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Munich Discussion Paper No. 2003-13

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Online at <https://doi.org/10.5282/ubm/epub.57>

# **The Industrial Revolution as the Escape from the Malthusian Trap**

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Need one state the obvious, that the Industrial Revolution has surely fascinated as many historians as any other topic in the history of civilization? It was undoubtedly one of the most momentous development, one which continues to have a major impact on virtually all aspects of human experience. It changed the very basis of our existence: not only in the way we produce and consume, but outside of this realm as well, from our social interactions, to our political system. In short, the processes unleashed by the Industrial Revolution are crucial to understanding the primary forces that shaped the modern world.<sup>1</sup> Yet, in spite of the immense outpouring of literature on the topic, there is much confusion regarding appropriate conceptualizations. I review some of the salient conflicting viewpoints, and outline the complexities of change without claiming to do justice to a literature whose enormity prohibits precision within the modest confines of an essay.<sup>2</sup> I conclude by arguing that it is useful to think of the Industrial Revolution as a multidimensional pan-European process with deep roots in the past, intricately intertwined with demographic developments.

## Paradigms and Controversies

There are a multitude of reasons why the debate over the Industrial Revolution is far from moving toward closure. One of these is that scholars have tended to focus excessively on the British experience to the disadvantage of continental developments, and on a few branches of industry, instead of either the industrial sector, or the economy as a whole.<sup>3</sup> Such an approach is bound to distort, inasmuch as it is concerned with

selected aspects of a larger process.<sup>4</sup> It belittles parallel developments across the channel, as well as the simultaneous expansion of economic activity in a large number of regions, such as, Alsace, Bohemia, Flanders, Hamburg, Lombardy, the North of France, Saxony, Silesia, and the Zurich highlands, to name just a few.<sup>5</sup> Yet, these achievements were in some ways quite substantial: for example, the industrial labor force of Bohemia and Moravia, for instance, expanded at a rate of four percent per annum between 1760 and 1800, well above British growth rates.<sup>6</sup> On a per capita basis, the French economy grew as impressively in the eighteenth century as did the British. Perhaps it was not accidental that contemporaries noted in 1799 that the Industrial Revolution had begun in France.<sup>7</sup>

The narrow concentration on Britain fails also to appreciate alternative developmental processes, e.g., that the economic expansion was accompanied everywhere by an acceleration in population growth, as during the cyclical upswings of the Middle Ages and Renaissance. Focusing on England emphasizes excessively those segments of the economy in which the island kingdom was, indeed, an unquestionable leader: cotton textiles, steel, and steam engine production, to the detriment of numerous industries (silks, linens, needles, cutlery, glass, woolens and porcelain production), in which profits were to be had, but in which Britain was not setting the pace. The conventional wisdom also overlooks that "London paper makers strove eagerly to learn the secrets of French, Dutch, and Italian superiority; London calico printers imitated the methods practiced in Hamburg, while tin-plate makers set up rolling mills of Swedish design."<sup>8</sup> In short, England's manufacturing technology was by no means the best in the

world in every respect. That paradigm also minimizes the contribution of other sectors (i.e., finance in Amsterdam) to economic growth, including the concurrent expansion in agricultural exports from Eastern Europe and North America that propagated growth impulses throughout their economies.<sup>9</sup> Hence, we should be more open to appreciating the uniform patterns in development, and not magnify out of proportion the differences in outcomes.<sup>10</sup> In many respects, the countries on the continent were by no means merely following in Britain's footsteps.<sup>11</sup>

We should also leave room in our theories for the fact that *ex ante* expected profits in various endeavors could vary legitimately, due to asymmetric information, industry specific skills, resource endowments, or location externalities. In Britain, the accumulated knowledge of the cotton textile trade with India, and the experience gained in being an entrepot for raw cotton, could have sufficed to lead British entrepreneurs in one direction and their continental counterparts, who lacked such information, in another.<sup>12</sup> The British investment in cotton technology paid off well during the first phase of the Industrial Revolution, but that was by no means apparent *ex ante*.<sup>13</sup> An important point frequently disregarded is that a spatially widespread outburst of creative energy occurred simultaneously.

Moreover, Britain's leadership, even in the narrow sense, was quite short lived.<sup>14</sup> Not only was the standard of living in North America higher in some ways,<sup>15</sup> but by the early nineteenth century US industrial efficiency reached that of England.<sup>16</sup> Even in cotton spinning technology, firms on the Continent did not remain far behind for long. By the 1830s Alsatian and Swiss producers were almost on par with Lancashire, and

machines built by Escher Wyss of Switzerland were found to be superior in many ways to English ones.<sup>17</sup> If the Continent's development had been substantially below that of England in 1760, it would not have been able to ameliorate its backwardness so quickly. These counterexamples indicate that to gain a balanced perspective on the Industrial Revolution we need to shift our focus from Britain to the world economy in which it was embedded.<sup>18</sup>

A related issue is that the appropriate geographic unit of analysis has remained ambiguous. Is Lancashire, England, Great Britain, or the United Kingdom to be used for comparative purposes, and what are their appropriate counterparts? Ought one compare a small country, such as England, to a large one, such as France with a population four times as large?<sup>19</sup> Inasmuch as the Industrial Revolution was essentially a regional phenomenon, the state is not necessarily the proper spatial unit of analysis.<sup>20</sup> According to Francois Crouzet, the "industrial revolution was not made in England but in a few small districts of England - south Lancashire, some sectors of the East Midlands and Yorkshire, Birmingham, and the Black Country."<sup>21</sup> East Anglia, Westmoreland, and Cornwall did not industrialize. Moreover, Herbert Kisch's regional studies of industrialization showed how far advanced German industry was in the eighteenth century, and demonstrated the conceptual weakness of equating the Industrial Revolution with a few innovations in the textile sector.<sup>22</sup> He concluded, that historians "failed to appreciate the achievements" of the industrial enclaves in Krefeld, the Rhineland, Saxony, and Silesia.<sup>23</sup> Crouzet argued similarly that French economic development commanded more respect than it is usually accorded.<sup>24</sup>

Yet another source of contention has been, that a consensus on a definition of the Industrial Revolution has been elusive. In many minds the Industrial Revolution is practically synonymous with technological change: "the technological changes that we denote as the 'Industrial Revolution' implied a far more drastic break with the past than anything since the invention of the wheel."<sup>25</sup> In this view, the design of the rotary steam engine, the discovery of iron puddling, and, above all, the mechanization of cotton spinning, all British achievements, signaled the beginning of the Revolution. However, this position does not appreciate sufficiently the precursors of these inventions.<sup>26</sup> After all, examples of technological creativity abound: thousands of water-driven machines had provided inanimate source of power in fulling mills, in mines, and in iron works since the Middle Ages.<sup>27</sup> Already in 1066, there were 6,000 water mills in operation in Britain.<sup>28</sup> These developments even led some to argue that there was an "industrial revolution of the thirteenth century."<sup>29</sup> An example of a subsequent invention is the spinning wheel, which increased labor productivity manifold after 1530. Mines in the early seventeenth century used wooden railways, suction pumps, and water-driven bellows; forge hammers and stamp-mills were some of the sophisticated mechanized technologies in use. The increase in coal production in England from 0.2 to 3 million tons per annum between the 1550s and 1680 led Nef to write of "an early industrial revolution" of the sixteenth century.<sup>30</sup> Technological progress was clearly visible: by the first days of the eighteenth century, copper, tin, and lead were smelted in reverberatory furnaces using coke as fuel, preparing the way for their adoption in the iron industry.<sup>31</sup>

Darby's application of this technique to iron smelting in 1709 paved the way to

the adoption of this technology later in the century. Steam engines were operating in mines beginning with 1712. The lint-mills in Scotland after 1729 "were equipped with machines for breaking and scutching flax."<sup>32</sup> In sum, machines were in widespread use well before the Industrial Revolution: the inventions of the eighteenth century took place in a civilization that was technologically and scientifically well advanced, and that sophistication was by no means confined to the British Isles.<sup>33</sup> Hence, it is crucial to recognize that the Industrial Revolution grew out of, and continued a tradition to improve the material condition with the use of productivity-enhancing devices, even if the rate of technical progress after 1760 was, to be sure, unprecedented.<sup>34</sup>

Therefore, the "leading sector" model of the Industrial Revolution, according to which growth first accelerated in cotton textile production, and then spread to other sectors of the economy, provides a distorted view of the nature of industrial progress. Once one questions the common wisdom that the cotton textile sector was - by itself - the harbinger of modernization, then prior and contemporaneous achievements in other branches and other processes, important in their own right, become discernable. The economic expansion was evident practically everywhere: from the outset the Industrial Revolution was regionally widespread, encompassed a large array of technologies and branches of industry.<sup>35</sup>

Arguably, technological inventiveness might have been the single most impressive aspect of eighteenth-century achievements, yet the ubiquitous and incessant efforts to improve the human condition is just as awe inspiring. From agriculture to government, and to infrastructure, the emphasis was on organizing and producing more

rationally, and hence more efficiently. The significance of the increased use of paper money, for example, can be easily overlooked. In a similar vain, improvements in public sanitation were important in guarding against recurring epidemics. There were also advances in definition of property rights, such as the development of patent laws.<sup>36</sup> In other words, practically all aspects of the society and economy were improving and helping to shift the production function outward, and not only in England. To accentuate technological change without proper emphasis on improvements in other spheres, including a credible political system, is misleading.<sup>37</sup>

Furthermore, the technological "marvels" of the eighteenth century initially found limited application, even within England. Economic growth had become a permanent feature of the European economies even before these technologies contributed significantly to aggregate labor productivity. Productivity was increased through other means, not only through the introduction of new techniques. Smith's example of the gains in efficiency brought about by the division of labor in a pin factory is part of the folklore of economics. Less well known, however, is that at the same time such gains were also captured in a number of other branches.

The endogenous nature of technological change has also been underestimated. Its acceleration in the eighteenth century was fostered by urbanization, which facilitated a creative response to the challenges of an increasing population pressure faced after 1750.<sup>38</sup> The unprecedentedly large urban sector was important, because "technological innovation proves to have been of distinctly urban origin."<sup>39</sup> Thus, it was beneficial in this respect that already 25 percent of the English population was urban. Furthermore, in



the wake of the Scientific Revolution, ordinary people assimilated a world-view that was becoming more rational and secular.<sup>40</sup> With the role of magic receding, attitudes were more materialistic and calculating. People could reason logically in conducting experiments with industrial technology, thereby amassing practical experience, know-how, and benefiting from productivity advances induced by learning-by-doing.

Innovations in industrial organization enabled entrepreneurs to utilize larger machines, to benefit from the division of labor, and the resultant scale economies of mass production methods lowered average costs. Nonetheless, one should not go as far as to conceive of the Industrial Revolution as the transition to factory production, as, for instance, in Mendel's model of proto-industrialization.<sup>41</sup> After all, "factories," i.e., large scale firms, partly mechanized and with considerable fixed capital investments predate the Industrial Revolution: medieval silk filatures, for instance, bore similarities to their eighteenth-century counterparts producing cotton yarn. The "first modern British textile factory" was a large water-powered silk throwing mill put into operation in Derby in 1721, i.e., before the Industrial Revolution. In addition, "it is unreasonable to exclude from the factory sector ironworks, copper-smelters, chemical works, engineering shops," inasmuch as these were often large establishments even before the classical factory age."<sup>42</sup> Huge iron combines (multiplant firms) came into operation already in the early seventeenth century, and many pre-industrial enterprises, such as bleacheries, dye works, glass works, blast furnaces, paper works, and textile printing firms employed hundreds, often thousands, of workers, and used some machines in the process of production. In short, mechanized large-scale production was not an invention of the Industrial

Revolution, and ought not be equated with it. In any event, the proto-industrial sector coexisted with factories in a symbiotic relationship for an extended period, even well after the Revolution. In other words, the Industrial Revolution did not create modern industry; it did not bring about industrialization; rather, it was a continuation of an evolutionary developmental process, and built upon the staggering achievements of earlier centuries.

The discontinuous nature of the Industrial Revolution has also been controversial.<sup>43</sup> If mechanization, and changes in industrial organization were unique developments, and if technological change proceeded abruptly during the second half of the eighteenth century, then the processes of growth represented a distinct break with the past. In the 1950s such metaphors as "take off" and "great spurt" were used to describe the beginning of this process.<sup>44</sup> One of the weaknesses of this point of view is that it compares the rate of change during the Industrial Revolution with that of the century just preceding it, and those were years of relative stagnation. Thus, the growth after 1760 does appear discontinuous. However, the upswing phase of a business cycle is always impressive compared to the preceding trough. In order to make a balanced judgement, one needs to evaluate the Industrial Revolution in the perspective of the previous long-run development. It then becomes apparent that continuities were superimposed on discontinuities, and that the Industrial Revolution can be thought of as possessing several discontinuous aspects considered from the perspective of the eighteenth century, yet simultaneously be a continuation of previous economic upswings. For this reason, it is important to compare the expansion of the late eighteenth century to the boom phases

of the late sixteenth century, the previous time during which the European economies experienced rapid economic growth.

A series of iconoclastic essays in the late 1970s and early 1980s by Nick Crafts and Knick Harley prepared the way for a paradigm switch on the conceptualization of the Industrial Revolution.<sup>45</sup> They demonstrated convincingly that the growth rate of British industry was overestimated by the previous generation of quantifiers.<sup>46</sup> Instead of growing at a rate well in excess of three percent per annum during the closing decades of the century, the new estimates put the growth of industrial product closer to two percent per annum.<sup>47</sup> On a per capita basis the revised estimates of GNP growth are even more striking: in the range of 0.5-1.0 percent per annum, practically halving the previously obtained results.<sup>48</sup>

However, the conclusion drawn from this finding, that the Industrial Revolution is essentially a "misnomer", is hardly warranted.<sup>49</sup> Because the pace of transformation in the aggregate required longer than the use of the political concept "revolution" normally connotes, one does not have to discard the concept entirely. If one takes a longer view of the processes of change, say, measured on a scale calibrated in centuries, then the metaphor surely does retain its validity. After all, in spite of slower economic growth, there is agreement that productivity increased sufficiently rapidly not only to outpace population growth, but to overcome diminishing returns to labor as well.<sup>50</sup> In a historical context, the fact that real wages did not decline by even more, was itself a major achievement! Moreover, the structural shift from agriculture to industry and services was also unprecedented in both its pace and intensity. Provided

one emphasizes the importance of the antecedents of the upswing, as well as the coexistence well into the next century of traditional modes of production alongside a "germinal" modern sector, one can obtain a more balanced view of the processes of change.

It is crucial to the understanding of the Industrial Revolution that "mechanization in early nineteenth-century Britain was a complex and uneven process; large parts of the country and many sectors of the economy were changing slowly, and even in the most rapidly transforming areas there were many surviving legacies. The amount of craft and small-scale industry was high and still expanding."<sup>51</sup> Old technologies and traditional modes of organization persisted, and the production of a large number of products was not mechanized even by the 1830s, the end of the classical phase of the Revolution.<sup>52</sup> Hosiery production, clothing, leather trades, coach making, building industry, food stuffs, and scores of others were produced using traditional methods well into the century. Moreover, there is no warrant, theoretical or empirical, for believing that English spinning and weaving inventions were indispensable to the success of an Industrial Revolution. Thus, the focus on the developments in the cotton textile sector is misleading.

Furthermore, the other major breakthrough of the time, - Watt's steam engine - spread slowly, and its application remained limited to the cotton textile sector. Even half a century after the beginning of the upswing, British industry was still primarily powered the same way it had been for hundreds of years, i.e., by exploiting the potential energy of falling water.<sup>53</sup> The "modern sector employed fewer than 20

percent of all workers as late as 1841."<sup>54</sup> Among the four largest employers in mid-nineteenth century England, a century after the beginning of the Industrial Revolution, three were not the ones we usually associate with it: agriculture, domestic service, and construction. In fact, Jones concludes that "few aspects of economic life were thoroughly altered by 1850."

Europe was much more advanced, more industrialized and more urbanized by 1750 than at any time before.<sup>55</sup> Even during the course of the crisis-torn seventeenth century, urban population increased by some 25 percent. On the eve of the Industrial Revolution, Western Europe was capable of sustaining an urban population of nine millions, ten percent of the total.<sup>56</sup> The urban share of the population had roughly doubled since the beginning of the previous upswing of the 1500s. Inasmuch as towns incorporated more social overhead capital than did villages, this fact is also indicative of the broad level of wealth accumulated by 1750. Transportation facilities were much improved over the centuries, bringing down the cost of moving people as well as goods across long distances.<sup>57</sup>

Improvements in river navigation in England by private companies during the century prior to 1750 doubled the navigable waterways. The decline in transport costs was an inducement to trade, to spatial mobility of factors of production, to shifts out of the primary sector, and to specialization within the industrial sector.<sup>58</sup> The division of labor in the production of such varied products as pins, toys, and pottery "had reached such complexity... as to permit reductions in cost of staggering proportions."<sup>59</sup> In short, by the dawn of the century that was to witness the beginning of the most

powerful and most enduring expansion in economic activity in recorded history, only 40 percent of England's national product originated in the agricultural sector, a share that such underdeveloped countries as Hungary did not reach until the twentieth century.<sup>60</sup>

Much of the institutional and incentive structures of a market economy were in place well before the eighteenth century.<sup>61</sup> Capitalism was not an offspring of the Industrial Revolution: "What is called capitalism had long existed in Western Europe. In one or another of its forms, it is as old as civilization...."<sup>62</sup> Throughout most of the continent firms could be organized without overbearing government interference, even though guild restrictions, for instance, meant that there were barriers to entry into many occupations. However, property rights tended to be secure, and capital markets were highly integrated.<sup>63</sup> Insurance, paper money, financial know-how, enforcement mechanisms for contracts, commercial law, accounting techniques had been developed, experimented with, and improved.<sup>64</sup> In brief, most, if not all of the basic attributes we associate with the modern economy was already an integral part of the European business world by 1760. An economic system had evolved, it should be stressed, that was sufficiently efficient to overcome further hindrances to permanent growth.<sup>65</sup>

We now know that capital formation did not play as important a role during the early phase of the Industrial Revolution as the economic historians of the 1950s thought.<sup>66</sup> The rate of saving did not need to increase so dramatically for the Industrial Revolution to become reality:<sup>67</sup> in England it increased from 5.7 percent of national

income in 1760 to 7.9 percent in 1801, but more as a consequence, than a cause, of the increased rate of output growth.<sup>68</sup> One reason for this is that foreign capital was also available to the British economy, so that not all investments had to be financed from domestic saving, and another was that the productivity of new capital was greater than that of the old.<sup>69</sup> In addition, fixed capital formation was not only financed from new savings, but also from existing circulating capital that was freed up through improvements in transportation and communication.

Until recently historians did not fully acknowledge that productivity can increase not only through the accumulation of physical capital, or technological progress, but through a number of other means. Institutional change, learning-by-doing, accumulation of human capital, decreasing mortality rates, increased financial sophistication, and positive externalities generated by increasing population densities can all contribute to increasing productivity. Moreover, the new methods of production increased the speed of throughput, thereby saving capital invested in inventories. Thus, during the classical phase of the Industrial Revolution (1760-1830), the stock of reproducible fixed capital per capita increased by only 0.2 percent per annum.<sup>70</sup> The cost of installing the new machinery, moreover, was insignificant relative both to the cost of structures, a fair proportion of which was already in place, and, to inventories, which had been required earlier as well. Thus, the new requirements of fixed capital did not put an unusual strain on savings, at least until the investment in railroads required bulky capital expenditures. The early machines were, as a rule, not very expensive. Many of the early designs could be

constructed by skilled carpenters.<sup>71</sup> Hence, machines composed a small percentage of the capital stock: in England merely 2.5 percent in 1800, and 4 percent in 1832.<sup>72</sup>

Hence, regardless of which aspect of the process one considers, capital formation, industrial organization, or mechanization, one finds that there was "gradual metamorphosis and considerable elements of continuity with the past."<sup>73</sup> Thus, the origins of the Industrial Revolution are sought in the eighteenth century in vain.<sup>74</sup> Instead, its roots are imbedded in the long-run continuity of economic processes, and in the discoveries, inventions, and accomplishments of prior centuries.<sup>75</sup> "Ordinarily we believe that growth won only once, in the `industrial revolution,'" asserts Eric Jones, but we fail to appreciate the extent to which "the pressure for growth was there all the time."<sup>76</sup> From this vantage point, economic growth becomes a typical component of human experience, and the absence of growth atypical. Indeed, the recognition that Western Europe in the eighteenth century was wealthy in many respects (even by today's third-world standards), and that the economies were already complex, with widespread specialization, implies that intensive growth, even if slow and intermittent, must have been going on for a long time prior to 1760.<sup>77</sup>

### Synthesis

In order to synthesize the various viewpoints on the Industrial Revolution one should, above all, avoid singling out one aspect of it, and, instead, recognize its multidimensionality. This implies that, without belittling the contribution of such factors as technological change, we should acknowledge the myriad of other causes that made its success possible. None of these factors was sufficient to bring about the



Revolution, but many of them were necessary.<sup>78</sup> Its causes are to be sought in this complexity, and not in any single aspect of it. We need to abandon our focus on technology, and, instead, explore more systematically the generation of income and profit regardless of its source. We start by defining the Industrial Revolution as the economic upswing of the late-eighteenth century. It follows from this definition, that the Industrial Revolution becomes a pan-European phenomenon, insofar as the expansion, as the previous ones of the Middle Ages and of the Renaissance, was spatially widespread.<sup>79</sup> We need also to appreciate both its evolutionary nature, in the sense that it grew out of earlier achievements, and its simultaneous revolutionary character as well, inasmuch as it had many unique features.<sup>80</sup> Without being exhaustive, one might mention that it inaugurated an unprecedented period of economic prosperity, even if not immediately for all; it brought about a persistent sectoral shift out of agricultural production; it created new social classes, redistributed political power and signaled the end of the Malthusian demographic regime.<sup>81</sup> The essential point to stress is that the Industrial Revolution was a continuation of earlier growth, but brought about a discontinuity in the processes of growth.

In the pre-industrial world rapid population growth for an extensive period was fraught with danger.<sup>82</sup> Whenever population densities neared critical levels, the procurement of food became ever more problematic, and overshooting these ceilings led to subsistence crisis of various proportions.<sup>83</sup> At such times nature struck back with vengeance. The expansion of the Roman Empire was followed by the Dark Ages. The spectacular upswing of the Middle Ages fizzled out in the fourteenth century with

adverse climatic trends, followed by stagnation and the catastrophic shock of the bubonic plague. The "Commercial Revolution", too, was overtaken by the crisis of the seventeenth century. While there were reversals, each of these upswing started from a higher capital/labor ratio than the previous one. In other words, while growth itself was intermittent, the accumulation of human and physical capital had a persistently positive trend.

Hence, the acceleration in the growth of total product after 1760 started from a higher capital/labor ratio than earlier upswings, and this enabled growth to become permanent, inasmuch as it was no longer constrained by mortality shocks. Knowledge of disease control was advanced enough by then to prevent major epidemics that had killed so many in prior centuries. The institution of quarantine measures, and the development of smallpox inoculation are just two measures that counteracted the devastating effects of epidemic outbreaks.<sup>84</sup> The consequence of a more equal distribution of nutrients, of improved agricultural terms of trade, and of better control over the disease environment, in contrast to the sixteenth century, meant that Europeans could continue to reproduce even in face of a steep rise in their numbers. Compared to the previous demographic upswing of the sixteenth century, production as well as trade in nutrients was much better developed by 1760. The New World provided nutrients in the form of sugar, dried cod, flour, and most importantly, new products such as the potato which increased agricultural productivity greatly (measured in calories per acre).<sup>85</sup> In addition, regions of grain production in Eastern Europe were integrated into the European trading network to a greater degree than

ever before. Moreover, transportation and storage facilities had improved sufficiently to distribute food locally to the indigent, so that subsistence crises would not return with the same vengeance as in the fourteenth, and again in the seventeenth centuries.<sup>86</sup> Thus, not only was more food available per capita compared to similar phases of previous demographic expansions, but its distribution was also more equal.

As in similar episodes in the past, the increased market activity during the Industrial Revolution was also accompanied by an acceleration in population growth.<sup>87</sup> This was not a coincidence: population growth increased demand, and thereby led to a further division of labor. It lowered transaction and information costs, and brought about economies of scale in production with positive feedback effects conducive to market expansion.<sup>88</sup> It also induced technological change, by creating challenges that invited a creative response.<sup>89</sup> In addition, the acceleration in population growth brought about urbanization, which had a further impact on technological change, inasmuch as urban environments are more conducive to human capital formation than rural ones.<sup>90</sup> This model thus synthesizes Malthusian and Boserupian notions of the ways in which population growth and economic growth were intertwined in the pre-industrial era.<sup>91</sup> The two effects alternated. Once one, then the other was more powerful, until the very end of the process, when the Malthusian forces weakened, and the Boserupian forces permanently gained the upper hand.<sup>92</sup>

We should evaluate the quantitative evidence of economic performance during the Industrial Revolution relative to previous experience, rather than those of the twentieth century. That labor productivity did not grow faster during the last third of

the eighteenth century becomes immaterial: important is that it was not negative.

"Although productivity growth was gradual, it was high enough to sustain a much increased population which, under earlier economic circumstances, would have perished."<sup>93</sup> The late eighteenth century was that watershed when thousands of years of ingenuity, striving, and effort culminated in a solution to the problem that had been the single most important challenge to Mankind: the problem of survival.<sup>94</sup>

The broaching of the Malthusian ceilings on an enduring basis meant that economic growth became permanent (i.e., self-sustaining) inasmuch as population grew unconstrained, and economic growth followed naturally in its wake, as in prior occasions.<sup>95</sup> The positive forces of growth had existed all along.<sup>96</sup> However, they had been counterbalanced by the negative forces of malnutrition and disease. Once these checks on growth vanished, it became possible to escape from the food-controlled homeostatic equilibrium that had prevailed since time immemorial. Insofar as neither the upswing in economic activity nor the demographic revolution was confined to England, conceptualizing the Industrial Revolution in this manner also leads automatically to viewing it as a pan-European experience.

In sum, the European societies were sufficiently advanced, and were able to grow sufficiently quickly to feed themselves, and to overcome the capital-diluting effects of population growth, even as an increasing share of the labor force was detached from the land. The minimum nutritional needs of a growing population were met in the face of increasing pauperization, even if the biological standard of living deteriorated in the short run for the common man. People did become shorter, but a

major subsistence crisis failed to materialize, as it did in the seventeenth century.<sup>97</sup> People who in previous similar episodes would have perished now remained alive, thereby contributing to production. Humanity was liberated from the constraints imposed by diminishing returns to labor in the agricultural sector: hence, the Industrial Revolution meant, above all, an escape from the Malthusian trap.<sup>98</sup> The last in a succession of economic-demographic upswings, this view enables us to retain the importance of the Industrial Revolution in human history without requiring either inputs or outputs to grow at a pre-conceived rate.<sup>99</sup> The advantage of conceiving of the Industrial Revolution in this way is that it ceases to focus on proximate causes. Instead, the Revolution is placed in the context of the long-run development of the European economies. Moreover, the emphasis is shifted from Great Britain to the Atlantic economy, and from technological change to the overall productivity-enhancing factors that induced an upward shift in the production function. Instead of selected sectors one's focus is on the different ways income was generated. One gains thereby a more thorough appreciation of the interaction of economic and demographic processes, and the latter's feedback effects on economic growth. One has a comparative framework to judge the achievements of the Industrial Revolution in light of earlier, as well as of subsequent developments. Its continuous and discontinuous aspects become more clearly delineated. Above all, this framework enables us to gain a more balanced appreciation of its multidimensionality: it widens our horizons, and captures the Industrial Revolution in the perspective of thousands of years of human development.

## Endnotes

<sup>1</sup> David S. Landes, The Wealth and Poverty of Nations: Why are We so Rich and They so Poor?.

<sup>2</sup> Joel Mokyr (ed), The Economics of the Industrial Revolution, (Totowa, NJ. 1985).

<sup>3</sup> A thorough survey of the literature is found in Joel Mokyr, "Editor's Introduction: The New Economic History and the Industrial Revolution", in Joel Mokyr (ed), The British Industrial Revolution. An Economic Perspective, (Boulder 1993), pp. 1-131; David S. Landes, "Introduction", in Patrice Higonnet, David S. Landes, and Henry Rosovsky (ed), Favorites of Fortune. Technology, Growth, and Economic Development since the Industrial Revolution (Cambridge, MA. 1991), pp. 1-32, esp. p. 1.

<sup>4</sup> Peter Stearns, The Industrial Revolution in World History, (Boulder 1993); Pat Hudson, The Industrial Revolution, (London 1992); Douglas Fisher, The Industrial Revolution. A Macroeconomic Interpretation, (New York 1992); Brinley Thomas, The Industrial Revolution and the Atlantic Economy. Selected Essays, (London and New York 1993).

<sup>5</sup> Cormac O'Grada, Ireland Before and After the Famine. Explorations in Economic History, (Manchester 1988), p. 25.

<sup>6</sup> The Mediterranean world, however, did not participate in this economic expansion. Gabriel Tortella, "Patterns of Economic Retardation and Recovery in South-Western Europe in the Nineteenth and Twentieth Centuries", Economic History Review 47 (1994), pp. 1-21; Sevet Pamuk, The Ottoman Empire and European Capitalism, 1820-1913, (Cambridge 1987).

<sup>7</sup> I use the term industry in today's usage among economists, as the second sector.

<sup>8</sup> Another Frenchman remarked in the 1770s that "a great revolution is under way in the

commerce of Europe." David S. Landes, "The Fable of the Dead Horse; or, The Industrial Revolution Revisited", in Joel Mokyr (ed), The British Industrial Revolution: An Economic Perspective, (Boulder 1993), p. 133.

<sup>9</sup> H. Heaton, "Industrial Revolution", in R. Max Hartwell (ed), The Causes of the Industrial Revolution, (London 1969), pp. 31-52, esp. p. 31. (This essay was first published in 1933.)

<sup>10</sup> Arcadius Kahan, The Plow, the Hammer, and the Knout: An Economic History of Eighteenth-Century Russia, (Chicago 1985).

<sup>11</sup> Richard Roehl, "French Industrialization: a Reconsideration", Explorations in Economic History 13 (1976), pp. 233-281; Patrick O'Brian and Caglar Keyder, Economic Growth in Britain and France, 1780-1914: Two Paths to the 20th Century, (London 1978); John Komlos, The Habsburg Monarchy as a Customs Union: Economic Development in Austria-Hungary in the Nineteenth Century, (Princeton 1983); Joel Mokyr, Industrialization in the Low Countries 1795-1850, (New Haven 1976); Sidney Pollard, Peaceful Conquest. The Industrialization of Europe 1760-1970, (Oxford 1981), p. v. One might note that England did not possess the largest industrial sector. The share of the labor force engaged in industrial activity was greater in the Kingdom of Saxony.

<sup>12</sup> Patrick K. O'Brien, "Path dependency, or why Britain Became an Industrialized and Urbanized Economy Long Before France", Economic History Review 49 (May 1996), pp. 213-249.

<sup>13</sup> N.F.R. Crafts, "Industrial Revolution in Britain and France: Some Thoughts on the Question 'Why Was England First?'" , Economic History Review 30 (1977), pp. 429-441; N.F.R. Crafts, "Macroinventions, Economic Growth and 'industrial revolution' in Britain and France", Economic History Review 48 (1995), pp. 591-598; David S. Landes, "What Room for Accident

in History? Explaining Big Changes by Small Events”, Economic History Review 47 (1994), pp. 637-56.

<sup>14</sup> Because it took the European economies at least 10 millennia from the Neolithic Agricultural Revolution to reach the Industrial Revolution, the lag of a few years in the adoption of certain technologies wanes in significance. Viewed from this long-run perspective, it is astonishing how uniform the European economies, including their overseas offshoots, in fact, were and how little variation there was within the Atlantic community in the rapidity and prevalence of growth in the nineteenth century. Ronald Findlay, "The Roots of Divergence: Western Economic History in Comparative Perspective“, American Economic Review 82.2 (1992), pp. 158-161.

<sup>15</sup> Richard Steckel, "Stature and the Standard of Living“, Journal of Economic Literature 33 (Dec. 1995), pp. 1903-1940.

<sup>16</sup> Steve N. Broadberry, "Comparative Productivity in British and American Manufacturing During the Nineteenth Century“, Explorations in Economic History 31 (1993), pp. 521-48.

<sup>17</sup> Wolfram Fischer, "The Choice of Technique: Entrepreneurial Decisions in the Nineteenth-Century European Cotton and Steel Industries“, in Higonnet, Landes, and Rosovsky (eds), Favorites of Fortune, pp. 142-58, esp. p. 145.

<sup>18</sup> Eric Jones, Lionel Frost. and Colin White, Coming Full Circle. An Economic History of the Pacific Rim, (Boulder 1993).

<sup>19</sup> There are exceptions to this generalization. Wrigley, for example, concludes that, "industrial growth was essentially a local rather than a national affair." E. Anthony Wrigley, "The Supply of Raw Materials in the Industrial Revolution, in Hartwell (ed), the Industrial Revolution, pp. 97-121, esp. p. 119.

<sup>20</sup> Herbert Kisch, "The Textile Industries in Silesia and the Rhineland: A comparative study in



industrialization“, Journal of Economic History 19 (1959), pp. 541-564; Pollard, Peaceful Conquest.

<sup>21</sup> "England and France in the Eighteenth Century: a Comparative Analysis of Two Economic Growths“, in Hartwell (ed), The Causes of the Industrial Revolution, pp. 139-174; esp. p. 158; Simon Kuznets, "The State as a Unit in Study of Economic Growth“, Journal of Economic History 11 (1951), pp. 25-41.

<sup>22</sup> In a similar vein, Nachoem M. Wijnberg, argues that, instead of analyzing the whole of the industrial sector, we should focus on branch-specific performance in "The Industrial Revolution and Industrial Economics“, Journal of European Economic History 21 (Spring 1992), pp. 153-168. Inasmuch as branches were regionally highly concentrated, his argument is related to that of Kisch.

<sup>23</sup> Herbert Kisch, Die hausindustriellen Textilgewerbe am Niederrhein vor der Industriellen Revolution: Von der urspruenglichen zur kapitalistischen Akkumulation, (Goettingen 1981), pp. 41, 361; and see also Richard Tilly's introduction in *Ibid.*, p. 17. A similar notion is expressed this way: "Enamoured of the 'big battalions,' of giant factories employing thousands of workers, of global figures for national production of coal and steel, the pessimists underestimated the ingenuity of French entrepreneurs and the productivity of dispersed, small scale industry." Rondo Cameron and Charles E. Freedeman, "French Economic Growth: A Radical Revision“, Social Science History 7 (1983), pp. 3-30.

<sup>24</sup> Crouzet, "England and France in the Eighteenth Century“, p. 154; Roehl, "French Industrialization"; C. E. Labrousse, La Crise de L'Economie Francaise a la Fin de L'Ancien Regime et au Debut de La Revolution, (Paris 1944), p. xlvi; Jack Goldstone, Revolution and Rebellion in the Early Modern World, (Berkeley), pp. 180ff.

<sup>25</sup> David Landes, The Unbound Prometheus. Technological Change and Industrial Development in Western Europe from 1750 to the Present, (Cambridge), p. 42.

<sup>26</sup> All three major inventions built upon earlier achievements. Watt's engine was an improvement of Newcomen and Savery's design. Hargreaves's hand-operated spinning wheel, and Arkwright's water-powered version, were adoptions of earlier patents along similar principles, and emulated technologies successfully employed in the silk industry as early as the Middle Ages

<sup>27</sup> Carlo Cipolla, Before the Industrial Revolution: European Society and Economy 1000-1700, (2nd ed.; New York 1980), p. 168.

<sup>28</sup> Graeme Donald Snooks and J. McDonald, Domesday Economy: A New Approach to Anglo-Norman History, (Oxford 1986); Jean Gimpel, The Medieval Machine. The Industrial Revolution of the Middle Ages, (New York 1977), p. viii

<sup>29</sup> Eleanora Carus Wilson, "An Industrial Revolution of the Thirteenth Century", Economic History Review, 1st ser. 11 (1941), pp. 1-20. China under the Sung dynasty (10th-13th centuries) barely missed having an industrial revolution. Hemp was spun using water-powered machines, and the iron industry used coke in blast furnaces that was not done in Europe for another half a millennium. Per capita output of pig iron increased by a factor of six in China and reached the level of European production of 1700 in 1100. Eric L. Jones, Growth Recurring: Economic Change in World History, (Oxford 1988), pp. 35, 75.

<sup>30</sup> John U. Nef, The Rise of the British Coal Industry, (London 1932). Idem., "The Progress of Technology and the Growth of Large Scale Industry in Great Britain. 1540-1640", Economic History Review, 1st ser., 5 (1934), pp. 3-24; Others wondered whether one should not go even farther back in time than the sixteenth century in search of the roots of the Industrial

Revolution. A reviewer of Nef's book asserted, "while we dethroned the year 1760 from its pedestal, we must resist the temptation to put the year 1558 in its place." See E. Lipson's review in Economic History Review 1 (1932), p. 238. Nef subsequently accepted this point.

<sup>31</sup> G. Hammersley, "The Effect of Technical Change in the British Copper Industry Between the Sixteenth and the Eighteenth Centuries", Journal of European Economic History 20 (1991), pp. 155- 174; Roger Burt, "The Transformation of the Non-ferrous Metals Industries in the Seventeenth and Eighteenth Centuries", Economic History Review, 48 (1995), pp. 23-45.

<sup>32</sup> Francois Crouzet, The First Industrialists. The Problem of Origins, (Cambridge 1985), p. 28.

<sup>33</sup> E. Anthony Wrigley, "The Supply of Raw Materials in the Industrial Revolution", in Hartwell (ed), The Causes of the Industrial Revolution, pp. 97-120, esp. p. 101.

<sup>34</sup> Joel Mokyr, The Lever of Riches: An Economic History of Technological Change, (New York 1990), pp. 61, 72; Karl Gunnar Persson, Pre-industrial Economic Growth. Social Organization and Technological Progress in Europe, (Oxford 1988); Richard Sullivan, "England's 'Age of Invention': The Acceleration of Patents and Patentable Invention during the Industrial Revolution", Explorations in Economic History 26 (1989), pp. 424-452.

<sup>35</sup> To be sure, with slower rate of technical progress, it would have been increasingly difficult to maintain the momentum of the upswing in face of the capital-diluting effect of population growth. Consequently, there must have been a critical level of the rate of change of technical progress below which the process of economic expansion eventually would have been halted, as it was in the sixteenth century. Yet, it has not been shown that without the three great inventions of the late-eighteenth century the Industrial Revolution would not have become a

reality.

<sup>36</sup> Richard Sullivan, "The Revolution of Ideas: Widespread Patenting and Invention During the English Industrial Revolution", Journal of Economic History 50 (1990), pp. 348-363.

<sup>37</sup> James Foreman-Peck, "A Model of Later Nineteenth Century European Economic Development", Revista de Historia Economica 13.3. (1995), pp. 441-472; Avner Greif, "On the Political Foundations of the Late Medieval Commercial Revolution: Genoa During the Twelfth and Thirteenth Centuries", Journal of Economic History 54 (1994), pp. 271-287; Nathan Rosenberg, and L.E. Birdzell, How the West Grew Rich: The Economic Transformation of the Industrial World, (New York 1986); Douglass C. North and Barry Weingast, "Constitution and Commitment: The Evolution of Institutions Governing Public Choice in Seventeenth Century England", Journal of Economic History 49 (1989), pp. 803-832.

<sup>38</sup> Theofanis C. Tsoulouhas, "A New Look at Demographic and Technological Changes: England, 1550-1839", Explorations in Economic History 29 (1992), pp. 169-203; Julian L. Simon and Richard J. Sullivan, "Population Size, Knowledge Stock, and Other Determinants of Agricultural Publication and Patenting: England, 1541-1850", Explorations in Economic History 26 (1989), pp. 21-44.

<sup>39</sup> Paul Bairoch, "The City and Technological Innovation", in Higonnet, Landes, and Rosovsky, Favorites of Fortune, pp. 159-76, esp. p. 165.

<sup>40</sup> Margaret C. Jacob, Scientific Culture and the Making of the Industrial West, (New York 1997).

<sup>41</sup> Franklin Mendels, "Proto-Industrialization: The First Phase of the Industrialization Process", Journal of Economic History 32 (1972), pp. 241-261.

<sup>42</sup> Crouzet, The First Industrialists, pp. 8, 29.

<sup>43</sup> David Greasley and L. Oxley, "Rehabilitation Sustained: the Industrial Revolution as a Macroeconomic Epoch", The Economic History Review (1993), pp. 760-68; N.F.R. Crafts and T. C. Mills, "The Industrial Revolution as a Macroeconomic Epoch: an Alternative View", Economic History Review 47 (1993), pp. 769-75; N.F.R. Crafts, "Exogenous or Endogenous Growth? The Industrial Revolution Reconsidered", Journal of Economic History 55 (Dec. 199), pp. 745-772.

<sup>44</sup> Richard Sylla and Gianni Toniolo (eds), Patterns of European Industrialization: The Nineteenth Century, (London 1992); Patrick K. O'Brien, "Do we Have a Typology for the Study of European Industrialization in the Nineteenth Century?", Journal of European Economic History 15 (1986), pp. 291-333.

<sup>45</sup> N.F.R. Crafts, "English Economic Growth in the Eighteenth Century: A Re-examination of Deane and Cole's Estimates", Economic History Review 29 (1976), pp. 226-235; Knick Harley, "British Industrialization Before 1841: Evidence of Slower Growth During the Industrial Revolution", Journal of Economic History 42 (1982), pp. 267-289; N.F.R. Crafts, British Economic Growth During the Industrial Revolution, (Oxford, 1985); N.F.R. Crafts, S. J. Leybourne, and T. C. Mills, "Trends and Cycles in British Industrial Production 1700-1913", Journal of the Royal Statistical Society 152 (1989), pp. 43-60.

<sup>46</sup> N.F.R. Crafts, "Exogenous or Endogenous Growth?".

<sup>47</sup> Walther G. Hoffmann, British Industry 1700-1950, (Oxford 1955); Phyllis Deane and W. A. Cole, British Economic Growth 1688-1959, (Cambridge 1962).

<sup>48</sup> Doubt is cast on the new estimates by Julian Hoppit, "Counting the Industrial Revolution", Economic History Review 43 (1990), pp. 173-93; R. V. Jackson, "Rates of Industrial Growth during the Industrial Revolution", Economic History Review 45 (1992), pp. 1-23, and by Javier

Cuenca Esteban, "British Textile Prices, 1770-1831: Are British Growth Rates Worth Revising Once Again?" Economic History Review 47 (1994), pp. 66-105. For a rebuttal, see C. Knick Harley and Nick F.R. Crafts, "Cotton Textiles and Industrial Output Growth During the Industrial Revolution", Economic History Review 48 (1995), pp. 134-144.

<sup>49</sup> Rondo Cameron, "The Industrial Revolution: A Misnomer", The History Teacher 15 (1982), pp. 377-384; idem., "A New View of European Industrialization", Economic History Review 38 (1985), pp. 1-23; see also Jeffrey G. Williamson, "Why was British Economic Growth so Slow During the Industrial Revolution?", Journal of Economic History 44 (1984), pp. 689-712.

<sup>50</sup> N.F.R. Crafts and Terence C. Mills, "Trends in Real Wages in Britain, 1750-1913", Explorations in Economic History 31 (1993), pp. 176-94; Gregory Clark, Michael Huberman, and Peter H. Lindert, "A British Food Puzzle, 1770-1850", Economic History Review 48 (1995), pp. 215-237; David Loschky, "New Perspectives on Seven Centuries of Real Wages", Journal of European Economic History 21 (Spring 1992), pp. 169-184; Sara Horrell and Jane Humphries, "Women's Labour Force Participation and the Transition to the Male-Breadwinner Family, 1790-1865", Economic History Review 48 (1995), pp. 89-117.

<sup>51</sup> Maxine Berg, The Machinery Question and the Making of Political Economy. 1815-1848, (Cambridge 1980), p. 29.

<sup>52</sup> Alexander Field, "On the Unimportance of Machinery", Explorations in Economic History 22 (1985), pp. 378-401.

<sup>53</sup> Dolores, Greenberg, "Reassessing the Power Patterns of the Industrial Revolution: An Anglo-American Comparison", American Historical Review 87 (1982), pp. 1237-1261; A. E. Musson, "Industrial Motive Power in the United Kingdom 1800-70", Economic History Review

2nd. ser. 29 (1976), pp. 413-439; Terry S Reynolds, Stronger than a Hundred Men: A History of the Vertical Water Wheel, (Baltimore, MD. 1983). As late as 1850 one third of the power used in woolen textile manufacturing came from water power. Landes, The Unbound Prometheus, p. 104.

<sup>54</sup> Jones, Growth Recurring, p. 14.

<sup>55</sup> Even decades after the beginning of the Industrial Revolution, British per capita income was not much above that of other countries: it was about the same as that of the Netherlands, and about a third more than that of Spain. Tortella, "Patterns of Economic Retardation", p. 2; Angus Maddison, Dynamic Forces in Capitalist Development. A Long-Run Comparative View, (Oxford 1991), p. 31.

<sup>56</sup> Urban is defined as cities with at least 10,000 inhabitants. The generalization is not true for some regions, i.e., Southern Italy. Jan de Vries, European Urbanization 1500-1800, (Cambridge, MA. 1984), pp. 30, 39.

<sup>57</sup> See the important contribution by Jan de Vries, "Barges and Capitalism. Passenger Transportation in the Dutch Economy, 1632-1839", in Afdeling Agrarische Geschiedenis Landbouwhogeschool 21 (Wageningen 1978).

<sup>58</sup> Rick Szostak, The Role of Transportation in the Industrial Revolution, (Montreal 1991).

<sup>59</sup> Sidney Pollard and David W. Crossley, The Wealth of Britain 1085-1966, (New York 1969), p. 170.

<sup>60</sup> Eric L. Jones, "Agriculture, 1700-80", in Roderick C. Floud and Donald N. McCloskey (eds), The Economic History of Britain since 1700, Vol I., (Cambridge 1981), p. 71.

<sup>61</sup> Douglass C. North, Institutions Institutional Change and Economic Performance, (Cambridge 1990), p. 131.

<sup>62</sup> J. H. Clapham, The Economic Development of France and Germany 1815-1914, (Cambridge 1968, 1st. ed. 1921), p. 2.

<sup>63</sup> Larry Neal, The Rise of Financial Capitalism: International Capital Markets in the Age of Reason, (Cambridge 1990).

<sup>64</sup> Florence E. de Roover. "Early Examples of Marine Insurance", Journal of Economic History 5 (1945), pp. 172-200.

<sup>65</sup> Armen A. Alchian, "Uncertainty, Evolution and Economic Theory", Journal of Political Economy 58 (1950), pp. 211-221.

<sup>66</sup> A. W. Lewis, "Economic Development with Unlimited Supplies of Labour", Manchester School (1954), pp. 139- 191; here p. 155.

<sup>67</sup> "A dramatic change in the savings rate, such as W. W. Rostow posits for the 'take-off', is certainly out of the question: there is no discernible institutional, political, economic, or social turning-point in the eighteenth century which would have induced people to suddenly double their rate of savings. Moreover, there is no convincing evidence that the lack of savings held back growth." Hartwell. "Introduction", p. 18.

<sup>68</sup> N.F.R. Crafts, British Economic Growth during the Industrial Revolution, (Oxford 1985), p. 74.

<sup>69</sup> Elise S. Brezis, "Foreign Capital Flows in the Century of Britain's Industrial Revolution: New Estimates, Controlled Conjectures", Economic History Review 48 (1995), pp. 46-67. Detailed work on the textile industry shows, however, that aggregate capital formation might have been underestimated. R. Pearson, "Capital Formation during the Industrial Revolution Revisited: Insurance valuations and some New Sectoral Estimates", Explorations in Economic History 30 (1994), pp. 450-69.



<sup>70</sup> Charles Feinstein, "Capital Formation in Great Britain", in Peter Mathias and M. M. Postan (eds), The Cambridge Economic History of Europe Vol. 8, Pt. 1, The Industrial Economies: Capital Labour' and Enterprise, (Cambridge 1978), pp. 42, 84.

<sup>71</sup> There is no convincing evidence that industrialization on the continent was constrained by capital shortage either. For the case of Germany see, Knut Borchardt, Perspectives on Modern German Economic History, (Cambridge 1991), p. 18.

<sup>72</sup> Feinstein, "Capital Formation in Great Britain", p. 88; Phyllis Deane and W. A. Cole, British Economic Growth, (2nd ed. Cambridge 1969), p. 142.

<sup>73</sup> Maxine Berg, Pat Hudson, and Michael Sonenscher, Manufacture in Town and Country before the Factory, (Cambridge 1983), p. 6.

<sup>74</sup> Kisch, Die Hausindustriellen Textilgewerbe, pp. 61, 64.

<sup>75</sup> Eric L. Jones, The European Miracle. Environments. Economics and Geopolitics in the History of Europe and Asia, (Cambridge 1981); Carlo Cipolla, The Economic History of World Population, (1962; reprint, Baltimore 1970); Douglass North, Structure and Change In Economic History, (New York 1981), p. 162.

<sup>76</sup> Jones, Growth Recurring, pp. 1, 6.

<sup>77</sup> According to Landes, per capita income tripled between the year 1000 and 1800. The Unbound Prometheus, p. 14; Persson, Pre-Industrial Economic Growth, p. 139.

<sup>78</sup> "Technical innovation may be a sufficient but is not a necessary condition of growth." Jones, Growth Recurring, p. 15.

<sup>79</sup> "Western Europe was a single economic community...." according to Wrigley, "Supply of Raw Materials", p. 119.

<sup>80</sup> According to John U. Nef, "the origins of industrialism [were] as far back as the Roman

Empire", The Conquest of the Material World, (Chicago 1964), p. viii.

<sup>81</sup> E. Anthony Wrigley and Roger S. Schofield, The Population History of England 1541-1871, (Cambridge 1981), p. 410; Maxine Berg and Pat Hudson, "Rehabilitating the Industrial Revolution", Economic History Review 45 (1992), pp. 24-50.

<sup>82</sup> Andrew Appleby, Famine in Tudor and Stuart England, (Stanford 1978), p. 95; Wilhelm Abel, Massenarmut und Hungerkrisen im vorindustriellen Europa, (Hamburg and Berlin 1974); Mark Bailey, "Demographic Decline in Late Medieval England: Some thoughts on Recent Research", Economic History Review 49 (Feb. 1996), pp. 1-19. Wilhelm Abel, Agrarkrisen und Agrarkonjunkturen; Eine Geschichte der Land- und Ernahrungswirtschaft Mitteleuropas seit dem hohen Mittelalter, (1935; reprint Hamburg and Berlin 1966); B. H. Slicher van Bath, The Agrarian History of Western Europe A.D. 500-1850, (London 1963), p. 225.

<sup>83</sup> "It was hardly a 'motionless history,' even though the great enforcer - the positive checks of Malthus holding society in thrall - was not entirely absent." Jan de Vries, "The Industrial Revolution and the Industrious Revolution", Journal of Economic History 54 (1994), pp. 249-271; esp. p. 252.

<sup>84</sup> James Riley, The Eighteenth-Century Campaign to Avoid Disease, (London 1987).

<sup>85</sup> John Komlos, "The New World's Contribution to Food Consumption during the Industrial Revolution", Journal of European Economic History 27.1 (1998), pp. 67-84.

<sup>86</sup> George Boyer, "Malthus was Right After All: Poor Relief and Birth Rates in Southeastern England", Journal of Political Economy 97 (1989), pp. 93- 114; Peter M. Solar, "Poor Relief and English Economic Development Before the Industrial Revolution", Economic History Review 48 (1995), pp. 1-22.

<sup>87</sup> Rondo Cameron, "The Logistics of European Economic Growth: a Note on Historical

Periodization“, Journal of European Economic History 2 (1973), pp. 145-148; Myron P. Gutmann, Toward the Modern Economy: Early Industry in Europe, 1500-1800, (New York 1988).

<sup>88</sup> "Fluctuations in population determine the... extent of trade." Eric L. Jones. "Institutional Determinism and the Rise of the Western World“, Economic Inquiry (1974), pp. 114-124; George J. Stigler, "The Division of Labor is Limited by the Extent of the Market“, Journal of Political Economy 59 (1951), pp. 185-193; Paul M. Romer, "Increasing Returns and Long-Run Growth“, Journal of Political Economy 94 (1986), pp. 1002-1038; Julian Simon, "Demographic Causes and Consequences of the Industrial Revolution“, Journal of European Economic History 23 (1994), pp. 141-158.

<sup>89</sup> Ester Boserup, Population and Technological Change: A Study of Long-Term Trends, (Chicago 1981); Julian Simon, The Ultimate Resource, (Princeton 1981); Julian L. Simon and Gunter Steinmann, "The Economic Implications of Learning-by-Doing for Population Size and Growth“, European Economic Review 26 (1984), pp. 167-85.

<sup>90</sup> "Europe's urban network,... was an achievement of the early modern period, establishing a framework for regional economic development in which industrial growth could occur, rather than being itself a product of that industrialization." de Vries, "The Industrial Revolution“, p. 252.

<sup>91</sup> Julian Simon and Richard Sullivan, "Population Size, Knowledge Stock, and Other Determinants of Agricultural Publication and Patenting: England, 1541-1850“, Explorations in Economic History 26 (1989), pp. 21-44.

<sup>92</sup> John Komlos and Marc Artzrouni, "Mathematical Investigations of the Escape from the Malthusian Trap“, Mathematical Population Studies 2 (1990), pp. 269-287.

<sup>93</sup> Berg and Hudson, "Rehabilitating the industrial revolution", p. 27.

<sup>94</sup> Kriedte, Medick, and Schlumbohm, Industrialization before Industrialization.

<sup>95</sup> The threat of a Malthusian crisis did, nonetheless, manifest itself: A "decline in living standards in the towns of the early XIXth century... has been verified by anthropological research on the height of conscripts." Maurice Aymard, "The History of Nutrition and Economic History", Journal of European Economic History 2 (1973), pp. 207-219, esp. p. 218.

<sup>96</sup> Jones, Growth Recurring, p. 7.

<sup>97</sup> John Komlos, "The Secular Trend in the Biological Standard of Living in the United Kingdom, 1730-1860", Economic History Review 46 (1993), pp. 115-144; Olwen H. Hufton, The Poor of Eighteenth Century France. 1750-1789, (Oxford 1974).

<sup>98</sup> This was raised as a hypothesis already a generation ago. Hartwell, "Introduction", p. 3; Carlo Cipolla also believes that population was "held in the 'Malthusian trap' until the industrial revolution."

<sup>99</sup> Rondo Cameron, "The Logistics of European Economic Growth: a Note on Historical Periodization", Journal of European Economic History 2 (1973), pp. 145-148; Myron P. Gutmann, Toward the Modern Economy: Early Industry in Europe, 1500-1800, (New York 1988).

industrial revolution; Malthusian trap. creation-date. 2003-07.Â Scientific relationships and associations with this publication A reader can select own publication from the list and specify relationships of scientific supplementary, closeness and/or other associations between own publication and this one. Professional opinion on this publication A reader can express their professional opinion about this publication. The escape from the "Malthusian trap"™ is shown to tend to generate in a rather systematic way quite serious political upheavals. Some demographic structural mechanisms that generate such upheavals have been analyzed, which has made it possible to develop a mathematical model of the respective processes. The forecast of political instability in Sub-Saharan African countries in 2015â€“2050 produced on the basis of this model is presented. Keywords: modernization, instability, Malthusian trap, mathematical modeling, youth bulge, urbanization, Africa, demographic dynamics, demographic transition, po