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Property Rights and The First Great Divergence: Europe 1500-1800

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Abstract

Recent literature on developing countries has revived interest in structural change involving the reallocation of resources from agriculture to industry. Here, we focus on the first such historically important structural transformation in which some parts of Europe escaped from the Malthusian trap centuries earlier than the Industrial Revolution, while others stagnated. There is as yet no consensus as to the causes of this First Great Divergence. The paper advances the thesis that what lies at the root of different paths is the type of property rights inherited. As populations everywhere in Europe recovered from the catastrophes of the late medieval period, what mattered for the direction taken was the size of the landlord class and their landholdings. In western Europe where peasant proprietors tilled small plots, increases in population levels led to lower real wages. Given the low incomes of landlords and peasants, demand for manufactured goods remained low. At the other extreme, in eastern Europe, second serfdom kept wages low, and rents high. Yet given the small size of the land-owning class, these rents could not generate enough demand for high-end manufacturing processes either. Northwestern Europe, being in the middle in terms both of the size of the landholding classes and their properties, prospered as wages failed to decline even when population levels rapidly rose. Combined demand from landlords and workers kindled an expansion of the manufacturing sector.

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1 Introduction

There has recently been a revival of interest in the development literature on structural change that reallocates resources from agriculture to industry.[1] In what follows, I focus on one of the earliest and historically most significant episodes of such a transformation that propelled relatively underdeveloped regions of northwestern Europe into economic prominence.

To see what is involved note that sixteenth century England was a marginal agrarian economy with an urbanization level below that of the Balkans.[2] The urban manufacturing core of Europe was located (with the exception of the precocious Low Countries) along the shores of the Mediterranean. By 1850, a "reversal of fortune" had given England the lead with an income per capita that far exceeded that of the previous leader Italy.[3]

The traditional answer to the question of how this reversal took place focused on the "Industrial Revolution" as the event that radically broke with the past of humanity, ushering in a new phase where, for the first time ever, "production started to grow *much* more rapidly than population." The recent analytical (as opposed to historical) literature dates the break to around 1800, prior to which it is supposed that a Malthusian mechanism operated to pull incomes down to some stable, constant level whenever they happened to exceed it.[4]

It is, therefore, paradoxical that in the last few years accumulated evidence has led a growing number of economic historians to question some of the basic tenets of the received wisdom concerning the timing, prehistory, and effects of the Industrial Revolution and the Malthusian transition. First, the currently accepted view is that the Industrial Revolution was much less of an abrupt transition, with earlier growth estimates of the British economy in the classic Industrial revolution era, 1760-1830, being reduced by more than half.[5] Given that in the mid-nineteenth century England had the

[1] See, among others, Gollin et al. (2002), Ngai and Pissarides (2007), Duarte and Restuccia (2010), Herrendorf et al. (2013b), and Gollin and Rogerson (2014).

[2] Bairoch, 1989, p. 179 puts the level of urbanization in Balkans and England in 1500 at 7-12% and 7-9% respectively.

[3] The relevant figures for GDP per capita in Maddison 2001 are as follows. In 1500 Italy led the world with $1100 (in 1990 international $), while Belgium, the Netherlands and England followed with $875, $754, and $714. By 1870, England had moved forward with $3191, as opposed to $2753, $2697, and $1499 of the Netherlands, Belgium, and Italy.

[4] See Galor and Weil (2000) and Lucas (2002).

[5] For the modest growth in per capita income and real wages in Britain between 1770 and 1850, see

highest income in the world, the lower growth estimates immediately raise the question: "If the industrial revolution was not substantial enough to explain England's lead in 1850, where did it come from?"[6] Second, an implication of lower growth rates is that the contrast with the earlier periods in terms of incomes is now revealed to be not as sharp as once thought, making pre-industrial Britain as well as a number of neighboring countries more prosperous. Evidence from a variety of sources, including probate and pauper inventories, point to a "consumer revolution" in Britain and the Netherlands, with significant increases in the quantity, variety and quality of consumer goods being registered well before the Industrial Revolution.[7] Third, research on the history of English real wages indicates that they did not display a trend from 1500 to 1850, despite a sevenfold rise in population.[8] These findings indicate that the economic expansions experienced by the English and Dutch economies in the crucial three-hundred-year period prior to the Industrial revolution were very important achievements, constituting a marked departure from the Malthusian past. For the first time in western history, these economies kept pace with the population for a remarkably extended period of time.

While these considerations do not diminish the importance of the classical Industrial Revolution as a watershed event, they call for a more nuanced approach to the economic and social transformations that took place in the period leading to it. That this period should be subject to closer scrutiny follows from the revised assessments of historians of economic growth, who argue that the Industrial Revolution can no longer be regarded "as the beginnings of growth altogether but as the time at which technology assumed an ever-increasing weight in the generation of growth" (Mokyr (2005)) and that the "accumulated evidence for an earlier increase in per capita income in northwestern Europe paired with a major refinement of material life casts serious doubt on the orthodoxy that the Industrial Revolution was the actual starting point for long-term economic growth" (de Vries, 2008, p.6). [9]

Once the roots of long-term growth are seen to be planted in an era earlier than has traditionally been accepted, the question that immediately arises is the one concerning

Crafts and Harley (1992), Crafts (1985), Feinstein (1998), Mokyr (2004), and Williamson (1984).

[6]This is the question posed by Allen (2001).

[7]See de Vries (1994) andde Vries (2008).

[8]See Feinstein (1998) and Clark (2005) for English wages and Allen (2001) for the history of prices and wages in a number of European cities. Brown and Hopkins (1956) find the same pattern in their study of provincial wages.

[9]See also Clark (2005) who writes "[t]hus the Industrial Revolution is not clearly an abrupt break around 1800 from a stagnant economy. It may just be the acceleration of a process of modern growth that began about 150 years earlier."

the nature of this period and the determinants of the extensive growth registered.[10] To start with, note that even such extensive growth is restricted to a few regions in northwestern Europe: England and the Low Countries. The rest of both western and eastern Europe lagged behind. This is reflected most importantly in the wage and price series collected by Allen (2001) which shows that while England and the Low Countries enjoyed a slight lead in terms of real wages relative to the rest of Europe in the fifteenth century, incomes significantly diverged in the next three centuries. The divergence is mostly explained by the fall in continental real wages by half, while real wages remained roughly constant in northwestern Europe.[11] Thus, while England and the Netherlands escaped the infamous "seventeenth century crisis," the rest of the continent mostly succumbed to it.[12]

This escape from the crisis was accompanied by a "consumer revolution," that found its expression in "a steady rise, generation by generation, of the number, range, and quality of material possessions" (de Vries, 2008, p. 124). Detailed regional studies covering areas as diverse as the Dutch countryside (Kammermans (1999) cited in de Vries, 2008), the English county of Kent (Overton et al. (2004)), London (Earle (1989)), and Edinburgh and Glasgow (Nenadic (1994)) and income groups from the rich to middling groups to paupers (McCants (2008), Styles (1994)).

The increased demand was met by substantial increases in manufacturing output. In England per capita cloth output more than doubled between the later fifteenth century and the 1640s. Import substituting English glassworks drove continental window panes out by the 1590s, bottles by the 1620s and drinking glasses and mirrors in the next decade. Around 1650 forty water-powered paper mills were in operation barely five decades after the opening of the first viable one. Iron output quintupled between 1550s and 1650s. Similar changes were observed for coal. In the Netherlands even more dramatic increases were registered in a wide variety of industries. Leiden's cloth output rose from 26,600 pieces in 1584 to 144,700 in 1664. Haarlem's bleaching industry processed

[10] It is "extensive" growth as per-capita incomes increased very moderately, if at all. "Intensive" i.e. long-run per-capita income growth is observed only after the Industrial Revolution proper.

[11] Everywhere real wages were subject to fluctuations, Thus, in the Low Countries, real wages declined slowly, but much more so than their counterparts on the continent. Real wages declined in England in the sixteenth century and then reversed course, rising slowly later on up to their previous levels.

[12] Additional evidence of divergence is obtained from international comparisons of body size and height. For the late eighteenth century, the evidence summarized by Floud (1992) indicates that the British and the Dutch were the tallest people in Europe, while the French, Italians, and Spanish were shorter. Austrians and Hungarians were also of smaller stature (Komlos (1989)).

about 100,000 pieces in 1628 while it had only processed 20,000 in 1586. Amsterdam developed a rich portfolio of manufactures such as silk weaving and dying, leather working, diamond cutting, glass blowing and food processing: it had sixty sugar refineries in 1661 up from three in 1605.[13]

The period also witnessed technological advances, some of which were "almost as dramatic as those in textiles in the Industrial Revolution".[14] Examples are legion. For instance, glassworks, gunpowder, nails, spectacles, and printing all saw substantial productivity gains. The "Dutch" loom was invented in 1604 and was in use in Leiden in 1610. New techniques used in producing kersey represented a productivity gain of 40-60 percent over Yorkshire broadcloth.[15] High fixed costs associated with wind-powered fulling mills did not prevent them from being adopted. These lowered the labor requirements dramatically and led to the near-collapse of the powerful Dutch fulling guild. New technologies employed by shipping yards enjoying economies of scale reduced the cost of Dutch ships 40 percent below that of the English ones in 1669.[16]

What then can account for this early period of economic expansion that constitutes the starting point for modern growth? One prominent answer, that of North[17], dates the English break with the past to the Glorious Revolution of 1688. The establishment of a constitutional monarchy and the security of property rights that followed is then argued to have promoted economic growth through a number of channels, all of which have been recently convincingly contested. Thus, for instance, studies of interest rates have been unable to find any growth promoting consequences of the Glorious Revolution (Clark 1996, Epstein (2000), Quinn (2002)). Others have shown that parliamentary rule in England led to taxes that exceeded those of absolutist France (Hoffman and Norberg (1994), Bonney (1999)). Finally, and most importantly for my purposes here, it is now clear that England's economic expansion had begun long before the Glorious Revolution

[13]See DuPlessis (1997) and the extensive literature cited therein.

[14]This is how Clark 2003 describes the productivity gains in printing.

[15]Duplessis (1997).

[16]Despite these changes, we do not, however, observe any significant TFP growth in this period. But this is also true not only for the classical Industrial Revolution era (1760-1830) but also the four decades that follow it. Clark argues that in this period "[m]ost of the economy saw no TFP growth, and the national TFP gains mostly came from one industry, textiles. Textiles contributed a large amount of national TFP growth because it met all three conditions above: it began as a substantial industry, its share of consumption did not decline with price declines, and there grew up a huge external market which eventually absorbed more than half of output. Absent textiles there would have been no change in the trend in TFP growth all the way from 1600-1869." (Clark 2003, p. 46)

[17]See North and Thomas (1973) and North and Weingast (1989).

(Allen (2001), Clark (2003), de Vries (2008)). This is in contrast to Acemoglu et al. (2005), who emphasize the role of Atlantic trade in the rise of northwestern Europe. They argue that the American and Asian trades gave rise to a politically influential merchant class that demanded and obtained protection of property rights, which, in turn, paved the way for economic growth. Though this mechanism undoubtedly played a role later on, as Allen (2003), building on the work of Davis (1973) and Rapp (1975), points out the rise of northwestern Europe and the decline of Italy predates the rise of Atlantic trade by a century. A third answer, proffered by De Vries, emphasizes an "industrious revolution" taking place in northwestern Europe during the "long eighteenth century." This revolution is said to have involved an increase in market-oriented labor by households who were eager to satisfy their new consumption goals. Thus, there was a simultaneous rise in both specialized production by households and their purchase of consumption goods with, however, a "consumer revolution" leading the way and providing the impetus to the increased production of consumer goods (de Vries (2008)). While this approach accounts for the observed increases in labor supply to markets, the rise of market production, and the consumer revolution, it is not of much help in answering as to why there was a reversal of fortune, i.e., why it fell to northwestern Europe to take the lead in these developments. Allen, whose work has focused squarely on this reversal of fortune, credits the success of this region to its productive agriculture, which, he in turn attributes to its vigorous urban economy (Allen (1998), Allen (2000), Allen (2003)). However, as Allen himself recognizes, the expansion of the latter is itself endogenously determined, while the initial level of urbanization, which can be taken as an exogenous variable, will not work for England because urbanization levels were substantially lower in England than either in Italy or Spain.[18] If these attempts at explaining the success of Northwestern Europe are not fully satisfactory, what other complementary mechanisms might have been at work?

The mechanism I highlight in this paper operates through the differences in the property rights in land that different European regions inherited from their past as a result of the political success of different segments of the medieval societies from which they emerged. For the purposes of the argument, it helps to think of Europe at the

[18]This last point is also made by Allen when he compares England and Netherlands to France and Germany on the one hand and Italy and Spain on the other (Allen (2008)). The other key feature Allen cites for success, participation in the intraeuropean trade (which preceded by a century the rise of the Atlantic trade emphasized by Acemoglu et al. (2005) and is more in line with the dating of the rise of northwestern Europe) would not do either as many eastern European countries participated heavily in this trade but remained economic failures.

beginning of the sixteenth century as being composed of three regions: the northwest (England and the Low Countries), the east (Europe east of Elbe), and the rest of western Europe. For various historical and political reasons, each region was characterized by a different set of distribution of rights to land. At one extreme were countries like France and western Germany, where at the end of the medieval era, in alliance with monarchs and princes, peasants were successful politically against feudal lords and ended serfdom with full legal recognition of their property rights to plots of land. Though these plots were initially relatively large, towards the end of the sixteenth century rising population and the subdivision of land (the famous French *morcellement*) left this region with a large class of peasant proprietors working on small plots of land. Thus, by 1550 for instance, 88 percent of the peasant properties were under 6.2 acres even in the more advanced Paris region.[19] At the other extreme, east of Elbe, where the political domination of the feudal lords gave them the ability to reintroduce the "second serfdom," that is to redefine peasants as unfree and tied to the expanded estates of their lords. Here a small group of lords ended up with substantial holdings of land upon which peasants, who were legally unable to move elsewhere, were forced to work. In Poland, for example, 80 percent of the peasant population had by 1650 holdings of no more that 20 acres when a typical family of 7.5 equivalent adults would not have been able to sustain itself on 40 acres.[20] Similarly, in Bohemia by the mid-seventeenth century, the nobility, the church, the towns, and the crown owned practically all the land, leaving peasant freeholders a mere 0.5 percent of the total (Klima (1979)). The northwestern European landholding pattern remained in between these two extremes as neither feudal lords nor peasants were able to dominate politically to the extent their counterparts did in the east or west of Europe. Thus, by the end of the sixteenth century, land holdings of English farmers averaged around 60 acres, substantially larger than the plots of, say, French farmers or their medieval counterparts.[21] These English farmers either owned their land or had it "directly under their control" (Campbell (1942)). A recent survey of the literature concludes that England in the period under consideration was "unambiguously a peasant

[19]See Jacquart (1974), Meuvret (1971), Duby and Wallon (1995-1976) and Brenner (1982) on the "pulverization" of land holdings in France.

[20]See Maczak (1968), Zytkowicz (1968), and Millward (1982).

[21]See Allen (1992). O'Brien (1996) argues that 1066 is not an inappropriate date to take as the start of divergence of property rights regimes in England and France. This is because the consolidation of Norman rule that followed led to major changes in the distribution of landownership and the status of indigenous populations in England. By the twelfth century the latter were largely enserfed, while in France serfdom had waned over large areas of Europe.

society in which 'owner-occupancy' reached its apogee early in the seventeenth century' (Smith (1998), p. 371).[22] I argue below that an important element in the mechanism that helps explain the great divergence of early modern European economies and the start of modern growth is this difference in the distribution of landed wealth. The reasoning behind the mechanism combines three elements. First of these is the observed twelfth and thirteenth century recovery of population levels everywhere in Europe from the catastrophic declines wrought by Black Death. The second is the differential rise in agricultural productivity in different parts of Europe. A mechanism a la Boserup (1981) that connects the first two elements is assumed here.[23] The third element is similar to the one described by Murphy et al. (1989) where industrialization of certain sectors requires large enough domestic markets. Increasing returns technologies need to secure enough demand to cover fixed costs and break even. For this to happen over a wide range of sectors a broad spectrum of the population needs to have enough income to demand manufactured goods.[24] In eastern Europe with its second serfdom and a small group of feudal lords siphoning off the income generated in agriculture, these conditions were hard to meet. In western Europe, where the population mostly consisted of peasant farmers with small plots, the combination of population growth and productivity increases was not conducive to a rise in agricultural incomes and individual landowners did not earn enough to generate enough demand for and, thus, to support a wide range of industries. It was only in northwestern Europe where landholdings were neither too small nor too large that the combination of higher population levels and productivity advances led to a relatively large number of households earning high enough income to demand a broader spectrum of goods.[25]

[22]Allen (1992) and Habakkuk (1940), inter alia, argue that the eighteenth century marked the end of the English peasantry, with land being increasingly concentrated in the hands of large landlords in the period corresponding to the classical industrial revolution. See also Beckett (1984) on this.

[23]Boserup (1981) argues that an increase in population forces farmers to open up more land in order to keep output from falling. Once all available land is used, they switch to a new set of farming techniques. de Vries (2008) adopts this line but emphasizes market incentives in explaining the induced a rise in productivity. Kremer (1993) finds that in the very long run higher population induces technological change. Galor and Weil (2000) assume that an increase in population leads to higher productivity growth.

[24]Obviously, for the argument to work exports must be either completely choked off or insignificant. In the period in question exports of manufactured goods were at best a negligible proportion of output.

[25]In Spain land ownership was higly concentrated with the Spanish church being one of the largest landholders, controlling 20 percent of Castillian land by the end of the sixteenth century. In addition, silver and gold from Spanish colonies in the New World fueled the Habsburg wars and inflation, which coupled with the relatively high customs duties that restricted domestic and international trade stifled

Parts of the argument adopted in the paper have their precedents in the analytical literature. Galor et al. (2009) build a model where inequality in landownership prevents the adoption of institutions promoting human capital formation. This is a setup where powerful landlords delay the implementation of education reforms, slowing the process of industrialization and the transition to modern growth. The model is thus complementary to the present one as it explicitly focuses on a period (from 1820 on) where human capital formation became important. Murphy et al. (1989) emphasize the role of demand for industrialization, however the mechanism in their model depends on a fraction of the labor force receiving profits and rents in addition to wages, an assumption that is hard to maintain for the period in question here.[26] Bilancini and D'Alessandro (2008) provide an extension of the Murphy et al. (1989) model to the case where only a fraction of the population owns land and discuss the various scenarios that give rise to different levels of industrialization. However, they confine their attention to a static model where workers only earn subsistence wages and thus cannot differentiate between the three European cases discussed here. Their setup, however, like the one here, emphasizes the role played by demand in determining the extent of industrialization.[27] Recently, Foellmi and Zweimuller (2006) have explored the role of income inequality in a model with demand-induced innovations. They show that changes in the distribution of income affect demand for goods and the incentive to innovate and, thus, long-run growth. Further, like Murphy et al. (1989), Bilancini and D'Alessandro (2008), and the present paper, they also adopt hierarchical preferences which are crucial for the model presented below. [28]

The rest of the paper is organized as follows. Section 2 sets up the model and derives the basic results concerning the divergent paths taken by different European regions before the classical Industrial Revolution. It shows that under certain historically-justified restrictions on the parameters of the model, one can derive different wage, land rent,

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the agricultural sector.

[26]This assumption in Murphy et al. (1989) also implies that those who receive land rents also receive the same share of profits out of income. This makes it impossible to study the independent effect of land distribution in their setup.

[27]Earlier Mokyr (1977) had rejected a role for demand for the classical Industrial Revolution. The counter arguments of Ben-Shachar (1984) are valid below as population growth and the associated rise in agricultural productivity provide exogenous factors that affect demand. Bairoch (1997) argues that increases in demand played an important role in the classical Industrial Revolution.

[28]Matsuyama (2002) uses hierarchical preferences of the type below to explain the rise of "mass consumption societies." Herrendorf et al. (2013a) argue that non-homothethic preferences adopted here are key to understanding the evolution of expenditure shares over time.

labor supply, and "industrialization" levels for the three regions in which our interest lies. Section 3 concludes the paper.

2 The Model

2.1 Saving, Consumption, and Labor Supply Decisions of Agents

A given economy is populated by a mass of N agents, of which there are three types: workers, landlords, and (potentially) entrepreneurs (denoted by superscripts L, R, and E below). In addition to possible wage income, landlords earn rents, r, on the land they own, while entrepreneurs earn profits π. Each agent lives for one period and decides (1) how much to spend on consumption, (2) how much labor to supply, (3) whether to leave bequests to offspring or not, and (4) how to allocate his consumption across goods. This last decision is made in the second stage of a two-stage process, the first stage of which involves decisions (1)-(3).

2.1.1 Point-in-time Consumption, Saving, and Labor Supply

At the first stage the agent maximizes[29]

$$U = \eta_c \ln C + \eta_b \ln(\overline{\Upsilon} + b') + \eta_l \ln(1 - l)$$

where η_j, $(j = c, b, l)$ and $\bar{\Upsilon}$ are non-negative constants, and l, C, and b', denote labor supply of a wage earner, a consumption aggregator, and bequests to offspring. The budget constraint of the agent is given by

$$C + b' \leq I$$

with $I = wl + y^i + b$ $(i = L, R, E)$ and b, and y^i denoting bequests received from parents and non-wage income (i.e. rents, r, and profits, π, earned by landlords and entrepreneurs respectively and derived below). Bequests to offspring b' are constrained to be non-negative. Defining $\Upsilon \equiv \frac{\eta_c}{\eta_b}\overline{\Upsilon}$, it is straightforward to solve for C and b' as

$$b' = \begin{cases} \frac{\eta_b}{\eta_b + \eta_c}(I - \Upsilon) & \text{if} \quad I > \Upsilon \\ 0 & \text{if} \quad I \leq \Upsilon \end{cases} \tag{1}$$

[29] See Galor and Moav (2004) for the use and implications of a similar log-linear utility function that yields savings as an increasing function of wealth.

$$C = \left(\frac{1}{\eta_b + \eta_c}\right)(\eta_c I + \eta_b \Upsilon). \tag{2}$$

Thus, agents leave bequests to their offspring only if their incomes exceed a threshold level.[30]

Having decided how much of his income will be used for consumption, in the second stage the agent decides how much to buy of each available good. These are of two types: a homogeneous agricultural good ("food" for short henceforth), the price of which is taken to be the numeraire, and a continuum $[0, \infty)$ of manufactured goods. Each good indexed by its distance q from the origin. All agents have identical but hierarchical preferences over goods, with the consumption aggregator C given by[31]

$$C = \begin{cases} c_f & \text{for} \quad c_f \leq \varpi \\ \varpi + \int_0^{\overline{q}} \min\{1, x(q)\}\, dq & \text{for} \quad c_f > \varpi \end{cases}$$

where c_f denotes food consumption, ϖ is the minimum amount of food that needs to be consumed before agents start buying manufactures, $\overline{q}$ is such that for $q \epsilon [0, \overline{q})$ commodity q is consumed, and $x(q) = 1$ if good q is consumed, zero otherwise. In this formulation agents first buy food and then (provided their income is high enough to purchase ϖ units of food) buy one unit of each manufactured good following the order in the interval. In what follows, I will assume that $\varpi = \Upsilon$, i.e., agents will start leaving bequests only after they meet their food requirements.[32] Agents with higher incomes buy the same goods as their poor counterparts plus more manufactures. As incomes rise what used to be luxuries eventually turn into necessities.

Labor supply is given by

$$l = \begin{cases} \left[(\eta_c + \eta_b + \eta_l)\,\eta_c w\right]^{-1} \left[(\eta_c + \eta_b)\,\eta_c w - \eta_l \Lambda\right] > 0 & \text{if} \quad (\eta_c + \eta_b)\,\eta_c w > \eta_l \Lambda \\ = 0 & \text{if} \quad (\eta_c + \eta_b)\,\eta_c w < \eta_l \Lambda \end{cases} \tag{3}$$

where $\Lambda \equiv (\eta_c b + \eta_b \Upsilon + \eta_c y^i)$ (for $i = L, R, E$).[33]

It is useful to make the following historically realistic assumption[34]

[30] Note how property rights through the distribution of land holdings affect incomes and, thus, bequests.

[31] Here I follow the formulation of Bilancini and D'Alessandro (2008).

[32] Relaxing this assumption does not change the basic insights gained from the paper but unnecessarily complicates the algebra.

[33] Note that $l = 1$ if $\eta_l = 0$. It is also straightforward to show that labor supply, l, is an increasing function of the wage.

[34] See below for the implications of relaxing this assumption.

Assumption 1. *y^i $(i = R, E)$ is above a critical level such that $(\eta_c + \eta_b)\,\eta_c w < \eta_l(\eta_c b + \eta_b \varpi + \eta_c y^i)$, while $y^L = 0$ and $(\eta_c + \eta_b)\,\eta_c w > \eta_l(\eta_c b + \eta_b \varpi)$*

Given equation (3), Assumption 1 implies that landlords and entrepreneurs do not supply labor, while workers receive only wage income.

Now, for future purposes, consider a worker who does not receive a bequest, b, from parents ($b = 0$). Then there is a wage level, $\widetilde{w}$ at which the agent chooses not to leave a bequest, i.e. $b' = 0$, or equivalently, from 1, $I = \Upsilon = \widetilde{w}\widetilde{l}(\widetilde{w})$ (which implicitly defines $\widetilde{l}$). Note that then all income is consumed: $C = \widetilde{C} \equiv I = \varpi$. First-order conditions yield $\eta_l \widetilde{c} = \eta_l \theta = \eta_c \widetilde{w}(1 - \widetilde{l}) = \eta_c \widetilde{w}(1 - \theta/\widetilde{w})$. Solving this we get the critical wage level below which the worker does not leave bequests

$$\widetilde{w} = \frac{(\eta_c + \eta_l)}{\eta_c}\varpi.$$

2.1.2 Steady-State Consumption, Saving, and Labor Supply

At a steady state we have $b' = b = \bar{b}$. Thus, the budget constraint $\overline{C}^i = \overline{I}^i - b'^i = w\bar{l}^i + y^i + b - b' = w\bar{l}^i + \overline{y}^i$ (with $\bar{l}^i = 0$ $(i = R, E)$, $\overline{y}^L = 0$ $\overline{y}^R = r$, $\overline{y}^E = \overline{\pi}$) at a steady state. Now the first-order conditions of the worker's problem imply

$$\bar{l} = \frac{\eta_c}{\eta_c + \eta_l} \tag{4}$$

and equation (1) yields

$$\bar{b}^L = \frac{\eta_b}{\eta_c}\left(\frac{\eta_c}{\eta_c + \eta_l} w - \varpi\right). \tag{5}$$

Similarly, for landlords and entrepreneurs we obtain

$$\bar{b}^i = \frac{\eta_b}{\eta_c}\left(\overline{y}^i - \varpi\right),\ i = R, E. \tag{6}$$

2.1.3 Stability

Given $b^i_{t+1} = \nu(wl^i + y^i + b_t - \theta)$ $(\nu \equiv \eta_b/(\eta_b + \eta_c) < 1)$ for the bequest levels to converge a sufficient condition is that

$$\left|\frac{\partial b^i_{t+1}}{\partial b_t}\right| = \nu\left[\frac{\partial y^i_t}{\partial b_t} + 1\right] < 1.$$

For a given wage rate, for the workers, we have $\partial b^W_{t+1}/\partial b^w_t = \eta_b/(\eta_c + \eta_b + \eta_l) < 1$ $\forall b^w_t$. As $\nu < 1$ and with $y^R_t = R/M$ we have $\frac{\partial y^R_t}{\partial b_t} = 0$; thus, the stability condition also holds for the landlords.

2.2 Production and Incomes

2.2.1 Agriculture

In the "agricultural sector" food is produced using land, T, and labor, L_f, under constant returns to scale. The agricultural production function is given by

$$Q_A = AF(T, L_f) \tag{7}$$

where A is a productivity parameter and $F(.,.)$ is a constant returns to scale production function and the aggregate amount of land T in a given economy is fixed.

Assuming that all agents are able to afford to buy the minimum amount of food, ϖ, goods market equilibrium in agriculture can be used to determine agricultural employment

$$\varpi N = AF(T, L_f) \tag{8}$$

where ϖN denotes demand for food.

Agricultural wages are a function of agricultural employment with $w^A = w(L_f)$, $w'(L_f) < 0$ following from the level of agricultural employment determined by equation (8). Note that this formulation is more general than but is consistent with workers being paid the marginal product of their labor services.

Landlords with mass M own all the land. The distribution of land across landlords, though typically non-uniform historically, is taken to be uniform here. This would be a justified simplification to the extent that the focus is on the interaction between landlords on one hand and landless workers and other agents on the other, as is the case here. Total rents earned by landlords, R, follows from equation (8) and the wage equation as $R = AF(T, L_f) - wL_f$. Each landlord, then earns rents $r = R/M$. This implies that the higher is the number of landlords, ceteris paribus, the lower will be the rents earned by a landlord.

2.2.2 Manufactures

Each manufactured good is produced in a separate sector that is small relative to the rest of the economy. There are two technologies available for the production of any good q: (1) a traditional constant-returns-to-scale (CRS) one which requires the use of α units of labor to produce one unit of a manufactured good, and (2) an increasing-returns-to-scale (IRS) technology that requires a fixed investment of k units of labor and β units of labor per unit of output with $0 < \beta < \alpha$. Labor is free to move across firms using

different technologies. Following Murphy et al. (1989), I will take the substitution of IRS technologies for CRS ones to mean industrialization.

Market Structure and Prices: Markets where goods sold are produced using the traditional CRS technology are perfectly competitive. Thus, given the wage rate, w^M, in manufactures a good q produced by a traditional technology fetches a price of αw^M. Firms using the IRS technology (and as a result having monopoly power) decide whether to enter a market and what price to charge. Observe that the maximum price that can be charged by a monopolist is αw^M; anything above would lead to the loss of the market to its CRS competitors. To see that $\alpha w^M$is also the lowest price a monopolist would charge note the following. Lowering the price below αw^M would only be beneficial for a monopolist if the decline in price is compensated by an increase in sales. However, given the preferences adopted here, demand for commodity q is independent of the price of this commodity. This is because consumers here demand one unit of each commodity type following the order $[0, \infty)$ until they use up the portion of their income devoted to the purchase of manufactures. As a result, the demand for a given type q commodity depends only on the prices charged in markets$[0, q)$ and, thus, whether they have exhausted the amount set aside for the purchase of manufactures. It is therefore independent of the prices of commodities of type $\widetilde{q} \geq q$.

Entrepreneurs (those who start IRS industries) make profits, π of

$$\pi = (p_Q - \beta w^M)D_Q - kw^M = (\alpha - \beta)(D_Q - \rho)w^M + w^M$$

where $p_Q = \alpha w^M$ and $\rho \equiv (k+1)/(\alpha - \beta)$. Note that for an IRS-firm to be started the potential entrepreneur should expect to earn an income that is at least as great as her reservation income, i.e., $\pi \geq w^M$. Further, if $\rho < 1$ it is straightforward to see that even with demand, D_Q, as low as one unit, it is the case that $\pi > w^M$ so that the IRS technology is always preferred to the CRS technology. To avoid this historically counter-factual result, I will assume that $\rho > 1$.

2.2.3 The Labor Market and Agents

At this point in the discussion it is useful to consider the allocation of labor across different sectors. First, note that free mobility of labor across agriculture and manufactures ensures that $w^A = w^M = w$. Second, given the mass, N, of the population and that of landlords, M, we have the rest, L, of the population either supplying labor (L_f in the agricultural sector and L_m in manufactures) or becoming entrepreneurs, E, and starting IRS firms. A mass L_{CR} of the manufacturing workers are employed in the CRS sector,

while a mass, L_{IR} are in the IRS sectors. To sum up, we have

$$N = M + L, \quad L = L_f + L_m + E, \quad L_m = L_{CR} + L_{IR}.$$

Though so far we have determined the the number of workers in agriculture, the number employed in the CRS and IRS sectors in manufactures and the number of entrepreneurs remain to be calculated. Further, the determination of the allocation of agents across sectors is tied closely to the question of the relative sizes of these sectors and, therefore, the level of industrialization.

2.3 Industrialization Before the Industrial Revolution

Since the main purpose of this paper is to explore the consequences of property rights in land on the extent of "industrialization" during the period leading to the classical industrial revolution in England, it is useful to adopt the following strategy. First, recall the division of pre-industrial revolution Europe into three regions which differ with respect to the distribution of rights to land. One way of measuring such differences in the context of the present model is to suppose that the two extremes of highly concentrated land ownership in eastern Europe (with its "second serfdom") and widely-diffused property rights in western Europe are represented by a small number of landlords in the former and a relatively large number in the latter. Northwestern Europe (England and the Low Countries) would then have a landlord class the size of which is somewhere in between these two extremes. Formally, I assume that

Assumption 2. $M^{POL} < M^{EN} < M^{FR}$

where for mnemonic purposes only I used superscripts POL, EN, and FR to denote eastern, northwestern, and western Europe (Poland, England, and France as representatives of their regions). For any given amount of land, this formulation yields relatively large and small landholdings respectively in eastern and western Europe, while the average land held by northwestern European landlords lies somewhere in between. The reverse ranking holds, *ipso facto*, for average land rents $r = R/M$.

Second, I am interested in how such property rights in land interact with (i) the recovery of the population everywhere in Europe starting at the beginning of the three centuries in question, (ii) the productivity improvements in agriculture observed simultaneously, and (iii) with the differential response of wages to these developments. Recall that in this period continental real wages fell, while real wages in northwestern Europe

remained trendless. Here the task is to replicate this result most importantly for western and northwestern Europe as wages in eastern Europe, where serfdom reigned, should be thought as politically determined given the ability of landlords there to impose and maintain strict restrictions on labor.[35] To be able to explain the difference between western and northwestern wage patterns it is useful to start with the observation that the recovery of population levels everywhere were associated with productivity improvements.[36] Here I will follow the Boserup (1981) and Galor and Weil (2000) line of thought that suggests that the former induced the latter.

Formally, I start by supposing that workers get paid their marginal products in agriculture in western and northwestern Europe. Given goods market equilibrium in agriculture (equation (8)) we obtain

$$\frac{dw}{dN} = \frac{w}{N}\left(1 - \frac{\nu_L}{\eta_L}\right)(\varepsilon_{A,N} - \xi) \tag{9}$$

where $\xi \equiv -\frac{\nu_L}{(\nu_A\eta_L - \nu_L\eta_A)} > 0$, and $\eta_L \equiv (\partial F(.)/\partial L_f)(L_f/F(.))$, $\eta_A \equiv (\partial F(.)/\partial A)(A/F(.))$, $\varepsilon_{A,N} \equiv (\partial A/\partial N)(N/A)$, $\nu_L \equiv (\partial F_L(.)/\partial L_f)(L_f/F_L(.)) < 0$, $\nu_A \equiv (\partial F_L(.)/\partial A)(A/F_L(.))$ are defined as the elasticity of agricultural output with respect to labor (η_L) and agricultural productivity (η_A), the elasticity of the marginal productivity of agricultural labor to labor (ν_L) and agricultural productivity (ν_A), and the Boserupian parameter $\varepsilon_{A,N}$ that measures the elasticity of agricultural productivity to population.

Thus, whether wages rise or not in response to an increase in the level of population depends on whether $\varepsilon_{A,N} - \xi$ is positive or not. Note that though the elasticity of productivity with respect to population, $\varepsilon_{A,N} = (dA/dN)(N/A)$, is a purely technical "blackbox" parameter, one would not expect it to exceed one. So, the answer to our question lies in the value of ξ. To see what is involved, specialize the production function

[35] Allen (1998) finds that though Polish agricultural productivity levels were among the highest measured in Europe, they did not translate into high wages for workers and argues that the "second serfdom" accounts for the discrepancy.

[36] The thesis put forward by Brenner (1982) that it was the larger size of the farms in England that made them more productive than their smaller counterparts in France is highly controversial (see, for instance, Keyder and O'Brien (1978) and O'Brien (1996)) and runs counter to the findings of contemporary empirical studies that find robust evidence for the inverse farm size and productivity relationship (see Binswanger et al. (1995), Eastwood et al. (2010), and Carletto et al. (2013)). For a different take on the latter see Adamopoulos and Restuccia (2014). Finally, note that Herrington et al. (2015) find that in US data sectoral differences in labor–augmenting technological progress are the main force behind the trends in observed relative prices and sectoral labor.

to the CES form:

$$F(T, L_f, A) = A\left[aT^{-\varsigma} + (1-a)L_f^{-\varsigma}\right]^{-1/\varsigma} \tag{10}$$

where a is a distribution parameter and ς denotes the usual substitution parameter. It then follows that

$$\xi = \frac{1}{1 + \frac{1-a}{a}\sigma\tau^{\varsigma}} < 1 \tag{11}$$

where $\tau \equiv T/L_f$ is the land-labor ratio in agriculture. Now, most empirical studies find the elasticity of substitution $\sigma = 1/(1+\varsigma)$ to be in the 0.4 to 0.6 range. This implies that $\varsigma > 0$ (and taking $\sigma = 0.4$ yields $\varsigma = 1.5$). As long as $\varsigma > 0$, it is clear from above that ξ is decreasing in τ, i.e., countries with higher land-labor ratios in agriculture would have lower values of ξ and, therefore, are more likely to have their wages rise in response to an increase in population. Allen (1998) and O'Brien (1996) point out that England was a country with a land-labor ratio in agriculture that is higher than France. Thus, we have reason to defend the view that England was more likely to have wages remain high in response to the recovery of its population.

Note also how the share of labor in agriculture responds to an increase in population:

$$\frac{dL_f}{dN} = \frac{L_f}{N}(1 - \varepsilon_{A,N})\left[1 + \frac{a}{(1-a)\tau^{\varsigma}}\right]. \tag{12}$$

Again, as long as $\varsigma > 0$, it is clear from above that countries with higher land-labor ratios in agriculture, τ, would have proportionately smaller increases in the share of labor in agriculture. Note also that a higher τ makes the elasticity, $(dL_f/dN)(N/L_f)$, more likely to be less than one so that a one percent increase in population would lead to a less than a one percent rise in the agricultural labor force, reducing the latter's share in total population. This also agrees with the historical accounts that show that a smaller percentage of the population in England than in France was engaged in agriculture in the period in question (see O'Brien (1996) among others).

Finally, to see how rents respond to an increase in population note that $R = Q - wL_f$. Differentiation now yields

$$\frac{dR}{dN} = \frac{R}{N}\rho\left(\frac{1}{1-\sigma} - \varepsilon_{A,N}\right). \tag{13}$$

Given that $\sigma < 1$, this implies that rents rise with an increase in population.

To sum up, so far I have argued that the recovery of European populations at the beginning of our period was associated with an increase in agricultural productivity. This had different effects on real wages and the allocation of labor across sectors depending on

the inherited regime of property rights in land in different regions of Europe. Thus, given the relatively large landholdings, real wages in northwestern Europe remained roughly the same, whereas population increases combined with smaller plots of land in western Europe and serfdom in eastern Europe had the effect of reducing real wages. Rents on land rose everywhere (in proportion to initial rents per capita; see equation (13)).

I now turn to the consequences of these changes in real wages and rents on the structure of the manufacturing sector.

2.3.1 Manufactures

The Structure of Demand for Manufactures: Agents' demands for manufactured goods are given by $Q_i = (C^i - \widetilde{C})/\alpha w = (1-\nu)(I^i - \widetilde{C})/(\alpha w)$. Thus,

$$Q_L = (1-\nu)\frac{wl^W + b^W - \widetilde{C}}{\alpha w}, \quad Q_R = (1-\nu)\frac{R/M + b^R - \widetilde{C}}{\alpha w}, \quad Q_E = (1-\nu)\frac{\pi + b^E - \widetilde{C}}{\alpha w},$$

or, defining $\delta \equiv \widetilde{C}/w \equiv \widetilde{w}\widetilde{l}/w$ (ratio of subsistence income to wages) and $\gamma \equiv r/w \equiv R/Mw$ (ratio of per-landlord rents to wages), $\theta \equiv (\alpha - \beta)/\alpha$ (the rate of profit) and recalling that $\overline{C}^i = w\overline{l}^i + \overline{y}^i$, at a steady state

$$\overline{Q}_L = \frac{\bar{l}^W - \delta}{\alpha}, \quad \overline{Q}_R = \frac{\gamma - 1}{\alpha} + \overline{Q}_L = \frac{\gamma - \delta}{\alpha}, \quad \overline{Q}_E = \theta(\overline{D}_Q - \rho) + \overline{Q}_L. \tag{14}$$

Note that if workers earn just enough to cover subsistence expenditure on food (i.e. $\delta = \widetilde{l}$ as when $w = \widetilde{w}$), $Q_L = 0$.

The following results prove useful in what follows.

Proposition 1. $\bar{Q}_L < \rho$

Proof. Noting that $\bar{l}^W < 1$, we have $\overline{Q}_L < Q_L^* \equiv (1-\delta)/\alpha$. If we can show that $Q_L^* < \rho$ we are done. Suppose that on the contrary $Q_L^* > \rho$. Given the definitions we then have $(1-\delta) > \alpha(k+1)/(\alpha - \beta)$. This implies $1 - \alpha(k+1)/(\alpha-\beta) > \delta$. Or, $0 > -(\alpha k + \beta)/(\alpha - \beta) > \delta \geq 0$, a contradiction. □

Assumption 3. *$r \geq 2w$. That is landlords earn at least twice as much as workers.*

Proposition 2. *Maintain Assumption 3. $\hat{Q} \equiv \theta(\overline{Q}_L + M - \rho) + \overline{Q}_L < Q_R$ with $M < \rho$.*

Proof. With $M < \rho$, $\hat{Q} < \check{Q} \equiv (1+\theta)\overline{Q}_L = (2-\overline{v})\overline{Q}_L$ (where $\overline{v} \equiv \beta/\alpha = 1-\theta$). If we can show that $\check{Q} < Q_R$ we are done. Now, suppose $\check{Q} > Q_R$. Using (14), this implies $1 > (1-\overline{v})(1-\delta) > (\gamma - 1)$. But $1 > \gamma - 1 \Rightarrow 2 > \gamma = r/w \Rightarrow 2w > r$. A contradiction. □

I now turn to the discussion of how the various European regions fared in terms of developing their manufacturing sectors given the regime of property rights they inherited. Recall that this regime determined how they responded to the recovery of population levels in the period in question. Most importantly, we are interested in the real wages of workers and rents on land as these determined the demand for manufactured goods. The latter, was affected, ceteris paribus, by the number of landlords in each economy. Thus, of particularly interest here is that subspace of the parameter space $\mathfrak{M}$ to which each M^i $(i = EN,\ FR,\ POL)$ belongs. The modeling strategy that I follow below is to parse this space so that each European region falls into a subspace which yields a historically roughly accurate characterization of the region's economy for the period in question.

2.3.2 Northwestern Europe

Here we need to determine the "extent of industrialization" and the "extent of the manufacturing sector" in northwestern Europe. Recall that in this case real wages remained roughly constant when population levels rose. In line with comparative historical evidence, I will make the following two assumptions for northwestern Europe.

Assumption 4. $w > \widetilde{w}$.

Thus, workers demand manufactures.

Assumption 5. $M < \rho < M + Q_L$.

That is, while the numbers of landlords is not high enough to generate demand for manufactures sufficient to cover fixed costs in IRS sectors, those sectors that receive demand $M + Q_L$ can cover fixed costs and switch to the IRS technologies.

Assumption 6. $\underline{M} < M < \overline{M}^{EN}$

Assumption 6 has two parts. $\underline{M} < M$ (where $\underline{M} \equiv R/\pi$ with $D_Q = N$) implies that the number of landlords is so high that the richest entrepreneur receives income π higher than the income R/M of a landlord.[37] $M < \overline{M}^{EN}$ (where $\overline{M}^{EN}$ is defined by $R/(w\overline{M}^{EN}) - \delta = \theta(\overline{M}^{EN} - \rho) + (1+\theta)\overline{Q}_L/(1-\theta)$ and obtained from $Q_2 = Q_R$) places an upper bound on the number of landlords so that their incomes exceed the wages of

[37] The richest entrepreneur is the one whose good is bought by the most. With all agents buying some IRS manufactures, there are some goods that all agents buy.

workers by an amount given by the productivity differential between the CRS and IRS sectors.[38]

Now, given $w > \widetilde{w}$, everyone, N, demands manufactures. Since their number, N, exceeds that required to cover fixed costs, those sectors with mass Q_L that receive everyone's demand initially industrialize. The Q_L entrepreneurs who receive $D_Q = N$ demand $\overline{Q} = \theta(N - \rho) + Q_L$ ($\overline{Q} > Q_R$ because the richest entrepreneur is richer than a landlord). Those Q_R entrepreneurs[39] receive $D_Q = M + Q_L$ and demand $Q_1 = \theta(M + Q_L - \rho) + Q_L < Q_R$ (inequality follows from Proposition (2)). Similarly, the Q_1 entrepreneurs who receive $D_Q = M+Q_L+Q_R$ demand $Q_2 = \theta(M+Q_L+Q_R-\rho)+Q_L < Q_R$ (by Assumption (6)) and the Q_2 entrepreneurs who receive $D_Q = M + Q_L + Q_1$ demand $Q_3 = \theta(M+Q_L+Q_1-\rho)+Q_L$. This describes a sequence the elements of which are $Q_{i+2} = \theta(M + Q_L + Q_i - \rho) + Q_L$ for $i \geq -1$ (with $Q_{-1} = 0$ and $Q_0 = Q_R$). The Appendix describes the solution to this recursive equation and some useful properties of the sequence. It also shows that $Q_i < Q_R$ ($i \geq 1$). This is used to establish the following result.

Proposition 3. *The extent of industrialization in northwestern Europe is given by* $\widetilde{Q}^{EN} = Q_R^{EN}$.

Proof. Q_R entrepreneurs receive $D_Q = M+Q_L > \rho$ so they industrialize. Given $Q_i < Q_R$ ($i \geq 1$) the mass of sectors using the IRS technology is bounded from above by Q_R. □

Aggregate demand that generates profits of the industrialized sector is calculated in Appendix 1 as:

$$[N - (\Omega + Q_R)]\, Q_L + \frac{(\Omega - \rho)}{1 - \theta}(Q_R - Q_L) + \frac{(\Omega + Q_R - \rho)}{1 - \theta} Q_L \tag{15}$$

Note that the quantities $(\Omega + Q_R - \rho)Q_L$ and $(\Omega - \rho)(Q_R - Q_L)$ have multiplier effects (with $1/(1-\theta)$ as the multiplier, where θ is the rate of profit), while $[N - (\Omega + Q_R)]\, Q_L$ does not generate further profits through the multiplier.

[38]The required ratio is historically justified. To have a sense of what is required, note that the condition $M < \overline{M}^{EN}$ is equivalent to the condition $\frac{1}{2}\frac{\gamma-1}{1-\delta} > \frac{\alpha-\beta}{\beta}$ or $\frac{Q_R}{Q_L} > 2\frac{\alpha}{\beta} - 1$. Thus, even when the IRS sector is twice as productive as the CRS sector, we require that landlords be able to purchase only 3 times more than wage-earners. Historically, this number is much higher. Note that Assumption (6), which is sufficient but not necessary, is needed below to have $Q_2 < Q_R$.

[39]This is because $Q_L < \rho$ entrepreneurs cannot by themselves generate enough demand for IRS sectors. Only those sectors that receive the combined demand of Q_L entrepreneurs and M landlords can industrialize. These sectors have mass Q_R, the range which both the landlords and richest entrepreneurs can afford.

2.3.3 Western Europe

We start by making a crucial assumption that restricts us to a subspace of the parameter space.

Assumption 7. *$M > \eta$. Thus $Q_R < \rho$.*

Assumption 7 (where η is defined as that M for which $Q_R = (R/M - \overline{w})/aw = \rho$ holds) formalizes the idea that in this case property rights in land are so diffuse that landlord income, and, thus, expenditures on manufactures are low. It is then natural to make a second assumption here.

Assumption 8. $\underline{M} < M < \overline{M}^{FR}$.

where I define $\bar{M}^{FR}$ by $\theta(\overline{M}^{FR} + Q_L + Q_R(\overline{M}^{FR}) - \rho) + Q_L = Q_R(\overline{M}^{FR})$. The implication of Assumption 8 is that each landlord is poorer than the richest entrepreneur but there is an upper limit on the income of the second-tier entrepreneurs such that their demand $\theta(M + Q_L + Q_R - \rho) + Q_L$ falls short of Q_R.

Here again given $w > \widetilde{w}$, initially everyone, N, demands manufactures. Since their number, N, exceeds that required to cover fixed costs, those sectors with mass Q_L that receive everyone's demand initially industrialize. Reasoning similar to the northwestern European case above yields $Q_{i+2} = \theta(M + Q_L + Q_i - \rho) + Q_L$ for $i \geq 1$ as the recursive equation that governs the sequence of demands. Reasoning identical to the one discussed in the Appendix shows that here we also have $Q_i < Q_R$ $(i \geq 1)$, which can then be used to establish the following result.

Proposition 4. *The extent of industrialization in western Europe is described by $\widetilde{Q}^{FR} = Q_R^{FR}$.*

Proof. Q_R entrepreneurs receive $D_Q = M + Q_L > \rho$ so they industrialize. Given $Q_i < Q_R$ $(i \geq 1)$ the mass of sectors using the IRS technology is bounded from above by Q_R. □

2.3.4 Eastern Europe

The eastern European case is straightforward and characterized by the following two assumptions.

Assumption 9. $M^{POL} < \rho$.

Assumption 10. $w^{POL} < \widetilde{w}$.

That is, in eastern Europe the land distribution is very concentrated ($M < \rho$), and, thus, the landlords have very high levels of income, R/M. Further, wages are kept low by political means (say at $w = \widetilde{w}$). These immediately yield the following result.

Proposition 5. *There exists no IRS sectors in eastern Europe:* $\widetilde{Q}^{POL} = 0$.

Proof. Given $M^{POL} < \rho$ landlords cannot generate enough demand by themselves to cover fixed costs in any IRS sector. Given $w = \widetilde{w}$, workers do not buy any manufactures. Thus, there is not enough demand for an IRS sector to break even. □

2.3.5 First Great Divergence

We can now bring together the results for the three different regions. Given assumption 2 it is natural to have $r^{FR} < r^{EN} < r^{POL}$. Given Assumptions 6 7, we also have $Q_R^{FR} < Q_R^{EN}$. We can now rank the "industrialized", i.e. IRS manufacturing, sectors of the three regions.

Proposition 6. $\widetilde{Q}^{EN} > \widetilde{Q}^{FR} > \widetilde{Q}^{POL} = 0$.

Proof. This follows directly from Propositions 3, 4, 5, and $Q_R^{FR} < Q_R^{EN}$. □

Thus, northwestern Europe ranks as the most advanced economy, followed by western and eastern Europe. This last region is characterized by the absence of any manufacturing sectors using IRS technologies. The manufactures produced using CRS technologies there are only bought by landlords who are not numerous enough to support industrialization.

2.3.6 Dynamics

To see how these three regions move from one steady state to another in response to the increase in population levels and the associated improvements in agricultural technology, recall that rents on land increased everywhere, while wages fell in western and eastern Europe, remaining roughly constant in northwestern Europe.

Consider first the effects of a decrease in wages, w. Across steady states, this has no effect on labor supply (see equation (4)), reduces bequests (equations (5) and (6)), and $\overline{Q}_L$ and raises $\overline{Q}_R$ (as it raises $\gamma - \delta = (r - \widetilde{c})/w$) (equation (14)). On impact as wages fall, so does labor supply. Along the transient path, as bequests decline adjusting to their new lower steady-state level, labor supply recovers, but remains lower than its

previous long-run level until it reaches the new steady state.[40] As wages remain roughly constant and higher than elsewhere in northwestern Europe, labor supply there remains higher than the other regions throughout.

To see how Q_L changes on impact note that though lower wages reduce the incomes of workers they also lower the relative price of manufactures. Formally, we have

$$\frac{dQ_L}{dw} = \frac{1}{\left[\left(\eta_c + \eta_b + \eta_l\right)\eta_c w^2 \alpha\right]} \left\{\theta\left[\eta_l\eta_b + \left(\eta_c + \eta_b + \eta_l\right)\eta_c\right] + b\eta_c\left[1 - \left(\eta_c + \eta_b + \eta_l\right)\right]\right\}$$

which, making the reasonable assumption that $1 \geq (\eta_c + \eta_b + \eta_l)$, implies that $dQ_L/dw > 0$ so that Q_L falls on impact. Along the adjustment path as bequests fall, labor supply rises creating an ambiguity. But, taking both of these effects into account we find that

$$\frac{dQ_L}{db} = \frac{1}{\alpha w}\left[1 - \frac{\eta_l}{\eta_c + \eta_b + \eta_l}\right] > 0$$

so that Q_L falls along the adjustment path as well. Thus Q_L falls on impact, along the adjustment path, and across steady states.

With wages falling and R rising, it is straightforward to show that Q_R rises all along.

Though wages remain unchanged in GB, rents rise so does Q_R^{GB}. The bequests of landlords also rise along the adjustment path and across steady states everywhere. With Q_R determining the extent of industrialization, Proposition (6) holds.

3 Conclusion

Above I built a model that may shed some light on the different and divergent paths followed by various European regions in the period leading up to the classical industrial revolution. The point of this exercise was to point out formally that though industrial revolution was a break with the past, it was not as radical a break as once thought and had a gestation period that went beyond a few decades and generations. This long period witnessed a divergence across regions and reversals of fortune. The thesis advanced here is that what lies at the root of divergent paths followed is the variety of property rights inherited. Thus, when populations everywhere in Europe recovered slowly from the shock they received, it was the size of the landlord class and their

[40] Is is interesting to note that peasants in many regions in France practiced "human hibernation." With no work to perform they would entomb themselves in their homes for months at a time, spending their days in bed and sleeping most of the time to lower their metabolic rates and prevent hunger. See Robb (2007).

landholdings that mattered. In western Europe where peasant proprietors tilled small plots, increases in population levels and advances in agricultural productivity led to lower real wages. Given the low incomes of landlords and peasants demand for manufactured goods remained low and increasing returns to scale technologies did not have much room to expand. At the other extreme, in eastern Europe, second serfdom kept wages low, and rents high. But given the small size of the land-owning class, these rents could not generate enough demand for high-end manufacturing processes either. Northwestern Europe, being located somewhere in between these two extremes, in terms of the size of both the landholding classes and their plots, prospered as wages failed to decline even when population levels rapidly rose. Combined demand from landlords and workers kindled an expansion of the manufacturing sectors using increasing returns technologies. Ultimately then the moral of the story formalized here is that property rights mattered in determining the divergent paths taken by the three regions.

Appendix

A. Consider the recursive equation $Q_{i+2} = \theta(M + Q_L + Q_i - \rho) + Q_L$ for $i \geq -1$ (with $Q_{-1} = 0$ and $Q_0 = Q_R$). It is straightforward to establish the following

1. $Q_1 < Q_2 < Q_R$. The first inequality follows from $Q_2 - Q_1 = \theta Q_R > 0$. The second inequality follows Assumption (6). One can also show that $Q_i < Q_R$ $(i \geq 1)$. This last point follows from

   (a) $Q_2 < Q_R$

   (b) $(Q_{2i+2} - Q_2 < 0, (i \geq 1))$. That is all even Q_i are less than Q_2.

   (c) $(Q_{2i+2} - Q_{2i+1} = \theta^{i+1} Q_R) > 0, (i \geq 0))$. That is all odd Q_i are less than their even counterparts.

   (d) Q_{2i} $(i \geq 1)$ fall at a decreasing rate $(Q_{2i+2} - Q_{2i} = \theta^i (Q_2 - Q_R) < 0, (i \geq 1))$. Q_{2i+1} $(i \geq 0)$ rise at a decreasing rate $(Q_{2i+3} - Q_{2i+1} = \theta^{i+1} Q_1 > 0, (i \geq 0))$. Both sequences converge to $Q = (1 - \theta)^{-1}[\theta(M + Q_L - \rho) + Q_L]$.

2. The solution to the recursive equation is (with Q_i $(i = 1, 2)$ given)

$$Q_i = \frac{Q_R(1-\theta)\left(\left(\sqrt{\theta}\right)^i + \left(-\sqrt{\theta}\right)^i\right) + Q_1\left(2 - \left(\sqrt{\theta}+1\right)\left(\sqrt{\theta}\right)^i + \left(\sqrt{\theta}-1\right)\left(-\sqrt{\theta}\right)^i\right)}{2(1-\theta)}.$$

B. To calculate the total demand (above ρ) for the IT sector, we find the area of rectangles (see Figure 1) above ρ. Define $\Omega \equiv M + Q_L$. We then have as the total area

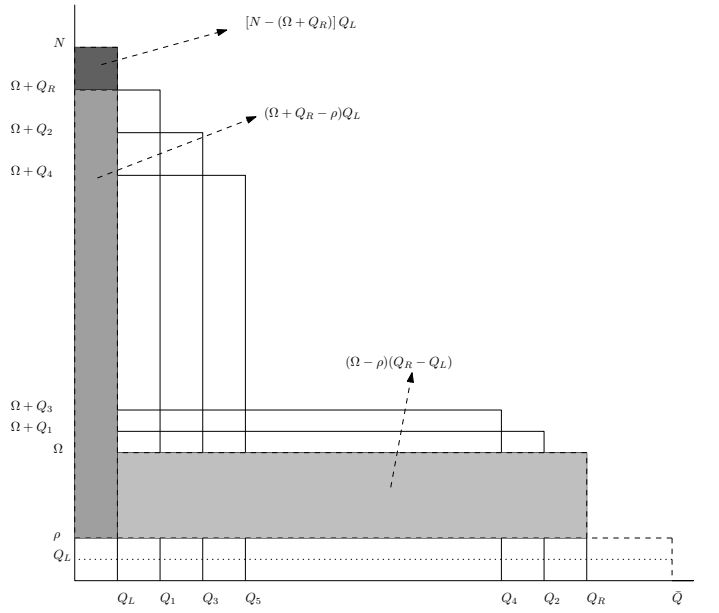

Figure 1: Total Demand

above ρ: $\sigma^\rho = [(N-\Omega)Q_L + Q_R(\Omega-\rho)] + \sigma^o + \sigma^e$ where σ^o and σ^e refer to the areas of odd and even numbered rectangles.

For the odd-numbered ones (σ^o), we have (with $Q_{-1} = Q_L,\ Q_0 = Q_R$)

$$\sigma^0 = (Q_1 - Q_{-1})Q_0 + (Q_3 - Q_1)Q_2 + (Q_5 - Q_3)Q_4 + ...$$

$$\sigma^0 = \sum_{i=0}^{\infty}(Q_{2i+1} - Q_{2i-1})Q_{2i}$$

For the even-numbered ones we have

$$\sigma^e = (Q_2 - Q_4)Q_1 + (Q_4 - Q_6)Q_3 + ...$$

$$= \sum_{i=1}^{\infty}(Q_{2i} - Q_{2i+2})Q_{2i-1}$$

When added these yield (after some manipulation) equation (15).

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