Working Paper No. 465

Social Institutions and Economic Growth: Why England Rather than China Became the First Modern Economy

by
Avner Greif
Murat Iyigun
and Diego Sasson

January 2013
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January 25, 2013

Abstract

This paper highlights the crucial impact of social institutions on the historical process leading to the modern economy. Social institutions that insure risk-takers and limit violent responses to economic changes influence investment in generating and implementing individually-risky, growth-enhancing new knowledge. The model allows for the possibility that even when social institutions are designed by the elite, social and cultural norms impact their form and that institutional forms matter, particularly due to institutions’ unforeseen consequences. An historical analysis and simulation of an endogenous growth model incorporating England’s and China’s pre-modern social institutions substantiate that distinct social institutions were among the factors rendering England, and not China, the first modern economy.

*Greif: Stanford University. Iyigun: University of Colorado. Sasson: Goldman Sachs. Corresponding author: avner@stanford.edu. This paper benefited from comments by Lee Alston, Andy Baker, David Brown, Karen Clay, Saumitra Jha, Pete Klenow, Joel Mokyr, and participants in seminars at Stanford, Berkeley, University of Colorado, Universidad Torcuato di Tella, and the 2011 IEA Meetings in Beijing. We gratefully acknowledge Max Floetotto and Weisi Xie’s superb research assistance. Avner Greif thanks the Canadian Institute for Advanced Research (CIFAR) for support.
1 Introduction

This paper substantiates that social institutions play a crucial role in long-run growth by examining why England, rather than China, became the first modern economy. Social institutions determine access to economic opportunities and provide social safety nets thereby influencing investment in human capital, initial endowments, and innovations. In particular, growth-promoting social institutions prevent violent, innovation-inhibiting reactions from the economic agents threatened by economic change. The role of social institutions in economic growth has largely been unrecognized in the literature on growth that has mainly focused on either endowments (broadly defined) or legal, political, and economic institutions.¹

Specifically, this paper makes three amendments to the convention that institutional development is a precursor of sustained economic growth. First, it establishes the importance of social institutions in the rise of the modern economy. Second, it demonstrates that social and cultural factors impact the design of institutions with which they subsequently coevolve. Although social institutions have often been chosen by the elite to avoid social upheavals, their forms were influenced by pre-existing cultural and social factors. Third, institutional forms matter. Social and cultural elements not only constrain the design and function of formal social institutions, but also impact long-run economic outcomes.²

China was the most technologically advanced economy prior to its decline in the second half of the last millennium.³ Its economic growth was fueled and sustained by productivity-enhancing innovations but, by the 19th century, the number of important innovations in China was less than six percent of its 16th century level (Chen and Soylu, 2004, Table 7.1). This decline—the so called "Needham puzzle"—is typically explained by China’s endowment or rigid political institutions and ideology (Lin, 1995). However, the decline in Chinese innovations coincided with deteriorating social order: cases of severe civil disorder—those unrelated to wars or rebellions—rose from the 15th century onward in China and, by the 19th century, it was 55 times higher.⁴ That England experienced the opposite trends suggests that risk-sharing institutions influenced economic growth and sustained development by maintaining social order and encouraging risk-taking in

¹Legal institutions govern contractual relations and the private use of force, political institutions guide the political decision-making process, and economic institutions govern interactions among economic agents. For recent contributions see, for example, Acemoglu, Johnson, Robinson (2000, 2001), Greif (2006), North, Wallis and Weingast (2009).
²The latter two points are also made in Greif (1994, 2006). On the relations between culture and institutions, see, for example, Zak and Knack (2001); Rodrik, et. al. (2004); Helpman (2004); North (2005); Tabellini (2005); Guiso, Sapienza and Zingales (2006).
³GDP, grain per-capita, and tax: Brandt et al. (2011), Tables 1 and 2.
⁴Tong (1991). Table 5.5: 14th to 17th centuries (collective violent actions); Table 3.7: 18th to 19th centuries (from 1845 and 1846 to 1911; mass action incidents). Also see p. 72 for a discussion of possible biases.
innovative entrepreneurship.

In pre-modern economies productivity-enhancing innovations required risky experiments. The prevailing risk-sharing institutions, however, were aimed at alleviating poverty and not fostering innovations. Thus, the risk-sharing institutions chosen by the elite took distinct institutional forms in China and England as they were influenced by pre-existing cultural and social factors. Kinship-based, risk-sharing institutions evolved in the collectivist, lineage-based Chinese society while in the more individualistic English society, the Church provided social safety nets prior to the Reformation after which the state, charity organizations and self-insurance associations became more important.

Embedding these distinct institutional forms in an OLG ‘technology transition’ endogenous growth model enables an evaluation of their importance. The model captures the complex process of risky experimentation, learning, and spillovers in a simple set-up in which each agent has to choose between two technologies. The ‘traditional,’ technology is less likely to generate new knowledge but is less risky. The ‘risky’ technology is more risky, although it is also more likely to generate new knowledge. New knowledge, if discovered, increases the capital productivity of the agent who discovers it and, subsequently, it also increases others’ productivity. Positive externalities imply that the risky technology is chosen less than socially optimal. In particular, due to decreasing relative risk aversion, poor agents select the traditional technology and, if sufficiently many agents are poor, a transition does not transpire and the economy stagnates.

As in some conventional growth models, ours highlights that the relatively wealthy (the elite) can decide to pursue risky innovations. Our model also captures, however, that in pre-modern societies the wealthy generally sought stability fearing that changes would trigger violent responses by those adversely affected. We capture the relation between new knowledge and violence by embedding into our model a boilerplate production versus appropriation trade-off, according to which economic agents use their resources to appropriate wealth (when the returns to this activity exceed that of production). This specification captures the notion that the return to the poor from attempting to appropriate wealth increases in income inequality. In other words, inequality increases the expected gains for the poor from investing their resources in extralegal means (that is, in using force to capture others’ income). The implied threat of appropriation, in turn, reduces the incentives of the wealthy for developing and implementing new knowledge.

\[^5\text{Without loss of generality, we focus on capital productivity rather than human capital to capture choices with positive externalities (e.g., cultivation techniques).}\]
\[^6\text{The elites may, however, be averse to growth if it threatens their political control (e.g., Acemoglu and Robinson. 2000).}\]
\[^7\text{To the best of our knowledge, this causal relation between technology-driven growth and violence has so far escaped attention in the growth literature, although there are some theoretical contributions which emphasize the link between predation and capital accumulation (see, for example, Grossman and Kim,}\]
Thus, risk-sharing institutions that reduce the net gains from banditry and are financed by wealthy individuals increase the expected returns from discovering and implementing new technologies.

Simulations and historical analyses confirm the importance of the exact form through which risk-sharing was provided—not the level of risk-sharing per se—which then determined how much socially beneficial risk-taking was induced. On that basis, our numerical calibrations and simulation results are consistent with the empirical pattern of initial Chinese lead and subsequent English leadership. China’s lineage-based institutions probably implied more risk-sharing prior to the introduction of the Old Poor Law (1601) that rendered the state responsible for supporting the poor in England. Yet, relative to the Old Poor Law, the clan-based system was ineffective in promoting risk-taking because lineages’ elders had, by law and custom, strong influence on technological choices made by younger members of the society. Age matters for risk taking because older people tend to be more risk averse than younger ones. Thus, the lineage-based institution led to less risk taking than if the young were in charge.8

If the Chinese and the English institutions had supplied the same level of risk-sharing, we find that an eleven percent initial difference between the risk aversion of the young and the old would have been sufficient to prevent China from transitioning to a modern economy. In contrast, to initiate a transition, the Chinese institutions would have had to provide, roughly speaking, about twice the risk sharing of the English institutions.9 China’s growth stalled not because it lacked risk-sharing institutions. It stalled because its risk-sharing institutions did not sufficiently foster risk-taking.

This analysis is further confirmed by accounting for otherwise puzzling historical details. It explains, for example, the relatively low levels of violence during the English

8Empirical analyses based on contemporary data show that the elders are more risk averse. Einav and Cohen (2007) found that risk aversion declines after the age of 18 and increases after the age of 48. See also Graham, Harvey, and Puri (2008); Halek and Eisenhauer (2001); Riley and Chow (1992). Early 20th century decisions by Chinese peasants regarding crops and labor were influenced by risk aversion (Wiens, 1976), while in the modern economy, low risk-aversion fosters entrepreneurship (van Praag and Cramer, 2001).

That noted, it is possible that the link between age and risk aversion is spurious, and more of a manifestation of changes in risk aversion driven by differences in the consumption patterns and habits of the old versus the young. We are agnostic on this point, because our model does not ride on the assumption that older people are simply more risk averse. As we shall elaborate further below, we can accommodate preferences such that individuals become more risk averse in old age not because they are old but, for instance, due to their higher consumption habits.

9Risk sharing here is measured as a reduction in the standard deviation of innovations in the process of productivity compared to the individualistic economy. See the model for details.
transition despite major economic and social transformations such as the enclosure of the open fields, urbanization, and industrialization. These implied redistributions of property rights, social dislocation, elimination of previously rewarding occupations, and transition to wage labor. Although some social unrest transpired, it paled in comparison to those in, for example, China, France, or Russia. Informatively, there was much more violence in other parts of the United Kingdom—Scotland and Ireland—whose institutions provided less insurance to the poor. We shall return to this issue below where we relate, more generally, to the relevant economic history literature.

In Greif and Iyigun (2012, 2013), we empirically document that the Old Poor Law, which was enacted in England in 1601, effectively subdued social disorder, thereby encouraging risk-taking and stimulating innovations. A county-level panel data (England, 1650 to 1818 CE) of poor relief, innovations and social unrest reveals a positive, significant and large coefficient when disorder is regressed on poor relief. The same panel also reveals a positive, large, and statistically significant coefficient when innovations is regressed on poor relief. Because the transition to the modern economy began long before the Industrial Revolution it is re-assuring to find these relations prior to 1750 CE.

Our theoretical analysis also contributes to endogenous growth theory. In the model developed here, whether a transition transpires depends only on the choice of institutions at the social level and choices involving risk-taking and violence at the individual level. With few exceptions, neither neoclassical nor modern growth models can similarly explain an endogenous transition to modern growth.\(^\text{10}\) For instance, multiple-equilibria models invoke accidents (Galor 2005, pp. 176-7) while endogenous transition models “are built around a positive rate of technological change, either simply assumed or generated as an equilibrium outcome by the assumption of [for example] constant or increasing returns to the accumulation of knowledge” (Lucas, 2002, p. 110).

Analyzing the adoption and evolution of different social risk-sharing institutions bridges the view that economic transitions are due to luck and the view that transitions are inevitable. Transitions transpire when ‘luck’ creates the conditions under which economic agents find it beneficial to make the choices leading to a positive rate of technological change.\(^\text{11}\) Luck did not come in the form of a random draw of knowledge or wealth but in the form of historical processes leading to risk-sharing institutions whose unintended consequences encouraged productivity-enhancing risk-taking. Transitions were conditional

\(^\text{10}\) A notable exception is Galor and Weil (2000). However, their emphasis in garnering the transitions from stagnation to epochs of sustained economic growth revolves around the interplay between technological progress and demographic change.

\(^\text{11}\) Previous works in economic history have focused on an endowment windfall due to discoveries (e.g., Pomeranz, 2000), better informal contract enforcement institutions and the enlightenment (Mokyr, 2006), and higher mortality rates which increases per-capita incomes (Voigtländer and Voth, 2006, forthcoming).
on having risk-sharing institutions that increased their rates of productivity growth.\footnote{On the role of risk taking in economic growth, see, for example Hausmann and Rodrik (2003), Iyigun and Rodrik (2005), and Iyigun and Owen (1998, 1999).}

The rest of the paper is organized as follows: Section 2 substantiates the importance of risky experiments for innovations in the pre-modern period and presents our benchmark model of risky entrepreneurship, technological change and endogenous growth. Section 3 presents evidence for and models the relations between violence, risk-sharing institutions, and growth. Section 4 presents the details of China’s and England’s risk-sharing institutions and extends the basic model to capture those distinctions. Section 5 presents our simulations and main numerical findings. Section 6 reviews a variety of other empirical implications and elaborates on their relevant historical support. Section 7 concludes.

2 Risk-taking and Innovations

Risky experimentation was the main source of new productivity-enhancing knowledge in the pre-modern era. This section substantiates this claim, models it and presents the conditions under which risk-sharing institutions are necessary for growth.

2.1 History: Risky Experimentation and Useful Knowledge

England’s transition to a modern economy manifested itself in new useful knowledge embodied in multiple technological, organizational, and social changes that directly increased production and/or productivity. Among these changes were the putting-out system, enclosures, canals, turnpikes trusts, drainage projects, the factory system, the New Husbandry, and urbanization.

The narrow epistemological basis of useful knowledge implied that it was mainly gained through experimentation, micro-inventions, and small improvements (Mokyr, 1990, 2002; Allen, 2009). "Experimentation was ... the common feature" that characterized inventions during this time (Allen, 2009, p. 255). Experimentation is reported in 62 percent of the important inventions of the English Industrial Revolution. Wedgewood, for example, is known for his 5,000 experiments and similar to him, second- and third-tier inventors experimented much (ibid, pp. 252-3). About 150 years earlier, Bennet Woodcroft, the first technical expert in the 19th century GB Patent Office, similarly noted "almost all the inventions on which her [Britain] colossal system of manufactures has been founded have been produced by individual projectors, mostly poor and of obscure condition, toiling unaided" (1863, p. vii).

The knowledge generated by experimenting—by ‘deviating’ from the conventional ways of ‘doing things’—was socially beneficial but individually risky. The high personal risk
associated with developing new knowledge in the pre-modern period is suggested by the observation that inheritances left by English entrepreneurs (from 1700 to 1850) are "consistent with the intuitively appealing hypothesis that entrepreneurs in the modern sector suffered a higher failure rate" (Mokyr, 2006, p. 31).

In Woodcroft’s (1863) words, the inventors work "on projects which ... can not advance their own interest without, at the same time, opening ways of wealth to the community. Many of these enthusiasts have, no doubt, perished unknown, destroyed by encountering difficulties ... thousands have wasted their labour and funds on machines ... unsuited for practice" (p. vii).

2.2 The Benchmark Model: Risk Taking and Economic Growth

Intuitively, the existence of risky experiments with positive externalities implies that growth may fail to occur in a poor society in the absence of appropriate institutions. The following benchmark model formally substantiates that stagnation might prevail in a poor market economy in which economic growth depends on risky ventures. Although, strictly speaking, the model is about technological change, it captures, more generally, any risky behavior that generates new useful knowledge such as new technologies, organizational knowledge, internal migration or participation in arms-length labor markets.

2.2.1 The Basics

Consider the following full information, OLG model. There is a continuum of agents in \([0, \frac{1}{1-\lambda}]\) each of whom is young for two periods and is old for the rest of her life. An agent might die with probability \(1 - \lambda\) at the beginning of each period and an agent who dies is immediately replaced.\(^{13}\) An agent is a ‘newly born’ in his first period, a ‘young adult’ in the second, and an ‘elder’ thereafter. Standard models let agents be young for only one period. Yet, the relevant choice in our model is next period’s capital productivity, which is driven by the utility function in that period. If agents were young for only one period, we could not capture age-dependent risk preferences.\(^{14}\)

Denote by \(u^y\) the utility function of a young agent (either newly born or young adult), by \(u^o\) the utility function of an old agent and by \(\beta\) the discount factor. The utility functions

\(^{13}\)Our analysis abstracts from fertility in order to demonstrate that things do not depend on time-dependent variables and changes in relative prices. This implies, however, that we have to ignore fertility-related facts. We agree that fertility issues are important, but our focus is on the effects of risk-sharing institutions and we leave potential linkages between fertility and risk sharing for future work. Moreover, capping population growth in this manner biases the analysis against our argument.

\(^{14}\)Alternatively, we could have changed the timing of moves and let agents first make their technological choices, then have the productivity realizations, and finally let agents produce. But this would have implied that young agents had to make decisions before they were born.
are defined over income and are increasing, concave, (twice) continuously differentiable, satisfying the Inada conditions and having decreasing relative risk aversion (DRRA).15

Ignore, for the time being, appropriation risk (which we shall incorporate in subsection 3.2 below). Only newly born agents can produce and each newly born is endowed with one indivisible unit of labor which they can only use to operate their own plant. Production also requires capital. The per-period production function of each newly born’s plant is:

\[ y = (Ak)^\alpha, \]  

where \( A \) is capital productivity, \( k \) is capital units, \( Ak \) is the units of effective capital and \( \alpha < 1 \) is the capital share. At the end of her first period, a newly-born agent divides her income between consumption and saving in the form of capital. Young adults and elderly agents rent out their capital, consume, and save. Capital depreciates at rate \( \delta \) per period.

A newly born is endowed with the previous period’s average capital productivity and depreciated average capital level.16 This ‘inheritance’ creates inter-generational spillover effects in our fertility-free model.17

Each agent \( i \) uses, by default, the prevailing ‘traditional’ technology and, due to idiosyncratic variations among the agents, might be able to learn something new about how to productively use it. This serendipitous knowledge revelation may be either beneficial or harmful implying, respectively, a higher or lower future productivity of agent \( i \)’s capital.18 But each agent learns potentially more from intentionally experimenting with and improving upon the traditional technology. Experimentation is costly in the period in which it is carried out, although for simplicity we ignore this cost focusing only on the impact of experimentation on future productivity of capital. And although experimentation implies higher expected future capital productivity, it is also more risky in leading the agent along the wrong path of capital utilization.

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15Specifically, the utility function for individual \( i \) is given by:

\[
U\left( C^i_{\tau+t}\right) = \sum_{t=0}^{\infty} \sum_{s_{\tau+t+1}} \pi \left( s_{\tau+t+1} | s_{\tau+t-1} \right) \left( \beta \lambda \right)^t u^\alpha \left( c^i_{\tau+t} \left( s_{\tau+t} \right) \right) + \sum_{t>1} \sum_{s_{\tau+t}} \pi \left( s_{\tau+t} | s_{\tau+t-1} \right) \left( \beta \lambda \right)^t u^\alpha \left( c^i_{\tau+t} \left( s_{\tau+t} \right) \right)
\]

where \( S \) is the space of states of the world, \( s_{\tau+t} \) is the state of the world at time \( \tau + t \), \( \pi \left( s_{\tau+t+1} | s_{\tau+t-1} \right) \) is the conditional Markovian probability, \( c^i_{\tau+t} \) is the consumption of agent \( i \) of generation \( \tau \) in period \( \tau + t \) and \( C^i_{\tau+t} \left( s_{\tau+t} \right) \) represents every possible consumption value for each state of the world conditional on survival.

16The analysis is robust to reasonable alternative specifications such as one in which a newly-born individual’s initial capital equals that of someone she replaces.

17An alternative specification is that capital fully depreciates upon one’s death and there is no intergenerational capital bequest. We simulated this model too and our results remained qualitatively the same. This is because \( \delta \) is already so large that the effect of the additional depreciation becomes of second order.

18In principle, we can set this new-knowledge impact to be nil.
Specifically, the traditional technology, \( \tau \), implies an expected increase of new knowledge of \( \mu_\tau \) and a variance of \( \sigma_\tau^2 \). Experimentation, by contrast, is associated with an expected increase of useful knowledge of \( \mu_\epsilon \) and a variance of \( \sigma_\epsilon^2 \), where

\[
\mu_\tau < \mu_\epsilon, \quad \sigma_\tau < \sigma_\epsilon. \tag{2}
\]

Productivity of agent \( i \)'s capital next period, \( A_{i,t+1}^j \), depends on her current productivity, \( A_{i,t} \), the return on the technology she chooses, \( \mu_j \), and an individual-level idiosyncratic shock, \( \varepsilon_{i,t,j} \). Specifically, we assume that the logarithm of productivity follows a random walk with drift as in

\[
\log A_{i,t+1}^j = \log A_{i,t}^j + \mu_j + \varepsilon_{i,t,j} \tag{3.a}
\]

where the distribution of the idiosyncratic shock for technology \( j \) is

\[
\varepsilon_{i,t,j} \sim F: \{F: F^\sim (0, \sigma_j^2)\} \quad \text{where} \quad j = \tau, \epsilon. \tag{3.b}
\]

### 2.2.2 Analysis: Growth and Stagnation in a Market Economy

Let this be a small open economy with a fixed, state independent rental rate of capital, \( r \), and recall that a newly born agent produces by combining her labor with capital. The profit-maximizing level of effective capital units is therefore \( Ak = \left( \frac{\alpha}{\sigma} \right)^{\frac{1}{1-\alpha}} \). Although all newly born agents have the same endowment, denote, for ease of exposition, the capital productivity and capital of a newly born agent \( i \) born at time \( t \) by \( A_{i,t} \) and \( k_{i,t} \), respectively. If a newly born is endowed with less than the optimal units of effective capital, \( \left( \frac{\alpha}{\sigma} \right)^{\frac{1}{1-\alpha}} \), she rents \( A_{t,k_t} \) units on the market and otherwise rents her excess capital in the market. The maximization problem for the newly born is

\[
\text{max}_{A_{t,k_t}} \left( A_{t,k_t} \right)^{\alpha} - rA_{t,k_t} \]

implying the profit function of newly born agents in period \( t \) is

\[
\pi_t \left( A_{i,t}^j, k_{i,t}, r \right) = \left( 1 - \alpha \right) \left( \frac{\alpha}{\sigma} \right)^{\frac{1}{1-\alpha}} + rA_{i,t}^j
\]

which is continuous and linearly increasing in the agent’s initial capital \( k_{i,t} \) and capital productivity \( A_{i,t}^j \).

Given the agent’s stock of capital and her productivity at the beginning of a period, she chooses a technology and how much to save. All individuals—including the young adults and the old who do not directly engage in production—decide in every period whether or not to alter their technology in an attempt to upgrade their capital productivity. Thus, when newly-born agents rent capital on the market, rented capital comes coupled with a
technology chosen by the owners of capital.

Recall that the capital productivity of a young adult and an elder can differ due to individual-specific past outcomes. For simplicity, however, we present the optimization problem of an agent \( i \) of cohort \( I \) at time \( t \). Denote by \( J^i_{k,t} \) and \( k^i_{t+1} \) the technological and saving decisions, respectively, of agent \( i \)'s cohort \( I = 1, 2, 3 \) (a newly born, young adult, and elderly respectively) in period \( t \). Note that \( k^i_{t+1} \) equals her net capital plus saving at the end of period \( t \).

Denote by \( V^{i,k}_{k,t} \) the value functions of such an agent. The dynamic programming problems are (using superscript \( m \) to denote a market economy):

\[
V^{i,m}_{1,t}(A^i_t, k^i_t) = \max_{k_{t+1}, J^i_{1,t}} u^y(\pi_t(A^i_t, k^i_t, r) - (k^i_{t+1} - (1 - \delta) k^i_t)) + \beta \lambda E \left[ V^{i,m}_{2,t+1}(A^i_{t+1}, k^i_{t+1}) \mid A^i_t, J^i_{1,t} \right] \tag{4.a}
\]

\[
V^{i,m}_{2,t}(A^i_t, k^i_t) = \max_{k_{t+1}, J^i_{2,t}} u^y(\tau r A^i_t k^i_t - (k^i_{t+1} - (1 - \delta) k^i_t)) + \beta \lambda E \left[ V^{i,m}_{3,t+1}(A^i_{t+1}, k^i_{t+1}) \mid A^i_t, J^i_{2,t} \right] \tag{4.b}
\]

\[
V^{i,m}_{3,t}(A^i_t, k^i_t) = \max_{k_{t+1}, J^i_{3,t}} u^y(\epsilon r A^i_t k^i_t - (k^i_{t+1} - (1 - \delta) k^i_t)) + \beta \lambda E \left[ V^{i,m}_{3,t+1}(A^i_{t+1}, k^i_{t+1}) \mid A^i_t, J^i_{3,t} \right] \tag{4.c}
\]

Decreasing relative risk aversion implies that sufficiently poor agents (those with low \( A^i_t k^i_t \)) adopt the traditional technology while sufficiently wealthy agents choose experimentation. If initially there are sufficiently many poor agents, the average productivity of capital is low enough to make the traditional technology optimal for subsequent generations. If, however, initially there are sufficiently many wealthy agents who adopt experimentation, their choice has a positive inter-temporal spillover; it increases the initial capital productivity of the newly born. This process of higher capital productivity reinforces itself and eventually every agent employs the risky technology. Hence, technological choices have an external effect on productivity growth and either the \( \tau \) or the \( \epsilon \) technology can perpetuate in equilibrium.\(^{19}\)

\(^{19}\)Similarly, increasing returns to scale in the endogenous growth literature implies that higher income per capita leads to higher productivity levels, which itself increases income per capita and reinforces growth
Experimentation Pareto dominates the traditional technology because shocks are agent specific and there is no aggregate uncertainty.\textsuperscript{20} It is, hence, Pareto optimal for all agents to experiment and share the output, thereby gaining from its positive inter-temporal spillover effects. But this is predicated on the assumption that production uncertainty solely stems from technology choice. With this in mind, we next capture the role of extralegal appropriation and its commensurate uncertainties in entrepreneurial calculus.

3 Violence, Appropriation Risk and Innovations

In an economically unequal society, innovations can negatively impact the livelihood of those who did not take risk. Expecting poverty, those negatively affected might respond violently thereby rendering unprofitable the investment in generating new knowledge. Expecting such an outcome, an innovator would not invest to begin with. This section first argues that contemporaries in pre-modern China and England were cognizant of the risks of poverty and the appropriation risk caused by economic changes. It then extends our model to capture the links between appropriation and innovations.

3.1 History: Social Safety Nets and Social Order

The working people of pre-modern England were aware of poverty risk as evident in the proliferation of mutual insurance organizations. In the early 16th century, the majority of England’s rural and urban population belonged to fraternities and guilds that provided social safety nets (Richardson, 2005). Friendly Societies were later common and in 1803 more than 35 percent of the households in England were members in at least one society. In 18th century Yorkshire county, 15 parishes had at least 144 societies with 5737 members implying one member per every four households (calculated from Eden, 1797, vol. 3, pp. 811-890). Members included “almost every manufacturer” (ibid, p. 874) in the parish of Wakefield, “several shop-keepers, and respectable trade-men,” in Surrey-Epson (ibid, pp. 697-700) and, more generally skilled workers such as bakers, carpenters, tailors, butchers, watchmakers, white-smiths, and paper-makers.

The fear of poverty and destitution was the main source of social unrest in England during its transition (which included the agricultural revolution, the transportation revolution and the Industrial Revolution, to name a few). The four largest rebellions under the Tudor, and the only ones with more than 10,000 participants, were wholly or partially in

\footnote{For a proof, see Kocherlakota (1996) or Ligon, Tomas, and Worral (2000). Since the endowment is state invariant in the economy and there is perfect risk sharing, agents will have constant consumption across states. Since total endowment is larger with the high-risk, high-return technology, agents will have a higher state-invariant consumption with the latter technology.}
response to threats on peoples’ livelihood. (The Cornish revolt of 1497, Kett’s Rebellion in 1549, the Pilgrimage of Grace, and the Lincolnshire rising in 1536.) The link between economic change and social order manifested itself in the 16th century legislation aimed at preventing and reversing enclosures of open fields.

More generally, social disorder was mainly caused by economic concerns involving labor-saving machinery, food prices, wages, and enclosures. About 50 percent (51/101) of the significant riots and protests from 1770 to 1806 fall in this category and four percent (4/101) were concerning taxation.21 In China, civil disorder was also mainly about livelihood. We know the causes of 484 collective protests against the state from 1740 to 1839 and of these 43 percent were concerned with the right to pursue an economic activity, get a higher wage, or obtain cheaper food, while an additional 16 percent were concerned with taxation (Hung, 2011, table 2.3).

"Vagrancy was one of the most pressing problem of" the Tudor and early Stuart (Beier 1985, p. xix) and violence due to poverty was perceived by contemporaries a threat to social order. Such perception is expressed, for example, by Sir Matthew Hale, the Lord Chief Justice of the Kings Bench who published a book concerning poverty in 1683. Hale recommended to invest heavily in eradicating poverty in England because it undermines “public wealth, and peace” (p. 7) as the poor engaged in “thieving and stealing, ... cutting and destroying of woods, pulling of hedges, and [trespassing] to corn” (p. 58-9). An earlier student of poverty, writing in 1646 estimated that although there were only "80,000 idle vagrants" they "prey upon the commonwealth" thereby causing great damage. Specifically, in addition to a yearly maintenance cost of £88,740.12s.6d they also cause £365,000 in damages (cited in Eden, 1797, vol. 1, p. 167). Taken together, these sums amount to about 50 percent of the king’s revenue from direct and indirect taxes in 1640.22

The links between poor relief and socially beneficial economic change, however, seem to have been recognized only by the end of the 18th century. In his 1797 book on poverty, Sir F.M. Eden explicitly recognized the trade-offs between poor relief and socially beneficial economic changes. He argued that enclosures, “manufactures and commerce are the true parents of our national Poor” (vol. 1, p. 60-1). Moreover, “any ... machines or contrivances calculated to lessen labour ... throw many industrious individuals out of work; and thus create distresses that are sometimes exceedingly calamitous. Still,... [they] promote the general wealth, by raising the largest quantity of provisions, or materials for manufacture” (ibid, p. xiv). Poor relief can be used so that "their inconvenience to individuals will be softened and mitigated, indeed, as far as it is practical" (ibid).

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21 Data and calculations available from the authors upon request.
alternative is stagnation. Relief should "by no means ... counteract any new plans of improvement, ... If this were not the proper line to pursue, it must be confessed, the Turks alone are right, in not suffering a printing-press to be introduced into their dominions, merely because one of it’s immediate- effects would be, the depriving many thousands of unoffending, industrious, hackney writers, of their usual means of earning a livelihood” (ibid).

Risk-sharing institutions can thus facilitate economic transitions by fostering social order and reducing the likelihood of violent responses from those who would be economically disadvantaged by economic changes. Social institutions can thus increase the expected return from risk-taking activities leading to new useful knowledge.

3.2 Extension 1: Social Order and Risk Taking

We now extend our benchmark model to incorporate appropriation risk. For historical consistency, we assume that there is no market for insurance. Nevertheless, we recognize not only that risk-sharing relates to the allocation of resources between production and appropriation, but also that risk-sharing institutions differ in whom they confer decision rights. Our specification will thus enable us, in Section 4 below, to compare an individualistic economy in which there is appropriation risk but no income-risk insurance with one in which there is state-based insurance or lineage-based insurance.23

Suppose that newly born individuals have an alternative use of their one unit of labor time, which, together with their efficiency units of capital, they can allocate to either extralegal appropriation or production.24 Let \( \rho_t \) represent the fraction of the newly born who choose to engage in appropriation at time \( t \). Those individuals target the rest of the population (i.e., all the young adults and the elderly, as well as the newly born who choose production over appropriation). But they can appropriate only the contemporaneous return to capital or profits. In other words, we assume that capital ownership is secure and cannot be appropriated, while the income streams generated from capital are up for grabs in every period.

In deciding whether or not to engage in production versus appropriation, the newly born consider their return from extralegal appropriation net of its opportunity cost. The latter is defined by forgone earnings from production at time \( t \), which equals \( \pi_t \left( A_i^t, k_i^t, r \right) = \left( 1 - \alpha \right) \left( \frac{r}{r} \right)^{\frac{-\alpha}{r}} + rA_i^tk_i^t \) for a newly born individual \( i \) at time \( t \). Thus, the opportunity cost of extralegal means would be lowest for those who possess low incomes—either because

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23 Markets prevailed in pre-modern China, of course, but our focus is on the non-market relations among members of lineages.

24 Keep in mind that, for newly born agents, production involves operating their own plants and, for young adults and the old, it comprises of renting out their capital to the newly-born.
their stock of capital is low, or their adopted technology is inferior, or both. Accordingly, *ceteris paribus*, the poorest $\rho_t$ fraction of the newly born would engage in extralegal means.

Following standard convention, we employ a contest success function in order to determine the gross return from extralegal activities. Hence, letting $B$ represent the technology of appropriation and $b_t$ denote the total amount of capital devoted to appropriation, we have

$$\Gamma_t = \frac{Bb_t}{1 + Bb_t!}.$$  \hspace{1cm} (5)

Equation (5) represents the fraction of the targeted income that is eventually appropriated by those who engage in extralegal appropriation.\(^{25}\) Hence, the success of appropriative activities is increasing in the total amount of resources devoted to it, $b_t$, and in the technology of appropriation, $B$. In deciding their mode of economic action, note that each newly-born individual $i$ takes $b_t$ as given, which in turn makes $\Gamma_t$ given.

Those who engage in appropriation target all returns to production.\(^{26}\) Hence, letting $G_{It}$ denote the cumulative distribution function of the efficiency units of capital of cohort $I$, $I = 1, 2, 3$, in the economy at time $t$, and $\widetilde{A}_t k_t$ representing the capital-technology duo that leaves the newly born indifferent between production and appropriation, we have

$$\int_0^{\widetilde{A}_t k_t} G'_{1t}(x)dx = \rho_t,$$ \hspace{1cm} (6.a)

as the fraction of newly born at the bottom end of the wealth distribution who specialize in extralegal appropriation. And,

$$\int_{\widetilde{A}_t k_t}^{\infty} G'_{1t}(x)dx + \int_0^{\infty} G'_{2t}(x)dx + \int_0^{\infty} G'_{3t}(x)dx \equiv 1 - \rho_t + \frac{\lambda}{1 - \lambda},$$ \hspace{1cm} (6.b)

which defines the measure of society targeted by extralegal appropriation.

Using (5), (6.b) and (6.a), and assuming that the captured profits are shared equally among those who pursue extralegal means, the net return to extralegal appropriation at

\(^{25}\) Alternatively, equation (5) denotes the probability that the targeted income is fully captured by appropriation, according to which those who are specialized in production avoid losing any of their income with $1 - \Gamma_t$ probability. We have chosen not to employ this interpretation due to the fact that it would also require us to adjust the utility functions to express conditional expected utilities. In any case, our choice does not have a qualitative bearing on the findings.

\(^{26}\) The contest success function we employ here is most parsimonious in that it excludes reasonable other factors, such as resources that the ‘target’ could devote to defend their property or wealth and the technology of defense. With more complicated but realistic contest success functions, it is possible that, under some parameter values, the wealthiest individuals wouldn’t be targeted by those who choose to devote their resources and time to extralegal means.
time $t$ equals, $\forall i = 1$,

$$
\frac{\Gamma_t}{\rho_t}\left[(1 - \alpha) \left(\frac{\alpha}{\tau} \right)^{\frac{1}{1-\alpha}} \int_{\frac{A_t k_t}{x}}^{\infty} G'_{1t}(x) dx + r \left(\int_{\frac{A_t k_t}{x}}^{\infty} xG'_{1t}(x) dx + \int_{0}^{\infty} xG'_{2t}(x) dx + \int_{0}^{\infty} xG'_{3t}(x) dx\right)\right] - \left[(1 - \alpha) \left(\frac{\alpha}{\tau} \right)^{\frac{1}{1-\alpha}} + rA_t^i k_t^i\right] \geq 0.
$$

Ceteris paribus, (3.2) is more likely to be positive for more individuals in more unequal economies (those with higher $\sigma_j^2$’s) and with sufficiently effective technologies of appropriation (those with high $B$’s). In economies with inherently higher income risk, inequality is higher. In such economies, not only the income of the target population—the expression in the first line of (3.2)—is relatively larger, but also the opportunity cost of appropriation—the term in the second line of (3.2)—is relatively lower for more newly born at the lower end of the capital distribution. And when (3.2) is satisfied for more of the newly born, the risk and cost of appropriation, captured in this formulation by $\Gamma_t$, comes to bear more heavily on the decisions of those engaged in productive activities.

An equilibrium is then defined such that (i) those who choose to engage in production solve (4.a) through (4.c) subject to the fact that income from productive activities are appropriated at the rate $\Gamma_t$; (ii) (3.2) holds as a strict equality when $A_t^i k_t^i$ equals $\widetilde{A_t^i k_t^i}$; (iii) (5) and (3.2) provide the two equations to simultaneously determine $\rho_t$ and $\widetilde{A_t^i k_t^i}$; and where (iv) $b_t = \int_{0}^{\infty} xG'_{1t}(x) dx$.

3.3 Analysis: Equilibria & Endogenous Risk-Sharing

In every given period $t$, there are three possible equilibrium outcomes in such economies. First, there is an appropriation equilibrium, with the poorest $\rho_t$ fraction of the newly born pursuing extralegal, appropriative means, the $1 - \rho_t$ fraction engaged in production and all of the young adults and the elderly renting out their capital to the productive newly born. In such an equilibrium, there is always some appropriation and all producers and capital owners face a positive risk of income appropriation every period.

Two additional equilibria exist although they require some coordination among those potentially targeted by appropriation: In the risk-sharing equilibrium, they coordinate to tax themselves and use the proceeds for transfers to the poorest $\rho_t$ fraction of the newly born. In such an equilibrium, the per-person amount of transfers to the poor newly born
are such that (3.2) is non-positive for all of the poorest \( \rho_t \) newly born. Accordingly, there is no appropriation in this equilibrium, with the sufficiently rich producers and capital owners choosing to experiment with high-risk technologies.\(^{27}\)

But, in an attempt to limit appropriation risk, the rich could also coordinate among themselves to suppress experimentation with high-risk technologies. In this case, which we label as the *coordination-cum-stagnation equilibrium*, there is no tax-and-transfer scheme. Instead, income growth and risk among the rich as well as wealth inequality in society is limited because coordination among the rich ensures that they all employ the low-risk and low-return technology. This, in turn, lowers the gross return from extralegal appropriation—given by the first term of the equation in (3.2)—and serves to reduce appropriation incentives among the poor.\(^{28}\)

Together with the capital distribution and the technology of appropriation given in (5), the costs of coordination would determine which of the three equilibria would hold. If the appropriation risk is relatively high (because the incomes of the poor are low relative to the wealthy) and the technology of appropriation is potent (such that \( B \) in (5) is fairly large), but coordination among the rich or those engaged in production is not prohibitively costly, then either the *risk-sharing* or the *coordination-cum-stagnation equilibrium* would emerge. Furthermore, even if the coordination costs of the two latter equilibria are similar, the risk-sharing equilibrium is dynamically efficient, whereas the *coordination-cum-stagnation equilibrium* is not. Hence, as long as the coordination costs of the risk-sharing equilibrium are not much higher than the *coordination-cum-stagnation equilibrium*, the former is more likely to emerge as the equilibrium.

Recall that, with DRRA, poorer agents adopt the traditional technology while wealthier ones choose experimentation. If initially there are sufficiently many poor agents, then average capital productivity is low enough to make no experimentation optimal for subsequent generations as well. If, however, initially there are sufficiently more wealthy agents who adopt experimentation, their choice has a positive inter-temporal spillover effect; it

\(^{27}\)According to (3.2), the transfer amount that would dissuade each individual from choosing appropriation is individual specific, depending on the wealth of each individual. Thus, if transfers cannot be individual specific, then an identical amount of transfer to all poor individuals would suffice to eliminate appropriation risk, as long as the transfer amount is determined by (3.2) evaluated for the wealthiest among the \( \rho \) fraction of the economy. And while we assume that a risk-sharing system targets to eliminate appropriation altogether, it could be reduced up to the point where the social marginal cost of the income transfers equals their marginal benefit.

\(^{28}\)One other possibility is that the rich coordinate to fend off extralegal appropriation by investing in defensive activities. The simple appropriation technology we consider here in (5) leaves no room for such choice. Nevertheless, more generally, it is resources invested in appropriation versus those invested against it that decides the contest success function shown in (5). Then, there could be another equilibrium in which the rich tax themselves and devote resources to defend against extralegal appropriation. For a model of extralegal appropriation and production with offensive as well as defensive fortifications, see Grossman and Kim (1996). For a discussion, also peruse Bates, Greif, and Singh (2002).
increases the initial capital productivity of the newly born. This process of higher capital productivity reinforces itself and eventually every agent employs the risky technology.

In the absence of appropriation risk, experimentation Pareto dominates the traditional technology because technology shocks are agent specific and there is no aggregate uncertainty regarding the choice of technologies. Thus, without appropriation risk, it is Pareto optimal for all agents to experiment with new technology and share the output, thereby gaining from its positive intertemporal spillover effects. But, when agents who decide to engage in production risk extralegal appropriation, it is possible that the threat of appropriation, in and of itself, becomes a source of economic stagnation. In that case, the adoption of a risk-sharing mechanism is necessary—but, by our key argument, not at all sufficient—to set the economy on a path of sustained economic growth. Sustained economic growth clearly cannot materialize in the coordination-cum-stagnation equilibrium, while it cannot be ruled out in an appropriation equilibrium. And, due to serendipitous entrepreneurial manifestations of different-risk sharing systems, a risk-sharing equilibrium would not necessarily involve sustained economic growth.

Risk-sharing institutions can therefore determine whether an economy remains in a traditional-technology equilibrium or exhibits a transition to the experimentation equilibrium. In our model, a society can remain trapped in a low-growth equilibrium in the absence of an appropriate risk-sharing institution. If a risk-sharing institution is introduced, it unambiguously will help to curb appropriation risk. That, in turn, could induce a larger fraction of the agents to adopt experimentation and the increase in wealth can reinforce the adoption of the risky technology, up to the point where all agents experiment.

The political economy literature has long emphasized the risk of extralegal appropriation and the threat of violent conflict as important motives for redistributive policies that were supported by the political and economic elite. And while this exposition is agnostic in terms of the specific social arrangements that could emerge in a risk-sharing equilibrium, the cultural and institutional constraints presumably dictated the specific social form of the risk-sharing arrangements that emerged (i.e., kin-based versus non-kinship risk-sharing). With this in mind, we consider two specific social forms of the risk-sharing arrangements that could emerge in equilibrium.

4 Risk-sharing and Risk-taking in History and Theory

Throughout history, social institutions have been created to share risk, maintain social order, and help those in need (more on which below). Nevertheless, because their growth implications were unforeseen, risk-sharing institutions were not designed to promote growth. It is therefore appropriate to consider the forms of these risk-sharing institutions as exogenous while modeling their impact on growth. Institutional forms were endogenous with respect to pre-existing cultural and social features.

This section substantiates that clans, dominated by their elders, prevailed in premodern China and provided social safety nets. Hence, in China more economic choices involving risk-taking were made by the elders. By contrast, in England this was initially done by the Church and, after 1601, the main risk-sharing institutions were state-based (or based on non-kin organizations).

4.1 History: Social Structures

By 1000 CE, social structures in England and China had already differed. In England, generally speaking, there were no large, kin-based social structures such as lineages and tribes. In China, clans were a basic social and cultural unit, a position they held to the modern period.30

The decline of large, kin-based social structures in Europe was due to policies of the late Roman Empire and the Church (e.g., Mitterauer et. al., 1982; Goody 1983; Herlihy 1985; Ekelund et al., 1996; Greif 2006). The Church, for example, prohibited polygamy, restricted marriages among the kin, often up to the seventh degree, and prohibited unions without the bride’s explicit consent.

The reasons motivating this policy is beyond the scope of this paper, but it should be noted that the outcome was not pre-determined. In particular, the Germanic people reinforced kinship-based structures after the fall of the Roman Empire. The (Germanic) Salic law of the 6th century denied legal rights to anyone not affiliated with a large kinship group. By the 8th century, nevertheless, tribes and lineages, by and large, were no longer institutionally relevant (Guichard and Cuvillier, 1996). By the 10th century, the English King issued a law mandating every male to join a group that would guarantee his appearance in court, suggesting that kinship groups could no longer be held accountable as was the case when the Salic law was specified. Similarly, English court rolls from the 13th century reveal that cousins and non-kin were similarly likely to be in each other’s presence (Razi, 1993). Only about 10 percent of the households had a resident kin (Laslett, 1969, 30See Greif and Tabellini, (2010, 2012) for a discussion of the literature and the analyses of these cultural and institutional equilibria.
Kin-based social structures in pre-modern China remained culturally, socially, politically, and economically prominent well into the modern period. Indeed, the ideology and practice of patrilineal descent, filial pity, and ancestral worship was the hallmark of Chinese culture (e.g., Freedman, 1958). Furthermore, social and economic relations were commonly kinship-based and lineages provided members with local public goods such as protection and education (e.g., Hamilton, 1990). The state, whose magistrates were positioned at the county level and above, operated under the "presumption of collective liability of lineage members for each other’s conduct and debts" (Rowe, 1998, p.382).

The Chinese kin-based social structures evolved over time and were not uniform across different regions. In particular, there was a gradual shift from communal families to lineage organizations. The communal family is the kinship group referred to most during the Tang (618-690 CE, 705-907 CE) and the Song (960-1279 CE) dynasties. This was a domestic unit that had not divided—in terms of property or membership—for five, six, or even ten generations. Some communal families included hundreds and even thousands of members. The state praised communal families as an ideal form of organization and supported exceptional ones through tax exemptions. Given the complexity of supporting, organizing and maintaining the coherence of such large groups, really large communal families must have been relatively rare and they seem to have gradually vanished.

From the Song dynasty (960-1279 CE) onward, lineage organizations became common. These looser associations of relatively large numbers of kin "were the predominant form of kinship organizations in late imperial China" (Ebrey and Watson, 1986, pp. 1, 6; Watson, 1982). Detailed information on the share of the population with lineage affiliation is not available, but lineages were common in southern China, less common at the center and least common in northern China.

In addition, those with sufficient means often maintained large households, either in the form of a ‘stem’ or an extended family. A stem family included parents and at least one married son and his family and averaged ten people (Fei and Liu, 1982). The extended family encompassed members of several families related through the male line. Members often lived in a family compound, had common property and an internal dispute-resolution mechanism. Such larger households were culturally esteemed and economically beneficial to their members, practically because they consolidated assets and local political power.

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31 This discussion draws particularly on Smith (1987); Ebrey and Watson (1986); Szonyi (2002); Freedman (1958); Watson (1982); Liu (1959).

32 By tracing clans’ life-cycle, Fei and Liu (1982, p. 399) concluded that the critical maximum size (CMS) of a lineage is about 1,400 males and females which is about 300 families. Abramitzky (2008) presents an empirical analysis of contractual problems in large, risk-sharing organizations.
under family control.

Comparing household structures in England and China highlights the prominence of parents in an adult son's life in China. In one hundred English communities in which 70,255 people lived from 1574 to 1821, the proportion of households with three or more generations was 6.8 percent (Laslett, 1969, Table 14, p. 219). In China, the percentage of stem-family households was between 30 to 35 percent as late as the 1970s (Sheng, 2004, p. 101). Moreover, “although most married couples ... have their own houses near their parents' homes, and they may also officially be registered as individual households, they do not normally consider themselves as separated from parents' families” (Sheng, 2004, p. 104). The meaning of this is well expressed in clan rules printed in the early 20th century. Filial piety means that the son "should do nothing to cause them [his parents] worry" (Liu, 1959, p. 51).

In China, the preferences of the elders thus had a large and institutionalized influence on economic actions by young adults. Sons, even married ones, were expected to live in their parental household as long as their father was alive. During that time, all income was to be pooled under the control of the father. “A typical clan rule states the ideal: “one should turn over to his parents his salary, income, land, and house. When he needs money, he should ask his parents for it” (Liu, 1959, p. 64). In sharp contrast, adult sons were not under their fathers’ authority under English law and customs, long before the 17th century.

4.2 History: Risk-Sharing Institutions

In Europe, prior to the 16th century, secular and religious organizations—monasteries, fraternities, mutual-insurance guilds, and communes—assisted the poor or their members in times of need (e.g. Reynolds, 1984; Brenner, 1987; Archer, 1991). They provided individuals with such services as poor relief and unemployment and disability assistance. In the early 16th century, the majority of the commoners in England belonged to fraternities and guilds that provided social safety nets (Richardson, 2005). Getting relief from these risk-sharing institutions was, however, uncertain as they were either provided by charity organizations (e.g., by the Church) or cooperatively financed by working people without much wealth.

Population growth and urbanization during the 16th century pressured this system of poor relief. Matters got worse when, during the Wars of Religion, rulers confiscated the property of many welfare-providing organizations. In England, Henry VIII dissolved the monasteries in 1536-40 and shut down all religious guilds, fraternities, almshouses, and hospitals in 1545-49. These actions "destroyed much of the institutional fabric which had provided charity for the poor in the past" (Slack, 1990, p. 8).
The lack of an effective poor relief system and population growth pressured wages and increased poverty. States responded by demanding local administrative bodies, such as parishes and cities to support the needy. In England, the first tax to support the poor was introduced in 1572 but the Poor Law Act of 1601 (the Old Poor Law) formalized the system which lasted, with some modifications, until 1834. Each parish was authorized and obliged to levy a property tax to care for the poor (Boyer, 1990).

Private relief remained important in England and was encouraged by the state. The Statute of Charitable Uses (1601) was aimed at encouraging charitable gifts and protecting the funds from misuse. Moreover, a 1597 law holding parents and children responsible for each others’ support was extended, in 1601, to include grandparents and grandchildren. Thus relatives, friends, charity organizations and Friendly Societies were important sources of support (e.g., Dyson, 2009; Ben-Amos, 2008). Yet, 1601 marked the beginning of an era in which the state was a major provider of poor relief.

Shifting the responsibility for poor relief to the state (via local administrators) was a European phenomenon and poor relief systems similar to England’s were established elsewhere (Geremek, 1997; de Vries and de Woude, 1997, pp. 654-664). Yet the English Poor Law system was more reliable and generous than the continental ones. In England, expenses were financed through a variable poor rate on the assessed rental value of local real estate property and most aid was given without forcing the recipient to move to the poor house. Continental poor relief, by contrast, was financed from a variety of sources: voluntary donations, capital income, subsidies from local and national governments, and general tax revenues. Funding was, therefore, less reliable. Furthermore, the legal right to relief was well defined in England while rights were vaguely defined, less credibly assured, and generally at the discretion of local authorities on the continent.

Annual spending on poor relief in England was about 1 percent of national income in the 17th century and peaked at about 2.5 percent during the 19th century. At that time, it supported about 11 percent of the population and may have boosted average incomes of the bottom 40 percent by 14 to 25 percent. Expenditure per capita in England was 7.5 times higher than in France in the 1780s, 2.5 times higher than in the Netherlands in the 1820s, and 5 times higher than in Belgium in the 1820s. England’s exceptionality reflects distinct needs in the late 16th century when these systems were created. While peasantry and other ‘customary’ labor relations that insured the poor still dominated in other European states, the transition to wage laborer had already begun in England.

Those who financed the Poor Law had no legal rights to influence risk taking. Moreover, farmers who took risks (by specializing in grains) had the political power to transfer the cost of insurance on to others (Boyer, 1986).


On these and other aspects of the system see, for example, Boyer (1986); Slack (1990); Solar (1995); Kelly and Ógrada (2008). Patriquin (2006) compares the English case with those of Scotland and Ireland.
When enacted, the Poor Law improved welfare. The elasticity of mortality with respect to real wages was negative and statistically significant from 1540 to 1640 but it was basically zero from 1640 to 1740.\textsuperscript{36} The improvement was due to better poor relief, and not higher real wages, reduced variance of grain output, increased urbanization, or changing climate (Kelly and Ógrada, 2008). Mortality rates of non-elite declined (ibid) while in China it was stable during this period (Lee and Feng, 1999). Better nutrition, to which the Poor Law contributed, "should be regarded as one in a battery of factors, often interacting, which played a key role in Britain’s mortality transition" (Harris, 2004, p. 380).\textsuperscript{37}

Imperial China also experienced great diversity and changes in its poor relief institutions. The state sporadically financed general or medical aid to the old, poor, sick, and disabled. Buddhist monasteries and temples provided medical service, fed the hungry, and sheltered the aged and decrepit. Their support, however, was uncertain as they fed any poor including ‘undeserving’ ones. Benevolent societies were established after 1580, particularly by members of the mercantile elite and the gentry. Yet their forms and functions were often rigid and did not adjust to various needs.

In China, the major source of aid to the poor, the sick, and the aged were kinship groups.\textsuperscript{38} A prominent 17th century Chinese scholar and administrator explains: "Confucius once observed that it is not poverty itself which leads to the disaster [of class warfare], but rather inequality. Now, the implementation of the lineage system is designed to stimulate the basic human impetus to share foodstuffs on the basis of seasonal need, and to foster the collective husbanding of resources to smooth over good and bad years. [When the people adhere to this properly] there will be no need to rely upon government action to care for the destitute, the orphaned, and the ill. ... It was for this reason above all that the ancient rulers instituted the lineage system" (Rowe, 1998, p. 383).

The role of communal and extended families in providing insurance is transparent from their internal organization. In such families, all property was held in common and the "underlying principle was distribution of income to all members equally according to need, just as though they were members of a small family" (Ebrey and Watson, 1986, p. 33). The young provided labor while the elders controlled all assets and had the legal and customary rights to make communal decisions.

\textsuperscript{36}Nicolini (2007); information from Parish’s registers is available from 1540. See Landers (1987) about London.

\textsuperscript{37}The role of better nutrition in mortality decline has been particularly emphasized by McKeown and his co-author and surveyed in Harris (2004). Smith (2008) emphasizes the positive role of the Poor Law in reducing risk of labor migration.

\textsuperscript{38}This discussion particularly draws on Smith (1987); Ebrey and Watson (1986); Szonyi (2002); Freedman (1958). We are not familiar with any quantitative analysis of these kinship organizations’ relative importance.
In many respects, the lineages were the functional successors of communal families. They similarly exerted considerable legal and customary control over their members, provided them with public goods such as education, held common property, and acted as social and political units. A lineage "performs many functions related to education, ceremony, social security, and maintenance of law and order. Whereas now most of these functions are performed by the government, the clan was a primary social group through which these functions were carried out before the art of government was perfected" (Fei and Liu, 1982, p. 375).

After the 11th century, lineages were the most common and reliable source of poor relief in China. The first lineage charitable estate was established by Fan Chung-yen (989-1052 CE). Although such estates were considered by the state and their members as lineage property, they were controlled and managed by the elders of the lineage’s prominent families. Income was used to finance lineage rituals and provide members with education, income, and support for weddings, burials, and illness. Members in poverty received additional benefits such as free lodging. Here too elders had important decision-making roles.

The next subsections extend the analytical framework to incorporate the above institutional distinctions. These extensions then enable us to explore the roles of the Chinese and English social risk-sharing institutions in these countries’ distinct trajectories of economic development.

4.3 Extension 2: State-based Insurance (the Old Poor Law)

Regardless of the social institutions involved—be it state- or clan-based—relief to the poor could have distorted technological choices and the allocations of capital and labor if it had to be financed through taxes on the factors of production. The Old Poor Law, however, was financed by a tax on land. Taxing a fixed factor acts as a quasi lump-sum tax and it is therefore reasonable that distortions were relatively small. The evidence confirms that this was the case. According to Clark (2008) estimates that the Old Poor Law was not distortive. Personal and commercial wealth was not taxed. To the extent that the Poor Law thereby led to an allocation of more resources toward commerce and industry, it had an additional favorable impact on industrialization.

Another way to model the Poor Law is to truncate shocks below a certain threshold:
\[ \sigma_{j,PL}^2, \ j = \tau, \epsilon \text{ and assume that:} \]

\[ \varepsilon_{t,j}^{PL} F_{PL} \text{ with } \left\{ F_{PL} : F_{PL}^{-\left(0, \sigma_{j,PL}^2\right)} \right\} \]

(8.a)

with \( \sigma_{j,PL}^2 < \sigma_j^2 \) (8.b)

The Poor Law thus had two effects on entrepreneurial decisions: On the one hand, it directly reduced the income risk associated with experimentation in new technologies. That is, an entrepreneur was now better afforded failure if and when he made the riskier technology choice. On the other hand, the net expected return to entrepreneurial ventures rose because the Poor Law eliminated the risk that part of the return from risky experimentation was captured by extralegal appropriation.

In principle, both of these effects encouraged experimentation and reduced the capital productivity levels above which agents adopted the risky technology. Formally, denote these thresholds of capital productivity levels in the market economy by \( (A^m_y, A^m_o) \) for the newly born and the rest of the agents respectively before the Poor Law, and by \( (A'^{PL}_y, A'^{PL}_o) \) after the Poor Law. The reduction in risk implies that \( A'^{PL}_y < A^m_y, A'^{PL}_o < A^m_o \).

42 See proof in Appendix A.

By reducing the threshold levels above which agents adopt the risky technology, the

\[ \varepsilon_{t,j}^{PL} F_{PL} \text{ with } \left\{ F_{PL} : F_{PL}^{-\left(0, \sigma_{j,PL}^2\right)} \text{ and } \sup_{\mathbf{F}} [-t_{PL}, t] \right\} \]

where \(-t_{PL} > -\ell, F(-t_{PL}) > 0 \) and \( F_{PL}(x) = F(x) \ \forall x > -t_{PL} \)

Since \( E(\varepsilon_{t,j}^{PL}) > 0 \), this modeling of the Poor Law implies both a change in the risk structure and wealth. To keep the introduction of the Poor Law wealth neutral, we prefer modeling it as a reduction in the volatility of the shocks.

41 The risk of destitution for most innovators was likely to be low, but new winds carried even some previously wealthy individuals to poverty.

One such individual was William Radcliffe, a Derbyshire ‘improver of cotton machinery,’ who apparently died poor after a roller-coaster career; another was Samuel Hall, a cotton-spinner and engineer who died in ‘very reduced circumstances’ (Mokyr, 2006, p. 31). Perhaps the most spectacular example of a failed wealthy entrepreneur was the highly eccentric Archibald Cochrane, earl of Dundonald, who spent his family’s fortune on his ill-fated chemical business. Somewhat comparable was the case of Henry Fourdrinier, a well-to-do London stationer who gambled on the main innovation in paper-making of his age, spent £60,000 on the business and failed in 1810. Both Cochrane and Fourdrinier are thus examples of a significant negative private return on entrepreneurship (Mokyr, 2006, pp. 24-5).

More generally, even previously well to do individuals sometimes had to rely on poor relief. In the late 18th century “a decayed Gentleman” of 75 years, “a certain number of old persons, of respectable conditions, which have, through mere misfortune, been reduced to poverty,” and skilled-workers families such as white-smith, butcher, shoemaker, and a blacksmith were getting public assistance (Eden 1797, vol. II, p. 7, 31; vol. III, 713). Moreover, 1.5 percent of vagrants arrested between 1620 and 1640 were defined as being gentlemen (Beier 1985, p. 224).

42 It is sufficient to focus on the newly born and the elders because the threshold for the young adult and the elderly are the same. The choice of the technological regime impacts next period utility, with both the current young adults and elder agents having the same preferences.
Poor Law could have initiated a transition that otherwise would not have taken hold. The simulations below lend support to the argument that the Old Poor Law had such impact. Before turning to those simulations, however, we address the comparative question: couldn’t an equivalent lineage-based insurance system have been similarly effective in initiating a transition? As it was practiced in China, our answer is ‘no’.

4.4 Extension 3: Clan/Lineage-based Insurance

The distinct assignment of decision rights were associated with the Chinese lineage-based institution and the English Poor Law. Under lineage-based insurance, elders had more decision rights over technological choices than they had under the English Poor Law. The following extension of the model captures this notion.

A lineage, $\Gamma$, is a finite group of agents of different generations that pool their endowments, share the output they produce and communally decide which technology to use. Accordingly, we assume that the elders determine the technological choice and the capital accumulation within each lineage. Formally, the evolution of the capital stock for the average lineage is $k_{t+1}^\Gamma = k_t^\Gamma (1 - \delta) + h_t^\Gamma$ where $k_t^\Gamma = \sum_{i\in\Gamma} k_t^i$ and $h_t^\Gamma$ is investment at time $t$. Since each lineage has a finite number of agents, even initially identical lineages will subsequently differ in their per-period mortality and membership. We therefore model the dynamics of an average lineage, whose demographics are identical to that of the population as a whole. The average lineage is composed of $\frac{N}{N-1}$ agents. For each newly born agent, there are $\lambda$ young adults and $\frac{\lambda}{N-1}$ elderly agents implying an expected number of $N^{\frac{N}{N-1}}$ agents.

Capital and labor are matched within the lineage and output is divided, without loss of generality, equally among members. Each member obtains $\frac{1}{N-1}$ of the total production. To maintain comparability with the individualistic society and to capture insurance provided by the lineage, we assume that the capital of each lineage’s member is still subject to individual-level idiosyncratic shocks. The variance of the productivity shock that such a lineage faces is $\frac{N}{N-1}$ times smaller than the variance of any given technology.$^{43}$

Lineages provide insurance. Insurance provided by the lineage, everything else being

\[ A_t^\Gamma K_t^i = \sum_{i\in\Gamma} \frac{A_t^i K_t^i}{N}. \]

For sake of simplicity we assume that, for each newly born, there are $\sum_{i\in\Gamma} \frac{A_t^i K_t^i}{N}$ units of effective capital. Note that since the production function is decreasing in units of effective capital, dividing the units of effective capital evenly across the newly born agents is the most efficient allocation (and bodes well for our analysis focusing on the average lineage). Also note that the lineage’s variance is $\frac{N}{N-1}$ times smaller than an individual shock only if shocks are independent across lineage members and also if all members have the same units of effective capital. We will take the most comprehensive case of insurance in the lineage and then compare it to the individualistic, market economy.

\[ \text{43} \]

The stock of units of effective capital per lineage is $(A_t^\Gamma K_t^i) = \sum_{i\in\Gamma} A_t^i K_t^i$. For sake of simplicity we assume that, for each newly born, there are $\sum_{i\in\Gamma} \frac{A_t^i K_t^i}{N}$ units of effective capital. Note that since the production function is decreasing in units of effective capital, dividing the units of effective capital evenly across the newly born agents is the most efficient allocation (and bodes well for our analysis focusing on the average lineage). Also note that the lineage’s variance is $\frac{N}{1-\lambda}$ times smaller than an individual shock only if shocks are independent across lineage members and also if all members have the same units of effective capital. We will take the most comprehensive case of insurance in the lineage and then compare it to the individualistic, market economy.
equal, makes a transition more likely. Lineage-based insurance, similar to the Poor Law reduces risk and therefore the capital productivity levels above which agents adopt the risky technology. Formally, denote these thresholds, when there is insurance, by \( (A_{y}, A_{o}) \). Everything else equal, the lineage-based insurance might be as effective in promoting risk taking as the Poor Law.

But not everything was equal and, in the case of China, elders had more decision rights than others. Accordingly, the elders determine the choice of technology and the capital accumulation within each lineage. Hence, only the problem of the elders matters for the derivation of a clan’s optimal policies. The value functions for the newly born and the young adults are determined by the elders’ investment choice and there is full insurance—equal consumption, at least for each cohort—within the clan.\(^4^4\) The elders’ decision can be summarized in recursive form as before:

\[
V_{3,t}^{\Gamma} (A_{t}, k_{t}) = \max_{k_{t+1}, J_{3,t}} u^{\alpha} \left( (1 - \lambda) \left( (A_{t}^{\Gamma} k_{t}^{\Gamma})^{\alpha} - (k_{t+1}^{\Gamma} - (1 - \delta) k_{t}^{\Gamma}) \right) \right) + \beta \lambda E \left[ V_{3,t+1}^{\Gamma} (A_{t+1}, k_{t+1}^{\Gamma}) | A_{t}, J_{3,t} \right]
\]  

Since the elders are more risk averse than the young, they would choose, ceteris paribus, the traditional technology in situations in which the newly born agents would be indifferent between the \( \tau \) and \( \epsilon \) technologies. As we show in Appendix A, different choices are likely for ‘intermediate’ levels of capital productivity. Nevertheless, two opposite forces emerge in the lineage-based society. On the one hand, insurance within the lineage fosters risk taking. On the other hand, the elders’ higher risk aversion discourages risk taking. Which force would dominate and whether the lineage-based insurance promotes growth is then an empirical matter.

5 Simulations

The absence of data prevents us from conducting an empirical analysis. In the context of our model, however, we can use simulation analyses to answer the following questions:

1. Could differences in decision making rights inherent in these social structures have affected risk-taking in a quantitatively significant way?

2. Could the resulting differences in risk-taking account for England’s transition and China’s stagnation?

\(^4^4\) All elders will make the same choice given that each considers the clan’s total effective capital.
3. Could changes in income inequality and their commensurate risks of appropriation account for the emergence of social insurance structures, such as the English Old Poor Law and Chinese clan-based networks?

Our simulations suggest an affirmative answer to all three questions although one has to keep in mind that other factors—such as the security of property rights—are assumed in the model also favor growth. On this basis, our findings support the conjecture that good social institutions were necessary, rather then sufficient for an economic transition.

5.1 Parameter Choices

Table 1 lists the parameters chosen for our baseline simulations. In calibrating our model, we resort to historical evidence in choosing our parameters wherever possible. In the absence of such evidence, we set the parameters, when reasonable, to values that are standard in the literature. We calibrate the remaining parameters to render the model consistent with the observed long-run growth trajectory prior to the transition in England.

5.1.1 Demographic Structure

Each period lasts twenty years. Agents are referred to as newly born in the 0-19 cohort, young adults in the 20-39 cohort and elderly for the rest of their lives. Agents die and exit the model with a per-period probability, \( 1 - \lambda \), of 0.5. This is consistent with the high rates of pre-modern mortality before adulthood and implies that an agent’s expected working life is thirty years. Given that, as late as the early 19th century, life expectancy at birth was about 40 years, this seems to be a sensible assumption. The probability of being older than 100 years is 3.125 percent. This is clearly unrealistic, but keeping an unconditional death probability simplifies the model and keeps the issue of fertility as silent as possible.

5.1.2 Preferences

As explained in detail in the previous section, our mechanism hinges on the agents’ decreasing appetite for risk at lower levels of wealth or old age. One way to ensure that is with a utility function that exhibits DRRA and higher risk aversion for the elders. We choose a standard CES utility function that is augmented by a minimum level of (subsistence) consumption that varies by age. The risk aversion parameter, \( \omega \), is set to 5 which is within the range of risk aversion coefficients used in macroeconomics. We assume

\[45\] In early nineteenth century China (the Yangzi Delta), male life expectancy at 15 was between 30 to 54 years (Liu, Cuirong, 1992 cited by Brenner and Isett, 2002). In our model, the probability of being older than 100 years is 3.125 percent. This is clearly unrealistic, but keeping an unconditional death probability simplifies the model and keeps the issue of fertility as silent as possible.
Stone-Geary preferences with a higher minimum consumption for the old to endogenize differences in risk preferences. Specifically, we use the following utility function where the exponent $a = \{y, o\}$ signifies the agent’s age:

\[ u^a = \frac{(c - \bar{c}^y)^{1-\omega} - 1}{1 - \omega} \]  

(10.a)

The coefficient of relative risk aversion $R$ varies by age and the agent’s level of consumption:

\[ R^a = \omega \left( \frac{c}{c - \bar{c}^a} \right) \]  

(10.b)

We assume that there is no minimum consumption requirement for the young, hence $\bar{c}^y = 0$. The minimum consumption requirement for the elderly is set at a higher value of $\bar{c}^o = 0.06$. This specification leads to a moderate difference in risk aversion between the young and the old when the steady state consumption per capita is the same across societies. (Namely, before the poor law is established.) In that steady state, the risk aversion coefficient for the young is 5 and only 11.3 percent higher for the elders, at 5.58.

5.1.3 Technological Choices

As set in equation (3.a), the logarithm of $A$ follows a random walk with drift. For each technology, we thus have to calibrate the drift term as well as the variance of its innovations. For the traditional technology, the average growth rate is set to zero, $\mu_r = 0$, to reflect the absence of sustained growth before the Industrial Revolution. In the early stages of the English Industrial Revolution (roughly from 1780 to 1820), the annual income per-capita growth rate increases to a value just below 0.5 percent (Maddison 1991). Accordingly, we assume that experimentation has a per-period return of $\mu_e = 10.5$ percent which implies a 0.5 percent return a year.

The innovations in $A$ are assumed to be uncorrelated both across agents and time and normally distributed with a mean of zero. The standard deviation of innovations for the

As a side note, we have already stated in footnote 7 on page 3 that there could be economic fundamentals behind individuals getting more risk averse in old age. In that vein, an alternative to the specification in (10.a) is a CES utility function with habit formation in consumption, where

\[ u^a_t = \frac{(c_t - c_{t-1})^{1-\omega} - 1}{1 - \omega}, \]  

(11.a)

with the coefficient of risk aversion now being equal to

\[ R^a_t = \omega \left( \frac{c_t}{c_t - c_{t-1}} \right). \]  

(11.b)

As long as $r < 1$, the optimal consumption path would be upward sloping, making individuals relatively more risk averse with age.

In the simulations discussed below, we shall employ the specification in (10.a), although other simulations in which we use the utility in (11.a) yielded qualitatively similar results.
low-risk technology is set at a low value of 0.015. The standard deviation of innovations for experimentation is then set at a value of 0.19 which implies slightly more than a tenfold increase. This value is chosen to reproduce the historical evidence of stagnant growth in the baseline case and a take-off in England after the introduction of state-based insurance through the Poor Law.

Under the system of clan based insurance in China, the standard deviation of innovations can be directly linked to the size of the clan which determines the number of agents who pool resources and thus partially insure each other. There is some historical evidence on the size of a typical clan. While a stem family had, on average, ten members with about six working adults (Liu, 1959, pp. 2-3), a clan could reach a size of more than 1000 adults. Fei and Liu (1982, p. 387) report a ‘critical maximum’ size of 1400 adults and note that clans disintegrated beyond that size. Their effectiveness in assisting their poor members, most likely, declined long before reaching their maximum size for two reasons. First, effectiveness declined as members of the clan lived further away from each other. Second, clans usually supported their needy members by using the income from a trust set up for this purpose early in the clan’s history. As the clan grew in size, the support per-pauper was likely to decline. In the same book, Fei and Liu report numbers for a typical clan with an average of 144 male adults.47 In the context of our model, this implies a clan size of 288 male members which yields a value of 144 for the parameter $N$ which denotes the number of newly born male members. Under our assumptions, the standard deviation of shocks to the lineage is given by $\sigma^{CH} = \sigma N^{-0.5} (1 - \lambda)^{0.5}$.48

Turning to the case of England, the Poor Law itself provides partial insurance against those shocks. This is captured by the parameter $\varphi_{PL}$ that determines the standard deviation of innovations under the Poor Law as a share of the standard deviation in the baseline case such that $\sigma_{PL} = \varphi_{PL} \sigma$. As we are lacking a strong empirical prior on how to calibrate this parameter, we set it at a value that exactly equalizes the variance of innovations in China to those in England under the Poor Law. In that sense, we calibrate the model such that both methods of insurance alleviate the shocks agents are confronted with by the same degree. To achieve this end, we set this parameter at 1/17.

The remaining parameters are chosen as follows: We set the annual discount factor to 0.975 which implies a discount factor in the model, $\beta$, of 0.603 per period. The capital share $\alpha$ is 1/3 and the depreciation rate $\delta$ is set to 0.543, implying a 3 percent annual depreciation. Based on the historical interest rates reported in Homer and Sylla (1998), we set the interest rate $r$ to an annual value of 4.5 percent which yields a 141 percent return

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47 Of the clan’s 481 members, 60 percent were adults. Hence, we are left with 144 male adults.
48 We performed a comparative static analysis where we increase the number of agents per lineage. Not surprisingly, the more agents were present in the lineage, the more inclined the lineage was to engage in the risky technology.
every twenty years. For the effectiveness of appropriation, captured by the parameter $B$ in equation (5), we work within a range of 0.1 to 6.

## 5.2 Simulations

### 5.2.1 The Setup

The problem of the elderly can be solved as a standard infinite horizon consumption-saving problem that is extended by the endogenous choice of technology. Given the value function of the elderly, we can solve the model backwards. The problem of the young adults can be solved in a single iteration where each young adult cohort uses the elder cohort’s value function as a continuation value. This allows us to derive optimal policies for the young adults and the elderly. For the newly born we do the same, but also allow for the choice between production versus appropriation. In the case of China, the problem is even easier and reduces to solving the problem of the elderly, who decide for the whole clan taking into account the fact that the risk-sharing inherent in the operation of the clan eliminates appropriation.

With the optimal policies at hand, we can simulate an economy inhabited by a large number of agents. As outlined above, every agent who dies is replaced by a newly born agent who enters the model with the average capital stock and productivity as the surviving agents in the economy or the clan, respectively. The initial capital stock and productivity values are chosen to prevent $A^t_i$ from becoming negative. This economy is simulated for a large number of periods until it reaches its stationary distribution.

We then model the introduction of the Poor Law and the clan-based Chinese system as a reduction in the variance of innovations to the productivity process. In terms of the simulations, this is achieved by simply using the appropriate policy functions and transition matrix.

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49 We use value-function iteration on a grid for capital and productivity. The process for productivity is approximated as a finite state Markov process using a variant of the approximation method developed by Tauchen (1986) and Tauchen and Hussey (1991). We use a very wide grid to prevent artificial mean reversion at the bounds of the grid. In addition, we approximate the value function outside the grid for productivity using a spline approximation.

50 As we close the model with an exogenously assumed interest rate, the number of agents in each generation does not affect the results other than to provide smoothing across simulations. The graphs depicted in this paper come from a simulation that uses 10,000 agents.

51 Alternatively, one could assume that the Poor Law is introduced gradually. There is evidence that the insurance provided by the Poor Law reached different parishes at different times reaching all of England only around 1700. In terms of our model, the only difference would be a smoother transition to the growth path.
5.2.2 Results

In every period, agents who specialize in production choose between the \( \tau \) and \( \epsilon \) technologies. The optimal choices can be represented graphically as shaded areas in the \((A, k)\)-space. Figures 1 and 2, for instance, show the combinations of productivity and capital for which the elderly and the newly born choose the different technologies, respectively. For the elderly, the shaded area at the lower left represents the adoption of the traditional technology while the white area denotes the adoption of experimentation in \( \epsilon \). For the newly born, the dark shaded area at the bottom left corner of the figure delineates the combinations of \((A, k)\) for which agents forgo production in favor of extralegal appropriation. A comparison of the two figures illustrates that agents with a relatively low capital stock and a low level of productivity are less likely to choose experimentation despite its higher expected growth rate. Moreover, when comparing Figures 1 and 2, it becomes clear that the elderly are less willing to take risks. This is simply a result of their larger risk aversion implied by the preference specification.

The introduction of the Poor Law has two effects: First, as a comparison of Figures 2 and 4 illustrates, risk sharing eliminates appropriation by the newly born. Second, it reduces the dispersion of shocks under both technological choices. Comparisons of Figure 1 versus 3 and Figure 2 versus 4 illustrate that both the elderly and the newly born are now willing to take more risks—the shaded area of \( \tau \) choices is much smaller and only applies for very low levels of capital and productivity.

In the lineage society, decisions are made by the elderly alone. Figure 5 depicts their choices, again in the \((A, k)\)-space. While the partial insurance within the clan yields significantly larger risk taking than in the market society, the effect is not as strong as under the Poor Law. Indeed, as we shall illustrate shortly below, this helps to account for the fact that economic growth occurred in China as well, although not at the pace and sustain that England experienced.

The time-series simulation supports the conjecture that risk-sharing institutions played a pivotal role in England’s transition and China’s relatively slow economic growth. Before the introduction of the Poor Law, there is no risk sharing in the market economy. Consequently, agents opt for the low-risk technology and the economy is literally stagnant. When the Poor Law is introduced, the thresholds to engage in riskier activities fall and there is an instantaneous spike in the fraction of the population that chooses the \( \epsilon \) technology as the benefit of a higher expected growth rate and is no longer offset by the larger dispersion of shocks. This generates income per capita growth that fosters further risk taking. A transition transpires until every agent experiments.

This process can be observed in Figure 6 which plots the share of agents in the market society that experiment. After the Poor Law introduction, this share jumps up to just
below 50 percent before increasing slowly toward full adoption. In the lineage economy,
by contrast, risk-sharing within the clan motivates some of the relatively more risk-averse
elders to choose experimentation, due to which there is some economic growth, but their
number is too low to initiate a sustained transition. Hence, there is no major shift toward
more experimentation.

The transition to a dynamic growing economy after the Poor Law introduction can be
studied further in Figures 7 through 10. Average productivity growth takes off after the
adoption of the Poor Law as more and more agents choose experimentation. Investment,
however, drops at first as there is less need to insure against bad realizations of productivity
growth. This is depicted in Figure 8. As productivity reaches higher and higher levels,
however, investment picks up too. Figure 9 illustrates the resulting development of the
capital stock and Figure 10 plots consumption which increases immediately following the
Poor Law’s introduction.\footnote{In light of these transition dynamics, which suggest that English economic takeoff began in the 17th
century after the adoption of the Poor Law, a relevant issue is whether the timing of England’s economic
takeoff agrees with our simulations. On the one hand, our simulations do not fully capture factors or
complementarities that potentially slowed England’s transition and produced more of a lag between the
adoption of the Poor Law and the Industrial Revolution (such as those that slowed the intergenerational
transmission of new knowledge). On the other hand, there exists evidence that some efficiency advances and
productivity improvements began to take place starting in the 17th century (see, for example, Clark
2007, p. 125).}

\subsection{5.2.3 Income Inequality, Appropriation and Endogenous Social Insurance}

In our next set of simulations, we explore the role of appropriation in our dynamics, as
well as changes in income inequality in the adoption of risk-sharing systems in response
to the threat of appropriation.

To that end, Figures 11 through 14 jointly illustrate how the adoption of the Poor Law
changes the dynamics of an economy in which there are varying degrees of the threat of
extralegal appropriation. As shown, even when the technology of appropriation is at its
lower bound ($B = 0.1$) and relatively fewer newly born agents engage in it, the risk of
appropriation suffices to block the advent of an economic transition to sustained growth.
Of course, all the dynamics are worse when time devoted to appropriation is more effective
(that is, when $B = 6$), but the differences in the two cases in which appropriation risk
exists pale in comparison to the outcomes under the Poor Law.\footnote{We shall shortly address whether or not a fairly ineffective technology of appropriation (i.e., $B = 0.1$)
would make it socially optimal to adopt the Poor Law. For now, however, we should point out that it
depends not only on the effectiveness of time allocated to appropriation but also income inequality.}

Next, we turn to a comparison of China and England and, in particular, the differential
growth impacts of their respective social insurance systems. Regardless of their functional
peculiarities, risk-sharing institutions aid economic growth, which is evident in Figures
15 through 18. As shown, the lineage-base Chinese risk-sharing system helps to kick into gear growth in productivity, investment and consumption, although—and this is the key distinction—it pales in comparison to the state-based English insurance in terms of sustaining accelerated economic growth. This is the main reason why, as shown in Figures 15, 16, and 18, there is marked divergence of Chinese versus English productivity levels, investment, and consumption.

The net social benefit of a risk-sharing system depends on the degree of income inequality in the economy and the effectiveness of extra-legal appropriation. In our final set of simulations, we investigate the combinations of parameter values and state variables that socially and dynamically justifies the adoption of social insurance. We then reference the threshold inequality levels that validated the adoption of social insurance against the actual levels of income variance observed at different times in England.

Figure 19 reports the outcome of one such exercise in which the degree of income inequality (as measured by income variance) is set at the level observed in England in 1688, relatively low at 10.3. In the figure, we plot average social welfare as a function of the parameter of technology of appropriation, $B$, and with all other parameters set according to Table 1. As shown, when no social insurance program exists, social welfare declines as the return to appropriation rises with increases in $B$. With the Old Poor Law in effect, there is no appropriation and average welfare remains independent of $B$, although the amount of income transfers from the rich to the poor rises with $B$. Most importantly, however, is the fact that $B$ needs to be sufficiently high (i.e., roughly 3, or close to 25 out of 50 in our grid scale) for the Old Poor Law to be socially optimal. And although not shown, higher income inequality would also make it more likely that the Old Poor Law is adopted, even when $B$ is below the threshold shown. For reference, income variance in England in 1290 equaled 21.4, more than double its level in 1688 and it was around 244.3 in 1759. Thus, much less effective appropriation technologies than the threshold of 3 made it optimal to adopt risk-sharing back in 1290, and even values of $B$ slightly lower than the threshold justified the continuation of the Poor Law in 1759.

### 6 Further Historical Evidence and Discussion

Without appealing to differences in social institutions, the comparative history of China and England is puzzling. China was initially the world technological leader (Mokyr 1990, 54

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54 To make our calculations easier, we normalized this variance vis-a-vis the effective capital units observed in our simulations. This is the normalized variance to which the legend of Figure 19 refers.

55 We do not have income data for China during the relevant period. But those from 1880 show an income variance of 371.4, which is way above the inequality observed in England in 1688 but closer to the 244.3 variance the English data yield in 1759.
particularly under the Song dynasty (960-1279 CE), its policies fostered commerce (Rosenthal and Wong, 2011), and markets were as integrated as Europe’s up until the 19th century (Shiue and Keller, 2007). Yet, innovations and growth stalled around 1600 CE when England, and then Europe, began their transition to the modern economy.

To highlight the puzzle, consider the two dominant economic explanations of England’s ascent. The first asserts that in the 17th century additional institutional limits on the power of the English Crown secured property rights and fostered markets. Modern growth naturally followed.\textsuperscript{56} The second view explains England’s technological innovativeness as a component of its Enlightenment culture (Mokyr, 2006, 2007, 2010) or a response to high labor costs (Allen, 2009).\textsuperscript{57}

The social institutions conjecture complements both views. The view that only political institutions mattered does not actually explain the creation and implementation of useful knowledge upon which the modern economy rests. Markets were common in history while England’s transition to the modern economy was the first. The Enlightenment and high labor costs did not mitigate the problem of violent responses to economic change as also evident from the experience of Scotland. Despite the Scottish Enlightenment, economic growth had to wait for a more tranquil social order brought about by the increasing involvement of England in keeping social order and in reforms that improved poor relief (e.g., Smout 1969).

China’s technological rise and decline corresponded to the relative and absolute efficacy of its social institutions and their dynamics. Its lineage-based risk-sharing institutions generated two offsetting effects on growth: Intra-lineage insurance encouraged risk-taking while control by the risk-averse elders discouraged it. If correct, there should have been more technological progress when kin relations were strong, the elders were relatively weak and the state provided some social safety nets. This, in fact, was the case under the Song dynasty (960-1279). At that time communal families (in which output was equally shared) predominated and elders had less legal authority over their children. Under the Song, a killing of an unfilial son by a father was legally a lesser crime than other murders but in later dynasties it was not a crime at all! (Hamilton, 1990, p. 86.) Moreover, the only post-1000 CE dynasty that offered a substantial state-based, risk-sharing institution was the Song. Wang Anshi, a prominent Song minister and reformer, held the state responsible for the poor and instituted pensions for the needy. (Ebrey, Walthall, and Palais, 2005).

England’s economic ascendancy had started in the 17th century (Nef, 1940; Clark, 56 E.g., North and Weingast (1989) and see the generalization in Acemoglu and Robinson (2000). 57 Simulations by Voigtländer and Voth (2006) suggest that the Old Poor Law did not influence England’s industrialization by increasing wages. Yet, real wages in England either ceased a downward trend or began rising in the early 17th century (Kelly and ÓGrada, 2008, Figure 1).
2005) as revealed by higher real wages despite population growth (Allen 2009, p. 45). In particular, real wages in the 1740s was 67 percent higher than would have been predicted by the pre-1600 relation between population and real wages (Clark, 2005, p. 1312). Moreover, following the introduction of the Poor Law, there was a rise in the distribution and creation of new knowledge. For example, between 1550 and 1600, the number of published farming technical manuals was 16 but, in the next 50 years, the numbers increased to 43 (Sullivan, 1984, Table 1).

If the Poor Law reduced risks of social unrest, areas with better poor relief should have had higher rates of innovation and growth. Based on an English county-level panel of poor relief, social unrest and innovations over the period from 1650 to 1818 CE, in Greif and Iyigun (2012, 2013) we supply empirical evidence that variations in the amount of poor relief came to bear negatively and statistically significantly on the propensity of social unrest and positively and significantly on recorded innovations across the English counties.

England, as predicted by our analysis, did not stand out as particularly inventive but it was particularly good at adopting, adapting, and commercializing inventions made elsewhere. France, by contrast, was more inventive (Mokyr, 1990). Why was this the case? England’s risk-sharing institutions and patent law did not reward inventors well (e.g., Khan, 2008). The Poor Law encouraged risk-taking in commercializing inventions by securing local landlords and industrialists from the social unrest that their innovative activities might have otherwise caused. Patents were expensive and insecure. Although France did not have a patent system during that period, inventors were rewarded by the Crown (Kremer, 1998). France’s system of poor relief, however, was not as effective as England’s (e.g., Solar, 1995, p. 7; Lindert, 2004, p. 8) and innovations did not follow inventions.

Unlike other growth models, the one here predicts investment by individuals lacking the wealth required for self-insurance. The evidence in fact reveals that the number of individuals of modest means that took the risk of creating new knowledge during the English transition was far from negligible. For example, there were 333 ‘great inventors’ who were active in England and the USA after 1790 and were born prior to 1845. (The USA also had a Poor Law system). Of these inventors, some 38 percent were of modest means. Similarly, among the 533 ‘great’ English inventors born between 1660 and 1800,

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58 Real wages declined during the second half of the 18th century and rose again only in the 19th.
59 Sullivan conjectured that the increase reflects population growth. The rate of population growth, however, was much lower.
60 Mokyr (1990, 2002) highlights the importance of complementary factors such as an advanced machine tool industry. These, however, also reflect the growth in useful knowledge.
61 A ‘great inventor’ is an individual who was included in biographical dictionaries because of his or her contributions to technological progress. Low means are extrapolated from the fact that their fathers were
202 were non-elite. They were trained by apprenticing and did not attend a school or a university (Meisenzahl and Mokyr, 2010, Table 2). Presumably, many more individuals of modest means tried but failed becoming a great inventor. Among the vagrants arrested in England from 1620 to 1640, about 23 percent were apprentices or servants.

The importance of motivating non-wealthy individuals to contribute to new knowledge is also reflected in the Scottish ‘improvement’ publication ‘Signet’ (‘The Society of Writers to Her Majesty’s Signet’). Although Scotland’s poor law improved only after 1790, 18 percent of the contributors were not born to elite families (1690 and 1828). Six percent were sons of unskilled laborers, traders, and tenant-farmers and additional twelve percent were sons of merchants (Smout 1973, p. 351). Similarly, the importance of risk taking by commoners is notable in the occupational structures in Edinburgh and Glasgow in the late 18th century. Glasgow was at the center of Scotland’s economic growth yet only 13.3 percent of its population were from the old elite of nobles, gentry, and professionals whose percentage, in the old urban center of Edinburgh was 34.2 (Smout 1973, p. 357).

In Scotland, poor relief was initially not as generous or certain as England’s (Mitchison, 2000) and prior to resolving this problem, transition did not transpire. In Scotland, the landlords were generally successful in blocking taxation for poor relief. The Church of Scotland that administered relief frowned upon the idea of mandatory charity and conditioned relief on the ‘moral character’ of the poor. As predicted by our analysis, and in contrast to England’s experience, the 150 years following 1603 were not a turning point in Scotland’s economic history. Sir George Nicholis, a poor law commissioner, noted in 1856 that “after James’s accession to the crown of England ... in 1603, ... the country [Scotland] still continued in a backward and disordered state” (p. 48). Although the Union with England in 1707 improved trade and Glasgow became a center of tobacco trade, growth did not follow. The Scottish Enlightenment that transpired after the union was a remarkable intellectual event, but it initially had little economic impact. Only in “the 1770s the Poor Law seems to have secured an important role in keeping people alive ... in most of Scotland” (Mitchison, 2000, p. 112) and Scotland grew fast between 1780 and 1830 (Smout, 1973, p. 97) and particularly in the Lowland in which poor relief was better than elsewhere.62

In China, during that time, economic hardships bred violence. After 1750, the Qing emperors invested less in both the granary system that stabilized food prices and in flood control. The resulting increase in famines and flooding (Hung, 2009) led to more

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62 On political and social unrest in the 1790s (e.g., radicalism and the objection to the Militia Act), see Honeyman (2008).
demanding food riots (Li, 1982; Wong 1982). The number of collective political protests in the 1740s and 1830s was similar (87 and 65 respectively) but all the latter protests were violent compared to 50 percent in the earlier period (Hung, 2009, pp. 83-4, 101). In contrast, food riots declined in England after the Poor Law went into effect. There were, on average, 2.8 riots per year prior to 1632 but only 1.7 following 1643 (Bohstedt, 2010, p. 49).

More generally, England’s major transformation did not cause a major violent response. For example, the enclosure of the open fields ended traditional rights on common land. Yet, "while there was some resistance ... the English were, by continental or Irish standards, quite easily separated from the land in the seventeenth and eighteenth centuries" (Solar, 1995, p. 9). Similarly, there was relatively little resistance to other major changes such as the decline in the putting-out system, the introduction of hourly wage, or the New Husbandry. England was remarkably peaceful during a transition that destroyed numerous traditional occupations, shifted risk toward the poor by increasing wage labor and eliminating many of their small landholdings and communal rights. A poor law that supported between 5 to 15 percent of the population at any time (Solar, 1995, p. 8) probably contributed a great deal to a relatively peaceful economic transition.

Finally, consider why Europe, and not China first followed England’s example. Despite the differences in poor relief between England and the continent, the European states were in a better position to imitate England than China. They did not have lineages, elders had less power, and some state-based poor relief existed. As our analysis predicts, Europe’s transition to the modern economy quickly followed England’s, while China’s did not. Notably, the continental industrialization transpired in the context of creating the modern, state-based welfare system (Lindert, 2004). At this point in the process of development, formal education became a more important source of productivity growth (Easterlin, 1981).

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63 Rowe (2002, p. 557) reports some 312 collective acts of rent resistance and 58 of tax resistance 1661 - 1796. Charlesworth (1983) is the best source of ‘rural protests’ in England but we found it impossible to compare the cases.

64 Charlesworth (1983) details the rural protests in Britain from 1548 to 1900. Protests were particularly likely when food prices were high. He notes that, in Lowland England, "by the second decade of the seventeenth century ... lords were successful in ... sweeping away ... tenantry to make way for the large leasehold farm ... through the poor law, the attack on alehouses, the quarter session and the church court" (pp. 16-18). Patruquin (2006) notes that "it is striking that a profound recasting of class relations in England, one which left most people bereft of property and control over their lives, occurred without inducing a protracted and violent revolution" (p. 223).
7 Conclusion

In pre-modern China and England risk-sharing institutions were introduced for similar moral and political reasons. The forms of these institutions, however, were determined by pre-existing cultural, social, and institutional features. Clans were in China's social and cultural fabric and provided the state with such services as taxation and adjudication. It was optimal for the state to rely on clans also to provide social safety nets. The resulting clan-based risk-sharing institutions contributed to the influence of the elders on economic decisions. The stronger influence of the relatively more risk-averse elders had a negative effect on risk-taking, new knowledge and growth. Societies in which risk-sharing was provided by elder-dominated kinship groups were less likely to experience a transition to a modern economy.

In England, during the same time, there were no large kinship groups and non-kin based organizations, such as parishes provided the state with administrative services. It was optimal for the state to rely on parishes to provide insurance as made explicit in the Old Poor Law of 1601. This risk-sharing institution did not shift decision power to the relatively more-risk averse elders. The Poor Law had the unintended consequence of fostering risk-taking, new useful knowledge, higher rate of productivity growth and the transition to the modern economy. Better insurance to the poor reduced the risk from social unrest that the wealthy faced when implementing new knowledge.

Distinctions in functions and forms among social institutions were central to the first transition to a modern economy and, by analogy, social institutions have probably been important in fostering or forestalling subsequent ones. Clearly, social institutions protecting the poor were not the only distinction between China and England or the only factor contributing to the rise of the modern economy. These qualifications notwithstanding, the importance of social institutions highlights that favorable political and economic institutions are insufficient in bringing about modern economic growth. In order to better understand development and growth we have to bring society back in.\footnote{E.g., Greif (1993, 2005, 2006), Greif and Tabellini (2010), Hoff and Sen (2005), Goldstein and Udry (2008).}
Bibliography


Eden, Sir. F. Morton, Bart. 1797. The State of the poor ... from the Conquest to the Present Period... together with Parochial Reports. vols. I-III. London, UK: J. Davis.


Table 1: Parameter Choices

Panel A: Demographics and Preferences

<table>
<thead>
<tr>
<th>Description</th>
<th>(Annual) Value</th>
<th>(Model) Parameter</th>
<th>(Per-Period) Value</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 year periods</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Number of newly born in each generation</td>
<td>-</td>
<td>N</td>
<td>144</td>
<td>H</td>
</tr>
<tr>
<td>Survival probability</td>
<td>0.066</td>
<td>( \lambda )</td>
<td>0.5</td>
<td>H</td>
</tr>
<tr>
<td>Discount factor</td>
<td>0.975</td>
<td>( \beta )</td>
<td>0.003</td>
<td>M</td>
</tr>
<tr>
<td>Risk aversion coefficient</td>
<td>5</td>
<td>( \omega )</td>
<td>-</td>
<td>M</td>
</tr>
<tr>
<td>Subsistence level of consumption for young</td>
<td>0</td>
<td>( c^y )</td>
<td>-</td>
<td>C</td>
</tr>
<tr>
<td>Subsistence level of consumption for elderly</td>
<td>0.00</td>
<td>( c^d )</td>
<td>-</td>
<td>C</td>
</tr>
</tbody>
</table>

Panel B: Technology Choices

<table>
<thead>
<tr>
<th>Description</th>
<th>(Annual) Value</th>
<th>(Model) Parameter</th>
<th>(Per-Period) Value</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. growth rate for LR technology</td>
<td>0</td>
<td>( \mu_{LR} )</td>
<td>0</td>
<td>H</td>
</tr>
<tr>
<td>Avg. growth rate for HR technology</td>
<td>0.005</td>
<td>( \mu_{HR} )</td>
<td>0.113</td>
<td>H</td>
</tr>
<tr>
<td>Stand. dev. of innovations for LR technology</td>
<td>0.067*</td>
<td>( \sigma_{LR} )</td>
<td>0.015</td>
<td>C</td>
</tr>
<tr>
<td>Stand. dev. of innovations for HR technology</td>
<td>0.85*</td>
<td>( \sigma_{HR} )</td>
<td>0.19</td>
<td>C</td>
</tr>
<tr>
<td>Insurance effectiveness under the Poor Law</td>
<td>-</td>
<td>( \psi_{PL} )</td>
<td>1/17</td>
<td>C</td>
</tr>
</tbody>
</table>

* Converted from two-decade values of .015 and .19 as 0.015*(20)^2 = .067 and .19*(20)^2 = .85, respectively.

Panel C: Residual Parameters

<table>
<thead>
<tr>
<th>Description</th>
<th>(Annual) Value</th>
<th>(Model) Parameter</th>
<th>(Per-Period) Value</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of land</td>
<td>0.33</td>
<td>( \alpha )</td>
<td>-</td>
<td>M</td>
</tr>
<tr>
<td>Exogenous interest rate</td>
<td>0.045</td>
<td>( r )</td>
<td>1.412</td>
<td>H</td>
</tr>
<tr>
<td>Depreciation rate</td>
<td>0.03</td>
<td>( \delta )</td>
<td>0.543</td>
<td>M</td>
</tr>
</tbody>
</table>

Method:  
Historical Evidence (H)  
Modern Data (M)  
Calibration (C)  

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**Table 1:** Parameter Choices (continued)

Panel D: All Parameter Choices

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \lambda )</td>
<td>0.5</td>
<td>20-year survival probability</td>
</tr>
<tr>
<td>( \beta )</td>
<td>0.633</td>
<td>(Annual) discount factor is 0.975</td>
</tr>
<tr>
<td>A</td>
<td>0.8 - 6</td>
<td>state space for technology of production</td>
</tr>
<tr>
<td>B</td>
<td>0.1 - 6</td>
<td>state space for technology of appropriation</td>
</tr>
<tr>
<td>k</td>
<td>0.1 - 3</td>
<td>state space for capital stock</td>
</tr>
<tr>
<td>( \omega )</td>
<td>5</td>
<td>Risk aversion coefficient at high levels of wealth</td>
</tr>
<tr>
<td>cy</td>
<td>0</td>
<td>Subsistence level of consumption for young</td>
</tr>
<tr>
<td>co</td>
<td>0.06</td>
<td>Subsistence level of consumption for elderly</td>
</tr>
<tr>
<td>( \mu_{LR} )</td>
<td>0</td>
<td>Average annual growth rate for low risk / low reward technology is zero</td>
</tr>
<tr>
<td>( \mu_{HR} )</td>
<td>0.113</td>
<td>Average annual growth rate for high risk / high reward technology is 0.5%</td>
</tr>
<tr>
<td>( \sigma_{LR} )</td>
<td>0.015</td>
<td>Standard deviation of innovations under low risk / low reward technology</td>
</tr>
<tr>
<td>( \sigma_{HR} )</td>
<td>0.19</td>
<td>Standard deviation of innovations under high risk / high reward technology</td>
</tr>
<tr>
<td>( \sigma_1 )</td>
<td>1</td>
<td>Standard deviation of high income inequality under low risk / low reward technology</td>
</tr>
<tr>
<td>( \sigma_2 )</td>
<td>3.25</td>
<td>Standard deviation of high income inequality under high risk / high reward technology</td>
</tr>
<tr>
<td>( \sigma_3 )</td>
<td>0.3</td>
<td>Standard deviation of low income inequality under low risk / low reward technology</td>
</tr>
<tr>
<td>( \sigma_4 )</td>
<td>1</td>
<td>Standard deviation of low income inequality under high risk / high reward technology</td>
</tr>
<tr>
<td>( \sigma_0 )</td>
<td>0.33</td>
<td>Share of land</td>
</tr>
<tr>
<td>( r )</td>
<td>1.412</td>
<td>(Annual) interest rate is 4.5%</td>
</tr>
<tr>
<td>( \delta )</td>
<td>0.543</td>
<td>(Annual) depreciation rate is 3%</td>
</tr>
<tr>
<td>N</td>
<td>144</td>
<td>Number of newly born agents in each generation</td>
</tr>
<tr>
<td>( w_{PL} )</td>
<td>1 / 17</td>
<td>Insurance effectiveness under the Poor Law</td>
</tr>
</tbody>
</table>

Note: The motivation for each parameter is explained in detail in the main text.
Appendix A: The Productivity Level and Optimal Technology

Remark 1 For every state of the world and social arrangement \((r = m, PL, or \Gamma)\) there is a pair of productivity levels \(\{A^r_y, A^r_o\}\) such that if \(A_t < A^r_y\), LR technology is optimal for all agents; if \(A_t \in [A^r_y, A^r_o]\), the HR (LR) is optimal for the newly born (young adult and older agents); and if \(A_t > A^r_o\), HR technology is optimal for all agents.

Proof. The preferences depend on the comparison between the two technological regimes, that can be viewed as two lotteries. The decision of the newly born agents depends on:

\[
\text{sign } E_{A_{t+1}|A_t} V^r_2 (A_{t+1}, k_{t+1}| (A_t, k_t), HR) - E_{A_{t+1}|A_t} V^r_2 (A_{t+1}, k_{t+1}| (A_t, k_t), LR)
\]

for \(r = m, PL, or \Gamma\)

The young adult and the older agents always have the same optimal technology. The choice of technology impacts on next period utility, where both types of agents will have the same (elderly type) preferences. Their decision depends on:

\[
\text{sign } E_{A_{t+1}|A_t} V^r_3 (A_{t+1}, k_{t+1}| (A_t, k_t), HR) - E_{A_{t+1}|A_t} V^r_3 (A_{t+1}, k_{t+1}| (A_t, k_t), LR)
\]

for \(r = m, PL or \Gamma\)

Since all the agents have DRRA utility functions, given the state variables \((A_t, k_t)\), there is a threshold productivity value, \(\{A^r_y, A^r_o\}\), such that for any value below that threshold agents choose the low-risk regime and for any value above that threshold they choose the high-risk regime in each of the social structure organizations. Since elderly agents are more risk averse than young agents \(A^r_y < A^r_o\). This determines three zones. Given \((A_t, k_t)\), if \(A_t < A^r_y\), there is unanimity and all the agents favor the low risk-low return regime. If \(A_t \in [A^r_y, A^r_o]\) newly born favor the high-return regime while the rest of the agents the low-return regime. If \(A_t > A^r_o\), all the preferences are realigned again and everybody favors the high-return regime.