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Inequality in the capital and land distribution and growth take-offs

This paper studies the impact of inequality in capital and land distribution on the pace of industrialization, thereby explaining the effect of wealth inequality on the timing of countries' take-offs. We build a two-sector unified growth model, in which the outcome of public policy contest between the supporters and opponents of modern sector development determines the pace of industrialization. The distribution of wealth affects the incentives of agents to invest in political conflict, and hence influences the probability of pro-growth policies. We show that while higher inequality in land distribution hampers modern sector development, higher inequality in capital within landless agents is growth enhancing. The strength of the latter effect increases with the amount of accumulated capital. The model also captures the hump-shaped path of conflict intensity observed throughout the industrialization phase. We present several historical narratives that support these results.

JEL Classifications: D72, D74, N10, O14, O41, O43

Keywords: unified growth, public policy contest, endogenous institutions, industrialization, inequality

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1. Introduction

Literature on unified growth (e.g. Galor and Weil (2000), Hansen and Prescott (2002), Galor (2011)) emphasizes that a significant part of modern cross-country variation in living standards can be explained by differences in the moment of transition from the stage of stagnation with miniscule technological progress to modern growth regime. The Great Divergence began when some countries managed to industrialize and overcome stagnation while others did not; it has now resulted in a ratio of poor-to-rich countries' incomes per capita of about 20:1 in comparison to 3:1 at the end of the 18th century. This widening gap was largely due to the fact that in countries that managed to escape from stagnation, the process of industrialization was associated with rising shares of manufacturing and capital income in the GDP, the migration of labor from the traditional to the modern sector, and technological advances becoming more frequent and widespread. Together these forces led to higher levels and growth rates of income per capita, as well as pro-growth political and demographic changes (Mokyr (1990), Galor and Weil (2000), Acemoglu and Robinson (2000b), Allen (2009)). However, the reasons of cross-country differences in the timing of the take-off and pace of industrialization remain not as well explored as the forces that gave rise to the Industrial Revolution itself.

In this paper we try to deepen the understanding of the mechanisms that led to the Great Divergence. We consider in more detail a previously underexplored feature of the industrialization period, namely, the political conflict between the supporters and opponents of modern-sector development. Political conflict over government policies and institutional set-up was particularly important and pronounced in the Industrial Revolution era. Different interest groups and social classes had opposing views regarding the adoption of new technologies, educational reforms, and the protection of property rights (see e.g. North and Weingast (1989), Canton et al. (2002), Llavador and Oxoby (2005), Mokyr and Nye (2007), Galor et al. (2009), Acemoglu and Robinson (2012) and Desmet and Parente (2014)). The outcome of this political struggle between the supporters (usually, the emerging capitalist elite and skilled workers) and opponents (it could be traditional landowning elite and/or workers incapable of using new technologies) of modern sector development determined the pace of industrialization and the timing of economy's take-off. It is therefore crucial to study the forces that influence the outcome of this conflict and how they evolve over time as economy proceeds, in order to understand the Great Divergence phenomenon. We contribute to this goal by explaining the impact that inequality in the distribution of capital and land has on the outcomes and intensity of political contest over the implementation of pro-growth policies.

The existing papers in the political economy of industrialization (see e.g. Llavador and

Oxoby (2005), Boschini (2006), Bertocchi (2006), Galor et al. (2009) and some other) typically do not consider the mechanisms of political conflict explicitly: it is usually assumed that the conflict resolves under either majority voting or the veto power of the elite. Therefore, there are no actual efforts or struggle over the institutional framework, which we show to be the major obstacle to the understanding of the political economy of industrialization and growth. Firstly, as noted by e.g. Doepke and Zilibotti (2005) and Galor (2011), crucial institutional changes in many countries including Britain took place before the franchise was significantly extended, therefore the policies to be realized were chosen by the elite. Moreover, in spite of the fact that in some cases the old traditional elite changed its attitudes towards industrialization, to a large extent many pro-growth institutional changes happened due to a lobbying efforts of the supporters of modern-sector development, who managed to overcome the resistance of the status-quo supporters.

Therefore, in contrary to the existing literature, we try to capture the important mechanisms of the political conflict using the asymmetric public policy contest approach (see e.g. Tullock (1980), Epstein and Nitzan (2006), Baik (2008), Esteban and Ray (2011)), such that agents, heterogeneous in their preferences, invest in political conflict in our framework. In this context, we demonstrate why the shape of wealth distribution in the economy was crucial for the pace of industrialization. Namely, we show how the agents' incentives to participate in political conflict and the collective action mechanisms inside the competing groups depend on the shape of wealth distribution. We show that, taking account of the conflict's mechanisms, the distribution of capital and land both within and between the competing groups helps to explain the large differences in the pace of industrialization worldwide, thereby contributing to the understanding of the Great Divergence phenomenon.

We build a two-sector unified growth model, in which the political conflict between the supporters and opponents of industrialization determines its pace, either allowing or blocking the reform that increases productivity in the modern sector. Two-period living agents form political preferences based on the structure of their assets, and may participate in conflict in order to increase the probability that their preferred institutional set-up would be in place. The distribution of capital and land among agents becomes crucial for the pace of industrialization, since it determines the stake of each agent in a conflict i.e. the expected gain from winning a conflict. As the economy proceeds, aggregate capital, relative productivity and the distribution of assets change, thereby affecting the stakes of agents in winning the conflict and, thus, the incentives to participate in it. Therefore, the political barriers to industrialization persist or dissipate due to economic reasons, namely, the changes in aggregate capital-land ratio, the distribution of capital and land between and within classes, and the migration of labor between the two sectors due to technological improvement and capital accumulation.

The results we obtain contribute to the existing debate on the impact of inequality on industrialization, showing that inequality in wealth did not necessarily hamper industrialization and development through political mechanisms, as, e.g., the theories of Boschini (2006) and Galor et al. (2009) suggest. Firstly, higher inequality in capital holdings within a group of capitalists is growth enhancing since it leads to higher efforts by new elite (capitalists) in lobbying modern sector development. The reason is that if all capitalists have a similar and rather small share in the aggregate capital then all of them may lack incentives to influence the outcome of conflict due to the low individual benefits from winning and a severe free-riding problem. Thus, less egalitarian distribution of capital within a group that supports industrialization makes this group more likely to win. The comparison of industrialization and growth dynamics between two countries with more and less concentrated capital ownership shows the increasing gap in well-being due to a slower pace of pro-growth reforms and structural change in a country with more dispersed capital ownership. Generally, however, the impact of inequality in capital distribution depends on the class affiliation of the biggest capital owners; if much of the capital is concentrated in the hands of the landowning elite, it may even hamper development. We also note that the result about the negative impact of land inequality on industrialization (e.g. Galor et al. (2009)) holds in a variety of cases in our paper, though there are conditions under which this result may not hold and even may reverse.

Finally, the model captures the hump-shaped dynamics of conflict intensity observed throughout the industrialization phase, along with dynamics of factor prices, cross-country divergence in GDP per capita, and other variables, consistent with the data. We use the historical narratives and data about the distribution of assets, firm sizes in industries, spatial concentration of production, and the nature of political conflict, presented in Kinghorn and Nye (1996), Boschini (2006), Mokyr and Nye (2007), Acemoglu and Robinson (2012), Desmet and Parente (2012) and Trew (2014), in order to support and motivate our theoretical findings.

The remainder of the paper is organized as follows. Section 2 reviews relevant theoretical and empirical papers. Section 3 describes the assumptions and structure of our model. Section 4 deals with a temporary equilibrium and the main comparative statics results. Section 5 analyzes the model dynamics and discusses its properties. Section 6 concludes.

2. Related literature and empirical evidence

2.1 Theoretical findings

The growing branch of literature to which our paper relates closest is the unified growth theory (see Galor (2011) for an in-depth review of the seminal ideas and results). The seminal

papers of Galor and Weil (2000), and Hansen and Prescott (2002) provided the first answers about the crucial mechanisms behind the Industrial Revolution and the escape from stagnation[3]. However, our research is more closely related to the explanation of why did the pace of industrialization and the moments of take-off differ so much across the globe (Galor (2011) provides a detailed review of the most important findings). Sachs and Warner (1995) and Diamond (1997), for example, insist that favorable geographical factors (climate, disease environment, transportation costs, natural resource endowments, etc.) made Europe first to advance. The role of natural resources in this context is controversial though; see also Engerman and Sokoloff (2002) and Mehlum et al. (2006). Voigtlander and Voth (2006) stress the importance of a favorable demographic regime, based on fertility restriction, which led to higher per capital income and, hence, more diversified capital input. In Galor and Mountford (2008) the authors emphasize the asymmetric impact of international trade on technologically advanced and technologically inferior countries. The specialization in manufacturing goods accelerated growth and human capital formation in the former, but the specialization in agriculture had the opposite effect in the latter.

Among many other ideas, we are mostly inspired by the findings of North and Weingast (1989), Parente and Prescott (1997), and Jones (2001) seminal papers, emphasizing that good institutions and policies were necessary to make entrepreneurship, innovation, and capital accumulation in the modern sector profitable. The simulations of the unified growth model in Jones (2001) demonstrate a very strong effect of proper institutions on the timing of take-off. Good policies and institutions can significantly alter the incentives and abilities of agents to adopt new technologies and ideas, and, hence, affect the profitability of the industrial sector. However, the question is why some countries adopted policies and institutions that encouraged growth of the modern sector earlier, while others failed[4].

One influential opinion of why policies and institutions beneficial for industrialization and development are not introduced, is the economic and political losers hypothesis, see, e.g., Krussel and Rios-Rull (1996), Acemoglu and Robinson (2000a). It says that powerful interest groups may be interested in preserving the "status-quo" policy in comparison to the proposed policy, even if the reform leads to faster growth and development, in order to protect their economic rents and/or

[3] Namely, Galor and Weil (2000) show that only when the slow technological progress had developed beyond a certain threshold, the transition could have happened. The new technologies started to demand higher human capital, and agents began to care more about the quality (not quantity) of their children, which created a virtuous circle of technological development and human capital accumulation. Hansen and Prescott (2002) use the two-sector model with exogenous technological progress to demonstrate that with initially scarce and expensive capital, industrialization could have started only when the modern-sector technology is enough developed. Lagerlof (2003) and Voigtlander and Voth (2013) in turn stress the importance of demographic factors, exogenous shocks (such as Black Death) and wars for the rise of Europe, since the weakened population pressure increased the demand for manufacturing goods.

[4] The huge literature is devoted to studying the effects of institutions on development, as well as the question of where these institutions come from, i.e. why some countries fail to adopt good institutions and policies. See e.g. Hall and Jones (1999) and Acemoglu et al. (2005).

political power. In our paper the industrialization may be delayed if such interest groups win the contest over the realized policy, and thus the inefficient "status-quo" regime persists. Therefore, even if the economic opportunities to industrialize exist, the take-off may not happen.

Our research is thus closely tied to several papers in political economy of industrialization; see, e.g., Canton et al. (2002), Llavador and Oxoby (2005), Bertocchi (2006), Boschini (2006), Galor et al. (2009), and Desmet and Parente (2014). The opposing preferences of the old landowning elite and the emerging class of capitalists regarding modern sector development (namely, educational reforms) are studied in Galor et al. (2009), where the old elite has exogenous political power to decide on the bequest taxation that finances expenditures on education. In land-rich economies with high inequality in land distribution the traditional elite switches its preferences towards policy optimal for industrialization later. The reason is that the landowners in such countries lose more from workers migrating to the modern sector. Capital begins to play a key role in the assets of the land-rich elite later, which means that support for education reforms is delayed. The results obtained in Bertocchi (2006) and Boschini (2006) hinge, in contrary, on the majority voting equilibrium with exogenous wealth qualifications for voting. In that setting, Boschini (2006) concludes that in elitist regimes, flat wealth distribution and skilled elite corresponds to earlier industrialization, while in democratic regimes, high inequality at the beginning of the industrialization may be beneficial since it increases the tax that finances public investment in the modern sector. Bertocchi (2006) also finds that higher inequality corresponds to inferior institutions (primogeniture and feudal rights) and lower support for industrialization. In the framework of partisan competition, Llavador and Oxoby (2005) show how parties representing the interests of heterogeneous capitalists and landlords may extend the franchise in order to get the necessary support for the policy they propose from skilled or unskilled workers. The recent paper by Desmet and Parente (2014) is probably the closest to ours in their idea that the existence of sufficient incentives and abilities of a group that tries to overcome the status-quo lobbyists is crucial for development. In the context of the struggle between would-be innovators and workers' guilds, the authors show that the take-off happens only when the firms grow sufficiently in size and gain large enough profits to be able to both innovate and successfully defeat guilds' resistance.

Because of the nature of political process in these papers, the de-facto political power of the groups is either simply proportional to the size of the enfranchised group or exogenously belongs to the landed elite (alternatively, as in Desmet and Parente (2014), there is an exogenous lobbying cost that a firm must incur to defeat the guild in opposition). Therefore, the impact of wealth distribution on individuals' stakes from policy changes, and hence their incentives to invest in political conflict are not taken into account, along with the collective actions mechanisms. In contrast, in our paper, we make the relative de-facto political power of competing groups endogenous, coming from these

groups' investment in political conflict. The desire of each group member to invest in conflict is in turn driven by the initial endowment, its endogenous evolution and distribution both within and between competing groups. In such a way, our paper is related to the literature on asymmetric contests literature (see Nti (1999), Stein (2002), Esteban and Ray (2008)). More specifically, we incorporate the mechanisms of asymmetric public policy contests between groups (e.g. Epstein and Nitzan (2006), Baik (2008), Esteban and Ray (2001, 2011), Nitzan and Ueda (2014)) into the otherwise quite standard two-sector unified growth model. The results in this literature link the asymmetries (in stakes, effectiveness, information, budget constraints, etc.) both between and within opposing groups to their winning probabilities, total expenditures on conflict, and the economy-wide consequences of conflict.

Using the methodology of both unified growth theory and asymmetric public policy contest literature, we contribute to the existing growth-inequality debate in the context of industrialization. The results of Boschini (2006), Bertocchi (2006) and Galor et al. (2009) emphasize the negative relationship between inequality and the pace of industrialization, and thus growth. However, Galor and Moav (2004) show that in the early stages of industrialization higher inequality may be beneficial, since rich individuals' higher propensity to save along with higher inequality means faster physical capital accumulation. On the contrary, when human capital becomes a prime engine of growth, inequality becomes detrimental since credit constrains prevent large part of a population from acquiring human capital. This argument is in line with the 'Kuznets curve', Kuznets (1955). It represents a hump-shaped relationship between inequality and GDP per capita in the course of industrialization, driven by the process of labor reallocation between two sectors; see also Acemoglu and Robinson (2002) for the political economy explanation of the Kuznets curve. Moreover, below we discuss several papers that provide evidence of a positive impact of capital and wealth concentration on industrialization and growth in the time of industrialization, which makes us confident that additional research in the field is needed.

2.2 Empirical (historical) evidence

Our research was partly motivated by the inconclusiveness of inequality-growth relationship (see e.g. Barro (2000), Benabou (2000), Forbes (2002)). We argue that the deep causes of growth and income divergence in the period of the Industrial Revolution can shed more light on this relationship. In this section, we discuss historical evidence on the link between inequality in capital and land distribution and the pace of industrialization presented in Mokyr (1990), Kinghorn and Nye (1996), Mokyr and Nye (2007), Acemoglu and Robinson (2012), Desmet and Parente (2012), Lagerlof (2013), Trew (2014) and some other papers.

Existing evidence on capital distribution and production concentration points to the ambiguous relationship between inequality and industrialization. The data on firm size distribution for industries in Britain, France, Germany and the USA analyzed in Kinghorn and Nye (1996) makes one think of the impact of concentration of capital ownership on the pace of industrialization and take-off. Namely, the authors emphasize the idea of more concentrated industries leading to faster growth, but argue that this was not always the case. Namely, data for the USA and Britain confirms the common view, while for France and Germany it does not.

In the same fashion, the evidence presented in Trew (2014) indicates that a more concentrated production in the pre-industrial districts of England was associated with a more rapid industrialization. Desmet and Parente (2012) also review the evidence on industry and firm sizes in England in the period of industrialization. They indicate that bigger firm sizes were a prerequisite for growth-accelerating innovations to occur since it enabled the firms to split the costs of innovations over the large amount of production. However, we argue that the ability to innovate and introduce new technologies were only necessary conditions for industrialization, yet not sufficient.

As indicated by Mokyr and Nye (2007), purely economic mechanisms (like the economy of scale arguments) cannot provide the full picture of the relationship between asset ownership distribution and industrialization. The presence of new ideas, economic incentives and abilities to invent needed to be complemented with the incentives and abilities of capitalists to win in a political contest against the opponents of industrialization. In such a way purely economic forces behind industrialization and a divergence in incomes seem to represent the necessary yet not the sufficient conditions for the take-off to occur. Mokyr (1990) emphasizes that many countries, including Britain, suffered from interest groups that lobbied for a "status-quo" policy that corresponded to blocking new technologies (despite the fact that the necessary ideas and inventions were in place), education reforms and property rights protection.

Results of Mokyr and Nye (2007) further actualize our research of the 'inequality - political conflict - industrialization' chain. The authors show that the necessary support for industrialization in England emerged in the process of the coalition formation between capitalists and landowners. The country's fragmentation in the pre-modern stage was a major obstacle to development, and only when a sufficient concentration of production emerged, was England able to industrialize. Concentration of production and capital ownership was crucial since it provided the emerging big capitalists with the incentives and abilities to lobby for policies appropriate for industrialization. Therefore, "oligarchs" in fact promoted industrialization: it was the coalition of new big capitalists and big landowners (who had started to support pro-growth policies since high incomes allowed them to invest in the modern sector and grasp sufficient benefits from modern-sector growth despite the contraction of the traditional sector). The process of industrialization was matched with a new

merchant and industrialist class gaining more political power. In contrary to Mokyr and Nye (2007), in Galor et al. (2009) the authors emphasize that big landowners were the prime opponents of industrialization. After the concentration of land was diminished significantly due to land reforms (e.g. in Russia at the beginning of 20th century, or in Korea in the 1950s), pro-growth educational reforms were also realized. These observations make one think of the possible reasons behind this inconsistency of ideas and evidence.

Acemoglu and Robinson (2012) also provide several historical cases indicating that countries with bigger cities and more concentrated production managed to defeat the vested interests of the elite in preserving inefficient institutions. But does more concentrated industrial production and bigger firm sizes mean more or less inequality? As we argue in this paper, the class affiliation of the biggest capital owners matters in this context. Boschini (2006), based on Adelman and Taft Morris (1988), indicates that in England and Australia the distribution of wealth was skewed, and these countries were among the first to industrialize. While in Russia, Argentina, Egypt and other countries also with high inequality the pace of industrialization was much slower. The authors argue that this is due to the differences in skills of the elite, who possess the most of wealth. We provide an alternative explanation that distinguishes between inequalities in land and in capital holdings, and stresses the importance of both between - and within - class inequality for the outcome of political conflict.

3. The framework

In this section we describe the assumptions and structure of both economic and political sides of the model. The economic structure of our model is based on the two-sector unified growth models; see e.g. Hanssen and Prescott (2002), Voigtlander and Voth (2006), Galor et al. (2009). The political economy structure of our model employs literature on the asymmetric public policy contests between groups; see e.g. Epstein and Nitzan (2006), Baik (2008), Nitzan and Ueda (2014).

3.1 Population, endowments and preferences

We consider an OLG model with bequests where each generation lives for two periods. We normalize total population to unity and assume that it is constant in order to concentrate on the mechanisms we are interested in[5]. Households are divided into two classes: landowners ($\mathcal{L}$), who constitute a share λ of population, and landless capitalists (or citizens) (C) with share $(1-\lambda)$ (who own capital but not land). The initial amount of capital, K_0, is distributed between the elite and the

[5] See Galor and Weil (2000), Lagerlof (2003), Galor (2005), and related papers for an in depth analysis of fertility and growth. In our framework, introduction of growing population or even endogenous fertility choice would not qualitatively alter the main results.

citizens. Given that, capital is distributed within the group of capitalists with C.D.F. $G(K)$. And $H(K,T)$ stays for the joint C.D.F. of capital and land within the elite. Land is a fixed and non-tradable factor of production. Moreover, inside one family it is inherited from one generation to another without any changes in size, so that $T_t = T = const$, and $T_{i,t} = T_i = const$.[6]

In the first period of their lives, agents do not take any economic or political decisions; they only receive their capital and land bequests, b_t^i and T^i[7]. Capital bequests are invested and become productive capital in the next period, i.e. $k_{t+1}^i = b_t^i$. In the second period, all agents inelastically supply one unit of labor to the market. Moreover, before the production and labor allocation take place, agents may participate in political struggle and invest some effort e_{t+1}^i in order to increase the probability of the institutional outcome they prefer, namely, the advancement of the modern sector productivity or the status-quo policy. The outcome of this conflict affects relative productivity which influences labor allocation, and, thus, all factor incomes. However, the efforts put into conflict lead to a disutility level $C(e^i)$.

In the second period of the agents' lives, after the political conflict is resolved, and production takes place, individuals receive their factor incomes, which for the agent i are given by: $I_{t+1}^i = w_{t+1} + k_{t+1}^i R_{t+1} + T^i \rho_{t+1}$, where $w_{t+1}, R_{t+1}, \rho_{t+1}$ are the returns to the unit of labor, capital, and land. After incomes are obtained, agents optimally allocate them between consumption and bequest it in order to maximize the following utility function:

$$U(c_{t+1}^i, b_{t+1}^i, e_{t+1}^i) = (1-\beta)\ln(c_{t+1}^i) + \beta \ln(b_{t+1}^i) - C(e_{t+1}^i)\,, \qquad (1)$$

where c_{t+1}^i stands for consumption, b_{t+1}^i for bequest, e_{t+1}^i for the input in contest, and β is a consumption-bequest preference parameter. Here e^i may stand for the effort, time devoted to the political struggle. Therefore, one interpretation of this cost function is the "disutility of labor".

3.2 Production

The economy consists of two sectors, traditional (T) and modern (M). The traditional sector employs land T and labor L_T as inputs, and operates using the following Cobb-Douglas technology:

$$Y_{T,t} = A_{T,t} T^{\alpha} L_{T,t}^{1-\alpha}\,, \qquad (2)$$

[6] For the analysis of endogenous land inheritance system see, for example, Bertocchi (2006), where landowners choose between primogeniture and land partition among children. In her paper, landowners choose to bequest the entire amount of land they own to a single offspring in the early stages of development, since large estates were the source of political power. The pattern of land inheritance changed when capital replaced land as the main factor of production. In our paper we abstract from endogenous land inheritance since our prime focus is on capital and its accumulation and distribution.

[7] We assume that land is the immobile factor of production, and are therefore tied to the firm\estate owners they were bequeathed to. In such a way, we do not allow trading capital and land among agents. The introduction of market for land would probably significantly complicate the analysis. Moreover, what is more important, it would contradict the evidence that in a time period we are considering in our paper, land was quite an illiquid asset (see also Bertocchi (2006, 2001)) due to both political power coming from land ownership and different legal constraints. Finally, the effect of wealth distribution in fact was so important in the historical perspective because of markets imperfections and lack of abilities to e.g. borrow capital or buy land.

where A_T is the sector productivity level, and t stands for the discrete time period. The modern sector employs physical capital K and labor L_M as inputs. The productivity level equals A_M. Therefore, with Cobb-Douglas technology we have:

$$Y_{M,t} = A_{M,t} K_t^{\alpha} L_{M,t}^{1-\alpha} . \quad (3)$$

We also assume that labor is perfectly mobile and choses the sector with higher wages. The aggregate product of the economy is $Y = Y_M + Y_T$, i.e. the two goods produced in the sectors are perfect substitutes. The final good can be either consumed or saved in the form of a bequest to the offspring[8].

3.3 Factor incomes

We capture a historical feature of the non-competitive, exploitative nature of landowner-worker relations in a traditional sector by following Bertocchi (2006) and Acemoglu and Robinson (2008). We assume that all landowners appropriate a fraction φ of the traditional sector output, while their peasants get an average of what is left, i.e. $w_{T,t} = \frac{(1-\varphi)Y_{T,t}}{L_{T,t}} = (1-\varphi) \cdot A_{T,t} \left(\frac{T}{L_{T,t}}\right)$. Moreover, we can represent the total rent of the landowners, $\varphi Y_{Y,t}$, as $T \cdot \varphi A_T \left(\frac{L_{T,t}}{T}\right)^{1-\alpha}$, which is shared among landowners proportionally to the size of a landholding. Finally, we make a substitution $\varphi = \big(\alpha + \tau(1-\alpha)\big)$ and get the following factor incomes for the unit of labor and land:

$$w_{T,t} = (1-\tau)(1-\alpha) A_{T,t} \left(\frac{T}{L_{T,t}}\right)^{\alpha} , \quad (4)$$

$$\rho_t = \left(1 + \frac{\tau(1-\alpha)}{\alpha}\right) \alpha A_{T,t} \left(\frac{L_{T,t}}{T}\right)^{1-\alpha} , \quad (5)$$

where $\tau \geq 0$ represents the relative bargaining power of the landowners versus their peasants[9] and the deviation of factor incomes from competitive ones. The land income of each landowner is proportional to the size of the estate and equals $T^i \cdot \rho_t$.

In the modern sector we assume a competitive market structure[10]. With the output price normalized to one, we get the following factor incomes for the unit of labor and capital:

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[8] In such a way, we refrain from making a distinction between the agricultural production and manufacturing goods that are quite standard for the unified growth models, see e.g. Galor and Weil (2000), Voigtlander and Voth (2006, 2013), Desmet and Parente (2012). The reason is that, although being crucial for the economic side of the industrialization phenomenon, neither the demand for industrial goods nor the minimal subsistence level of agricultural consumption is important for the main arguments and goals of this paper concerning the political conflict over the institutions and policies favoring industrialization.

[9] In fact, the historical conflict between peasants and landowners is beyond the scope of our research, so we treat this admittedly endogenous institutional variable as exogenous. Alternatively, we could consider τ to be endogenous and chosen by the elite in order to maximize their land rents, ρ_t in each period (see also Bertocchi (2006)). In such a case, optimal τ^* would balance the benefits from higher expropriation rate and its costs, namely, the outflow of labor to the modern sector. Moreover, τ^* would be a decreasing function of aggregate capital, and in the limit it would tend to zero. However, such a complication would not significantly affect our results. Finally, instead of introducing a distortion to competitive prices, τ, we could have assumed that labor is immobile due to political and economic barriers established by the elite (see also Bertocchi (2006), Lagerlof (2009)). Such a construction would be almost equivalent to ours if the political conflict (to be described below) is over the existence of these labor migration barriers.

$$w_{M,t} = (1-\alpha)A_{M,t}\left(\frac{K_t}{L_{M,t}}\right)^{\alpha} \quad (6)$$

$$R_t = \alpha A_{M,t}\left(\frac{L_{M,t}}{K_t}\right)^{1-\alpha}. \quad (7)$$

Therefore, the total capital income (profit) is given by $K_t \cdot R_t$, which is shared among the capitalists proportionally to their capital holdings, i.e. $k_t^i \cdot R_t$.[11]

3.4 Political struggle and institutions

Those agents who are in favor of modern sector development propose a reform policy that improves productivity in this sector. Those who oppose changes propose a status-quo policy. Opposing parties may invest some effort in order to increase the probability of winning a contest over public policy (institutional set-up[12]). In our model players vary by their prize valuation (stakes in conflict), since different ownership of capital and land makes agents assess the consequences of reforms and institutional changes differently.

More formally, the outcome of the contest is a realization of reform (R) policy or status-quo (S) policy. In the case of reform, modern-sector productivity after the conflict improves by γ times, $A_{M,t} = \gamma A_{M,t-1}$, while in the case of status-quo it stays unchanged, $A_{M,t} = A_{M,t-1}$. Therefore, the dynamics of productivity in the modern sector[13] is given by $A_{M,t} = \begin{cases} \gamma A_{M,t-1}, & if\ R \\ A_{M,t-1}, & if\ S \end{cases}$, $\gamma > 1$. In such a way, the expected rate of productivity growth is $g_t = p_{R,t}(\gamma - 1)$, where $p_{R,t}$ is the probability of reform, which is determined through the contest and is going to be specified below. We also assume, see e.g. Mokyr (1990), that there exists a spillover from the modern-sector productivity to the productivity in the traditional sector, such that $A_{T,t} = A_{M,t-1}$. It follows that if the productivity in the modern sector did not improve in the period t, then $a_t = \frac{A_{M,t}}{A_{T,t}} = 1$, and if it improved, then $a_t = \gamma$.

Relative productivity affects factor incomes in both sectors due to direct productivity effect, and due to changes in the allocation of labor. As a result, agents' incomes depend on the outcome of

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[10] One can argue that prices in the modern capital-intensive sector should not be competitive, especially in that time period, when labor exploitation, probably, was common to both sectors. However, in that case, one can interpret τ as simply a relative measure of labor exploitation.

[11] If we let each agent in the modern and traditional sectors to have his own production technology (own firm\estate), we would get the same factor incomes as in (4)-(7). The reason is that we assume perfect labor mobility and constant returns to scale in both sectors, which results in homogeneity of degree zero of the first derivatives of the production functions, and hence $\frac{k_t^i}{L_{M,t}^i} = \frac{K_t}{L_{M,t}}$ and $\frac{T^i}{L_{T,t}^i} = \frac{T}{L_{T,t}}$.

[12] It is important to note that, generally, it should not be only the technological progress. The contest is over the ease of operating in the new "business" environment, which includes property rights protection, infrastructure, more educated labor, etc. (as e.g. in Llavador and Oxoby (2005)).

[13] We do not consider the possibility of innovations in the traditional sector as in the initial period of development (with miniscule modern sector) this type of innovation is beneficial for all members of the society, and so, there are no political barriers for their realization.

the conflict. Agent i derives an indirect utility level of $V^i(Z) = \max_{c^i_{t+1}, +b^i_{t+1} \le I_Z} U\left(c^i_{t+1}, b^i_{t+1}, e^i_{t+1}\right)$ if Z policy is realized, where $Z \in \{S, R\}$. The net benefit from winning a contest is $\Delta^i_R = V^i_R(R) - V^i_R(S) > 0$ for the supporters of reforms in the modern sector, and $\Delta^j_S = V^j_S(S) - V^j_S(R) > 0$ for the opponents of reforms. Those who are in favor of modern-sector improvements may put an input e^i_R in order to increase the probability of reform. Those who support the status-quo make an input e^j_S.

The probability that a reform in the modern sector will take place and its productivity will increase is determined by the standard logit contest success function (CSF) with efforts of individual members inside one group being perfect substitutes (see also Baik (2008), Esteban and Ray (2011), Nitzan and Ueda (2014)):

$$p_R = \frac{\sum e^i_R}{\sum e^i_R + \sum e^j_S} = \frac{E_R}{E}, \tag{8}$$

Agents non-cooperatively choose the amount of effort to put into the contest driven by the following expected payoffs for supporters and opponents of modern-sector development respectively:

$$W^i_R = p_R \cdot V^i_R(R) + (1 - p_R) \cdot V^i_R(S) = V^i_R(S) + p_R \cdot \Delta^i_R, \tag{9}$$

$$W^j_S = (1 - p_R) \cdot V^j_S(S) + p_R \cdot V^j_S(R) = V^j_S(R) + (1 - p_R) \cdot \Delta^j_S. \tag{10}$$

To conclude with assumptions and structure, the model has the following timeline.

1. The generation is born in period t and receives capital and land bequests at the end of that period. Capital bequest is invested in order to become a productive capital in period $t + 1$.
2. In the beginning of period $t + 1$ agents (may) participate in conflict over this period's institutional set-up, trying to increase the probability of the desired policy outcome, S or R.
3. Next, either the reform or status-quo policy is realized, and production in both sectors takes place with the supplied amounts of land, labor and productive capital.
4. Finally, agents receive their factor incomes, which depend on the outcome of the conflict, and optimally allocate them between consumption and bequest to their offspring.
5. The generation born in period $t + 1$ receives capital and land bequests, and the game repeats.

4. Temporary equilibrium and comparative statics of conflict

In this section, we put aside the dynamic evolution of the economy. We concentrate on the outcome of the political conflict and its response to the changes in economic environment, namely, the distribution of land and capital holdings among agents. We solve the intra-generational politico-

economic equilibrium backwards, starting from the optimal allocation of income, given the dynamic variables from the previous period and given the outcome of the political struggle.

4.1 Intra-generational equilibrium

Utility maximization and indirect utility

Each agent i maximizes utility from consumption and bequeathing given in (1) with respect to $c_{t+1}^i + b_{t+1}^i \leq I_{t+1}^i$, given the outcome of political conflict and all the aggregate variables. The optimal solution satisfies:

$$\left(c_{t+1}^i\right)^* = (1-\beta) I_{t+1}^i \tag{11}$$

$$\left(b_{t+1}^i\right)^* = \beta I_{t+1}^i \tag{12}$$

Using (1), (11) and (12), we derive the indirect utility function (or payoff function):

$$V^i = \ln\left(I_{t+1}^i\right) - C\left(e_{t+1}^i\right) + \xi(\beta), \tag{13}$$

where $\xi(\beta) = (1-\beta)\ln(1-\beta) + \beta \ln \beta$, and plays no role in what follows. Therefore, each agent's policy preferences are determined by his income. Next, we show how the incomes of agents from different classes depend on the distribution of capital and land wealth, its aggregate amounts, and the modern sector development.

Labor market clearing and individual incomes

The labor market clears when, first, $w_{T,t} = w_{M,t}$, which comes from the fact that labor is perfectly mobile between two sectors, and, second, $L_{T,t} + L_{M,t} = L$, where L is normalized to 1. Using (4) and (6), we get the equilibrium amount of workers employed in the modern sector:

$$L_{M,t}^* = \frac{1}{1+\left(\frac{T}{K_t}\right)\cdot\left(\frac{1-\tau}{a_t}\right)^{\frac{1}{\alpha}}} \tag{14}$$

where $a_t = \frac{A_{M,t}}{A_{T,t}}$ is the productivity ratio after that the outcome of the conflict is realized (equals γ if the reform was implemented, and equals 1 in the case of a status-quo policy). Increased relative productivity of the modern sector pushes wages up and attracts more workers until wages equalize at a new, higher level. Capital accumulation also attracts more workers to the modern sector due to capital-labor complementarity, and, hence, higher wages.

Using (14) and (4) - (7), we get the equilibrium factor prices $w_t^* = w_t\left(L_{M,t}^*\right)$, $R_t^* = R_t\left(L_{M,t}^*\right)$, and $\rho_t^* = \rho_t\left(L_{M,t}^*\right)$. It is straightforward to note that a higher $A_{M,t}$, by attracting more labor to the modern sector and enhancing productivity, increases R_t^* and w_t^*, but lowers ρ_t^*, since land and labor are complements in the traditional sector. This consideration reflects the nature of

conflict, i.e. why landowners (could have) opposed industrialization, while capitalists supported it[14]. Moreover, it is clear that $(w_t^*)'_K > 0$, $(R_t^*)'_K < 0$, and $(\rho_t^*)'_K < 0$. The income of agent i is therefore given by

$$I_t^i = w_t^* + k_t^i \cdot R_t^* + T^i \cdot \rho_t^* \quad (15)$$

In what follows, we consider factor prices only in the temporary equilibrium, and drop the "$*$" and time indices for the simplicity of exposition. Thus, since $T^i = 0 \; \forall \; i \in C$, it is clear that incomes (and, hence, payoffs given in (13)) of capitalists positively depend on the level of modern sector productivity. At the same time, landowner i may either support or oppose industrialization, depending on the amount of land and capital he owns. Denote the subset of landowners, who support industrialization reforms, by $\mathcal{L}_R$ (and the subset of landowners, who oppose it, by $\mathcal{L}_S$). Also denote by w^R, R^R, and ρ^R the equilibrium factor prices under the reform policy, while w^S, R^S, and ρ^S stand for the equilibrium factor prices under the status-quo policy. Below we show how the division of landowners into supporters and opponents of industrialization depends on their individual characteristics (capital and land holdings) and aggregate variables.

Proposition 1. (Preferences towards industrialization)

a. Individual capital and land holdings. For a given K_t, T, g, and τ, there exists a (possibly empty) subset $\mathcal{L}_R$ of landowners, who have sufficiently high k^i and low T^i, such that they support reform policy (industrialization), i.e. $V^i(R) > V^i(S)$ holds for all $i \in \mathcal{L}_R$, where

$$\mathcal{L}_R = \left\{ \left(k^i, T^i\right) : T^i < \frac{\Delta w}{\Delta \rho} + \frac{\Delta R}{\Delta \rho} \cdot k^i \right\} \quad (16)$$

Here $\Delta w = w^R - w^S > 0$, $\Delta R = R^R - R^S > 0$, and $\Delta \rho = \rho^S - \rho^R > 0$,

b. Strength of support. For a given K_t, T, g, and τ, the larger k^i is; the stronger the support for industrialization is, i.e. $\left(\Delta_R^i\right)'_{k^i} > 0$, and the larger T^i is; the weaker the support for industrialization is, i.e. $\left(\Delta_R^i\right)'_{T^i} < 0$[15]. Moreover, $\left(\Delta_R^i\right)''_{k^i} < 0$, and $\left(\Delta_S^i\right)''_{T^i} < 0$, i.e. the higher the individual capital is, the smaller the increase in support for reform policy is in response to an increase in capital holdings; the same holds for the supporters of status-quo policy and their land holdings.

c. The end of conflict. There exists a threshold level of aggregate capital $\overline{K}$, such that for all $K_t \geq \overline{K}$ even the most eager supporter of status-quo policy switches his preferences towards industrialization; therefore, there is no conflict, and $p_R = 1$ when $K_t \geq \overline{K}$.

Proof. See appendix A.1

[14] It is important to notice here that we abstract from considering differences in abilities and human capital. Otherwise, some workers could be in opposition to development, as well as agents whose skills are applicable only to old technologies; see e.g. Mokyr (1990), Canton et al. (2002), Desmet and Parente (2014).

[15] And since $\Delta_S^i = -\Delta_R^i$, we also have $\left(\Delta_S^i\right)'_{k^i} < 0$ and $\left(\Delta_S^i\right)'_{T^i} > 0$.

Therefore, the supporters of the reform policy are all capitalists plus a subset of landowners. The supporters of status-quo policy are the landowners with bigger landholdings and smaller capital holdings. The intuition is that bigger capital holdings increase the benefits from reform policy, since it increases productivity and attracts more labor to the modern sector, both of which increase returns to capital. However, if an agent owns both capital and land, he wins from industrialization as a capital owner, but loses as a landowner. The relative position in capital and land, as well as their factor prices, determines the attitudes towards industrialization (part a). Moreover, if the aggregate capital is high, the share of the traditional sector in the economy becomes small (see (14)) due to labor movements. Hence, when aggregate capital-to-land ratio is high, incomes gained from the traditional sector begin to play an inferior role in landowners' portfolios. Therefore, at the limits, the return from land vanishes, and even the most eager supporter of status-quo policy switches his preferences (part c). Thus, the economy obtains not only the necessary economic conditions for industrialization to speed-up, but also the sufficient political and institutional set-up.

Finally, the higher the capital holdings of an agent are, the higher the relative income gain from reform policy in comparison to the status-quo policy is; the contrary holds for higher land holdings (part b). Moreover, $\Delta_R^i(k^i)$ is a concave function, as well as $\Delta_S^i(T^i)$, which has important consequences for the comparison of different distributions of assets inside the competing groups.

Outcome of the conflict

In this section, we provide the simplest possible version of the model with $C(e^i) = e^i$, and no upper constraints on e^i, which is enough to illustrate our main ideas and results concerning the effects of wealth distribution on the outcome of political conflict. We also drop time indices for the ease of exposition. Using (8) – (10), (13), we get the following objective functions for the member i of reform supporters and the member j of status-quo supporters:

$$\max_{e_R^i} W_R^i = \ln I_S^i + \frac{E_R}{E} \cdot \ln\left(\frac{I_R^i}{I_S^i}\right) - e_R^i, \tag{17}$$

$$\max_{e_S^j} W_S^j = \ln I_R^j + \frac{E_S}{E} \cdot \ln\left(\frac{I_S^j}{I_R^j}\right) - e_S^j, \tag{18}$$

where $E_Z = \sum e_Z^i$, $Z \in \{S, R\}$, and $E = \sum E_Z$. Equations (17) and (18) are maximized with respect to e_R^i and e_S^j (first terms in (17) and (18) can be ignored as constants). Such types of asymmetric public policy contests with linear costs are studied in-depth in e.g. Epstein and Nitzan (2006) and Baik (2008).

We search for a pure strategy Nash equilibrium in this two-group asymmetric contest. Applying FOCs for problem (17), we get the following:

$$\frac{E_S}{E^2}\cdot \ln\left(\frac{I_R^i}{I_S^i}\right)-1=0, \qquad if\ e_R^i>0$$

$$\frac{E_S}{E^2}\cdot \ln\left(\frac{I_R^j}{I_S^j}\right)-1\le 0, \qquad if\ e_R^i=0$$

The similar FOCs apply for each member of the group supporting the status-quo. The only things that vary among agents in each group are the valuations of winning in political conflict: $\Delta_R^i=\ln\left(\frac{I_R^i}{I_S^i}\right)$ and $\Delta_S^j=\ln\left(\frac{I_R^j}{I_S^j}\right)$, which are the percentage gains in terms of incomes in the preferred institutional set up relative to the inferior one, i.e. the "rate of return from reform\status-quo". The FOCs above guarantee that only one player (or a single sub-group of players with similar valuations) in each group will participate in the conflict. Namely, it is the player with the highest valuation, i.e. the highest $\ln\left(\frac{I_R^i}{I_S^i}\right)$ among the supporters of productivity change, and the highest $\ln\left(\frac{I_R^j}{I_S^j}\right)$ among status-quo supporters. To see this, note that if FOC holds with equality for a player with the highest valuation (h), i.e. $1=\frac{E_S}{E^2}\cdot\ln\left(\frac{I_R^h}{I_S^h}\right)$, then for every player $i\neq h$ with a lower valuation marginal benefits $\frac{E_S}{E^2}\cdot\ln\left(\frac{I_R^i}{I_S^i}\right)$ from participating in the conflict are lower than marginal costs. See Baik (2008) for an in depth discussion of such public policy contests with linear cost functions[16].

One important special case here is that there may exist several agents (or a group of agents) inside one group with similar (highest) valuations. In such a case, all the players with highest valuations participate in conflict. Moreover, there are multiple Nash equilibria, each of which give the aggregate effort of the group similar to the effort of one single most interested player; see also Baik (2008).

In a reduced two-player (or two sub-groups) contest, using FOCs for participating agents (h) in both groups, we get the following pure strategy Nash equilibrium:

$$\frac{E_R^*}{E_S^*}=\frac{\Delta_R^h}{\Delta_S^h}, \qquad (19)$$

[16] In our context, the realization of a certain policy, reform or status-quo, is a pure public good for each group. Therefore, since the gains from reform\status-quo do not decrease with the group size, there is no so-called Olson's group size paradox here (see also Esteban and Ray (2001)). In other words, the smaller group is not necessarily more efficient in defending its interests. In our model, a smaller group can still be more efficient in contest due to the fact that given a certain aggregate amount of land or capital for a group as whole, the lower is its size, the larger are (other things equal) individual shares in wealth ownership. In the case of capitalists, it leads to an increase in the efforts of the most interested (biggest) capitalists, and hence promotes industrialization. In the case of landowners, this may not be the true, since lower group size corresponds to both more concentrated capital and land, and hence has an ambiguous effect on the incentives of landowners (see proposition 2 and discussion after it). Also note that if we consider an effort cost function with increasing marginal costs, the Olson's result may reverse (see Esteban and Ray (2001) and Nitzan and Ueda (2014)), such that larger groups would have an advantage in lobbying for their preferred policies.

$$E_R^* = \frac{\Delta_S^h}{\left(1+\Delta_S^h/\Delta_R^h\right)^2} \quad (20)$$

$$E^* = E_R^* + E_S^* = E_R^*\left(1+\frac{\Delta_S^h}{\Delta_R^h}\right) = \frac{\Delta_R^h \cdot \Delta_S^h}{\Delta_R^h+\Delta_S^h} \quad (21)$$

From (19) and (8), we derive the probability of pro-growth reform policy, which represents institutional quality:

$$p_R^* = \frac{1}{1+\Delta_S^h/\Delta_R^h} \quad (22)$$

Equations (22) and (21) indicate that the institutional outcome and intensity of conflict are determined by the "stakes" ratio of the players with highest valuations in both groups. Moreover, we can formulate the following lemma that would be useful in both comparative statics and dynamics of the model (this result is well established in the literature on asymmetric contests, see e.g. Nti (1999) for one of the seminal related contributions)

Lemma 1. (Outcome and intensity of political conflict)

a. Probability of reform. The higher the stake in the conflict for the most eager supporter (or the sub-group of most eager supporters) of industrialization relative to the stake of its most rampant opponent is, the higher the probability of reform is, i.e. $\frac{\partial p_R^*}{\partial(\Delta_S^h/\Delta_R^h)} < 0$;

b. Total efforts. The intensity of conflict increases with participants' stakes, i.e. $\frac{\partial E^*}{\partial \Delta_Z^h} > 0$, $Z = S, R$. Moreover, given a certain sum of stakes, $\Delta_R^h + \Delta_S^h = \Delta$, conflict intensity is highest when $\Delta_R^h = \Delta_S^h$. Thus, $\left(\frac{\Delta_S^h}{\Delta_R^h}\right)^* = argmax E^*(\Delta) = 1$, i.e. the intensity of conflict is maximal, other things being equal, when participating contestants are equally interested in it.

Proof. Parts a. and b. follow simply from differentiating equations (22) and (21) respectively.■

Therefore, the pace of industrialization and the intensity of conflict crucially depend on the groups' relative incentives to participate in political struggle. In the following subsection, we consider how these incentives respond to changes in the distributions of capital and land holdings.

4.2 Wealth distribution and probability of reform policy

In general, in our model the distribution of capital in each period is endogenous and depends on the initial distributions of capital and land, labor market clearing, productivity levels, conflict outcomes, etc. However, in this chapter we do comparative statics by changing capital/land

distribution among agents in a given period, focusing on the effect on the expected pace of industrialization in this period[17].

As it follows from proposition 1.b, $\left(\Delta_R^i\right)'_{k^i} > 0$, i.e. inside the class of capitalists (who have $T^i = 0$) the biggest (or the group of biggest capitalists) is one the most interested in reform policy. We also know from proposition 1.a that some landowners may as well support reform policy. In such a way, in each period a set of agents who support reform policy consists of all landless individuals and a portion of landowners whose assets are such that $T^i < \frac{\Delta w}{\Delta \rho} + \frac{\Delta R}{\Delta \rho} \cdot k^i$ for all $i \in \mathcal{L}_R$. Moreover, if the richest capitalist h has relatively small k_C^h, and there is a landowner m with relatively large k_L^m and small T^m, this landowner may be the most eager supporter of the reform policy, such that $\Delta_R^h < \Delta_R^m$ (the sufficient condition for $\Delta_R^h > \Delta_R^m$ is that k^h of the biggest capitalist is higher than any k^j, $j \in \mathcal{L}$). Consider next, how the change in the distribution of capital would affect the incentives of opposing groups.

Proposition 2 (within-group distribution of capital).

a. For $\Delta_R^h \geq \Delta_R^m$, i.e. when the most eager supporter of industrialization is inside the capitalist class, any strict Lorenz-worsening change[18] of capital distribution within capitalists increases Δ_R^h and consequently leads to higher p_R^*.

b. For $\Delta_R^h < \Delta_R^m$, a strict Lorenz-worsening change in the distribution of capital within capitalists does not affect p_R^* if the biggest capitalist do not get too much capital, while p_R^* increases if he gets a large enough amount of capital. Specifically, p_R^* is unchanged if $\Delta k^h \leq \tilde{k}$, and p_R^* increases if $\Delta k^h > \tilde{k}$, where $\tilde{k}$ is such that $\Delta_R^h\left(k^h + \tilde{k}\right) = \Delta_R^m$.

Proof. See appendix A.2

The results of Proposition 2 correspond well with the observations of Kinghorn and Nye (1996), Desmet and Parente (2012), Acemoglu and Robinson (2012) and Trew (2014) that regions, which in the beginning of industrialization had more concentrated industries managed to industrialize earlier. Moreover, as Mokyr and Nye (2007) indicate, the industrialization became possible only when the initially fragmented market with many small-scale firms was replaced by an integrated economy with concentrated production and a new "oligarchic" class of big emerging capitalists. This "new elite" lobbied more actively for the (reform) policies they needed through Parliament. Our model demonstrates the mechanism. Higher inequality in the distribution of capital

[17] Probably, it is better to consider these comparative statics changes as a comparison between two countries that have different profiles of wealth distribution, and not as a sudden change in capital distribution inside one country, since individual as well as aggregate levels and profiles of capital distribution are endogenous (which we study in detail in the section 5).

[18] Consider two distributions of capital, $G(k)$ and $\tilde{G}(k)$ inside of a group of N agents. The latter distribution is said to be more unequal in the sense of strict Lorenz-worsening, if $\sum_{i=1}^{m} k^i > \sum_{i=1}^{m} \tilde{k}^i$ for all $m < N$, and $\sum_{i=1}^{N} k^i = \sum_{i=1}^{N} \tilde{k}^i$.

(i.e. more concentrated capital) among capitalists means that the benefits from winning political conflict for those, who actively participate in lobbying for pro-growth reforms, increase. Therefore, the biggest capitalists become more eager to invest their efforts in political struggle in order to increase the probability of reform policy. Standard free-riding effects are at play here, guaranteeing that the lower interest in conflict by smaller capitalists is more than compensated for by an increase in the largest capitalists' efforts.[19]

However, since the landowners as well as pure capitalists were accumulating capital and gaining more interest in modern sector development, the distribution of capital and land within the landowners also matters for the pace of industrialization. The difficulty here is that we cannot rank the strength of support\opposition of landowning agents on the one-scale basis (as we did for capitalists with respect to their capital holdings).

Consider how the inequality in the distribution of land can affect the attitudes of different landowners towards the amount of effort they want to put into conflict, and hence, the probability of reform policy. In Galor et al. (2009), higher inequality in land distribution reduced the attitudes of the landowning elite (who have the veto power over political outcome) towards educational policies. This result rests on the assumption that all landowners are equal, and hence "higher inequality" in land distribution is equivalent to "more concentrated" land distribution. However, in our paper, landowners are heterogeneous, and we do not impose any ex-ante restrictions on the relationship between landowners' individual capital and land holdings at this. Thus, there could be various compositions and structures of $\mathcal{L}_R$ and $\mathcal{L}_S$ groups in terms of (T^i, k^i), constrained only by (16). In such a way, an agent with the biggest land holdings is not necessarily the most eager supporter of status-quo policy. In fact, it corresponds well with the observations of Mokyr and Nye (2007), who note that the coalition of big capitalists and big landowners was the group that eventually lobbied for and promoted reforms necessary for industrialization. The joint distribution of capital and land, as well as factor prices, together determine the effect of inequality in land distribution. In such a case, higher inequality in land distribution may not lower and may even increase the probability of reform policy.

Remarks (within-group distribution of land).

The Lorenz-worsening change in the distribution of land lowers the probability of reform policy if the following necessary conditions hold:

[19] Note also that the alternative specifications with increasing marginal costs of efforts would bring similar implications saying that any Lorenze-worsening change in the distribution of capital among capitalists would improve their chances of winning the political conflict. Two conditions are crucial for this result: 1) the natural assumption $C'(0) > 0$ holds (e.g.$C(e) = -\ln(1-e)$ – the functional form of cost function that would arise if we assume a logarithmic utility from leisure, given constraint $e + l = 1$), which gives rise to potential non-contributors to the group efforts, and 2) the contest is "hard" enough for the group, i.e. when the opposing group is strong (this condition also holds in the early stages of industrialization for the group of capitalists). For details see Nitzan and Ueda (2014).

1. An agent h (or a group of agents) with the highest interest in status-quo policy, i.e. the one with Δ_S^h, receives a positive land transfer x; or an agent j (or a group of agents) with $\Delta_S^j < \Delta_S^h$ receives a positive transfer ε such that $\Delta_S^j(T^j + \varepsilon) > \Delta_S^h(T^h + x)$.
2. Due to a land transfer, participating agents from $\mathcal{L}_R$ lose x, and participating agents from $\mathcal{L}_S$ gain z, such that $d\Delta_R^h(x) < d\Delta_S^h(z)$. i.e. active reform supporters lose not as much land, as is needed to increase their benefits from reform policy by more than the benefits of their opponents from status-quo policy increase.

Condition 1 can be easily violated if inequality in land distribution increases because of a land transfer from one non-participating member of $\mathcal{L}_R$ group with less land to another non-participant from $\mathcal{L}_R$ with more land. In other words, if the most eager opponents of industrialization are not affected by the redistribution policy, there would be either no effect on reform probability, or the effect would be positive, since taking land away from landowners who actively support industrialization would increase their stakes from reform policy (violation of condition 2). An important consideration that makes us conclude that the probability of reform may increase in response to higher inequality in land distribution is that $\left(\Delta_S^j\right)_T'' < 0$, i.e. the larger the landholding of agent j is, the smaller the increase in his benefit from status-quo policy in response to an increase in the amount of land he owns is (proposition 1.b). Consider the example of an economy, populated by two landowners, with $T_1 = 1, k_1 = 1$, and $T_2 = 10, k_2 = 1$, and several capitalists, with $k_C^j < 1$ for all j. Moreover, factor prices are such that landowner 1 actively supports the reform policy, while landowner 2 fights for the status-quo policy. Then consider a Lorenz-worsening transfer of $\bar{T} = 0.5$ to the second landowner, such that $T_1^{new} = 0.5, T_2^{new} = 10.5$. The incentives of the poor landowner to support industrialization increase more strongly than the incentives of the rich landowner to oppose industrialization. Hence, in this example economy, p_R^* increases with higher inequality in land distribution among landowners.

The distribution of capital within the class of landowners also can significantly affect the outcome of political struggle, and explain why a more concentrated industry and bigger firms should not necessarily promote pro-growth reforms and industrialization. For example, consider a regressive system of transfer of capital within the group of landowners, such that the capital holdings of the landowner who actively participated in conflict as a supporter of industrialization decrease by ε, and the capital holdings of a landowner j who does not participate in conflict increase by ε. In such a case, the probability of reform policy would decrease (since the strength of support for it diminishes) with capital distribution becoming more unequal in the sense of Lorenz-domination. Consider another example, when the biggest capital holdings among the landowners

belong to those of them who actively support reform policy (agents h). Then a regressive transfer of ε units of capital away from landowner j to landowner h who supports industrialization would increase the probability of reform policy if landowner j did not participate actively in conflict. Otherwise, such a transfer would decrease the chances for reforms, since the incentives of a landowner j to oppose reforms would increase stronger than the incentives of landowner h to support them[20]. Therefore, a distribution of capital such that landowners with small capital holdings have even less capital, while capitalists with large capital holdings have more capital could be detrimental to industrialization, regardless of the fact that it corresponds to more concentrated industry.

These considerations stress the importance of the class affiliation of the biggest capital owners. In such a way, we can possibly account for the fact that in some circumstances more concentrated industry was associated with faster industrialization, while in other cases it did not; see e.g. Kinghorn and Nye (1996), Boschini (2006). For example, the reason why in some cases higher concentration in industry was not matched with faster industrialization could be that the biggest capitalists were inside the class of landowners. In this case, a concentration of capital in their hands could even have deterred industrialization, since they still were not willing to actively fight for reforms (due to their interest in incomes from land holdings), while pure capitalists lacked capital and incentives to defeat vested interests.

5. Model dynamics

5.1 Capital accumulation and growth

Applying (12) and aggregating over individual incomes, we get the following capital accumulation equation:

$$K_{t+1} = \beta Y_t = \beta(A_{T,t} T^{\alpha} L_{T,t}^{1-\alpha} + A_{M,t} K_t^{\alpha} L_{M,t}^{1-\alpha}), \tag{23}$$

where the level of employment in the modern sector is given by the equation (14), the level of employment in the traditional sector is

$$L_{T,t} = 1 - L_{M,t}, \tag{24}$$

the expected rate of technological progress in the modern sector is equal to

$$\mathbb{E}\left(\frac{A_{M,t}}{A_{M,t-1}}\right) = p_{R,t}(\gamma - 1), \tag{25}$$

[20] This result comes from the fact that $\left(\Delta_R^i\right)''_{k^i} < 0$ (see proposition 1.b), which makes the opponent of reforms with small capital holdings react stronger on the decrease of his capital holdings by ε, than the supporter of reforms with large capital holdings on the increase of his capital holdings by ε.

and the probability of the reform policy, $p_{R,t}$, is determined by the equation (22). The technological progress in the traditional sector is equal to

$$A_{T,t} = A_{M,t-1}. \quad (26)$$

Because of the non-competitive structure of the labor market in the traditional sector the curve $K_{t+1}(K_t)$ can be non-monotonic for a given level of technology and for a high level of the bargaining power of landowners versus workers (τ). In this case, for a low level of capital, the output in the economy decreases with a rise in capital. The intuition behind this result is the following: the rise of the modern sector gives opportunities to workers to flow from the traditional to the modern sector. For a higher level of a bargaining power of landowners, τ, more workers will move to the modern sector even if the marginal product of labor in the traditional sector is higher than in the modern sector; hence, their decision to move may decrease the aggregated output. However, for a low level of τ, the $K_{t+1}(K_t)$ curve becomes monotonic.

Assumption 1. The bargaining power of landowners, τ, is sufficiently low, such that $\tau < \alpha$.

Assumption 1 guarantees that the rate of capital accumulation is positive even if the level of the capital tends to be zero[21], such that $K'_{t+1}(K_t) > 0$ for all K_t. This result is formally proved in Appendix A.4.

Lemma 2. For the given level of technological progress $A_{T,t} = A_{M,t} = A$ and for $\tau < \alpha$

$$K'_{t+1}(K_t) > 0,$$

$$K''_{t+1}(K_t) > 0 \text{ for } K_t < K' \text{ and } K''_{t+1}(K_t) < 0 \text{ for } K_t > K',$$

$$\lim_{K \to \infty} K'_{t+1}(K_t) = 0,$$

and the capital dynamics asymptotically converge to the steady state level $\widetilde{K}$, where $\widetilde{K} = \beta Y(\widetilde{K})$.

Proof. See Appendix A.4

We model the level of productivity in the modern sector as a stochastic variable since the reform policy is implemented with a probability $p_{R,t}$ Hereby we focus on the expected dynamics of the model.

Definition. Intertemporal politico-economic equilibrium.

[21] It is interesting to note that if we allow for τ to be endogenous and determined by the landowners maximizing their land rents ρ_t at each date t, then the equilibrium level of τ^* would be a decreasing function of the aggregate amount of capital, K_t. Hence, at low levels of development, when K_t is low, τ^* would be high. Therefore, the $K_{t+1}(K_t)$ curve would be downward-sloping at low levels of K_t. This can even lead to an existence of a poverty trap, represented by the stable steady state level of capital, in which aggregate capital is low, expropriation of peasants is high, and political process is stagnant with the landowning elite holding their grip on power. Such a state corresponds well with what is known about the time period before the industrialization had started. However, the slow pace of productivity growth would eventually lead to the disappearance of such a poverty trap (much in the spirit of Galor and Weil (2000)), and give rise to the steady accumulation of capital and industrialization.

A sequence of $(K_t, L_{M,t}, L_{T,t}, A_{M,t}, A_{T,t}, w_t, R_t, \rho_t, p_{R,t}, k_t^i, I_t^i)$ is called the intertemporal equilibrium of the model, if for a given initial values of $(K_0, k_0^i, A_{M,0}, A_{T,o})$, the dynamics of physical capital is determined from the dynamic equation (12), the dynamics of technology is determined from the equations (25, 26), the dynamics of individual levels of capital is determined from the equation, $k_t^i = \beta I_{t-1}^i$. Moreover, labor market clearing conditions (14), (24) hold, factor prices are determined from (5),(6),(7), the probability of the reform policy satisfies (22), and the level of incomes is determined by the equation (15).

If the technology in the modern sector does not change over time (the status-quo policy), capital will converge to its temporary steady state, $\tilde{K}$, given by $\tilde{K} = \beta Y(\tilde{K})$, see (23). Therefore, the long-run dynamics of income per capita and capital accumulation is driven only by the technological progress. When the new technology develops, the locus $K_{t+1}(K_t)$ shifts upwards, and the temporary steady state point changes (moves to the right)[22].

Definition (conditional steady state). The combination of the total amount of capital, the level of employment in both sectors, the factor prices and the amount of capital and income, belonging to each agent, $(\tilde{K}, \tilde{L}, \tilde{w}, \tilde{R}, \tilde{\rho}, \tilde{k^i}, \tilde{I^i})$ is called a conditional steady state, if all these variables remain constant over time for a given level of technological progress, $A_{M,t} = A_{T,t} = A_t$.

From the preceding analysis, factor prices and employment levels in both sectors are also constant in the conditional steady state given the level of $\tilde{K}$ and A_M, A_T. The individual level of capital in the steady state can be found from the following dynamic equation

$$k_{t+1}^i = \beta\left(\tilde{w} + \tilde{\rho} T^i \tilde{R} k_t^i\right),$$

From Lemma 2, it follows that the aggregate amount of capital converges to the steady state, which is locally stable; hence, it follows that $\beta\tilde{R} < 1$. Therefore, the sequence of individual i's capital holdings asymptotically converges to the steady state level

$$\tilde{k^i} = \frac{\beta(\tilde{w} + \tilde{\rho} T^i)}{1 - \beta\tilde{R}}.$$

Substituting the steady state amount of capital to the income of agent i we get the following formula for the steady state income level of an agent i:

$$\tilde{I^i} = \frac{\tilde{w} + \tilde{\rho} T^i}{1 - \beta\tilde{R}},$$

[22] Even if the bargaining power of landowners, τ, is high, a sufficiently high level of productivity in the modern sector leads to disappearance of the multiple steady-state case and makes the dynamics of capital accumulation monotonic.

which is proportional to the level of wage and to the revenues from rent incomes. Thus, the distribution of capital between agents in the temporary steady state is determined by the distribution of land and by the factor prices, which are determined by the aggregate amount of capital and technology. As it was shown in section 4.1, $w'_K > 0$ and $\rho'_K < 0$ and so in the modern growth period the share of rent from land to wages ($\rho T / w$) shrinks to zero and so, the income of all agents converges to the same level[23]. Therefore, the income gap between agents vanishes in the modern growth regime, which is consistent with Galor and Moav's (2006) result about demolishing the class structure (in this case, the difference between the landed elite and other citizens disappears over time). However, in the early stage of development the income gap is large between agents because of the unequal distribution of land.

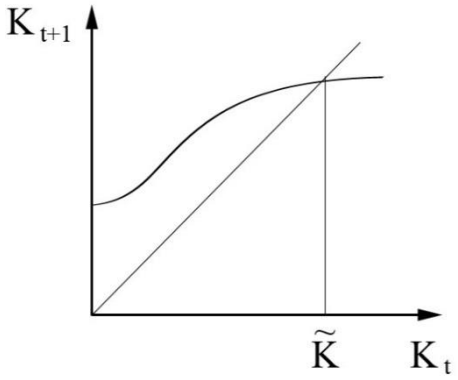

Figure 1. The dynamics of aggregate capital for a given level of A_M, A_T

5.2 The evolution of technological progress

The expected productivity growth in the modern sector is $g = p_R^*(\gamma - 1)$, and it is increasing with the probability that the reform policy will not be blocked. The equilibrium probability of the reform is determined in the political conflict between the supporters and opponents of industrialization. From Proposition 1 we can define two periods of industrialization, which can be named as the conflictual and consensual period respectively.

In the consensual period, when the economy accumulates a sufficient amount of physical capital, the preferences of the traditional landowning elite switch towards industrialization (see Proposition 1.c). Therefore, there exists a certain threshold level of capital accumulation, $\bar{K}$, after which a "peaceful" transition to the modern growth regime occurs. After this moment there is no political conflict and the probability that the reform policy is implemented equals one. In infinite

[23] This result does not hold if we assume different level of skills and so differences in wage incomes among agents would determine the inequality in the modern growth regime

times, the economy behaves like the standard Solow growth model with a constant rate of technological progress as the share of the traditional sector tends to zero.

In the conflictual period of industrialization the supporters and opponents of the reform policy coexist. These two groups apply positive efforts on the political conflict and so the probability of reform policy is less than 1, $p_R < 1$. Below we show that if we approximate the path of the economy by the sequence of its conditional steady states, then the set of dynasties that actively participate in political conflict does not change with capital accumulation.

Lemma 3. In the temporary steady state, the order of expected gains from the reform policy does not change with $\widetilde{K}$. For any two agents i and j, if agent i holds less land than agent j, then the expected gain from the reform policy is higher for agent i, i.e. $T_i > T_j$ implies $\Delta_R^i < \Delta_R^j$.

Proof. See Appendix A.5

Corollary 1. In the conflictual period, in any temporary steady state, the agent (or a group of identical agents) with the highest stock of land (*H*) makes positive efforts in political conflict supporting the status-quo policy, while the agent (or a group of identical agents) with the lowest stock of land (zero) (*h*) make positive efforts in political contest supporting reform policy.

This corollary follows from Lemma 3 and from the results of Section 4.1. Therefore, if the economy is near the steady state the conflict disappears when the agent holding the highest stock of land changes their preferences towards for reform policy. It follows also that in the steady state only the landless agents invest in political conflict to lobby the reform policy. It is important to note that only in the conditional steady state do the differences in the capital holdings of landless agents disappear. However, the differences in capital endowment of landless agents affect their political preferences and the outcome of the contest in each path to the steady state.

In the next subsection, we first demonstrate, how the economy (capital accumulation, factor prices, factor shares in aggregate incomes, conflict outcome and intensity) behaves in the dynamic framework we have just described. Second, we illustrate the effects of inequality in the distribution of capital and land on the outcomes of political conflict, and therefore on the pace of industrialization, thereby contributing to the explanation of the Great Divergence phenomenon.

5.3 Numerical simulations and comparative dynamics results.

The dynamic properties of the model are illustrated in figures 2-3. Let us consider the example of the transition of the three class economy from stagnation to growth with the agents differing initially only in land endowment. Assume that we have the richest landowners (1 agent),

small landowners (9999 agents) and the landless class (90000 agents). Thus, the elite consisting of all landowners constitute 10% of the population. By assumption $T^1 > T^2 > T^3 = 0$. Let us consider firstly the case, when inequality in the distribution of the land is low (Gini coefficient of the distribution of land within the elite equals 0.1) The following distribution of the land between agents is given: $T^1 = 100, T^2 = 0.09, T^3 = 0$ The share of capital income in total revenues (α) equals 1/3, the initial endowment of capital equals 1/3 for all groups, other parameters are defined as $\beta = 0.25, \gamma = 1.25, \tau = 0.3, A_M(1) = A_T(1) = 1$.

Figure 2 represents the expected dynamics of the gain from the reform policy for each class (Δ^i). Before the moment t^* , there are two conflictual groups of agents who make positive efforts in the political contest. After the moment, t^* , there is a consensus between all agents about the reform policy as $\Delta^i > 0$ for all *i*.

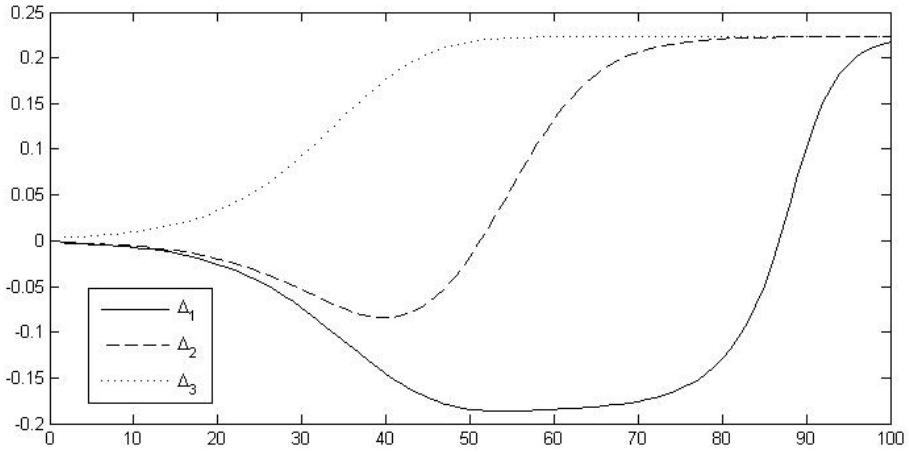

Figure 2. The dynamics of gains from the reform policy (Δ_i)

Figures 3 and 4 show the dynamics of employment and income structure over time. The evolution of the income structure captures the main properties of the dynamics of the share of incomes in developed countries in the last 300 years. During the process of transition to growth, the share of rent in total incomes steadily decreases to the zero level, and the share of capital and wage income increases to their steady state level. These changes in the distribution of incomes between different factors of production are crucial for understanding the changes in the incentives of agents to participate in the political contest. The preferences of big landowners toward the reform policy are non-monotonic because of two competing effects. The industrialization process accelerates over time which leads to the decrease in the rent incomes. This effect leads to the rise in support for the status-quo policy. On the contrary, the stakes in the modern sector of the big landowners and the

size of the modern sector rises over time. This effect diminishes the landowners support for the status-quo policy.

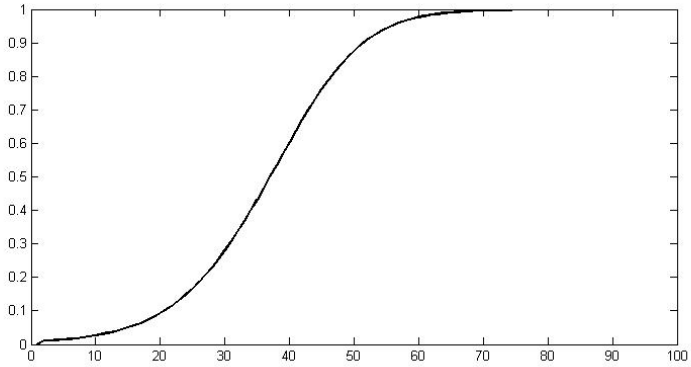

Figure 3. The dynamics of employment in the modern sector.

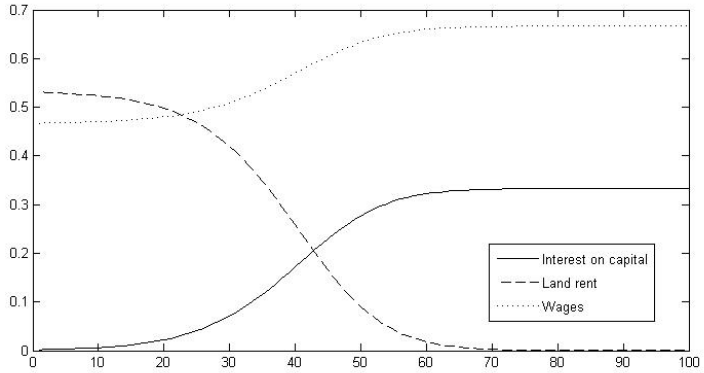

Figure 4. The dynamics of the share of factor incomes in total value added.

Let us now focus on the effect of the inequality of land within the elite on economic development.

Corollary 2. The higher inequality in land distribution within landowners lowers the probability of the reform policy, lowers the pace of industrialization, and delay the time of switching to the consensual period of industrialization.

In some sense, this result is similar to the Galor et al.(2009) result of the negative effect of land inequality on the timing of adoption of growth-promoting institutions (mass education policies). In our model the richest landowner (or a group of richest landowners) strongly opposes policies that encourage industrialization. They invest more effort in the political contest and, hence, lower the chances of the reform policy being implemented. Figure 5 describes their influence on the probability of the reform policy. Differing from the model of Galor et al. (2009) our model also gives an intuition about the dynamics of the outcome of the contest between supporters and

opponents of industrialization. For the given initial distribution of land, the intensity of the conflict has a hump-shaped path during the conflictual period of industrialization (figure 6).

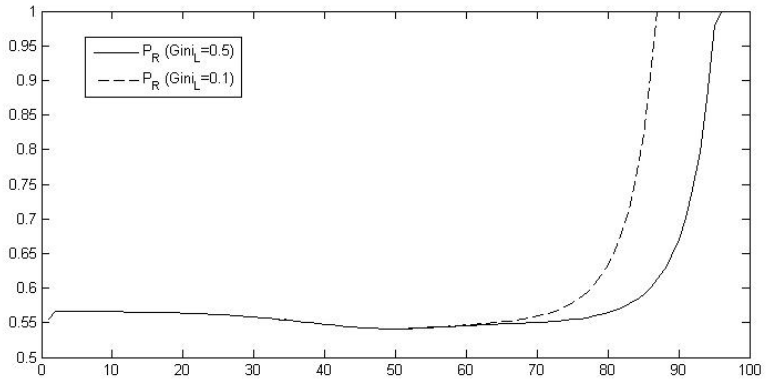

Figure 5. The dynamics of the probability of the reform policy in economies with different inequality of land within the elite.

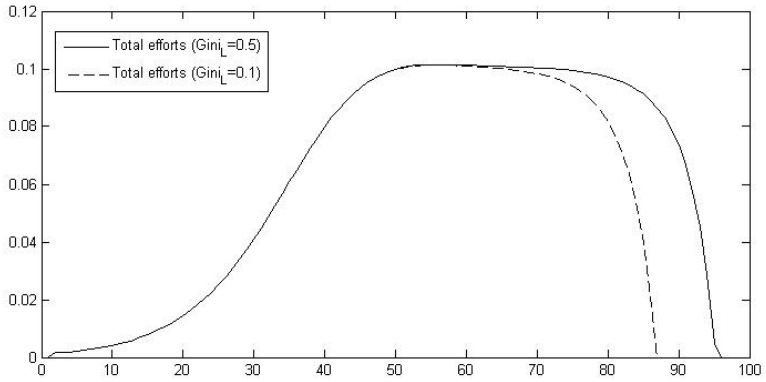

Figure 6. The dynamics of total effort in political contest in economies with different inequality of land within the elite.

These dynamics corresponds well with the evidence in Collier and Hoeffler (2004), Challier et al. (2010), Acemoglu and Robinson (2012), Lagerlöf (2013), who indicate that the intensity of conflict between social classes varied non-monotonously both over time and across countries. Our model captures the historically observed hump-shaped dynamics of conflict intensity, generated by the fact that contestants put in more effort when their stakes in a conflict are high and more closely tied to each other (Lemma 1.b). In the early periods of industrialization, when capital-land ratio is small, stakes of both landowners and capitalists are low, and there is no intense conflict. Conflict is also negligible in the late stages of industrialization, when the traditional sector contracts sharply in comparison to the modern sector, since a lot of workers migrate to industry and the richest landowners also become more interested in industrialization. In between, however, the intensity of conflict attains the maximum level. Figure 6 illustrates that a high concentration of land in the hands of the biggest landowner increases the amount of time of intensive contest between

landowners and the landless class and delays the moment of switching to the consensual period of industrialization. The difference in the timing of switching to the consensual period of industrialization also generates the rise in the gap in income per capita between countries, i.e the Great Divergence (figure 7)

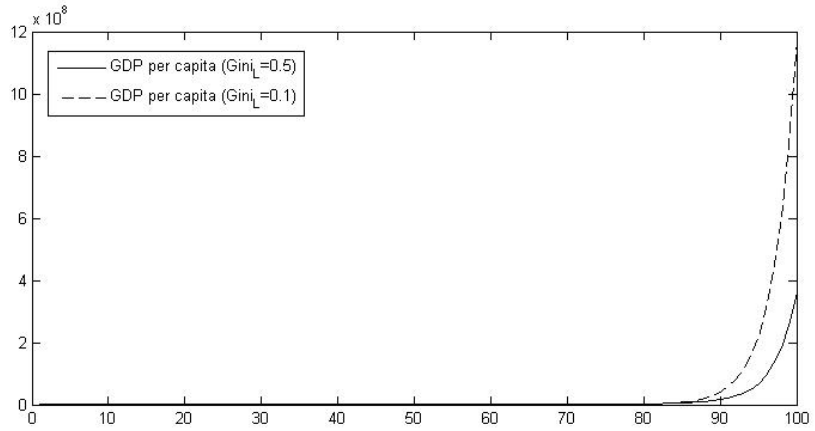

Figure 7. The dynamics of GDP per capita in the economy with a high and a low concentration of land within the elite.

Let us now consider the role of inequality in initial endowment of capital on the outcome of the political conflict and the pace of industrialization.

Corollary 3. During the conflictual period of industrialization a higher inequality in the initial distribution of capital within the landless class quickens the pace of industrialization and shortens the time of switching to the consensual period of industrialization.

This corollary follows from Proposition 2 and the fact that any increase in the level of technology accelerates the process of capital accumulation and transition to the modern growth regime. Figures 7-9 illustrate the dynamics of the four-class economy in two cases: in the first one, all landless agents are identical and so there is no inequality in capital distribution within the group of capitalists; in the second example, one of the capitalists holds initially 30% of the total capital. The initial employment in the modern sector in the following simulation is supposed to be 0.05, and so $A_M(1) = A_T(1) = 18.46, K(1) = 46.7$. The number of agents in each group is equal to

$$N^1 = 1, N^2 = 9999, N^3 = 1, N^4 = 29999$$

The first two groups are landowners. They own all land in the economy and by assumption $T^1 = 100, T^2 = 0.09, T^3 = T^4 = 0$. Therefore, the Gini index of land holding within the elite is equal 10% as in the previous example. All initial capital is supposed to be distributed among two groups of capitalists. In the first case, $K^3(1) = K^4(1) = 0.0016$, in the second case the capital is

distributed unequally, $K^3(1) = 0.3$, $K^4(1) = 0.0011$. Other parameters of this example are the following: $\alpha = 0.33, \beta = 0.25, \gamma = 1.25, \tau = 0.3$.

If capital is concentrated the conflict becomes more intensive in the earlier stages of industrialization, but capitalists begin to win faster and thus, a period of intensive conflict becomes shorter (see figure 8). Moreover, we see that in accordance with Proposition 2 and our account, higher inequality in capital distribution corresponds to faster industrialization (i.e. higher probability of reform policy, figure 9) and may contribute to the explanation of the Great Divergence phenomenon (Figure 10).

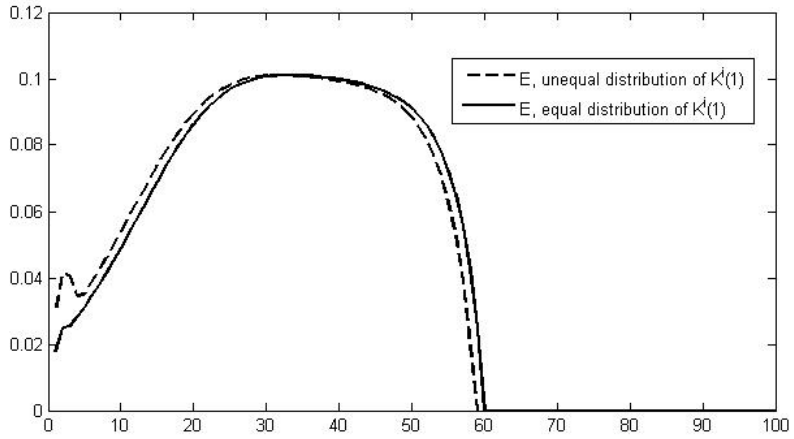

Figure 8. The dynamics of total effort in political contest for economies with a high and a low initial concentration of capital within a group of landless agents .

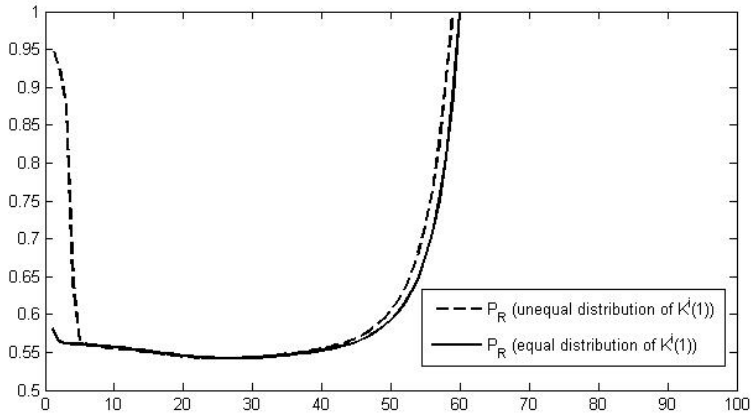

Figure 9. The dynamics of the probability that the reform policy is implemented for economies with a high and a low initial concentration of capital within a group of landless agents .

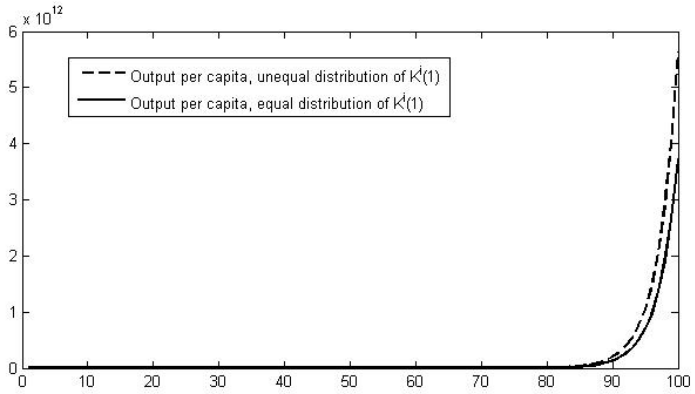

Figure 10. The dynamics of income per capita for economies with a high and a low initial concentration of capital within a group of landless agents.

6. Concluding remarks

In the present paper, we study the effect of inequality in capital and land distribution on the pace of industrialization and the intensity of political conflict that accompanied it. We propose a two-sector unified growth model augmented with political conflict between the supporters and opponents of industrialization in order to deepen the explanation of the Great Divergence phenomenon. We, therefore, contribute to the literature on unified growth and political economy of industrialization in several aspects.

First, we propose a new mechanism that explains the transition from stagnation to growth in a two-sector unified growth model. The advantage of the proposed mechanism is that it incorporates the crucial feature of the Industrial Revolution era, namely the endogenous political conflict between social classes. The political conflict between groups with different interests regarding modern sector development emerges and resolves endogenously, driven by the relative incentives of competing groups to invest in this conflict. Initial capital and land distribution and their evolution contribute to the explanation of cross-country differences in the pace of industrialization since they determine factor incomes of each agent and hence the stakes of each group member in this conflict.

In such a context we also show that higher inequality in capital distribution in many circumstances results in supporters of industrialization gaining more political power and winning a conflict more often, thereby increasing the pace of industrialization. Higher within-group inequality in capital holdings may be beneficial to development and industrialization, since the free-rider problem becomes less severe, and benefits from winning a political conflict become more concentrated, both of which make the group of industrialization supporters more active in lobbying their interests.

We have also incorporated the dynamics of conflict intensity into the joint evolution of capital accumulation, structural change, and productivity growth. The model predicts that conflict intensity follows a hump-shaped path, which corresponds well with historical observations; as well as the dynamics of technological progress, factor incomes, and sectoral allocation of labor.

It worth noting that, generally, we have almost ignored the economic forces that can drive the technological progress. The reason is that we intended to show that the economic forces behind the industrial revolution are the necessary, but not the sufficient conditions for the take-off to occur. However, the possible next step is to take account of one (or several) of the standard mechanisms that makes productivity changes a stable feature of the modern growth regime. For example, it could be either the demand for human capital accumulation, increasing with higher technological levels, and in turn accelerating technological progress, or the externality effect in the modern sector, where the rate of technological progress could depend on the share of this sector in the GDP.

Appendix A. Proofs

A.1 Proof of proposition 1

Part a. Consider inequality $V^i(R) > V^i(S)$ for $i \in \mathcal{L}$. Using (13), we get $\ln\left(I^i_{t+1}(R)\right) - C\left(e^i_{t+1}\right) + \xi(\beta) > \ln\left(I^i_{t+1}(S)\right) - C\left(e^i_{t+1}\right) + \xi(\beta)$, which simplifies to $I^i_{t+1}(R) > I^i_{t+1}(S)$. Using (4)-(7), (14), and (15), we may rewrite this inequality as follows: $w^R_{t+1} + k^i_{t+1} \cdot R^R_{t+1} + T^i \cdot \rho^R_{t+1} > w^S_{t+1} + k^i_{t+1} \cdot R^S_{t+1} + T^i \cdot \rho^S_{t+1}$ (next we drop time indices for the sake of simplicity). Rearranging terms, we get the condition for an agent i to prefer reform policy to status-quo policy, i.e. inequality (16): $T^i < \frac{\Delta w}{\Delta \rho} + \frac{\Delta R}{\Delta \rho} \cdot k^i$. Also note that $\Delta w = w^R - w^S > 0$, which follows from (6), (14); $\Delta R = R^R - R^S > 0$, which follows from (7), (14); and $\Delta \rho = \rho^S - \rho^R > 0$, which follows from (5), (14). ■

Part b. Remember that $\Delta^i_R = V^i_R(R) - V^i_R(S)$, and using (13), (15), we get $\Delta^i_R = \ln\left(\frac{w^R + R^R k^i + \rho^R T^i}{w^S + R^S k^i + \rho^S T^i}\right)$. Next, solve for $\left(\Delta^i_R\right)'_{k^i} > 0$ to get $\frac{I^i_R}{I^i_S} < \frac{R^R}{R^S}$. Denote this inequality by $(*)$. The RHS in $(*)$ is always larger than 1, which follows from the fact that $R^R > R^S$ (from (7), (14)). Hence, if the agent i supports status-quo, i.e. $I^i_R < I^i_S$, then the LHS in $(*)$ is less than 1, and $\left(\Delta^i_R\right)'_{k^i} > 0$ follows. Otherwise, if agent i supports reform policy, i.e. $I^i_R > I^i_S$, then we have to solve for $\frac{I^i_R}{I^i_S} < \frac{R^R}{R^S}$ explicitly. Inequality $(*)$ simplifies to $T^i > \frac{w^R R^S - w^S R^R}{\rho^S R^R - \rho^R R^S}$, where the denominator is definitely larger than zero (since $\rho^S > \rho^R$ and $R^R > R^S$), while the nominator is definitely less than zero (it follows

from the fact that $\frac{w^R}{W^S} < \frac{R^R}{R^S}$, i.e. wages grow not as fast as capital incomes after the reform policy is realized; this fact can be verified using (6), (7), and (14)). Hence, $T^i > \frac{w^R R^S - w^S R^R}{\rho^S R^R - \rho^R R^S}$ always holds. Therefore, $\left(\Delta_R^i\right)'_{k^i} > 0$.

Inequality $\left(\Delta_R^i\right)'_{T^i} < 0$ can be proved in the same way as in the previous paragraph. Noting that $\left(\Delta_R^i\right)'_{T^i} < 0$ simplifies to $k^i > \frac{w^S \rho^R - W^R \rho^S}{R^R \rho^S - R^S \rho^R}$, where the denominator is less than zero, while the nominator is larger than zero, hence, $\left(\Delta_R^i\right)'_{T^i} < 0$ is verified.

In order to establish the signs of the second derivatives, first note that $\left(\Delta_R^i\right)'_{k^i} = \left(\frac{R^R}{I_R^i} - \frac{R^S}{I_S^i}\right)$. Therefore, $\left(\Delta_R^i\right)''_{k^i} < 0$ simplifies to $\left(\frac{w^R}{R^R} - \frac{w^S}{R^S}\right) + T^i\left(\frac{\rho^R}{R^R} - \frac{\rho^S}{R^S}\right) < 0$. The expression in the first brackets is negative since capital gain increases faster with reform policy than the wage does. The expression in the second brackets is negative since $\rho^R < \rho^S$, while $R^R > R^S$

In the same way, we establish that $\left(\Delta_S^i\right)''_{T^i} < 0$. ■

Part c. Even ignoring for the time being the fact that k_t^i is in fact a function of K_{t-1}, it is easy to show (using (4)-(7) and (14)) that $(\Delta R)'_K < 0$, $(\Delta w)'_K > 0$, and $(\Delta\rho)'_K \geq 0$ if $K \leq \widetilde{K}$, while $(\Delta\rho)'_K < 0$ if $K > \widetilde{K}$ (therefore, $\Delta\rho$ is hump-shaped in K). Moreover, $\lim_{K\to\infty} \Delta\rho = 0$, $\lim_{K\to\infty} \Delta R = 0$, while $\lim_{K\to\infty} \Delta w > 0$; hence, there exists a threshold $\bar{K}$, such that even for the agent h with the highest Δ_S^i, it holds that $T^h \Delta\rho(\bar{K}) < \Delta w(\bar{K}) + \Delta R(\bar{K}) k^h$. ■

A.2 Proof of proposition 2

Part a. Since a distribution of capital is said to be more unequal in the sense of strict Lorenz-worsening, i.e. $\sum_{i=1}^m k^i > \sum_{i=1}^m \widetilde{k^i}$ for all $m < N$, and $\sum_{i=1}^N k^i = \sum_{i=1}^N \widetilde{k^i}$, it implies that a Lorenz-worsening change in the distribution of capital makes the capitalists with highest k^i have even more capital. Hence, first, $\Delta_C^h \geq \Delta_{L,R}^m$, still holds, i.e. the most eager supporter of industrialization is still inside the capitalist class. Second, k^h increases which leads to higher Δ_R^h (see proposition 1.b). Therefore, since the redistribution ignored all the agents inside the group of status-quo supporters, Δ_S^h remains unchanged. Hence, $p_R^* = \frac{1}{1+\Delta_S^h/\Delta_R^h}$ increases. ■

Part b. If $\Delta_C^h < \Delta_{L,R}^m$ holds, then any redistribution of capital inside the class of capitalists, such that the most eager supporter of reform policy is still outside the class of capitalists, does not affect the probability of reform, since neither $\Delta_R^h = \Delta_{L,R}^m$ nor Δ_S^h changes. The most eager supporter of reform

policy is still a landowner m after the redistribution, if the amount of capital the biggest capitalist gets is not high enough (using proposition 1.b here, i.e. $\left(\Delta_R^i\right)'_{k^i} > 0$). Namely, in order for the rankings of the biggest capitalist and landowner m in terms of their stakes Δ_R to switch, the amount of capital $\tilde{k}$ the biggest capitalists should get is such that $\Delta_C^h\left(k^h + \tilde{k}\right) \geq \Delta_{L,R}^m$. Therefore, if the transfer of capital to the biggest capitalists is larger than $\tilde{k}$, then higher inequality in the sense of Lorenz-worsening increases p_R^*. ■

A.3 Proof of lemma 2

For the given $A_{T,t} = A_{M,t} = A$ from the dynamic equation (23) it is straightforward to see that for $K_t = 0$ the level of the physical capital in the next period is $K_{t+1} = \beta A T^{\alpha}$. Taking derivative from the equation (23) we get

$K'_{t+1}(K_t) = \beta((1-\alpha)A_{T,t}T^{\alpha}L_{T,t}^{-\alpha}L'_{T,t} + \alpha A_{M,t}K_t^{\alpha-1}L_{M,t}^{1-\alpha} + (1-\alpha)A_{M,t}K_t^{\alpha}L_{M,t}^{-\alpha}L'_{M,t}$,

where the derivatives, $L'_{M,t}, L'_{T,t}$ can be found from equations (14), (24)

$$L'_{M,t} = -L'_{T,t} = \frac{xT}{(K_t + T\cdot x)^2}, \qquad \text{(A1)}$$

where $x = \left(\frac{1-\tau}{a_t}\right)^{\frac{1}{\alpha}}$.

Substitution of (14), (24) and (A1) into $K'_{t+1}(K_t)$ gives us

$K'_{t+1}(K_t) = \frac{\beta}{(K_t + T\cdot x)^{2-\alpha}}(-(1-\alpha)A_{T,t}x^{1-\alpha}T + \alpha A_{M,t}K_t + xTA_{M,t})$.

On the one hand, the increase in the level of capital leads to the decrease of employment in the traditional sector and to the decrease of output in the traditional sector, on the other hand, both employment and output in the modern sector increases. Hence, the final effect is ambiguous, but with the rise in the level of capital, the effect of the increase of modern sector output dominates the negative effect of the decrease of the output in the traditional sector. It is straightforward to see that $K'_{t+1}(K_t) > 0$ for all $K_t \geq 0$ if and only if

$(1-\alpha)A_{T,t}x^{1-\alpha} < xA_{M,t}$.

Using the definition of x, this condition simplifies to $\tau < \alpha$.

The second derivative of $K''_{t+1}(K_t)$ is equal to

$$K''_{t+1}(K_t) = \frac{\beta\alpha A_{M,t}}{(K_t + T\cdot x)^{2-\alpha}} - \frac{\beta((2-\alpha)(\alpha A_{M,t}K_t + xTA_{M,t} - (1-\alpha)A_{T,t}x^{1-\alpha}T)}{(K_t + T\cdot x)^{3-\alpha}}$$

It is straightforward to see that there exists a threshold level of K_t before which $K''_{t+1}(K_t)$ is positive and after which $K''_{t+1}(K_t)$ is negative. Moreover, $\lim_{K\to\infty} K'_{t+1}(K_t) = 0$. Therefore, from the intermediate value theorem, there exists a unique asymptotically stable steady state K^{*}, for which $0 < K'_{t+1}(K^{*}) < 1$ ■

A.4 Proof of lemma 3.

The net gain from the reform policy is given as $\Delta_R^i = \ln\left(\frac{I_R^i}{I_S^i}\right)$, and for the temporary steady state it takes the following form:

$$\Delta_R^{ss} = \ln[\frac{w_0^R + \beta_0^R T^i}{1-\beta R^{ss}} \frac{1-\beta R^{ss}}{w_0^S + \beta_0^S T^i}] \text{ or}$$

$$\Delta_R^{ss} = \ln(\frac{w_0^R + \beta_0^R T^i}{w_0^S + \beta_0^S T^i}) + \ln(\frac{1-\beta R^{ss}}{1-\beta R^{ss}}),$$

where w_0^R, β_0^R, R^{ss} are the level of wages, rent and interests on capital if the reform is implemented, and w_0^S, β_0^S, R^{ss} are the level of wages, rent and interests on capital for the status-quo policy.

Let us consider two agents i and j with different endowments of land (T_i, T_j). Assume that agent i has a higher gain from the reform policy than agent j. It is the case, only if the following condition is true

$$\ln(\frac{w_0^R + \beta_0^R T^i}{w_0^S + \beta_0^S T^i}) > \ln(\frac{w_0^R + \beta_0^R T^j}{w_0^S + \beta_0^S T^j})$$

After some calculations we get $w_0^S \beta_0^S (w_0^R / w_0^S - \beta_0^R / \beta_0^S)(T^j - T^i) > 0$. Hence, as soon as $\frac{\tilde{w}^R}{\tilde{w}^S} > 1$ and $\frac{\tilde{\rho}^R}{\tilde{\rho}^S} < 1$, it is straightforward to see, that $\Delta_R^{ss} > \Delta_R^{ss}$ only if $T^i < T^j$.

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