\alpha}}{(L+K_t)^{1-\alpha}}g$, due to increasing capital accumulation. The political transition from monarchy to oligarchy at T_k further increases the growth rate because the total amount of capital investment increases from B_{t-1}^{MK} under monarchy to a higher level B_{t-1}^{OK} under oligarchy due to reduced tax-collecting cost. Starting from t_h , human capital investment pushes up the growth rate to $\frac{(L+K_{t+1})^{1-\alpha} H_{t+1}^\alpha}{(L+K_t)^{1-\alpha} H_t^\alpha}g$, which is then increased further by the larger total capital investment B_{t-1}^{DH} under democracy after T_h . As a result, the final steady state output y^* is much higher than those that would have been achieved in any old economic and political regimes.

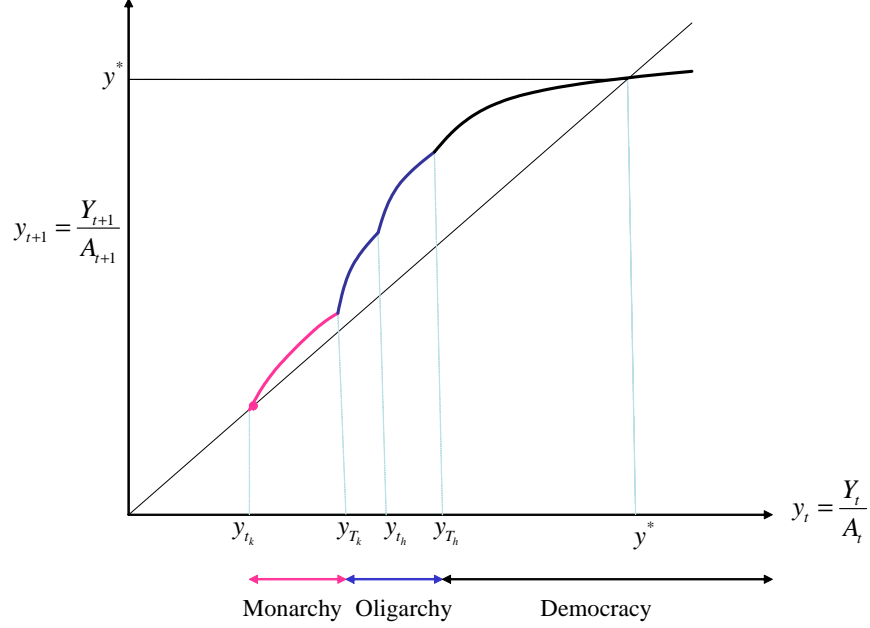


Figure 4: The Evolution of Detrended Output on the Smooth Development Path

4.5 Development Paths with Repression or Revolution

The smooth development path characterized above serves as the benchmark case to be compared with various deviations. When the fighting cost is low during the political transition period (that is, if $\theta < \theta_{t_k}^*$ at T_k or $\theta < \theta_{t_h}^*$ at T_h), the SPE outcome can be either repression or revolution. If repression occurs, the old political regime continues, and then the same political game is played in each following period t . Though this situation may continue for a long time, its probability gradually decreases as time goes on (due to $q'(x_t) < 0$ and x_t increasing), and sooner or later, either compromise or revolution will occur so that a transition to a new political regime is achieved.

When revolution happens in the transition process from monarchy to oligarchy, the result differs little from the compromise case since in both cases the political power is shared among landowners and capitalists, while only one landowner's treatment (namely, the monarch) is different. When it happens under elite rule, workers become the new ruler and impose tax τ on land and physical capital, which will last forever in this specific model context unless stochastic shocks are allowed to affect coercive capacities of different groups — if this happens, then the political regime may revert back to oligarchy, and then the same political game is to be repeated.

In both cases of repression and revolution, economic development lags behind that of the benchmark

case since resources are wasted in tax collection and fighting. Although different in the specific timing, the sequence of the developmental stages is the same in all scenarios: land endowment precedes physical capital investment, which in turn precedes human capital investment, and the correspondence between land predominance and monarchy, physical capital predominance and oligarchy, and finally, human capital predominance and democracy (or majority rule) is maintained. In other words, the dynamic compatibility between the economic and political development illustrated in Figure 3, which is the main insight of this paper, holds for all scenarios.

5 Robustness Check: Alternative Modeling Assumptions

The political economy model analyzed so far is extremely simplified in order to highlight the fundamental mechanism at work. The main results of this model, however, are robust to alternative modeling assumptions. To illustrate this, some alternative modeling choices and the resulting changes are discussed briefly in this section, while the detailed results and proofs are in Appendix B.

Imperfect Substitution between Land and Physical capital. The production function in the basic model is an extreme case ($\rho = 1$) of the more general production function $Y_t = A_t(L^\rho + K_t^\rho)^{\frac{1-\alpha}{\rho}}(H_t)^\alpha$, where land and physical capital are imperfect substitutes in production. When this general functional form is used, as shown in Appendix B, the main results of the basic model still hold. In other words, the exact degree of substitution between land and physical capital is not crucial.

A Two-Sector General Equilibrium Model. For a theory that analyses the transition from an agrarian economy to industrial production, the structural change in the economy is important. This is reflected in the basic model by the changing importance of the three factors in economic growth, where land is initially the main source of wealth, then physical capital accumulation starts and gradually replaces land as the prominent form of wealth, and finally human capital investment starts and becomes the most important factor in growth. Such a dynamic change of factor composition is actually the driving force behind the structural shifting from agricultural to industrial production and the associated change in workforce from unskilled raw labor to skilled workers.

To show this more explicitly, a two-sector general equilibrium model is worked out in Appendix B, where there are two goods in the economy: one is an agricultural good Y_t^L produced using land and human capital, the other is a manufacturing good Y_t^K produced by physical capital and human capital. The production

functions at time t are, respectively,

$$\begin{aligned} Y_t^L &= A_t L^{1-\alpha} (\sigma_t N h_t)^\alpha, \\ Y_t^K &= A_t (K_t)^{1-\alpha} ((1-\sigma_t) N h_t)^\alpha, \end{aligned}$$

where σ_t is the proportion of workers working in the agriculture sector. Individuals are identical in preferences, which are represented by

$$v_{ti} = (1-\beta) \log[(c_{ti}^L)^\rho + (c_{ti}^K)^\rho]^{\frac{1}{\rho}} + \beta \log(z + b_{ti}),$$

where c_{ti}^L and c_{ti}^K denote respectively the individual consumption of agricultural and manufacturing goods. The budget constraint is $c_{ti}^L + p_t c_{ti}^K + b_{ti} = I_{ti}$, where p_t is the relative price of the manufacturing good, and b_{ti} is still the individual bequest.

In the general equilibrium of this two-sector economy that is shown in Appendix B, the proportion σ_t^* of workers working in the agriculture sector declines over time, and so does the total profit of landlords, while that of capitalists increases over time; these changes are indeed driven by the increasing stock of physical capital. All the main results go through as in the basic model.

Positive Returns in Capital Market. When there is a positive return rate $\delta > 0$ for savings invested in the capital market, this will change the individual incomes but not the main result that the total income of capitalists grows faster than that of landowners, and that the coercive power of the elites will eventually match that of the monarch. Detailed results are in Appendix B.

Endogenous Tax on Capital. The pure exploitative tax rate τ , which represents the economic benefit of being the political ruler, is determined in the basic model by the exploitation technology where at most τ of the income of ruled agents can be grabbed by force. In an earlier version of this paper, a more realistic model of endogenous taxation was adopted where the incentives to accumulate physical and human capital are reduced when tax rates are higher, and the ruler has to choose distinct optimal tax rates on these two types of capital to maximize its total revenue. The main results of the paper are robust to this approach, since the endogeneity of the exploitative taxes imposes further discipline on the ruler against high tax rates, and this enables the ruled agents to accumulate an increasing amount of capital to eventually threaten the ruler. The case for endogenous tax on physical capital is shown in Appendix B.

Endogenous Occupational Choice of Capitalists. In the basic model the occupational choice of capitalists is assumed to be exogenous in the sense that they start physical capital production automatically at t_k once savings become available in society. This can be relaxed to allow for endogenous occupational

choice; for example, an individual capitalist may decide to switch from working as raw labor to physical capital production only when the return of the latter is higher. Appendix B shows that in this case, the equilibrium number of operating capitalists, denoted by n_{tk}^* , will increase over time and reach N_c in some period, that is, eventually all who have the skills to produce physical capital will be doing so, after which things will be the same as in the basic model.

Exogenous Political Transition. A reduced-form version of the political model without the game tree can also be used to derive the main results if one is more interested in the economy side of development. For example, one can simply assume conditions similar to the equilibrium results in Proposition 1 to hold exogenously. Specifically, suppose the challenging group will obey the current political rule when $x_t \leq x^*$ and revolt when $x_t > x^*$, while compromise is the outcome when $\theta \geq \theta^*$, otherwise an open fight occurs where repression is the outcome with probability $q(x_t)$ and revolution with probability $1 - q(x_t)$, where $x^* > 0$ and $\theta^* > 1$ are exogenously given. Then all results go through as in the basic model, where the specific condition in Proposition 2 becomes $L_m \geq (1 + x^*\psi^{-1}(N_l - 1, \bar{e}))^{-1}L$, that in Proposition 3 becomes $K_{T_k} = (1 + x^*\varphi^{-1})L_m - L$, and that in Proposition 5 becomes $\psi(N, h_{T_h}) = (1 - \alpha)\alpha^{-1}x^*\psi(N_c + N_l, \bar{e})$. The formal proof is in Appendix B.

6 Historical Evidence

Roughly speaking, most OECD countries have experienced all the developmental stages in the model and are now beyond T_h , although their paths may not be as smooth as that in England. This section gathers some historical evidence in western Europe to convince the reader that the simple model analyzed above is consistent with broad historical facts and is useful in organizing our thoughts on long-run economic and political development. The main focus is the history of England, France, and Germany, where the full time line suggested in the model has been realized, and political compromise was reached in time to avoid prolonged economic stagnation. A systematic analysis of other countries is best left for future research.

6.1 A Brief Overview

The key feature of economic development in the model, the main source of wealth evolving from land to physical capital and finally to human capital, is an almost indisputable fact. From the beginning of settled agriculture, the predominance of land in production lasted thousands of years (Cipolla 1976). Gradually, commercial and industrial sectors replaced agriculture to become dominant economic activities, leading to the Industrial Revolution in the last half of the eighteenth century (North 1981). By the early twentieth

century, the modern concept of the wealth of nations had emerged: “It was that capital embodied in the people – human capital – mattered” (Goldin 2001).

The dynamic compatibility between the evolving composition of production factors in the economy and the transition of political regimes, which is the main contribution of the paper, is also observed in history. After the fall of the Roman Empire in the fifth century up to the year 1000, Europe was stagnant both in income and population. The introduction of feudalism in the ninth century enabled Europe to gradually emerge from anarchy and develop a political-economic structure that produced sufficient order and stability and led to a concomitant expansion of both population and economic activity (North 1981). Feudal landlords directed all their attention and efforts to the maintenance and expansion of their inherited lands, which were the most important form of wealth and power. “The rising territorial rulers, the kings and emperors of the tenth to the thirteenth century, were in essence nothing more than the winners in the free-for-all for control over the sparse surpluses of a still relatively unproductive agricultural economy” (Blockmans 1998, p. 72). These are consistent with Proposition 2.

As more surpluses from agriculture became available, towns started to grow in the tenth century, in parallel with the formation and consolidation of kingdoms. Princes benefited from this process by receiving extra revenues from the cities. As economic development strengthened the business and profession classes, the citizenry struggled for autonomy and independence. The survival of effectively functioning representative bodies, however, depended on both external pressures and domestic structures. The development of parliamentary democracy was made easier in England by its relatively weak repressive apparatus compared to continental monarchies and by the joint force of the landowners and bourgeoisie (the upper stratum of town dwellers) against the monarch (Moore 1966, p. 32). After the Glorious Revolution in 1688 “Parliament became more sympathetic and accessible to the aspirations of merchants, masters and manufacturers, farmers and landowners” (O’Brien 1994). The Industrial Revolution started first in England around the mid-eighteenth century, and many years later spread to other countries. The industrialization process brought forth fundamental economic and political transformations across Europe, especially after the French Revolution. Although different in timing and format across countries, the propertied class in Western Europe had acquired substantial political powers during the nineteenth century and transformed the traditional absolute monarchies into an essentially oligarchical rule of landowners and capitalists, which corresponds to results in Proposition 3.

The Industrial Revolution created a large working class concentrated in urban neighborhoods and workplaces, which enhanced the coordination efficiency among workers. In its second phase, the demand for

skilled workers was driven up, which induced massive education reforms (corresponding to Proposition 4) in many European countries during the latter half of the nineteenth century (Galor and Moav 2006). The rising human capital of workers and their increasing ability to coordinate in collective actions eventually led to franchise expansion in several European countries (Acemoglu and Robinson 2000). In the early twentieth century, at the end of the First World War, the agrarian societies of peasants and craftsman in many European countries had already been turned into industrialized societies of machine-tenders and bookkeepers, and correspondingly, oligarchical rule was replaced eventually by democratic institutions with full suffrage (as in Proposition 5).

6.2 England

The English development path seems to fit best into the benchmark case of smooth development, where a national monarchy was established early to provide a stable and peaceful environment, and political compromises were achieved in a relatively peaceful way and timely enough to reflect the evolving composition of production factors in the economy and the corresponding change of power balance among factor owners. The economic development was thus greatly facilitated in England, which became the first nation to start the industrialization and democratization process that has fundamentally transformed the world.

The experience of England can be stated more explicitly in the terms of the model: The early establishment of a stable monarchy in 1066 facilitated economic development in England (which is consistent with the implications of Proposition 2). The growth of commerce and the joint force of landowners and capitalists (upper stratum town dwellers) forced the monarch to make a political compromise with the parliament in 1688, which marks the transition from monarchy to oligarchy, and the new political regime greatly promoted commercial and industrial interests (Proposition 3). Human capital investment did not begin until the 1830s when the physical capital stock was large enough in the second phase of the Industrial Revolution (Proposition 4), and it eventually led to full suffrage where workers were granted political power in 1918 (Proposition 5).

England has been a unified state since 1066 when William the Conqueror invaded Anglo-Saxon England and became its monarch. The monarch's power was based upon the economy of the crown lands, especially that of its concentrated location and productive capacity. In order to retain control over both the territory and his human resources, William the Conqueror made sure that the lands of his greatest vassals were located in the distant corners of his newly conquered country. In the following five hundred years, the essential integrity of the monarchy was not compromised although there were some royal concessions by

minorities and weak kings to the magnates (Roberts 2002, p. 506). Agricultural productivity began to increase under the stable political order, and the rise in food production enabled towns to develop steadily.

The growth of commerce in the towns during the sixteenth and seventeenth centuries had created a market for agricultural products in the English countryside, thereby setting in motion a process leading towards commercial and capitalist agriculture in the countryside itself. The joint force of the landowners and the upper stratum of town dwellers was an important cause of the Civil War and the ultimate victory of the parliamentary enterprise. Another important element in the success of parliament over the monarch is the latter's lack of strong repressive apparatus, such as an effective bureaucracy and a strong army. This may possibly be due to the previous evolution of the monarchy and the reliance on the navy rather than on the army (Moore 1966, p. 32).

The Glorious Revolution in 1688 marked the fundamental political transition in England from monarchy to the parliamentary rule of landowners and bourgeois, while the crown still kept considerable political power within the parliament. From then on, England was governed by oligarchies representing the effective possessors of social and economic power, who constantly took care "to defend the commercial interests of the country and accepted the leadership and guidance in this of the collective wisdom of the City of London" (Roberts 2002, p. 566). As a consequence, commercial and industrial interests were well reflected in governmental policies, and economic development was greatly facilitated in eighteenth-century England (North and Weingast 1989).

Inside the framework provided by prosperity and English political institutions, technical progress was continuous. By 1750 the most advanced techniques were practiced and the integration of agriculture with a commercial market economy had progressed furthest in England. The profits were then invested in capital to further improve productivity. An expanding overseas commerce generated further profits for investment, and the growing financial institutions enhanced the process. Thus it is no coincidence that the Industrial Revolution began first in England in the middle of the eighteenth century, and it fundamentally transformed a primarily agrarian society to a mature industrial society within a century.³⁰

The value of human capital in production was still limited in the first phase of the Industrial Revolution, when workers developed skills primarily through on-the-job training, and child labor was highly valuable. Under Elizabethan and Stuart statutes which remained unreformed between 1688 and 1815, the state retained considerable power in determining wages and conditions of employment; such statutes and the common law

³⁰Note that the growth of commercial and industrial sectors preceded the political transition to parliamentary rule in 1688, which in turn led to further economic growth as exemplified by the Industrial Revolution. Such timing is consistent with the model predictions.

strengthened the authority of employers and depressed wages (O'Brien 1994). Not surprisingly, workers still received very low wages, and their living standards showed no clear improvement before 1820 (Lindert 1994).

Fairly soon, however, employers realized that they needed more than just a labor force that was available, since the contribution of workers to superior economic performance is dependent upon both their skills and attitudes. The increasing importance of human capital in the second phase of the Industrial Revolution prompted a sequence of education reforms in England from the 1830s, which were designed primarily to satisfy increasing skill requirements (Galor and Moav 2006). Realizing that workers would only expend high levels of effort in the production process if they expected to receive a “fair share” of the consequent returns, employers became receptive to sharing power with workers’ organizations rather than fighting unionization. The employers’ acceptance of collective bargaining, in turn, opened the way for political transformation. “In the eyes of the British political elite of the 1860s and 1870s the advent of cooperative industrial relations under the aegis of business-minded union leaders transformed craft workers from uncontrollable subversive into responsible citizens. One result was the 1867 extension of the right to vote to the better-paid of the workers” (Lazonick 1994). Full suffrage was finally realized in Britain in 1918 for men and in 1928 including women.

6.3 France

The French experience is less smooth and clear-cut than that of England. The national monarchy was established in France much later than in England, and its commerce and manufacturing also lagged behind. Its political transition from absolute monarchy to oligarchy was accomplished by violent upheavals and revolutions (starting from 1789), while the subsequent transition to democracy with full suffrage was delivered by the military defeat of war (in 1871). The state’s high repressive capacity seems to be the main reason behind its difference from England. This was probably due to the necessity of a strong army to establish a central monarchy in the first place, and to survive the conflicts with other Continental European states. It seems likely that the repression and economic stagnation might have remained longer in France if it had been left alone without competition from the advanced economy of neighboring England. Fortunately, the revolutions broke the grip of the old regime early enough for France to catch up with the industrialization and democratization process ahead of many other nations.

The French kingdom was initially very decentralized. In the middle of the fifteenth century France gradually evolved from a feudal country to an increasingly centralized state organized around a powerful absolute monarchy. All the main structural variables and historical trends in French society differed sharply

from those in England between the sixteenth and eighteenth centuries. The final political outcome, however, was quite similar in the nineteenth and twentieth centuries.

Commerce and manufacturing in France lagged behind that of England. Under the seventeenth century monarchy, the bourgeoisie was heavily dependent on royal favor, subject to royal regulation, and oriented toward the production of arms and luxuries for a restricted clientele. The practice of selling positions in the bureaucracy, by converting the bourgeoisie into an aristocracy, diminished the bourgeois drive toward property and political independence. Commercial influences that penetrated into the French countryside, unlike those in England, did not undermine or destroy the feudal framework. There were no important technical innovations in agriculture, which continued to be carried out in fundamentally the same technical and social framework that had existed during the Middle Ages. The landed proprietor was not yet a full-blown capitalist farmer, while his earlier functions in the feudal system were taken over by royal officials; what he possessed were essentially claims to a specific share of the economic surplus enforceable through the repressive apparatus of the state.

The growth of the French monarchy had largely deprived the landed upper classes of political responsibility and diverted much of the bourgeois impulse to its own purposes, which made it unlikely for French society to generate a parliament of landlords with bourgeois overtones from the cities in the English fashion (Moore 1966, p. 62). The French situation was not alone in Continental Europe. The representative institutions that had appeared in many countries in the later Middle Ages experienced a nearly universal decline in the sixteenth and eighteenth centuries. By 1789, most of Western Europe was ruled by monarchs little hindered by representative bodies, the main exception being Great Britain (Roberts 2002, p. 572).

However, the ancient regime, which diverted energy and resources from commerce and industry and hence was repressive in terms of economic development, was already under severe strain and soon to be mortally wounded in 1789 by the French Revolution. "Hitherto, political power had been virtually a noble monopoly. Between 1789 and 1799, however, France was governed and reformed by overwhelmingly bourgeois assemblies, largely elected by bourgeois voters. No subsequent regime was ever able substantially to reverse these advances" (Doyle 1992, p. 376). The Revolution seriously weakened the whole interlocking complex of aristocratic privilege: monarchy, landed aristocracy, and seigniorial rights, a complex that constituted the essence of the ancient regime. The ultimate outcome of all the forces at work was a victory for an economic system of private property and a political system based upon equality before the law, the essential features in Western parliamentary democracies. Although not a bourgeois revolution in the restricted sense of the seizure of political power by a bourgeoisie that already had won the commanding heights of economic power,

historians generally agree that the French Revolution was a triumph for the bourgeoisie (Moore 1966, p. 109).

The right to vote in France was still severely restricted under the restored Bourbons from 1815 to 1830; the electorate included only the largest property owners. After the July Revolution of 1830, the number of voters doubled; at this point the old aristocracy disappeared as a coherent and effective political group. Then the French industrial revolution started, a century later than in Britain. Although universal suffrage for all adult male citizens was introduced as a result of the revolutionary upheavals of 1848, it did not function normally in the Second Empire from 1852 to 1870. Throughout this period industrial expansion continued, which strengthened the economic and political power of the working classes. The old regime collapsed upon defeat in the 1871 war, indicating the start of a lasting democratic constitution entailing universal male suffrage.

6.4 Germany

Germany as a modern nation state was unified only in 1871 when the German Empire was forged with the kingdom of Prussia as its largest constituent. The long-term fragmentation among German states contributed to their late industrialization compared with England and France, and as a result the democratization process was interwoven with nation building in a complicated manner that shaped its distinct conservative modernization path led by authoritarian governments. Stable democracy was finally realized only after the authoritarian state's strong repression capacity was destroyed by major military defeats.³¹ The German experience illustrates that, the later that a country develops, the more complex its developmental path is, since it is likely to be greatly affected by other advanced countries. Nonetheless, the dynamic coevolution between economic and political development can still be clearly seen, and the broad historical trend illustrated in Figure 3 is also evident.

By the middle of the fourteenth century, Prussia still resembled Western Europe where peasants were prosperous and relatively free. Towards the end of this century, however, certain changes began that later led to enserfment of the peasants. One of the most important changes was the introduction of grain exports. In the following two centuries, the German Junkers established a labor repressive system in order to grow grain for export, and at the same time reduced the towns to dependence by short-circuiting them with their exports. In the seventeenth and eighteenth centuries the result was a militarized fusion of royal bureaucracy and landed aristocracy.³²

³¹In this regard the experiences of Italy and Japan were similar.

³²England, in contrast, developed agricultural commercialization without tying peasants to the land and hence facilitated the

The ruler's strong repressing capacity was perhaps the main reason why a labor repressive agrarian system was adopted in Germany, which seemed to consistent with the observation that the resistance to such a system from peasants and towns was limited and easily suppressed. Early in the nineteenth century, when the industrialization started to gather momentum, a strong movement of liberal and democratic opposition began forming in the German states. It culminated in the Revolution of 1848 but was quickly suppressed. A fundamental reason is that the commercial and industrial class was still too weak and dependent to take political power, in part due to its need for authoritarian state support to unify the national market and compete with the advanced industrial economies.

The 1848 revolution also failed because it attempted to create democratization and national unification simultaneously. Nonetheless, it helped pave the way for the eventual achievement of its goals in a sequential matter. It "carried the rural social revolution, launched sixty years earlier in France, to its conclusion in central and most of eastern Europe" (Roberts 2002, p.753). In 1849, the Prussian three-class franchise system that greatly favored the wealthy class was introduced, and was carried over to the unified Germany until the Weimar Republic was formed in 1918. The coalition of "Iron and Rye" was formed in the 1850s "combining authoritarianism with bourgeois elements, against the menace of peasant and proletariat" (Trebilcock 1981). This alliance between the landed class and the rising industrial class created a climate more favorable to industrial advancement. The unification of Germany was finally achieved in 1871, when the Prussian army destroyed the last monarchical regime in France and created the German Empire or the Second Reich, a constitutional monarchy with a parliament of very limited power.

Germany's industrial proletariat had increased in size as the result of intensive industrialization since the 1850s, and workers started to organize a socialist party and trade unions in 1869. Feeling threatened by a potentially revolutionary force, the state issued repressive laws against socialist organizations, while at the same time extending suffrage and establishing a social welfare system to win over the poor masses. Full democracy, however, was to be achieved mainly as the consequence of military defeats. In 1918, at the end of World War I, the Weimar constitution came into effect, which transformed the German Empire into a democratic republic, albeit a fragile one. The establishment of a stable liberal parliamentary republic had to wait until after World War II in West Germany, and in East Germany until the reunification of Germany in 1990. "Without the defeat, it seems quite likely that Germany would not have become a democracy for decades, until something created a decisive shift in the balance of class forces" (Rueschemeyer et al. 1992, development of town life. "Much of the subsequent history of the two countries goes back to this homely difference" (Moore 1966, p. 460).

p. 109).

7 Concluding Remarks

This paper establishes a simple model in which the coevolution of economic and political development is driven by the inherent technical features of different production factors and the political conflicts among factor owners in output distribution. The dynamic economic progress transforms the main source of wealth from land to physical capital and then to human capital; enables their respective owners, landlords, capitalists, and workers to gain political power in the same sequence; and consequently shifts the political regime from monarchy to oligarchy of landowners and capitalists and then to democracy with full suffrage. When it is too costly for any group of factor owners to repress others, political compromise is reached during the transition periods so that economic progress is not interrupted; otherwise, political conflicts may lead to repression of some factor owners and economic stagnation.

A main insight to emerge from this paper is the dynamic compatibility of economic and political development. On one hand, it brings a developmental perspective into the discussions of appropriate or growth-enhancing political institutions. For instance, the paper suggests that when natural resources are the main form of wealth, monarchy or other authoritarian regimes are probably the political equilibrium that naturally arises; only when human capital becomes predominant in the economy, which often happens after a society has a large enough physical capital stock, would a political democracy be more likely to sustain itself. On the other hand, it highlights the importance of a society's capacity for smooth political transitions in facilitating economic development. For example, the willingness and ability to make political compromise may have greatly facilitated economic progress in the history of England, which had that "most elusive yet decisive institutional feature that makes for economic success: the flexibility to adapt its economic and legal institutions without political violence and disruptions" (Mokyr 2005). In societies where institutions are rigid and difficult to change from within, economic stagnation often prevails, and ultimate changes may be forced upon them by costly domestic violence or outside threats.

The paper's analytical framework may prove useful in understanding related long-run development issues. For instance, it can be readily extended to study the effects of international forces, such as war, colonization, and globalization, on the development process either of an individual country or at different historical times, while taking into consideration that the changing motivation, format, and frequency of these international activities may also reflect the shifts of factor composition in production. This may generate new insights into

the relationship between democracy and war: If democratic countries have human capital as the dominant form of wealth, which is often true, it is not surprising that they seldom wage wars against each other. What is the point of conquering a nation whose main wealth is human capital? The relevant parties could have been better off by engaging each other in peaceful international trade. The model can also be extended by endogenizing the state's repression capacity and costs. For example, the virtually perfect correlation between country size and landlord strength is no accident, since only strong landlords had the coercive power to conquer more lands and establish large monarchies; this may help explain the distinct developmental paths of small countries. The evolution of education system, in terms of both contents and financing methods, may also be shaped by similar driving forces as in the model, including the evolving factor composition and the changing power balance among factor owners.

APPENDIX A: Proofs

Proposition 1.

Proof. At the last node, the challenging group gets $(1 - \tau)I_t^C$ if they refrain from revolting, and an expected income $q\Pi_{tR}^C + (1 - q)\Pi_{tV}^C$ if they carry out the revolt, since with probability q the revolt is repressed and the group gets an income $\Pi_{tR}^C = (1 - \tau)I_t^C/\theta$, while with probability $1 - q$ the revolt is successful and the group gets an income $\Pi_{tV}^C = I_t^C + \eta\tau I_t^G + \eta\tau I_t^O$. So Not Revolt is chosen if

$$(1 - \tau)I_t^C/\theta \geq q\Pi_{tR}^C + (1 - q)\Pi_{tV}^C \quad (9)$$

holds. After some algebra this leads to $x_t \leq x_t^*(\theta)$ where

$$x_t^*(\theta) \equiv \omega_0 - \eta(1 + I_t^O/I_t^G)\psi_t^C/\psi_t^G,$$

with $\omega_0 = (1/\tau - 1)(1 - 1/\theta)\chi$, and $x_t^*(\theta) > 0$ is easily obtained.

At the second node, when $x_t \leq x_t^*(\theta)$ holds, given that the challenging group will stop revolting at the last node, the ruler's payoff is $\Pi_t^G = I_t^G + \eta\tau I_t^C + \eta\tau I_t^O$ if choosing Repress, and $\Pi_{tP}^G = I_t^G + \eta\tau I_t^O \frac{I_t^G}{I_t^C + I_t^G}$ if choosing Compromise. So the best choice is Repress. When $x_t > x_t^*(\theta)$ holds instead, given that the challenging group will still revolt, choosing Repress brings two possible outcomes to the ruler: It wins the fight with probability q and then gets an income $\Pi_{tR}^G = \Pi_t^G$, while if it loses, revolution occurs and it gets $(1 - \tau)I_t^G/\theta$. So the expected income of the incumbent ruler choosing to repress is $q\Pi_t^G + (1 - q)(1 - \tau)I_t^G/\theta$. If the ruler chooses to compromise instead, its income is Π_{tP}^G . So Repress is the optimal choice when

$$q\Pi_t^G + (1 - q)(1 - \tau)I_t^G/\theta > I_t^G + \eta\tau I_t^O \frac{I_t^G}{I_t^C + I_t^G} \quad (10)$$

holds. After some algebra this leads to $\theta < \theta_t^*(\eta, \tau, \chi)$, where

$$\theta_t^*(\eta, \tau, \chi) = \frac{1 - \tau}{1 - \eta\tau - \eta\tau(\chi\psi_t^G/\psi_t^C - 1)/(1 - I_t^O/Y_t)}$$

So Repress is more likely to be chosen when $\theta_t^*(\eta, \tau, \chi)$ is higher, which is true when $\eta\tau$ and χ are higher.

That is, the ruler's best strategy is Repress if $\theta < \theta_t^*(\eta, \tau, \chi)$, and Compromise if otherwise.

At the first node, when $x_t \leq x_t^*(\theta)$, given that the ruler will repress, it is best for the challenging group to choose Not Revolt, while when $x_t > x_t^*(\theta)$, it is best to choose Revolt, which will lead to compromise if $\theta \geq \theta_t^*(\eta, \tau, \chi)$, otherwise to Repress and conflict.

If $\theta \geq \theta_t^*(\eta, \tau, \chi)$ holds, given the ruler's optimal choice of compromise, the challenging group will choose to compromise instead of revolt if

$$q\Pi_{tR}^C + (1 - q)\Pi_{tV}^C \leq I_t^C + \eta\tau I_t^O \frac{I_t^C}{I_t^C + I_t^G}$$

holds, which is indeed true given $\theta \geq \theta_t^*(\eta, \tau, \chi)$. ■

Lemma 1.

Proof. The landlord's profit maximization problem is $\max_{N_{ti}} A_t(L_i)^{1-\alpha} N_{ti}^\alpha - w_t N_{ti}$, taking the wage rate w_t as given. The first order condition (FOC) $\alpha A_t(L_i)^{1-\alpha} N_{ti}^{\alpha-1} = w_t$ leads to the optimal labor demand $N_{ti}^* = (\frac{\alpha}{w_t} A_t)^{\frac{1}{1-\alpha}} L_i$. When the labor market clears, $\sum_{i=1}^{N_l} N_{ti}^* = N + N_c$ must hold, which yields the equilibrium wage rate $w_t^* = \alpha A_t (\frac{L}{N+N_c})^{1-\alpha}$. Then we get $N_{ti}^* = \frac{(N+N_c)L_i}{L}$ and the optimal profit is $I_{ti}^* = (1 - \alpha) (\frac{N+N_c}{L})^\alpha A_t L_i \equiv \lambda A_t L_i$. The size of a landlord's land L_i satisfies $L_i > \frac{L}{N+N_c} \frac{\alpha}{1-\alpha}$, which guarantees that a landlord's profit is higher than worker wage w_t^* . The monarch's total income at any period $t \in [0, t_k]$ is

$$I_{mt} = \lambda A_t L_m + \eta\tau \lambda A_t [L - L_m + \frac{\alpha}{1-\alpha} L] = \lambda A_t [(1 - \eta\tau)L_m + \frac{\eta\tau}{1-\alpha} L],$$

which includes his land profit and tax revenues from other landlords and workers. ■

Proposition 2.

Proof. The $N_l - 1$ landlords constitute the challenging group. Their coercive power is $v_t^C = \psi_t^C I_t^C = \psi(N_l - 1, \bar{e}) \lambda A_t (L - L_M)$, the monarch's coercive power is $v_t^G = \psi_t^G I_t^G = \psi(N, 1) \lambda A_t L_M = \lambda A_t L_M$ given that $\psi(1, \bar{e}) = 1$, and the joint before-tax income of the neutral group (workers) is $I_t^O = \lambda A_t \frac{\alpha}{1-\alpha} L$. According to Proposition 1, in the equilibrium landlords will not challenge the monarch if $x_t \leq x_t^*(\theta)$ holds, where $x_t = v_t^C/v_t^G = \psi(N_l - 1, \bar{e})(L - L_M)/L_M$ does not change over time, and

$$\begin{aligned} x_t^*(\theta) &= \omega_0 - \eta(1 + I_t^O/I_t^G) \psi_t^C/\psi_t^G \\ &= \omega_0 - \eta\psi(N_l - 1, \bar{e})(1 + \alpha L/(1 - \alpha)L_M) \end{aligned}$$

is also constant. Then $x_t \leq x_t^*(\theta)$ boils down to $L_M \geq \omega_1 L$, where

$$\omega_1 \equiv \frac{1 + \eta\alpha/(1 - \alpha)}{1 - \eta + \omega_0/\psi(N_l - 1, \bar{e})}.$$

So as long as $L_M \geq \omega_1 L$, the relative coercive power of land owners is not higher than the threshold $x_t^*(\theta)$ to challenge the monarch. Note that if after-tax incomes are used instead to calculate coercive powers, the result is the same qualitatively. ■

Proposition 3.

Proof. Landlord i 's objective function is $\pi_{ti}^* = \max_{N_{ti}, k_{ti}} A_t(L_i + k_{ti})^{1-\alpha} N_{ti}^\alpha - w_t N_{ti} - r_t k_{ti}$. The optimal demands for labor and physical capital are determined by

$$\begin{aligned} w_t &= \alpha A_t(L_i + k_{ti}^*)^{1-\alpha} (N_{ti}^*)^{\alpha-1}, \\ r_t &= (1 - \alpha) A_t(L_i + k_{ti}^*)^{-\alpha} (N_{ti}^*)^\alpha. \end{aligned}$$

The labor market clearing condition implies

$$w_t^* = \alpha A_t \left(\frac{L + K_t}{N} \right)^{1-\alpha}$$

and $N_{ti}^* = N \frac{L_i + k_{ti}^*}{L + K_t}$. Plug N_{ti}^* into the condition of r_t we get

$$r_t^* = (1 - \alpha) A_t \left(\frac{N}{L + K_t} \right)^\alpha,$$

and $k_{ti}^* = \frac{L_i}{L} K_t$ clears the physical capital market.

A landlord's profit π_{ti}^* is proportional to his land size L_i : $\pi_{ti}^* = (1 - \alpha) A_t \left(\frac{N}{L + K_t} \right)^\alpha L_i$. A landlord's income is thus $I_{tl} = \pi_{ti}^*$. The joint income of capitalists is $I_{tc} = r_t^* K_t$, while that of workers is $w_t^* N_t^* = \alpha Y_t$. The after-tax income of the monarch is

$$\begin{aligned} I_{tm} &= A_t \left(\frac{N}{L + K_t} \right)^\alpha [(1 - \alpha)(L_m + \eta\tau(L - L_m)) + (1 - \alpha)\eta\tau K_t + \alpha\eta\tau(L + K_t)] \\ &= r_t^* [(1 - \eta\tau)L_m + \frac{\eta\tau}{1 - \alpha}(L + K_t)], \end{aligned}$$

which includes the monarch's land profit plus tax revenues from other landlords, capitalists and workers.

The aggregate before-tax income of the elites (the capitalists and landlords)

$$I_t^C = (1 - \alpha) A_t \left(\frac{N}{L + K_t} \right)^\alpha (L - L_m + K_t) \quad (11)$$

grows faster than the monarch's, and so does their coercive power φI_t^C compared with the monarch's $I_t^G = (1 - \alpha) A_t \left(\frac{N}{L + K_t} \right)^\alpha L_m$. The relative power of the elites is thus $x_t = \frac{\varphi(L + K_t - L_m)}{L_m}$, while the threshold is

$x_t^*(\theta) = \omega_0 - \eta\varphi(1 + I_t^O/I_t^G)$, where $I_t^O = \alpha Y_t = \alpha A_t(L + K_t)^{1-\alpha} N^\alpha$. Then $x_t = x_t^*(\theta)$ will be reached in a certain period denoted by T_k when $K_{T_k} = \omega_2 L_m - L$ holds, where

$$\omega_2 = \frac{\omega_0/\varphi + 1 - \eta}{1 + \eta\alpha/(1 - \alpha)}.$$

Note that $K_{T_k} > 0$ is implied by $L_M \geq \omega_1 L$ in Proposition 2. Since K_t is strictly increasing in time, T_k is uniquely determined. Note that if after-tax incomes are used instead to calculate coercive powers, the result is the same qualitatively.

The mechanism of the game is the same as in Proposition 1. Revolt is chosen when $\theta < \theta_{tk}^*$ holds, where

$$\theta_{tk}^* = \frac{1 - \tau}{1 - \eta\tau - \eta\tau(\chi\psi_t^G/\psi_t^C - 1)/(1 - I_t^O/Y_t)} = \frac{1 - \tau}{1 - \eta\tau(\chi/\varphi - \alpha)/(1 - \alpha)}$$

for any period $t \geq T_k$ given that $\psi_t^G = 1$, $\psi_t^C = \varphi$, and $I_t^O/Y_t = \alpha$. ■

Proposition 4.

Proof. The objective function of the elites in period t is

$$\max_{\tau_t^h} I_{e,t} \equiv (1 - \alpha + \alpha\eta\tau)A_t(L + K_t)^{1-\alpha}(Nh_t)^\alpha,$$

taking as given $M_{t-1}^h = \tau_t^h B_{t-1}$, $h_t = f(\frac{M_{t-1}^h}{N})$, and $K_t = B_{t-1} - M_{t-1}^h = (1 - \tau_t^h)B_{t-1}$. The FOC for τ_t^{h*} is

$$\alpha[L + (1 - \tau_t^{h*})B_{t-1}]f'(\tau_t^{h*}B_{t-1}/N) - (1 - \alpha)f(\tau_t^{h*}B_{t-1}/N)N = 0 \text{ if } \tau_t^{h*} > 0, \quad (12)$$

$$\alpha(L + B_{t-1})\gamma - (1 - \alpha)N \leq 0 \text{ if } \tau_t^{h*} = 0, \quad (13)$$

where $f'(0) = \gamma$ and $f(0) = 1$ are substituted in (13). It is obvious to see that the *LHS* in (13) strictly increases in the total surplus B_{t-1} , and thus it would eventually arise to zero at certain period t_h , after which human capital investment starts. t_h is thus defined by (13) at equality.

Given $M_{t-1}^{h*} = \tau_t^{h*} B_{t-1}$, for interior solutions based on (12) we have

$$\begin{aligned} \frac{\partial M_{t-1}^{h*}}{\partial B_{t-1}} &= \frac{\partial \tau_t^{h*} B_{t-1}}{\partial B_{t-1}} = \frac{\partial \tau_t^{h*}}{\partial B_{t-1}} B_{t-1} + \tau_t^{h*} \\ &= \frac{\alpha f'}{-\alpha(L + (1 - \tau_t^{h*})B_{t-1})f''/N + f'} > 0. \end{aligned}$$

When γ is too small, human capital investment will start after the elite rule replaces monarchy at T_k .

The monarch's objective function at any $t \in (t_k, T_k]$ is

$$\max_{\tau_t^h} I_{tm} \equiv A_t \left(\frac{Nh_t}{L + K_t} \right)^\alpha [(1 - \alpha)\widehat{L} + \eta\tau K_t],$$

where $\widehat{L} \equiv (1 - \eta\tau)L_m + \frac{\eta\tau}{1 - \alpha}L$. The FOC is $\alpha(L + K_t)f'_t - (\xi_t - \alpha)Nh_t \leq 0$, where $\xi_t \equiv [1 + \frac{(1 - \alpha)(1 - \eta\tau)}{\eta\tau} \frac{L_m}{L + K_t}]^{-1}$, and thus $\xi \equiv \xi_{T_k} = [1 + (1 - \alpha)(1/\eta\tau - 1)/\omega_2]^{-1}$ given that $K_{T_k} = \omega_2 L_m - L$. So human capital investment

will not start under monarchy when the FOC holds strictly at T_k : $\alpha(L + K_{T_k})\gamma - (\xi_{T_k} - \alpha)N < 0$, which leads to $\gamma < \frac{N(\xi - \alpha)}{\alpha\omega_2 L_m}$. ■

Proposition 5.

Proof. The mechanism of the game is the same as in Proposition 1, while the detailed incomes are $I_t^G = (1 - \alpha)Y_t$, $I_t^C = \alpha Y_t$, and $I_t^O = 0$. The implicit assumption is that the total bequest in society is not reduced by the transition of political regime, which requires workers to have positive bequests at least from period T_h . When this is not true, the elites have more incentives to repress workers and hence may delay the transition, while the main results still hold.

The relative coercive power of workers is $x_t = \frac{\psi(N, h_t)\alpha}{\psi(N_c + N_l, \bar{e})(1 - \alpha)}$, while the threshold level is

$$x_t^*(\theta) = \omega_0 - \eta\psi(N, h_t)/\psi(N_c + N_l, \bar{e}).$$

Then $x_t \leq x_t^*(\theta)$ boils down to $\psi(N, h_t) \leq \omega_3\psi(N_c + N_l, \bar{e})$, where

$$\omega_3 \equiv \omega_0/[1 + \eta\alpha/(1 - \alpha)].$$

So T_h is determined by $\psi(N, h_{T_h}) = \omega_3\psi(N_c + N_l, \bar{e})$. Revolt is chosen when $\theta < \theta_{th}^*$ holds, where

$$\begin{aligned} \theta_{th}^* &= \frac{1 - \tau}{1 - \eta\tau - \eta\tau(\chi\psi_t^G/\psi_t^C - 1)/(1 - I_t^O/Y_t)} \\ &= \frac{1 - \tau}{1 - \eta\tau\chi\psi(N_c + N_l, \bar{e})/\psi(N, h_t)} = \frac{1 - \tau}{1 - \eta\tau\chi\alpha[(1 - \alpha)x_t]^{-1}}. \end{aligned}$$

It is obvious to see that $\partial\theta_{th}^*/\partial x_t < 0$. Then at $t = T_h$ we get $\theta_{T_h}^* = \frac{1 - \tau}{1 - \eta\tau\chi/\omega_3}$. ■

Proposition 6.

Proof. The evolution of the total output $\{Y_t\}_{t=1}^{+\infty}$ is characterized by the total bequest $\{B_t\}_{t=1}^{+\infty}$ in the economy, which is affected by the political schemes and their associated tax rates. In any period $t \leq t_k$ there is no capital accumulation, and the total output grows at a constant rate g due to the exogenous increase of knowledge stock A_t ; this implies $Y_{t+1} = A_{t+1}(L)^{1-\alpha}(N + N_c)^\alpha = Y_t(1 + g)$ at $t \leq t_k$.

During $(t_k, T_k]$, the economy is productive enough to have savings to invest in physical capital $K_{t+1} = B_t^{MK}$, where

$$\begin{aligned} B_t^{MK} &= b_{tm} + b_{tl} + b_{tc} \equiv I_{tm} - Z + (N_l - 1)\max\{I_{tl} - Z, 0\} + \max\{I_{tc} - N_c Z, 0\} \\ &\leq (1 - \alpha + \alpha\eta\tau)Y_t - (N_l + N_c)Z - (1 - \eta)(1 - \alpha)\tau\left(1 - \frac{L_m}{L + K_t}\right)Y_t; \end{aligned}$$

the last line in the above expression measures the total saving B_t^{MK} when all landlords and capitalists have positive bequests. Physical capital accumulation presents a new channel for growth so that the economy

grows faster than g . The total output at $(t_k, T_k]$ is

$$Y_{t+1} = A_{t+1}(L + K_{t+1})^{1-\alpha} N^\alpha = A_{t+1}(L + B_t^{MK})^{1-\alpha} N^\alpha \equiv \Psi_t(B_t^{MK}).$$

During $(T_k, t_h]$, monarchy is replaced by oligarchy of landlords and capitalists, and the total saving is higher than before due to less waste in tax collection. The total output is now

$$Y_{t+1} = A_{t+1}(L + B_t^{OK})^{1-\alpha} N^\alpha \equiv \Psi_t(B_t^{OK})$$

at $(T_k, t_h]$, where the total saving is

$$B_t^{OK} = (1 - \alpha + \alpha\eta\tau)Y_t - (N_l + N_c)Z.$$

It is easy to see that $B_t^{OK} > B_t^{MK}$ holds, and hence $\Psi_t(B_t^{OK}) > \Psi_t(B_t^{MK})$ is true. It is straightforward to show that $y_{t+1} = Y_{t+1}/A_{t+1}$ is strictly increasing and concave in $y_t = Y_t/A_t$, and

$$\frac{y_{t+1}}{y_t} = \left(\frac{L + K_{t+1}}{L + K_t}\right)^{1-\alpha} \quad \text{at } t \in (t_k, t_h].$$

After t_h , a new channel of growth, namely, human capital accumulation, is open. The total output is

$$Y_{t+1} = A_{t+1}(L + (1 - \tau_t^{h*})B_t^{OH})^{1-\alpha} N^\alpha f\left(\frac{\tau_t^{h*} B_t^{OH}}{N}\right)^\alpha \equiv \widehat{\Psi}_t(B_t^{OH}),$$

where the total saving is

$$B_t^{OH} = (1 - \alpha + \alpha\eta\tau)Y_t - (N_l + N_c)Z + \max\{\alpha(1 - \tau)Y_t - NZ, 0\}.$$

Note that $\tau_t^{h*} = \arg \max_{\tau_t^h} Y_{t+1}$, which implies $\widehat{\Psi}_t(B_t^{OH}) > \Psi_t(B_t^{OK})$, that is, the total output is higher with human capital investment than without. Note that $y_{t+1} = Y_{t+1}/A_{t+1}$ is again strictly increasing and concave in $y_t = Y_t/A_t$, and

$$\frac{y_{t+1}}{y_t} = \left(\frac{L + K_{t+1}}{L + K_t}\right)^{1-\alpha} \left(\frac{H_{t+1}}{H_t}\right)^\alpha \quad \text{at } t > t_h.$$

After T_h , the oligarchy of landlords and capitalists is replaced by democracy, where no exploiting tax is imposed so that the total saving is higher than before due to less waste in tax collection. The optimal tax rate τ_t^{h*} for public education again maximizes the total output as before. The total output is now

$$Y_{t+1} = A_{t+1}(L + (1 - \tau_t^{h*})B_t^{DH})^{1-\alpha} N^\alpha f\left(\frac{\tau_t^{h*} B_t^{DH}}{N}\right)^\alpha \equiv \widehat{\Psi}_t(B_t^{DH}),$$

where the total saving is

$$B_t^{DH} = Y_t - (N_l + N_c + N)Z = A_t y_t - (N_l + N_c + N)Z.$$

It is easy to see that the amount of total saving is increasing over time, $B_t^{MK} < B_t^{OK} < B_t^{OH} < B_t^{DH}$, due to political regime changing and investment in new capital forms.

Similar as before, $y_{t+1} = Y_{t+1}/A_{t+1}$ is strictly increasing and concave in $y_t = Y_t/A_t$:

$$\begin{aligned} \frac{dy_{t+1}}{dy_t} &= (L + K_{t+1})^{-\alpha} N^\alpha h_{t+1}^\alpha A_t [(1 - \alpha)(1 - \tau_t^{h*}) + \alpha(L + K_{t+1})(h_{t+1})^{-1} \frac{\tau_t^{h*}}{N} h'_{t+1}] > 0, \\ \frac{d^2 y_{t+1}}{d^2 y_t} &= (L + K_{t+1})^{-\alpha} N^\alpha h_{t+1}^\alpha (A_t)^2 [\alpha(L + K_{t+1})(h_{t+1})^{-1} (\frac{\tau_t^{h*}}{N})^2 h''_{t+1} \\ &\quad - \alpha(1 - \alpha)(L + K_{t+1})^{-1} (1 - \tau_t^{h*})^2 - \alpha(1 - \alpha)(L + K_{t+1})(h_{t+1})^{-2} (\frac{\tau_t^{h*}}{N} h'_{t+1})^2] < 0, \end{aligned}$$

and in the limit it converges to the steady state $y^* = (L + N_c k^*)^{1-\alpha} N^\alpha h^*$. ■

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APPENDIX B: Results under Alternative Assumptions in Section 5

1. The case with a general production function $Y_{ti} = A_t(L_i^\rho + k_{ti}^\rho)^{\frac{1-\alpha}{\rho}} N_{ti}^\alpha$.

(1) New results in **Proposition 3**.

In the political game between monarch and the elites, T_k is uniquely determined by

$$K_{T_k} = (\omega_2 L_m / L - 1)^{1/\rho} L. \quad (14)$$

Other results remain the same as before.

Proof. We first prove the following results. In any period $t \in (t_k, T_k]$, the incomes of a landlord, a capitalist, and the monarch are respectively

$$\begin{aligned} I_{tl} &= (1 - \tau)r_t^* \left(\frac{K_t}{L}\right)^{1-\rho} L_i, \\ I_{tc} &= (1 - \tau)r_t^* \frac{K_t}{N_c}, \\ I_{tm} &= r_t^* \left[\left(\frac{K_t}{L}\right)^{1-\rho} \widehat{L} + \frac{\eta\tau}{1-\alpha} K_t\right]. \end{aligned}$$

where the market-clearing rate of capital return is

$$r_t^* = (1 - \alpha)A_t^\alpha \left[\frac{N}{(L^\rho + K_t^\rho)^{\frac{1}{\rho}}}\right]^\alpha (K_t)^{\rho-1}.$$

The aggregate wage of workers is $Nw_t^* = \alpha Y_t$, where

$$Y_t \equiv A_t [(L^\rho + K_t^\rho)^{\frac{1}{\rho}}]^{1-\alpha} N^\alpha = \frac{1}{1-\alpha} r_t^* (L^\rho + K_t^\rho) (K_t)^{1-\rho}$$

is the aggregate output in the economy.

Landlord i 's objective function is

$$\pi_{ti}^* = \max_{N_{ti}, k_{ti}} A_t (L_i^\rho + k_{ti}^\rho)^{\frac{1-\alpha}{\rho}} N_{ti}^\alpha - w_t N_{ti} - r_t k_{ti}.$$

The optimal demands for labor and physical capital are determined by

$$\begin{aligned} w_t &= \alpha A_t (L_i^\rho + k_{ti}^\rho)^{\frac{1-\alpha}{\rho}} (N_{ti}^*)^{\alpha-1}, \\ r_t &= (1 - \alpha) A_t (L_i^\rho + k_{ti}^\rho)^{\frac{1-\alpha}{\rho} - 1} k_{ti}^{\rho-1} (N_{ti}^*)^\alpha. \end{aligned}$$

The labor market clearing condition implies $w_t^* = \alpha A_t [\sum_i (L_i^\rho + k_{ti}^\rho)^{\frac{1}{\rho}}]^{1-\alpha} N^{-1+\alpha}$ and $N_{ti}^* = \left(\frac{\alpha A_t}{w_t}\right)^{\frac{1}{1-\alpha}} (L_i^\rho + k_{ti}^\rho)^{\frac{1}{\rho}} = N (L_i^\rho + k_{ti}^\rho)^{\frac{1}{\rho}} / \sum_i (L_i^\rho + k_{ti}^\rho)^{\frac{1}{\rho}}$. Plugging N_{ti}^* into the condition of r_t we get

$$r_t^* = (1 - \alpha) A_t N^\alpha \frac{(L_i^\rho + k_{ti}^\rho)^{\frac{1}{\rho}}}{\left(\sum_i (L_i^\rho + k_{ti}^\rho)^{\frac{1}{\rho}}\right)^\alpha} \frac{k_{ti}^{\rho-1}}{L_i^\rho + k_{ti}^\rho}.$$

Solving k_{ti} from r_t^* equation and with some algebra we get $k_{ti}^* = \frac{L_i}{L} K_t$ and

$$r_t^* = (1 - \alpha) A_t^\alpha \left[\frac{N}{(L^\rho + K_t^\rho)^{\frac{1}{\rho}}} \right]^\alpha (K_t)^\rho = (1 - \alpha) \frac{(K_t)^\rho}{L^\rho + K_t^\rho} Y_t,$$

where $Y_t \equiv A_t N^\alpha [(L^\rho + K_t^\rho)^{\frac{1}{\rho}}]^{1-\alpha}$ is the aggregate output in the economy.

The landlord's profit level π_{ti}^* only depends on his land size L_i , $\pi_{ti}^* = (1 - \alpha) Y_t \frac{L^\rho}{L^\rho + K_t^\rho} \frac{L_i}{L} = r_t^* (\frac{K_t}{L})^{1-\rho} L_i$, so that $I_{tl} = (1 - \tau) \pi_{ti}^* = (1 - \tau) r_t^* (\frac{K_t}{L})^{1-\rho} L_i$. The joint income of capitalists is $I_{tc} = (1 - \tau) r_t^* K_t$. The aggregate income of workers is again $w_t^* N_t^* = \alpha Y_t$.

The total income of the monarch is

$$I_{t,m} = r_t^* \left[\left(\frac{K_t}{L} \right)^{1-\rho} (L_m + \eta \tau (L - L_m)) \right] + \eta \tau K_t + \frac{\alpha \eta \tau}{1 - \alpha} (L^\rho + K_t^\rho) K_t^{1-\rho} = r_t^* \left[\left(\frac{K_t}{L} \right)^{1-\rho} L_m + \frac{\eta \tau}{1 - \alpha} K_t \right],$$

which includes the monarch's land profit plus tax revenues from other landlords, capitalists and workers.

For the political game, we have

$$\begin{aligned} I_t^C &= r_t^* \left[\sum I_{ti} + I_{tc} \right] = r_t^* \left(\frac{K_t}{L} \right)^{1-\rho} (L - L_m) + r_t^* K_t, \\ I_t^G &= r_t^* \left(\frac{K_t}{L} \right)^{1-\rho} L_m = (1 - \alpha) \frac{(K_t)^\rho}{L^\rho + K_t^\rho} Y_t \left(\frac{K_t}{L} \right)^{1-\rho} L_m, \\ I_t^O &= w_t^* N_t^* = \alpha Y_t = \alpha A_t N^\alpha [(L^\rho + K_t^\rho)^{\frac{1}{\rho}}]^{1-\alpha}. \end{aligned}$$

So the relative coercive power of the elites x_t is

$$x_t = \frac{\varphi I_t^C}{I_t^G} = \frac{\varphi r_t^* \left[\left(\frac{K_t}{L} \right)^{1-\rho} (L - L_m) + K_t \right]}{r_t^* \left(\frac{K_t}{L} \right)^{1-\rho} L_m} = \varphi \left(\frac{L + K_t^\rho L^{1-\rho}}{L_m} - 1 \right),$$

while the threshold level $x_t^*(\theta)$ is

$$\begin{aligned} x_t^*(\theta) &\equiv \omega_0 - \eta (1 + I_t^O / I_t^G) \psi_t^C / \psi_t^G \\ &= \omega_0 - \eta \left(1 + \frac{\alpha}{1 - \alpha} \frac{L + L^{1-\rho} K_t^\rho}{L_m} \right) \varphi. \end{aligned}$$

Then $x_t < x_t^*(\theta)$ is equivalent to

$$K_t < (\omega_2 L_m / L - 1)^{1/\rho} L$$

after some algebra, where the equality leads to condition (14) that determines \bar{K}_{T_k} . Note that when $\rho = 1$, this condition coincides with (5) in the basic model.

Revolt is chosen when $\theta < \theta_t^*$ holds, where

$$\theta_t^* = \frac{1 - \tau}{1 - \eta \tau - \eta \tau (\chi \psi_t^G / \psi_t^C - 1) / (1 - I_t^O / Y_t)} = \frac{1 - \tau}{1 - \eta \tau (\chi / \varphi - \alpha) / (1 - \alpha)}$$

for any period $t \geq T_k$ given that $\psi_t^G = 1$, $\psi_t^C = \varphi$, and $I_t^O/Y_t = \alpha$. This is the same as before. ■

(2) The new version of **Proposition 4**.

Under the elite rule human capital investment starts in period t_h that is determined by

$$\alpha(L^\rho + K_{t_h}^\rho)^{\frac{1}{\rho}}\gamma - (1 - \alpha)NK_{t_h}^{\rho-1} = 0;$$

the optimal tax rate τ_t^{h} for public education in any period $t \geq t_h$ is determined by*

$$\alpha(L^\rho + K_t^{*\rho})^{\frac{1}{\rho}}h_t^{*'} - (1 - \alpha)Nh_t^*K_t^{*\rho-1} = 0;$$

the public education expenditure $M_t^{h} = \tau_t^{h*}B_t$ is strictly increasing in B_t . Human capital investment does not start under monarchy if*

$$\gamma < (\omega_2 L_m / L - 1)^{1-1/\rho} N(\rho\xi - \alpha) / \alpha\omega_2 L_m \quad (15)$$

holds.

Proof. The objective function of the elites in period t is

$$\max_{\tau_t^h} I_{e,t} \equiv (1 - \alpha + \alpha\eta\tau)A_t[(L^\rho + K_t^\rho)^{\frac{1}{\rho}}]^{1-\alpha}N^\alpha,$$

taking as given $M_{t-1}^h = \tau_t^h B_{t-1}$, $h_t = f(\frac{M_{t-1}^h}{N})$, and $K_t = B_{t-1} - M_{t-1}^h = (1 - \tau_t^h)B_{t-1}$. The FOC for τ_t^{h*} is

$$\alpha(L^\rho + K_t^\rho)^{\frac{1}{\rho}}h_t' - (1 - \alpha)Nh_tK_t^{\rho-1} = 0 \text{ if } \tau_t^{h*} > 0, \quad (16)$$

$$\alpha(L^\rho + K_t^\rho)^{\frac{1}{\rho}}\gamma - (1 - \alpha)NK_t^{\rho-1} \leq 0 \text{ if } \tau_t^{h*} = 0, \quad (17)$$

where $h'(0) = \gamma$ and $h(0) = 1$ are substituted in the second line. It is obvious that the *LHS* in (17) strictly increases in the total surplus B_{t-1} and thus would eventually arise to zero at a certain period t_h , after which human capital investment starts. t_h is thus defined by (17) at equality.

For interior solutions based on (16) we have

$$\begin{aligned} \frac{\partial M_{t-1}^{h*}}{\partial B_{t-1}} &= \frac{\partial \tau_t^{h*} B_{t-1}}{\partial B_{t-1}} = \frac{\partial \tau_t^{h*}}{\partial B_{t-1}} B_{t-1} + \tau_t^{h*} \\ &= -\frac{\alpha(L^\rho + K_t^\rho)^{\frac{1}{\rho}-1} h_t' \rho K_t^{\rho-1} + (1 - \rho)(1 - \alpha) N K_t^{\rho-2} h_t'}{-\alpha(L^\rho + K_t^\rho)^{\frac{1}{\rho}-1} [h_t' \rho K_t^{\rho-1} - (L^\rho + K_t^\rho) h_t'' / N] - (1 - \alpha) K_t^{\rho-2} [K_t h_t' + (1 - \rho) N h_t]} \\ &> 0. \end{aligned}$$

When γ is too small, human capital investment will not start before the elite rule replaces monarchy at T_k . The monarch's objective function is

$$\max_{\tau_t^h} I_{m,t} \equiv (1 - \alpha)A_t N^\alpha h_t^\alpha [(L^\rho + K_t^\rho)^{\frac{1}{\rho}}]^{-\alpha} \left(\frac{L_m}{L^{1-\rho}} + \frac{\eta\tau}{1 - \alpha} K_t^\rho \right).$$

The FOC is

$$\alpha(L^\rho + K_t^\rho)h'_t - K_t^{\rho-1}h_t(\tilde{\xi}_t - \alpha)N \leq 0,$$

where $\tilde{\xi}_t \equiv \rho(L^\rho + K_t^\rho)/(\frac{\hat{L}}{L} \frac{1-\alpha}{\eta\tau} L^\rho + K_t^\rho)$ and $\tilde{\xi}_{T_k} = \rho\xi$ by (14). So human capital investment will not start under monarchy when the above inequality holds strictly at T_k : $\alpha(L^\rho + K_{T_k}^\rho)\gamma - (K_{T_k}^\rho)^{\rho-1}(\rho\xi - \alpha)N < 0$, which leads to $\gamma < (\omega_2 L_m/L - 1)^{1-1/\rho} N(\rho\xi - \alpha)/\alpha\omega_2 L_m$, and it becomes the same as in the basic model when $\rho = 1$. ■

2. A two-sector general equilibrium model.

(1) Consumer's optimal choices.

Lemma 2 *An individual's optimal choices are*

$$\begin{aligned} b_{ti}^* &= \max\{\beta(I_{ti} - Z), 0\}, \\ c_{ti}^{L*} &= \frac{I_{ti} - b_{ti}^*}{1 + (p_t)^{\frac{\rho}{\rho-1}}}, \\ c_{ti}^{K*} &= \frac{(I_{ti} - b_{ti}^*)(p_t)^{\frac{1}{\rho-1}}}{1 + (p_t)^{\frac{\rho}{\rho-1}}}. \end{aligned}$$

Proof. An individual's objective function can be written as

$$\max_{b_{ti}, c_{ti}^K} (1 - \beta) \frac{1}{\rho} \log[(I_{ti} - p_t c_{ti}^K - b_{ti})^\rho + (c_{ti}^K)^\rho] + \beta \log(z + b_{ti}).$$

The FOCs (for interior solutions) are

$$\begin{aligned} \frac{(I_{ti} - p_t c_{ti}^K - b_{ti})^{\rho-1} p_t}{(I_{ti} - p_t c_{ti}^K - b_{ti})^\rho + (c_{ti}^K)^\rho} &= \frac{(c_{ti}^K)^{\rho-1}}{(I_{ti} - p_t c_{ti}^K - b_{ti})^\rho + (c_{ti}^K)^\rho} \\ \Rightarrow c_{ti}^{K*} &= \frac{(I_{ti} - b_{ti})(p_t)^{\frac{1}{\rho-1}}}{1 + (p_t)^{\frac{\rho}{\rho-1}}} \\ \Rightarrow c_{ti}^{L*} &= I_{ti} - b_{ti} - p_t c_{ti}^{K*} = \frac{I_{ti} - b_{ti}}{1 + (p_t)^{\frac{\rho}{\rho-1}}}, \end{aligned}$$

and

$$\begin{aligned} \frac{\beta}{z + b_{ti}} &\leq \frac{(1 - \beta)(c_{ti}^L)^{\rho-1}}{(c_{ti}^L)^\rho + (c_{ti}^K)^\rho} \\ \Rightarrow b_{ti}^* &= \max\{\beta(I_{ti} - \frac{1 - \beta}{\beta} z), 0\} = \max\{\beta(I_{ti} - Z), 0\}. \end{aligned}$$

Suppose $b_{ti}^* = b_{ti}^{L*} + p_t b_{ti}^{K*}$, where b_{ti}^L and b_{ti}^K denote the bequests of agriculture and manufacturing goods, respectively. Since only the sum is determined, let $b_{ti}^{L*} = \epsilon c_{ti}^{L*}$ and $b_{ti}^{K*} = \epsilon c_{ti}^{K*}$, then $\epsilon^* = \frac{\beta I_{ti} - (1 - \beta)z}{(1 - \beta)(I_{ti} + z)}$. ■

(2) Producers' optimal choices and the general equilibrium results.

Lemma 3 *In the general equilibrium of the two sector economy, the proportion of workers working in the agriculture sector is*

$$\sigma_t^* = [1 + (\frac{K_t}{L})^{\frac{(1-\alpha)\rho}{1-\rho\alpha}}]^{-1},$$

where $\frac{\partial \sigma_t^*}{\partial K_t} < 0$ if $\rho\alpha < 1$; i.e, σ_t^* declines over time as the capital stock goes up. The price of manufacturing good is $p_t^* = (\frac{L}{K_t})^{\frac{(1-\alpha)(1-\rho)}{1-\rho\alpha}}$. The total profit of capitalists $\pi_t^K = (1-\alpha)A_t((1-\sigma_t^*)N)^\alpha K_t^{1-\alpha}$ is increasing over time, while that of landlords $\pi_t^L = (1-\alpha)A_t L^{1-\alpha}(\sigma_t^* N)^\alpha$ is decreasing.

Proof. The profit maximization problems with $h_{ti} = 1$ are solved below; the solutions are the same when $h_{ti} > 1$. An individual landlord's objective function is

$$\pi_{ti}^L = \max_{N_{ti}^L} A_t L_i^{1-\alpha} (N_{ti}^L)^\alpha - w_t^L N_{ti}^L.$$

The FOC is

$$\begin{aligned} w_t^L &= \alpha A_t L_i^{1-\alpha} (N_{ti}^L)^{\alpha-1} \\ \Rightarrow w_t^{L*} &= \alpha A_t L^{1-\alpha} (\sigma_t N)^\alpha \Rightarrow N_{ti}^{L*} = \sigma_t N \frac{L_i}{L}. \end{aligned}$$

So the landlord's profit is

$$\pi_{ti}^L = (1-\alpha)A_t L^{1-\alpha} (\sigma_t N)^\alpha \frac{L_i}{L}.$$

An individual capitalist's objective function is

$$\pi_{ti}^K = \max_{N_{ti}^K} p_t A_t k_{ti}^{1-\alpha} (N_{ti}^K)^\alpha - w_t^K N_{ti}^K - r_t k_{ti}.$$

The FOCs are

$$\begin{aligned} w_t^K &= \alpha p_t A_t k_{ti}^{1-\alpha} (N_{ti}^K)^{\alpha-1} \\ \Rightarrow w_t^{K*} &= \alpha p_t A_t K_t^{1-\alpha} ((1-\sigma_t)N)^{\alpha-1} \\ \Rightarrow N_{ti}^{K*} &= (1-\sigma_t)N \frac{k_{ti}}{K_t}; \end{aligned}$$

and

$$r_t^* = (1-\alpha)p_t A_t k_{ti}^{-\alpha} (N_{ti}^K)^\alpha = (1-\alpha)p_t A_t \left(\frac{(1-\sigma_t)N}{K_t}\right)^\alpha.$$

So the capitalist's profit is

$$\pi_{ti}^K = (1-\alpha)p_t A_t K_t^{1-\alpha} ((1-\sigma_t)N)^\alpha \frac{k_{ti}}{K_t}.$$

The labor market should have the same wage level if in equilibrium $\sigma_t \geq 0$; this implies

$$w_t^{K*} = w_t^{L*} \Rightarrow \sigma_t^* = \frac{L}{L + (p_t)^{\frac{1}{1-\alpha}} K_t}.$$

The final element to pin down is the equilibrium price p_t , which will clear the two final goods markets.

The total demand for the agriculture good is equal to its total supply when

$$\begin{aligned}\frac{\sum(1+\mu)p_t c_{ti}^{K*}}{\sum(1+\mu)c_{ti}^{L*}} &= \frac{p_t A_t K_t^{1-\alpha} ((1-\sigma_t)N)^\alpha}{A_t L^{1-\alpha} N^\alpha (\sigma_t)^\alpha} \\ \Rightarrow p_t^* &= \left(\frac{L}{K_t}\right)^{\frac{(1-\alpha)(1-\rho)}{1-\rho\alpha}}.\end{aligned}$$

So we have

$$\sigma_t^* = \frac{L}{L + (p_t^*)^{\frac{1}{1-\alpha}} K_t} = \frac{1}{1 + (p_t^*)^{\frac{\rho}{1-\alpha}}} = \frac{1}{1 + \left(\frac{K_t}{L}\right)^{\frac{(1-\alpha)\rho}{1-\rho\alpha}}},$$

where $\frac{\partial \sigma_t^*}{\partial K_t} < 0$, i.e., the proportion of workers working in the agriculture sector is declining over time as the capital stock goes up. The total profit of capitalists $\pi_t^K = (1-\alpha)A_t((1-\sigma_t^*)N)^\alpha K_t^{1-\alpha}$ is increasing over time, while that of landlords $\pi_t^L = (1-\alpha)A_t L^{1-\alpha} (\sigma_t^* N)^\alpha$ is decreasing. ■

(3) New results in **Proposition 3.**

In the political game between monarch and the elites, T_k is uniquely determined by

$$K_{T_k} = \omega'_2 L, \quad (18)$$

where $\omega'_2 = \{(1/\tau - 1)(1 - 1/\theta)\chi\varphi + 1 - \eta L/L_m\} L_m/L (1 + \frac{\eta\alpha}{1-\alpha}) - 1\}^{\frac{1-\rho\alpha}{1-\alpha}}$.

Proof. The coercive power of the elites is

$$\begin{aligned}\varphi I_t^C &= \varphi(1-\alpha)A_t L^{1-\alpha} (\sigma_t^* N)^\alpha \frac{L-L_m}{L} + \varphi(1-\alpha)A_t ((1-\sigma_t^*)N)^\alpha K_t^{1-\alpha} \\ &= \varphi(1-\alpha)A_t N^\alpha [(\sigma_t^*)^\alpha L^{1-\alpha} \frac{L-L_m}{L} + (1-\sigma_t^*)^\alpha K_t^{1-\alpha}],\end{aligned}$$

while that of the monarch's $I_t^G = (1-\alpha)A_t L^{1-\alpha} (\sigma_t^* N)^\alpha \frac{L_m}{L}$. So the challenging group's relative coercive power is

$$\begin{aligned}x_t &= \frac{\varphi I_t^C}{I_t^G} = \frac{\varphi(1-\alpha)A_t N^\alpha [(\sigma_t^*)^\alpha L^{1-\alpha} \frac{L-L_m}{L} + (1-\sigma_t^*)^\alpha K_t^{1-\alpha}]}{(1-\alpha)A_t L^{1-\alpha} (\sigma_t^* N)^\alpha \frac{L_m}{L}} \\ &= \varphi [L/L_m - 1 + (1/\sigma_t^* - 1)^\alpha K_t^{1-\alpha} L^\alpha / L_m].\end{aligned}$$

Since the neutral group's income is

$$I_t^O = Y_t - I_t^C - I_t^G = \alpha A_t L^{1-\alpha} (\sigma_t^* N)^\alpha + \alpha A_t ((1-\sigma_t^*)N)^\alpha K_t^{1-\alpha},$$

we have

$$\begin{aligned}I_t^O / I_t^G &= \frac{\alpha A_t L^{1-\alpha} (\sigma_t^* N)^\alpha + \alpha A_t ((1-\sigma_t^*)N)^\alpha K_t^{1-\alpha}}{(1-\alpha)A_t L^{1-\alpha} (\sigma_t^* N)^\alpha \frac{L_m}{L}} \\ &= \frac{\alpha [1 + (1/\sigma_t^* - 1)K_t^{1-\alpha} / L^{1-\alpha}] L}{(1-\alpha)L_m}\end{aligned}$$

the threshold level is

$$\begin{aligned} x_t^*(\theta) &\equiv \omega_0 - \eta(1 + I_t^O/I_t^G)\psi_t^C/\psi_t^G \\ &= \omega_0 - \eta\varphi\left(1 + \frac{\alpha[1 + (1/\sigma_t^* - 1)K_t^{1-\alpha}/L^{1-\alpha}]L}{(1-\alpha)L_m}\right). \end{aligned}$$

Then $x_t < x_t^*(\theta)$ boils down to $K_t < \omega'_2 L$, where

$$\omega'_2 = \{[(1/\tau - 1)(1 - 1/\theta)\chi L_m/L\varphi + L_m/L - \eta](1 + \frac{\eta\alpha}{1-\alpha})^{-1} - 1\}^{\frac{1-\rho\alpha}{1-\alpha}}.$$

So T_k is uniquely determined by $K_{T_k} = \omega'_2 L$.

Revolt is chosen when $\theta < \theta_t^*$ holds, where

$$\theta_t^* = \frac{1 - \tau}{1 - \eta\tau - \eta\tau(\chi\psi_t^G/\psi_t^C - 1)/(1 - I_t^O/Y_t)} = \frac{1 - \tau}{1 - \eta\tau(\chi/\varphi - \alpha)/(1 - \alpha)}$$

for any period $t \geq T_k$ given that $\psi_t^G = 1$, $\psi_t^C = \varphi$, and $I_t^O/Y_t = \alpha$. This is the same as before. ■

(4) The new version of **Proposition 4**.

Under the elite rule human capital investment starts in period t_h that is determined by

$$\alpha K_{t_h} \gamma - (1 - \alpha)N[1 - \sigma_{t_h}^* + \frac{1}{1 - \alpha\rho}(\sigma_{t_h}^* - \tilde{\sigma}_{t_h})] = 0;$$

the optimal tax rate τ_t^{h} for public education in any period $t \geq t_h$ is determined by*

$$\alpha K_t h_t' - (1 - \alpha)N h_t [1 - \sigma_t^* + \frac{1}{1 - \alpha\rho}(\sigma_t^* - \tilde{\sigma}_t)] = 0;$$

where $\tilde{\sigma}_t = (1 + (\frac{K_t}{L})^{\frac{1-\alpha}{1-\rho\alpha}})^{-1}$. *The public education expenditure $M_t^{h*} = \tau_t^{h*} B_{t-1}$ is strictly increasing in B_{t-1} . Human capital investment does not start under monarchy if*

$$\gamma < \frac{(1 - \alpha)N(1 - \alpha\rho + \alpha\rho\sigma_{T_k}^* - \hat{\sigma}_{T_k})}{\alpha(1 - \alpha\rho)\omega'_2 L} \quad (19)$$

where $\sigma_{T_k}^* = [1 + \tilde{L}(\omega'_2)^{\frac{1-\alpha}{1-\rho\alpha}}]^{-1}$, and $\hat{\sigma}_{T_k} = [1 + (\omega'_2)^{\frac{1-\alpha\rho}{1-\rho\alpha}}]^{-1}$, and $\tilde{L} = (1 - \alpha)(1 - \eta\tau)L_m/L + \eta\tau$.

Proof. The objective function of the elites in period t is

$$\max_{\tau_t^h} I_{e,t} \equiv (1 - \alpha + \alpha\eta\tau)A_t(Nh_t)^\alpha[(1 - \sigma_t^*)^\alpha K_t^{1-\alpha} + L^{1-\alpha}(\sigma_t^*)^\alpha],$$

taking as given $M_{t-1}^h = \tau_{t-1}^h B_{t-1}$, $h_t = f(\frac{M_{t-1}^h}{N})$, and $K_t = B_{t-1} - M_{t-1}^h = (1 - \tau_{t-1}^h)B_{t-1}$. The FOC for τ_t^{h*} is

$$\alpha K_t^* h_t^{*'} - \frac{(1 - \alpha)}{1 - \alpha\rho} N h_t^* (1 - \alpha\rho + \alpha\rho\sigma_t^* - \tilde{\sigma}_t^*) = 0 \text{ if } \tau_t^{h*} > 0, \quad (20)$$

$$\alpha K_t^* \gamma - \frac{(1 - \alpha)}{1 - \alpha\rho} N (1 - \alpha\rho + \alpha\rho\sigma_t^* - \tilde{\sigma}_t^*) \leq 0 \text{ if } \tau_t^{h*} = 0, \quad (21)$$

where $\tilde{\sigma}_t = (1 + (\frac{K_t}{L})^{\frac{1-\alpha}{1-\rho\alpha}})^{-1} \leq \sigma_t^*$ for $\rho \leq 1$, and $h'(0) = \gamma$ and $h(0) = 1$ are substituted in (21). The *LHS* in (21) strictly increases in the total surplus B_{t-1} since

$$\frac{\partial LHS}{\partial B_{t-1}} = \alpha\gamma - \frac{(1-\alpha)}{1-\alpha\rho} N(\alpha\rho \frac{\partial \sigma_t^*}{\partial K_t} - \frac{\partial \tilde{\sigma}_t}{\partial K_t}) > 0,$$

and it would eventually arise to zero at a certain period t_h , after which human capital investment starts. t_h is thus defined by (21) at equality. $\partial M_{t-1}^{h*}/\partial B_{t-1} > 0$ can also be obtained similarly as before.

When γ is too small, human capital investment will start after the elite rule replaces monarchy at T_k . The monarch's total revenue is

$$\begin{aligned} & (1-\alpha)A_t L^{1-\alpha}(\sigma_t N h_t)^\alpha \frac{L_m}{L}(1-\eta\tau) + \eta\tau[A_t L^{1-\alpha}(\sigma_t N h_t)^\alpha + p_t A_t K_t^{1-\alpha}((1-\sigma_t)N h_t)^\alpha] \\ = & A_t L^{1-\alpha}(\sigma_t N h_t)^\alpha \tilde{L} + \eta\tau p_t A_t K_t^{1-\alpha}((1-\sigma_t)N h_t)^\alpha \end{aligned}$$

where $\tilde{L} = (1-\alpha)(1-\eta\tau)\frac{L_m}{L} + \eta\tau$. The FOC to maximize the revenue is

$$\alpha K_t h_t' - (1-\alpha)N h_t [1 - \sigma_t^* + \frac{1}{1-\alpha\rho}(\sigma_t^* - \hat{\sigma}_t)] \leq 0.$$

where $\hat{\sigma}_t = (1 + \tilde{L}(\frac{K_t}{L})^{\frac{1-\alpha}{1-\rho\alpha}})^{-1}$. So human capital investment will not start under monarchy when the above inequality holds strictly at T_k : $\alpha K_{T_k} h_{T_k}' - (1-\alpha)N [1 - \sigma_{T_k}^* + \frac{1}{1-\alpha\rho}(\sigma_{T_k}^* - \hat{\sigma}_{T_k})] < 0$, which leads to

$$\gamma < \frac{(1-\alpha)N(1-\alpha\rho + \alpha\rho\sigma_{T_k}^* - \hat{\sigma}_{T_k})}{\alpha(1-\alpha\rho)\omega_2' L},$$

where $\sigma_{T_k}^*$ and $\hat{\sigma}_{T_k}$ are obtained by using $K_{T_k} = \omega_2' L$. ■

3. The case with $\delta > 0$.

Suppose there exists a storage process that yields δb_{ti} in the next period, where $\delta \geq 0$. This means that the capital return cannot be lower than δ . The optimization problems for the elites and the monarch with regard to human capital investment are the same with $\delta > 0$ as in the basic model, which means Proposition 4 remains unchanged.

New results in **Proposition 3** with $\delta > 0$.

In the political game between monarch and the elites, T_k is uniquely determined by

$$K_{T_k} - \delta\omega_2(L + K_{T_k})^\alpha N^{-\alpha} b_{T_k-1,m}/(1-\alpha)A_t < \omega_2 L_m - L. \quad (22)$$

Proof. The optimization problem is the same as in the basic model; the only difference here is that landlords now share the capital returns with capitalists. The $N_l - 1$ landlords now get a capital return

$\delta b_{t-1,l}$ where $b_{t-1,l} = \sum \max\{I_{t-1,l} - Z, 0\}$, while the monarch's investment return from capital market is $\delta b_{t-1,m}$, where $b_{t-1,m} = I_{t-1,m} - Z$. In any period $t \in (t_k, T_k]$, the joint income of all capitalists is thus

$$I_{tc} = r_t^* K_{ti} - \delta b_{t-1,l} - \delta b_{t-1,m}.$$

The income of the monarch and the joint income of the other landlords are, respectively,

$$\begin{aligned} I_{tm} &= r_t^* (\widehat{L} + \frac{\eta\tau}{1-\alpha} K_t) + (1-\tau)\delta b_{t-1,m}, \\ I_{tl} &= r_t^* (L - L_m) + \delta b_{t-1,l}, \end{aligned}$$

where the market-clearing rate of capital return is

$$r_t^* = (1-\alpha)A_t \left(\frac{N}{L+K_t}\right)^\alpha.$$

The coercive power of the elites is thus

$$\varphi I_t^C = \varphi [I_{tc} + I_{tl}] = \varphi [r_t^* (L - L_m + K_t) - \delta b_{t-1,m}],$$

which increases over time at a faster speed than that of the monarch's $I_t^G = r_t^* L_m + \delta b_{t-1,m}$. The ratio between them is

$$x_t = \frac{\varphi I_t^C}{I_t^G} = \frac{\varphi r_t^* (L + K_t)}{r_t^* L_m + \delta b_{t-1,m}} - \varphi.$$

Since the neutral group's income is $I_t^O = \alpha Y_t = \alpha r_t^* (L + K_t)/(1-\alpha)$, we have

$$I_t^O / I_t^G = \frac{\alpha r_t^* (L + K_t)/(1-\alpha)}{r_t^* L_m + \delta b_{t-1,m}},$$

and the threshold level is

$$\begin{aligned} x_t^*(\theta) &\equiv \omega_0 - \eta(1 + I_t^O / I_t^G) \psi_t^C / \psi_t^G \\ &= \omega_0 - \eta\varphi \left(1 + \frac{\alpha r_t^* (L + K_t)/(1-\alpha)}{r_t^* L_m + \delta b_{t-1,m}}\right). \end{aligned}$$

Then $x_t < x_t^*(\theta)$ boils down to

$$\frac{(L + K_t)}{L_m + \left(\frac{L+K_t}{N}\right)^\alpha \delta b_{t-1,m} / (1-\alpha)A_t} < \omega_2,$$

where the LHS is strictly increasing in K_t because

$$\frac{\partial LHS}{\partial K_t} = \frac{L_m + (L + K_t)^\alpha N^{-\alpha} \delta b_{t-1,m} / A_t}{[L_m + (L + K_t)^\alpha N^{-\alpha} \delta b_{t-1,m} / (1-\alpha)A_t]^2} > 0.$$

So T_k is uniquely determined by

$$K_{T_k} - \delta\omega_2(L + K_{T_k})^\alpha N^{-\alpha} b_{T_k-1,m} / (1-\alpha)A_t < \omega_2 L_m - L.$$

It is easy to see that, when $\delta = 0$, the condition becomes the same as in the basic model. ■

4. The case with an endogenous income tax τ_t^k on physical capital investment.

Suppose the physical capital production function is $k_t = \kappa(\frac{M_{t-1}^k}{N_c}, \tau_t^k)$, where $\frac{\partial k_t}{\partial \tau_t^k} \leq 0$, $\frac{\partial^2 k_t}{\partial (\tau_t^k)^2} \leq 0$ and $\frac{\partial^2 k_t}{\partial \tau_t^k \partial M_{t-1}^k} < 0$. τ_t^k is the tax rate imposed on the income of ruled agents. In each period $t \in (t_k, T_k]$, the monarch first announces τ_t^k , then capitalists produce physical capital according to $k_t = \kappa(\frac{M_{t-1}^k}{N_c}, \tau_t^k)$, and finally landlords decide how much physical capital to rent and how many workers to employ. Their optimal choices are given in Lemma 2, where the total income of the monarch is

$$I_{tm} = A_t \left(\frac{N}{L + K_t} \right)^\alpha [(1 - \alpha)L_m + \eta \tau_t^k (L + K_t - (1 - \alpha)L_m)],$$

where $K_t = N_c \kappa(\frac{M_{t-1}^k}{N_c}, \tau_t^k) = N_c \kappa(\frac{B_{t-1}}{N_c}, \tau_t^k)$ for $t \leq T_k$.

The monarch's objective function is $\max_{\tau_t^k} I_{tm}$. The FOC is

$$(L + K_t)(L + K_t - (1 - \alpha)L_m) + (1 - \alpha) \frac{\partial K_t}{\partial \tau_t^k} \Upsilon = 0,$$

where $\Upsilon \equiv \tau_t^k (L + K_t + \alpha L_m) - \alpha \eta^{-1} L_m$. Note that

$$\begin{aligned} \frac{\partial K_t}{\partial B_{t-1}} &= \frac{\partial K_t}{\partial M_{t-1}^k} + \frac{\partial K_t}{\partial \tau_t^k} \frac{\partial \tau_t^k}{\partial M_{t-1}^k} \\ &= \frac{1 - \alpha}{-SOC} \left[-\frac{\partial K_t}{\partial M_{t-1}^k} \frac{\partial K_t}{\partial \tau_t^k} (L + K_t + \alpha L_m) + \left(\frac{\partial K_t}{\partial \tau_t^k} \frac{\partial^2 K_t}{\partial \tau_t^k \partial M_{t-1}^k} - \frac{\partial K_t}{\partial M_{t-1}^k} \frac{\partial^2 K_t}{\partial (\tau_t^k)^2} \right) \Upsilon \right] > 0, \end{aligned}$$

so K_t is again strictly increasing over time as in the basic model, and thus the main results are robust to the endogeneity of the income tax.

5. Endogenous occupational choice of capitalists.

This is to show that the equilibrium number of operating capitalists, denoted by n_{tk}^* , will increase over time and reach N_c in some period.

Suppose there are n_{tk} operating capitalists in period t . Then the total number of workers is $N + N_c - n_{tk}$.

A landlord i 's objective function is the same as in the proof of Lemma ??:

$$\pi_{ti}^* = \max_{N_{ti}, k_{ti}} A_t (L_i + k_{ti})^{1-\alpha} N_{ti}^\alpha - w_t N_{ti} - r_t k_{ti}.$$

The optimal demands for labor and physical capital are thus determined by

$$\begin{aligned} w_t &= \alpha A_t (L_i + k_{ti}^*)^{1-\alpha} (N_{ti}^*)^{\alpha-1}, \\ r_t &= (1 - \alpha) A_t (L_i + k_{ti}^*)^{-\alpha} (N_{ti}^*)^\alpha. \end{aligned}$$

The labor market clearing condition implies $w_t^* = \alpha A_t \left(\frac{L+K_t}{N+N_c-n_{tk}} \right)^{1-\alpha}$ and $N_{ti}^* = (N + N_c - n_{tk}) \frac{L_i+k_{ti}^*}{L+K_t}$. Plug N_{ti}^* into the condition of r_t we get $r_t^* = (1 - \alpha) A_t \left(\frac{N+N_c-n_{tk}}{L+K_t} \right)^\alpha$, and $k_{ti}^* = \frac{L_i}{L} K_t$ clears the physical capital market. Note that $k_t = B_{t-1}/n_{tk}$ holds since all capitalists have identical skills, and there is free entry among capitalists. Then the return of becoming an operating capitalist is

$$r_t^* k_t = (1 - \alpha) A_t \left(\frac{N + N_c - n_{tk}}{L + B_{t-1}} \right)^\alpha \frac{B_{t-1}}{n_{tk}},$$

which increases in the total bequest B_{t-1} but decreases in n_{tk} . The market wage w_t^* , however, is increasing in n_{tk} . And so the equilibrium n_{tk}^* will equalize $r_t^* k_t$ and w_t^* ; in other words, if we ignore the slight adjustment needed for n_{tk} to be an integral, n_{tk}^* is uniquely determined by $r_t^* k_t = w_t^*$, which is equivalent to

$$(N + N_c) \frac{B_{t-1}}{n_{tk}^*} - \frac{B_{t-1}}{1 - \alpha} = \frac{\alpha}{1 - \alpha} L.$$

Based on this expression, we get $\frac{\partial n_{tk}^*}{\partial B_{t-1}} = \frac{\alpha}{1-\alpha} \frac{L}{B_{t-1}^2} n_{tk}^{*2} / (N + N_c) > 0$, which means that more capitalists switch to physical capital production over time as B_{t-1} is increasing. And sooner or later, $n_{tk}^* = N_c$ will be realized and then we are back to the basic model.

6. Exogenous political transition.

The three threshold conditions for political stability are derived here when the challenging group is assumed to obey the current political rule when $x_t \leq x^*$ and revolt when $x_t > x^*$.

In Proposition 2, the $N_l - 1$ landlords constitute the challenging group, whose relative coercive power is $x_t = \psi(N_l - 1, \bar{e})(L - L_M)/L_M$. So $x_t \leq x^*$ boils down to

$$L_m \geq (1 + x^* \psi^{-1}(N_l - 1, \bar{e}))^{-1} L.$$

In Proposition 3, the challenging group is the elites, whose relative coercive power is $x_t = \frac{\varphi(L+K_t-L_m)}{L_m}$. So $x_t \leq x^*$ is equivalent to $\frac{\varphi(L+K_t-L_m)}{L_m} \leq x^*$, which boils down to $K_t \leq (1 + x^* \varphi^{-1}) L_m - L$, and thus the transitional period T_k from monarchy to oligarchy is uniquely determined by

$$K_{T_k} = (1 + x^* \varphi^{-1}) L_m - L.$$

In Proposition 5, the challenging group is the workers, whose relative coercive power is $x_t = \frac{\psi(N, h_t) \alpha}{\psi(N_c + N_l, \bar{e})(1 - \alpha)}$. So $x_t \leq x^*$ is equivalent to $\frac{\psi(N, h_t) \alpha}{\psi(N_c + N_l, \bar{e})(1 - \alpha)} \leq x^*$, which leads to

$$\psi(N, h_{T_h}) = (1 - \alpha) \alpha^{-1} x^* \psi(N_c + N_l, \bar{e})$$

that uniquely determines the transitional period T_h from oligarchy to democracy.