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Political Economy and Ecology on the Eve of Industrialization: Europe, China, and the Global Conjuncture

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THIS ARTICLE COMBINES one familiar and one unfamiliar project. The first involves bringing our knowledge of Chinese economic history closer to parity with what we know about Europe, largely by making estimates for consumption, income, and availability of natural resources. The results suggest that many important economic variables had similar values in the more advanced parts of China and Europe circa 1750. Even more surprising, they suggest that, despite their very dense populations, the Yangzi and Pearl River deltas in 1750 were not facing appreciably worse ecological pressures than those faced by the most developed areas in Europe: thus these strains cannot, by themselves, explain much of the huge divergence between East and West in the nineteenth century.[1]

Thus a second, more unusual, project: to use Chinese experiences to examine Europe. I take two eighteenth-century cases that are conventionally treated as already set on opposing paths—toward dramatic growth in Europe and stagnation in China—and find much that they shared, suggesting that their divergence was a discontinuous and partly exogenous development.

Thirty years ago, the European side of this divergence was described in terms of an "Industrial Revolution" with several agreed-upon features. First, it constituted a fundamental and fairly sudden break with "pre-industrial" times. Second, it was British in origin, with new best practices later diffusing to the continent. Third, its

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[1] The Yangzi Delta, consisting of the core prefectures of what G. William Skinner, "Cities and the Hierarchy of Local Systems," in Skinner, ed., *The City in Late Imperial China* (Stanford, Calif., 1977), calls the Lower Yangzi macro-region, had some 36.5 million people in 1770 as its borders were defined by Yeh-chien Wang, "Secular Trends of Rice Prices in the Yangzi Delta, 1638–1935," in Thomas G. Rawski and Lillian M. Li, eds., *Chinese History in Economic Perspective* (Berkeley, Calif., 1992), 35–68; I will sometimes use a slightly more restrictive definition, yielding an area with 31.5 million. Either way, it is clearly large enough to bear comparison with European nations of the time, in spite of not being an independent political unit. For more on the desirability of comparing China to Europe as a whole (rather than to individual countries), and parts of China to European states, see R. Bin Wong, *China Transformed: Historical Change and the Limits of European Experience* (Ithaca, N.Y., 1997).

essence was a string of spectacular breakthroughs in a few key industries (first cotton, then coal, then iron, steel, and land transport), rather than the steady but more modest gains in many other activities. Finally, Britain's foreign trade was central—especially for textiles—with some (though far from all) scholars emphasizing colonies and slavery.

But the literature since then has questioned all of this. Increasingly, European industrialization appears as just part of long, slow processes: market expansion, division of labor, many small innovations, and millions of people accumulating small profits. And since this gradual European story begins well before Europe had much extra-continental trade, and includes countries for which such trade never mattered as much as for Britain (much less Lancashire), it is much less global than the old British one.

In a recently published book, I argue that this picture is misleading—not because Europe's gradual market-driven growth did not matter but because it does not differentiate Europe from East Asia (or perhaps other places). Smithian dynamics worked just as well in China as in Western Europe, but they did not transform basic possibilities—eventually, highly developed areas faced serious resource constraints, in part because commercialization and handicraft industry also tended to accelerate population growth. Europe's escape required new technologies plus coal, New World resources, and various favorable global conjunctures—or, more properly, Britain's escape, since proto-industrialization in places such as Flanders and even Holland led to results more like the Yangzi Delta or Japan's Kantō plain than like England. (Not to mention Denmark, where very labor-intensive solutions to similar ecological pressures yielded agrarian prosperity, but with little growth of even handicraft industry until after 1850, and falling returns per labor hour.)[2] Industrialization did not follow naturally from any region's proto-industrialization; we can as easily see Europe as "China manqué" as vice versa. On the other hand, since I will argue that the most advanced parts of China in many ways resembled parts of the European mainland that initiated mechanized industrialization within a few decades of Britain—and are no longer seen, as they once were, as having been "blocked" from development by virtue of that relatively short lag—I would argue that our histories of Chinese core regions should also move away from too strong a focus on supposed blockages and developmental blind alleys.[3]

In a particularly powerful "gradualist" account, Jan de Vries has subsumed the Industrial Revolution in what he calls the "industrious revolution." In the first phase of this process, which spanned roughly 1550–1850, households in northwestern Europe worked more hours and allocated more of their labor to production for the market, while saving time for that labor by purchasing some things that they once made for themselves. The industrious revolution, then, involves both increas-

[2] Thorkild Kjærgaard, *The Danish Revolution 1500–1800: An Ecohistorical Interpretation* (Cambridge, 1994), 151–54, 158, 160.

[3] For a pioneering work that helped reverse the focus on "backwardness" and "failure" in France, see Patrick O'Brien and Caglar Keyder, *Economic Growth in Britain and France 1780–1914: Two Paths to the Twentieth Century* (London, 1978).

ing labor (a result of preferences shifting toward various goods over leisure) and Smithian specialization, with the expected gains in efficiency.[4]

But this describes the more commercialized parts of sixteenth to eighteenth-century China (and probably Japan, too) as well as it describes eighteenth-century Europe. Thus European industrialization must still need a separate explanation. I will argue below that the reasons why the industrious revolution played out so differently in European and East Asian cores have less to do with economic institutions, attitudes, or demographic processes in these core regions themselves than with the fortuitous location of coal, and with the very different, politically structured, relationships between these cores and their respective peripheries. (Of course, it also had something to do with the process of invention itself, but—to put things briefly—the important differences there seem to be external to the economy per se.)

Thus this essay has four parts: a discussion of consumption levels, an analysis of Chinese labor markets and household labor allocation, a discussion of possible ecological "limits to growth" at both ends of eighteenth-century Eurasia, and a discussion of why China's industrious revolution appears to have stalled at roughly the same time that both population and per-capita production in Europe began to grow faster, while some ecological indices that had been declining stabilized.

JAN DE VRIES' INDUSTRIOUS REVOLUTION helps resolve a paradox. The grain-buying power of Europeans' per-hour or per-day wages fell sharply between about 1430 and 1550, and it did not return to 1350 levels until 1840 or later (depending on the country).[5] Yet comparing death inventories over the same period (especially after 1650) shows clear increases in what ordinary people owned. These trends are compatible because people increased the time they spent working for the market; this let them buy both consumer durables and their increasingly expensive bread. This may have decreased people's leisure time. It certainly decreased the time they spent making things for their own households: instead of making, say, their own candles, people specialized in weaving and bought their candles with cash.

The same thing was happening in China. The rice-buying power of day laborers' wages probably fell from about 1100 on,[6] but even ordinary people seem to have increased their consumption of "non-essentials," especially between 1500 and 1750.

[4] Jan de Vries, "The Industrial Revolution and the Industrious Revolution," *Journal of Economic History* 54, no. 2 (1994): 249–70.

[5] Fernand Braudel, *Civilization and Capitalism, 15th–18th Century*, Vol. 1: *The Structures of Everyday Life*, Siân Reynolds, trans. (New York, 1981), 134–35; Wilhelm Abel, *Agricultural Fluctuations in Europe from the Thirteenth to the Twentieth Centuries*, Olive Ordish, trans. (New York, 1980), 121, 136, 161, 199; Gregory Clark, "Yields per Acre in English Agriculture 1250–1860: Evidence from Labour Inputs," *Economic History Review* 44, no. 3 (1991): 446. Recent unpublished research by Peter Lindert and Philip Hoffman and by Robert Allen that adjusts standard real wage indices for early modern Europe by factoring in housing costs suggests that the trends for most people may have been even worse than those suggested by the "grain wage" alone.

[6] Kang Chao [Zhao Gang], "Zhongguo lishishang gongzi shuiping de bianqian," *Zhonghua wenhua fuxing yuekan* 16, no. 9 (September 1983): 57. There are some problems with the way Zhao makes his argument—most importantly that he sometimes reports only cash wages, ignoring what was often a large in-kind supplement—but the general trend is probably nonetheless correct.

Many of these are the same non-essentials as in Europe: tobacco, sugar, more and better clothes, eating utensils, and so on.

But first let us consider basic foodstuffs. Most estimates of caloric intake in eighteenth-century China compare well with Europe, whether we take averages for the whole population or figures for the hardest-working laborers.[7] Comparable or even superior nutrition is also suggested by the rough parity between rural Chinese and English life expectancies around 1750, with both higher than most figures for continental European populations.[8] Moreover, recent studies suggest that Chinese birth rates were equal to or lower than European ones throughout the 1550–1850 period,[9] while the overall rate of population growth was first faster (1550–1750) and then similar (1750–1850);[10] this also indicates that Chinese death rates were probably lower.

Poor Chinese reached these nutritional standards without spending any more of their incomes on basic foodstuffs than did poor Europeans. Fang Xing estimates that Yangzi Delta farm laborers (the poorest non-beggars in the region) spent 55 percent of their earnings on basic grain supplies in the 1600s and very slightly less in the early 1800s.[11] Henry Phelps Brown and Sheila Hopkins come up with 53 percent for the rural English poor in the 1790s.[12] Moreover, Fang's method of calculation almost certainly understates both household earnings (he omits women's earnings entirely, for instance) and misses many non-grain expenditures.[13]

Chinese could have simply buried their "extra" income under the house, but

[7] Kenneth Pomeranz, *The Great Divergence: China, Europe, and the Making of the Modern World Economy* (Princeton, N.J., 2000), 38–39. See also Ming-te Pan, "Who Was Worse Off?" Preliminary draft of paper delivered at 1998 meeting of Chinese Historians in the United States (typescript in possession of the author), 10–11; Robert B. Marks, "Rice Prices, Food Supply, and Market Structure in Eighteenth-Century South China," *Late Imperial China* 12, no. 2 (1991): 77–78. See Gregory Clark, Michael Huberman, and Peter H. Lindert, "A British Food Puzzle, 1770–1850," *Economic History Review* 48, no. 1 (1995): 223–26; Ming-te Pan, "Rural Credit Market and the Peasant Economy (1600–1949)—The State, Elite, Peasant, and Usury" (PhD dissertation, University of California, Irvine, 1994), 327, for some of the key figures. For some French figures, which are considerably worse, see Maurice Aymard, "Toward the History of Nutrition: Some Methodological Remarks," in Robert Forster and Orest Ranum, eds., *Food and Drink in History* (Baltimore, 1979), 6–7.

[8] Compare William Lavely and R. Bin Wong, "Revising the Malthusian Narrative: The Comparative Study of Population Dynamics in Late Imperial China," *Journal of Asian Studies* 57 (August 1998): 714–48 (especially Table 2 and Figure 3); and James Lee and Cameron Campbell, *Fate and Fortune in Rural China: Social Organization and Population Behavior in Liaoning, 1774–1873* (Cambridge, 1997), 79; with E. A. Wrigley and R. S. Schofield, *The Population History of England, 1541–1871: A Reconstruction* (London, 1981), 230, 708–13 (and see Peter Razzell, "The Growth of Population in Eighteenth Century England: A Critical Reappraisal," *Journal of Economic History* 53 [December 1993]: 757–63, for a suggestion that these figures are too high; Razzell's suggested adjustment for infant mortality alone would bring a life expectancy at birth of 37.0 down to somewhere between 31.6 and 34.0). For continental examples, see John Knodel, *Demographic Behavior in the Past* (Princeton, N.J., 1988), 68–69; and Yves Blayo, "La mortalité en France de 1740 à 1829," *Population* (November–December 1975): 138–39 (showing a lower life expectancy in France).

[9] Li Zhongqing, "Zhongguo lishi renkuo zhidu: Qingdai xingwei ji qi yiyi," in Li Zhongqing and Guo Songyi, eds., *Qingdai huangzu renkou xingwei de shehui huanjing* (Beijing, 1994), 3.

[10] Li Bozhong, "Kongzhi zengchang yi bao fuyu—Qingdai qian, zhongqi Jiangnan de renkou xingwei," *Xin shixue* 5, no. 3 (September 1994): 32–34; compare Colin McEvedy and Richard Jones, eds., *Atlas of World Population History* (New York, 1978), 28–29.

[11] Fang Xing, "Qingdai Jiangnan nongmin de xiaofei," *Zhongguo jingji shi yanjiu* 11, no. 3 (1996): 93, 95.

[12] Henry Phelps Brown and Sheila V. Hopkins, *A Perspective of Wages and Prices* (London, 1981), 14.

[13] Pomeranz, *Great Divergence*, 137 and n. 110.

they did not.[14] Numerous domestic commentators described (and usually decried) increases in popular consumption; lists of products in local histories and in fiction that was meant to be realistic describe a broad range of goods for sale even in rather remote towns; other texts describe the food, clothing, and home furnishings of families at various social levels.[15] We also have accounts from various European visitors, most of whom (before 1800) compare levels of consumption favorably with those back home.[16]

Quantitative estimates confirm these impressions. They are necessarily inexact, but I have tried hard to make them conservative, and still came up with surprisingly high numbers (see Tables 1 and 2).[17] In each case, Chinese per capita consumption seems at least comparable to Europe's at the same or a later date; this is no great surprise for tea and silk but is quite unexpected for sugar and total cloth. And despite numerous data problems, per-capita cloth output for the Yangzi Delta in 1750 appears close to that for England in 1800.

Similar numbers may have different meanings. But here, too, I see broad similarities over the sixteenth to eighteenth centuries—the urbanization of elites, decline of retinues as a main mark of status, published guides to consumption, a long series of ineffective sumptuary laws (which are not even updated in China after about 1550). Peter Burke, a leading historian of early modern European consumption, has concluded that the Chinese and Japanese sources available in translation suggest more East-West similarities than differences, at least at the elite level.[18]

[14] Charles P. Kindleberger, "Spenders and Hoarders," in Kindleberger, ed., *Historical Economics: Art or Science?* (Berkeley, Calif., 1990), 35–85, does indeed suggest that Chinese were "hoarders" rather than "spenders," but gives little evidence for this.

[15] Particularly striking accounts may be found in the novels *Jin ping mei* and *Xingshi yinyuan zhuan*—striking in part because they deal with a medium-sized city and a small town, respectively, in North China rather than with any of the country's great metropolises. For some reflections on consumption in China by a leading historian of early modern European consumption, see Peter Burke, "*Res et Verba*: Conspicuous Consumption in the Early Modern World," in John Brewer and Roy Porter, eds., *Consumption and the World of Goods* (London, 1993), 148–61. I deal with this at much greater length in Pomeranz, *Great Divergence*, 127–52.

[16] For instance, George Staunton, *An Authentic Account of an Embassy from the King of Great Britain to the Emperor of China*, 3 vols. (Philadelphia, 1799), 2: 48; George Macartney (1793) in J. L. Cranmer-Byng, ed., *An Embassy to China: Being the Journal Kept by Lord Macartney during His Embassy to the Emperor Ch'ien-lung, 1793–1794* (London, 1962), 225; Louis Dermigny, *La Chine et L'Occident: Le commerce à Canton au XVIII^{e} siècle, 1719–1833*, 3 vols. (Paris, 1964), 3: 1253; Gaspar da Cruz in C. R. Boxer, ed., *South China in the Sixteenth Century, Being the Narratives of Galeote Pereira, Fr. Gaspar da Cruz, O.P. [and] Fr. Martín de Rada, O.E.S.A. (1550–1575)* (London, 1953), 106, see also 99.

[17] By starting with the quantity of land reported on the tax rolls, we build in a big conservative bias, since under-reporting was chronic throughout China. I have used the highest estimates I could plausibly defend of the amount of land that was under basic grain crops, and, where estimating cash-crop production for an area was particularly tricky, I have simply omitted it from national totals, even though contemporaries may have remarked often that it produced the good in question. In the case of sugar, for instance, I have counted only output in Guangdong and Taiwan plus known imports, even though we know that mainland Fujian was also a major producer, and production scattered through the rest of China was estimated by a contemporary to be about one-ninth of the total of Guangdong, Taiwan, and that uncounted mainland Fujian output (cited in Christian Daniels, "Agro-Industries: Sugarcane Technology," Vol. 6, Part 3 of Joseph Needham, *Science and Civilization in China* [New York, 1996], section 42a: 97, 105). And within Guangdong itself, I have used a figure for the cash-cropping area more than 20 percent below that generated in Robert Marks's study of that province, and assigned only one-tenth of this cash-cropping area to sugarcane: a figure that Marks suggests is almost certainly too low. For further discussion, see Pomeranz, *Great Divergence*, 119–22.

[18] Burke, "*Res et Verba*," 158.

TABLE 1
Tea and Sugar Consumption in China and Europe

Sugar in China circa 1750
3.8–5.0 lbs. per capita for country as a whole

(sugar use was more heavily concentrated in the Lower Yangzi, southeast coast, and Lingnan, where consumption may have been as high as 10 lbs. per capita)

Sugar in Europe per capita

Date	*All Europe*	*Europe except Britain*	*Britain*
1680	1 lb.	.85 lbs.	4 lbs.
1750	2.2 lbs.	1.90 lbs.	10 lbs.
1800	2.6 lbs.	1.98 lbs.	18 lbs.

Tea in China circa 1840 (no earlier figures available)
.7 lbs. per capita

Tea in Europe per capita

Date	*Britain*	*Non-Russian Europe (includes Britain)*
1780	1.0 lb.	.12 lb.
1840	1.4 lbs.	.25 lb.

SOURCES: Production figures from Carla Rahn Philipps, "Trade in the Iberian Empires, 1450–1750," in James Tracy, ed., *The Rise of Merchant Empires* (Cambridge, 1990), 58–61 (Portuguese and Spanish colonies); and Neils Steensgaard, "Trade of England and the Dutch before 1750," in Tracy, 140 (for French, Dutch, and British colonies); Fernand Braudel, *The Structures of Everyday Life*, Siân Reynolds, trans. (New York, 1981), 251–52; Robert Gardella, *Harvesting Mountains* (Berkeley, Calif., 1994), 6, 38; Xu Dixin and Wu Chengming, *Zhongguo zibenzhuyi de meng ya* (Beijing, 1985), 99. European population figures from Colin McEvedy and Richard Jones, eds., *Atlas of World Population History* (New York, 1978), 28. British consumption figures from Sidney Mintz, *Sweetness and Power: The Place of Sugar in Modern History* (New York, 1985), 67, 73 (using 1700 figure for 1680). For Chinese calculations, see Kenneth Pomeranz, *The Great Divergence* (Princeton, N.J., 2000), chap. 3.

CHINA'S HIGH STANDARD OF LIVING could conceivably have been produced by institutions that were a barrier to further development: this is often implied by scholars who refer to "involution" or a "high-level equilibrium trap."[19] But there is no convincing evidence that factor markets in either eighteenth-century China or Western Europe were clearly closer to neo-classical ideals than the other. Land was generally less encumbered in China and guild restrictions on artisanal activities far less important.[20] European capital markets were better places to raise really large sums of capital, but the relevance of this to productive activity prior to the railroad era was limited: Europe's biggest debtors borrowed mostly for war-making (and overseas colonization, on which more later). Chinese interest rates were higher, perhaps in large part because penalties for default were less severe; this combination of higher rates and lower risk may well have been preferred by the millions of households who made most of the investments for both agriculture and proto-industry. (Mechanized industry would have been profitable even at interest rates much higher than either Europe's or China's.)

[19] See Philip C. Huang, *The Peasant Family and Rural Development in the Yangzi Delta, 1350–1988* (Stanford, Calif., 1990); Mark Elvin, *The Pattern of the Chinese Past* (Stanford, 1973). Elvin himself sees the barriers as more environmental than institutional, but others have changed the emphasis.

[20] I compare these at much greater length in Pomeranz, *Great Divergence*, 69–107.

TABLE 2
Selected Comparisons of Cloth Output and Consumption

Yangzi Delta circa 1750 (omitting salt-producing prefectures) (population approximately 31 million)		
	Output per capita	*Amount Consumed Locally*
Cotton cloth	11.2–14.5 lbs.	unknown
Silk cloth	2.0 lbs.	unknown
China circa 1750		
	Output per capita	
Cotton cloth	6.2–8.3 lbs. (probably nearer low end)	
Ramie	unknown (still almost 4 lbs. per capita in 1914–18, despite a general long-term trend toward cotton)	
Great Britain circa 1800		
	Output per capita	*Consumed within Britain*
Cotton, linen, and wool cloth	12.9 lbs.	8.7 lbs.
France circa 1789		
	Output per capita	
Cotton, linen, and wool cloth	8.4 lbs.	
Germany circa 1830		
	Output per capita	
Cotton, linen, and wool cloth	5.0 lbs.	

FOR SOURCES AND DISCUSSION of data problems, see Pomeranz, *Great Divergence*, Appendix F, plus a revision in Kenneth Pomeranz, "Beyond the East-West Binary," forthcoming in *Journal of Asian Studies* 61, no. 2 (May 2002). On ramie, see Xu Dixin and Wu Chengming, *Chinese Capitalism, 1522–1840,* Anthony Curwen, trans. (New York, 2000), 124.

The best-known argument that China's rural economy grew along self-limiting lines fundamentally different from Europe's is Philip Huang's argument about "involution." (Zhao Gang and Jack Goldstone have made different, though related, arguments.)[21] Essentially, Huang claims that because China was so densely populated, people engaged in self-exploitation, working ever-increasing hours for minimal returns, as they tried to meet fixed consumption targets from their shrinking farms. But since (among other things) paddy rice yields far more per acre than wheat, we will see that land hunger may have been no worse in eighteenth-century China than in most of Europe. Huang's more promising argument is that because Chinese women were strongly discouraged from working outside the home, there was no market for their labor; and since they had to be fed anyway, their families pushed them into more and more hours of very low return, home-based

[21] Kang Chao [Zhao Gang], *Man and Land in Chinese History: An Economic Analysis* (Stanford, Calif., 1986); Jack Goldstone, "Gender, Work and Culture: Why the Industrial Revolution Came Early to England But Late to China," *Sociological Perspectives* 39 (1996): 1–21.

work for the market (mostly textile production) without buying goods that would have decreased their domestic burdens. Thus here, the intensification of labor was not accompanied by any meaningful reallocation of time in response to the market (or much specialization) and did not create a mass market for manufactures: consequently, it led to "involution," not development.[22]

Huang's argument is controversial; there is no room to rehearse the discussion in the present essay.[23] But two points from my own work are worth adding. First, the consumption estimates above make it doubtful that Chinese in 1750 were no further above subsistence than before. Second, Huang's estimates of the returns to spinning and weaving—the basis of his argument that women's work earned a sub-subsistence wage—are based on data from the 1690s, when cotton cloth prices reached one of their two lowest points in the entire 1450–1850 period, while raw cotton prices were relatively high.[24] Combining Huang's estimates of physical productivity with more typical mid-eighteenth-century prices yields very different results. Most recently, I have discovered that Huang also made some serious arithmetic and measurement errors that throw some of his earnings estimates off by as much as a factor of ten.[25]

The earnings of spinners still come out quite low. But as Huang himself notes, most spinning was done by young girls, not adult women (at least in the Lower Yangzi); and even in the most pessimistic scenario, 210 days of spinning a year would feed a girl all year round.[26] More optimistic scenarios yield enough earnings for an adult woman to feed herself and perhaps even a couple of small children. If a woman spun and wove, the same 210 days of labor would yield about twelve *taels* of income per year; at mid-century rice prices, this would buy about three times the typical consumption of an adult female. For another comparison, I assumed that a male agricultural laborer could have done twelve months a year of work and that, in addition to the cash wages reported in the sources, he would have received *all* his meals for the year. (Actual employers provided some but not all food.) Even with these assumptions, I came up with a range for male farm-workers' earnings that ranged from about 15 percent above the hypothetical spinner/weaver to 15 percent below.

In short, whatever other effects the culturally specific features of Chinese patriarchy may have had, it appears that, at least in this period, women's earnings *more* closely approximated men's than in Europe.[27] Thus there was every reason for Chinese families to consider the opportunity costs of both men's and women's time in making their purchases, and there are many indications that they did. So to a

[22] Huang, *Peasant Family and Rural Development in the Yangzi Delta*, 91, 110.

[23] See, for instance, the summary in R. Bin Wong, "Chinese Economic History and Development: A Note on the Myers-Huang Exchange," *Journal of Asian Studies* 51, no. 3 (1992): 600–11. I add a number of further points in Kenneth Pomeranz, "Beyond the East-West Binary," *Journal of Asian Studies* 61, no. 2 (2002), which also includes a response to Huang's objections to my work.

[24] Zhang Zhongmin, *Shanghai cong Kaifa dao Kaifang, 1369–1842* (Kunming, 1988), 207–08; compare Huang, *Peasant Family and Rural Development in the Yangzi Delta*, 84–86.

[25] See Pomeranz, *Great Divergence*, Appendix E; and Pomeranz, "Beyond the East-West Binary."

[26] Xu Xinwu, ed., *Jiangnan tubu shi* (Shanghai, 1992), 469. Page 215 suggests that a woman and her underage helper (counted as half a laborer) did 265 adult equivalent days of textile labor per year, which would suggest about 180 days for the adult woman.

[27] For English data, see Sara Horrell and Jane Humphries, "Women's Labour Force Participation and the Transition to the Male-Breadwinner Family, 1790–1865," *Economic History Review* 48, no. 1 (1995): 102–03.

rising standard of living, we should add, at least provisionally, a calculating approach to using the family's resources. Thus the Chinese and European pictures look quite similar, both for production and consumption.

But these resemblances did not last. Between 1750 and 1900, both population and per-capita consumption soared in Europe. But in China, population growth slowed significantly by 1800, and per-capita non-grain consumption declined: early twentieth-century figures for cloth, sugar, and tea are well below even my most conservative estimates for 1750.[28] As we shall see later, this is not because the eighteenth-century estimates were too high.

ECOLOGICAL DIFFERENCES explain much of this divergence—but *not* because, as some people have suggested, the most developed parts of China were uniquely "over-populated." Rather, Malthusian pressures seem to have been about equally relevant to core regions at both ends of Eurasia (as comparable life expectancies and living standards suggest). I will briefly review them in terms of Thomas Malthus's four necessities that compete for land: food, fuel, fiber, and building materials.

In neither place was a shortfall in food production imminent, although in Britain there was not much room left to expand agricultural production without either exhausting the soil or using techniques that were not yet available in 1800 (such as mined or synthesized fertilizer). Much of mainland Europe still had lots of slack capacity, thanks to institutions that encouraged too much fallowing, delayed the draining of swamps, and slowed the spread of mixed husbandry in pre-Napoleonic Western Europe (and even longer further east). From a Chinese perspective, this looks like a surprisingly slow spread of best practices due to peculiar institutional rigidities.[29] Britain had adopted these changes more readily, to the point where there was little more improvement to be expected from them on the eve of a greater than ever population boom: indeed, British agricultural yields changed very little between 1750 and 1850.[30] The only available methods for increasing per-acre yields still further in an ecologically sustainable way were, like those used in Denmark, highly labor intensive—so much so that England's profit-seeking, labor-hiring farmers would not have undertaken them—and these still created only limited gains.[31]

Even in dry-farming North China (generally a much more vulnerable ecosystem

[28] See, for instance, the estimate of roughly 2.2 pounds of sugar consumption per capita for the 1930s cited by Daniels, "Agro-Industries," section 42a: 85. Chang Chung-li, *The Income of the Chinese Gentry* (Seattle, 1962), 303, cites a 1930s estimate for tea consumption of 1.3 pounds, which would be much higher than my estimate for 1840; but the 1840 estimate, because it counts only tea that entered long-distance trade and paid internal customs, is surely an underestimate.

[29] See Pomeranz, *Great Divergence*, 73–80.

[30] F. M. L. Thompson, "Rural Society and Agricultural Change in Nineteenth-Century Britain," in George Grantham and Carol S. Leonard, eds., *Agrarian Organization in the Century of Industrialization: Europe, Russia, and North America* (Greenwich, Conn., 1989), 189, 193; Clark, "Yields per Acre in English Agriculture," 456–59; Brinley Thomas, "Food Supply in the United Kingdom during the Industrial Revolution," in Joel Mokyr, ed., *The Economics of the Industrial Revolution* (Totowa, N.J., 1985), 145–46.

[31] On Denmark, see Kjærgaard, *Danish Revolution*, 37–38, 55–56, 123, 151–58; on the difference between capitalist and peasant strategies for dealing with ecological strain, see Mauro Ambrosoli, *The*

TABLE 3
Ecological Comparisons for Parts of China and Europe, circa 1800

Soil Fertility and Nitrogen Flux Comparisons

Total wheat yields over 6 years
England 2,092 kg/acre
North China 1,836 kg/acre
(Note: If one adds the three soybean crops on the North China plot, versus two clover crops for the British crop, the North China land is probably a better total food producer.)

Nitrogen depletion by wheat crops
England 44.77 kg/acre
North China 42.49 kg/acre

Nitrogen added to soil by manuring
England 4,000–5,600 kg/cropped acre x .6%-4.9% nitrogen content *(assuming most manure from cows)*
North China 5,600–8,900 kg/cropped acre x 2.0–7.5% nitrogen content *(assuming mostly pigs)*
(Note: percentages of nitrogen content are for fresh manure, and decline sharply with time. Since North China farmers tended to add little bits of manure every few days, while English farmers more often did a massive application of fertilizer once or twice a year (using an animal-pulled cart to save labor), the Chinese fertilizer probably had an additional advantage not measured here.)

Nitrogen-fixing crops
England 2 crops of clover at an average of 60 kg nitrogen/acre
North China 3 crops of soybeans at an average of 48 kg nitrogen/acre per crop
(Note: very wide observed variation around mean for individual cases of both clover and soybeans—relatively little is known about what determines these variations.)

SOURCE: Pomeranz, *Great Divergence*, Appendix B.

than South China), our limited data suggest, the nutrient balances for grain growing were more favorable than in England circa 1800.[32] (They were probably less favorable for North China's cotton lands—of which more later.) And in China's rice-growing areas, known techniques could still raise yields without exhausting the soil.[33] (See Table 3.)

Both fuel and building needs drew heavily on forests. Here we might assume that China's cores would be far worse off than Europe's, given their denser population and the country's horrible deforestation in the late nineteenth and twentieth centuries, but this seems not to be true around 1750 or even 1800. The British Isles already had severe wood shortages before 1650, as did northern Italy; by 1800, Britain had perhaps 5 percent forest cover, and the rest of "insular and peninsular Europe" about 10–15 percent.[34] Even France, which was relatively well-forested by West European standards, was about 16 percent forest in 1789—compared to about 33 percent in 1550.[35] This meant that, even if no wood were ever wasted, France by 1789 would have needed about 90 percent of its annual

Wild and the Sown: Botany and Agriculture in Western Europe, 1350–1850, Mary McCann Salvatorelli, trans. (Cambridge, 1997).

[32] Pomeranz, *Great Divergence*, Appendix B and chap. 5.

[33] Li Bozhong [Po-chung Li], *Agricultural Development in Jiangnan, 1620–1850* (New York, 1998), 119–27.

[34] Michael Williams, "Forests," in B. L. Turner II, *et al.*, eds., *The Earth as Transformed by Human Action* (New York, 1990), 180–81.

[35] J. P. Cooper, "In Search of Agrarian Capitalism," in T. H. Aston and C. H. E. Philpin, eds., *The Brenner Debate: Agrarian Class Structure and Economic Development in Pre-industrial Europe* (New York, 1985), 139 n. 2.

forest growth just to meet people's minimum heating and cooking needs, leaving little for building, much less for expanding fuel-hungry iron forges (which often functioned only a few weeks a year for lack of fuel[36]) or other industries.

For China, anecdotal evidence suggests that even in the extremely densely populated Lower Yangzi, the *ecological* effects of clearing the highlands did not become severe until about 1820. Wood was not plentiful in North China, but apparently few people were desperately short of fuel.[37] On the aggregate, the only figures I know of for 1700 yield a perfectly acceptable 37 percent forest cover for all of China proper, but disastrous deforestation was widespread by 1900. Interpellating for dates in between is tricky.

To try to fill the gap, I have done a rough reconstruction of land use for southwest Shandong circa 1800—an interesting area because it was quite densely populated but did not import much timber, and *was* horribly deforested as of the 1930s.[38] Despite making every effort I could to make the 1800 situation look bad, it came out much like that of France: 13 percent forest cover and a sustainable fuel supply per year about 20 percent above probable minimum needs.[39] This surely meant great hardship for many people, since distribution was uneven and wood was also needed for other uses, but this was also true in France.

But what of still more densely populated rice-growing China? Calculations are impossible for the Lower Yangzi, since we have no figures on this area's huge timber imports; but they can be done for Lingnan, China's second richest macro-region (focused on Canton). Lingnan has about 70 percent of France's land area; it had 17.5 million people in 1753 and 30 million in 1853. Yet even in 1853, Lingnan had considerably more forest than France in 1789; and although a far denser population relied on those trees, available wood per capita was double French levels in 1793 and still above France's 1789 levels in 1853. Thanks to a milder climate, fuel-saving cooking methods, and the burning of crop residues, the difference in wood available for non-fuel uses (assuming fuel needs were met first) was enormous: six times France's 1789 per-capita levels in 1793 and still more than double France's 1789 levels in 1853. So despite its denser population, various Chinese efficiencies seem again to suggest that China may have faced no more "Malthusian" stress than Europe as of 1800. (See Table 4.)

But these tables also show that, even with efficient fuel-gathering and use, population and proto-industrial growth were pressing hard on forest resources. Timber prices in both China and Europe were high and rising in the eighteenth

[36] Fernand Braudel, *Civilization and Capitalism, 15th–18th Centuries*, Vol. 2: *The Wheels of Commerce*, Siân Reynolds, trans. (New York, 1982), 367.

[37] Staunton, *Authentic Account*, 2: 141–42; Kenneth Pomeranz, *The Making of a Hinterland: State, Society, and Economy in Inland North China, 1853–1937* (Berkeley, Calif., 1993), 123–27; more details in Pomeranz, "The Making of a Hinterland: State, Society, and Economy in Inland North China, 1900–1937" (PhD dissertation, Yale University, 1988), Appendix F.

[38] Pomeranz, *Making of a Hinterland*, 123–37.

[39] Pomeranz, *Making of a Hinterland*, 124–25; Kenneth Pomeranz, "How Exhausted an Earth? Some Thoughts on Qing (1644–1911) Environmental History," *Chinese Environmental History Newsletter* 2, no. 2 (1995): 7–11; also see Pomeranz, *Great Divergence*, Appendix B.

TABLE 4
Wood/Fuel Supply Comparisons: Lingnan, France, and Southwest Shandong

4.1	*Forested area (hectares)*			*Percent forested*		
Date	*Guangdong*	*Guangxi*	*Lingnan*	*Guangdong*	*Guangxi*	*Lingnan*
1753	9,000,000	6,500,000	15,500,000	45	35	40
1773	8,200,000	6,020,000	14,220,000	41	32	37
1793	7,440,000	5,660,000	13,100,000	37	30	34
1813	6,560,000	5,240,000	11,800,000	33	28	30
1833	5,760,000	4,940,000	10,700,000	29	26	28
1853	4,880,000	4,700,000	9,580,000	24	25	24
Comparison						
France circa 1550				33% forested		
France circa 1789				16% forested (little further decline after that)		
Southwest Shandong circa 1800				at least 13% forested		

4.2	
Date	*Total Lingnan fuel supply per capita in tons of coal equivalent (tce) (if wood had no other uses)*
1753	1.75 tce
1773	1.45 tce
1793	1.19 tce
1813	.99 tce
1833	.83 tce
1853	.70 tce
Comparison	
France circa 1789	.64 tce
Southwest Shandong circa 1800	.62 tce

4.3				
Date	*Forest land (hectares)*	*Forest needed for fuel*	*Remaining forest*	*"Surplus" wood per capita (tons)*
1753	15,500,000	1,650,000	13,850,000	2.85
1773	14,220,000	1,675,000	12,545,000	2.25
1793	13,100,000	2,260,000	10,840,000	1.73
1813	11,800,000	2,469,000	9,331,000	1.32
1833	10,700,000	2,956,000	7,744,000	1.00
1853	9,580,000	3,339,000	6,241,000	.74
Comparison				
France circa 1550				3.6 tons
France circa 1789				.29tons

FOR SOURCES AND METHODS OF CALCULATION, see Pomeranz, *Great Divergence*, Appendix C.

century,[40] and even if popular subsistence was not threatened yet, there were serious impediments to significant growth in per-capita energy use.

In Britain and Belgium, the wood crisis was greatly alleviated by a late eighteenth and nineteenth-century coal boom. However, mineral energy did not become central for most of Europe until quite late in the nineteenth century.

[40] For continental Europe, see, for example, Jack A. Goldstone, *Revolution and Rebellion in the Early Modern World* (Berkeley, Calif., 1991), 186; Ernest Labrousse, *Esquisse du mouvement des prix et des revenus en France au XVIII^eme siècle* (1933; rpt. edn., Paris, 1984), 343, 346–47, finding a larger price increase for fuel wood than for any other commodity in France between 1726 and 1789, with the rise continuing into the early nineteenth century. Britain is discussed later in this text. For China, see Li Bozhong, "Ming Qing shiqi Jiangnan de mucai wenti," *Zhongguo shehui jingji shi yanjiu* 1 (1994): 86–96.

Moreover, coal did not end the wood shortage, it just alleviated it—construction and the growing demand for paper kept European timber supplies very tight until North American imports eased the pressure. (Forested acreage roughly leveled off in Europe by 1850, but even that impressive holding action meant less wood per capita.)

The coal boom, as E. A. Wrigley has pointed out, represents a fundamental discontinuity. He calculates that the annual energy yield from British coal around 1820 (when output was five times that of 1750 and almost eight times that of 1700)[41] was the equivalent of the sustainable yield from 15 million forest acres.[42] A more standard conversion would make this 21 million "ghost acres": more than all of Britain's pasture and crop land combined.

This breakthrough required technical innovation *and* geographic good fortune. Huge coal seams with visible outcroppings lay relatively close to London: this provided both a rich and needy market and a pool of craftsmen who made crucial improvements in pumps, steam engines, and so on. By contrast, China's best coal deposits lay in Shaanxi, several hundred landlocked miles from the Yangzi Delta: a bit like if Europe's coal had mostly been under the Carpathian Mountains. The technical challenges also differed. British mines needed water pumped out constantly. For this, a coal-fired steam engine, which would later also solve the transport problem, was a great solution. Conversely, the availability of almost free coal at the pit-head made even the inefficient early steam engines worth deploying for this one use, and so worth tinkering with until they became efficient enough for use elsewhere. By contrast, China's largest coal deposits were in mines where ventilation was a much bigger problem. Change these geophysical accidents and it becomes a lot harder to imagine such an early escape from the limits of an organic economy; it becomes a lot easier to see Western Europe as a potential Lower Yangzi, with growing ecological pressures eventually outstripping the gains from further division of labor.

Eighteenth-century Europe needed more fiber if far more people were going to have more clothes per capita and to ship cloth overseas in return for primary products. But raising more wool would simply take too much land away from more intensive uses. Flax is both very hard on the soil and very labor intensive. This made it a garden crop in much of Western Europe, something grown on a small scale in peri-urban areas with plenty of nightsoil and labor. Parliament repeatedly enacted heavy subsidies for flax during the seventeenth and eighteenth centuries, but British production rose very little, and continental production not much more (except in Russia, where the soil could be given a long rest after a couple of flax crops).[43] Matching the fiber supply that came from New World cotton by 1830 with domestic

[41] Michael W. Flinn (with the assistance of David S. Stoker), *The History of the British Coal Industry*, Vol. 2: *1700–1830, the Industrial Revolution* (Oxford, 1984), 26.

[42] E. A. Wrigley, *Continuity, Chance, and Change: The Character of the Industrial Revolution in England* (New York, 1988), 54–55.

[43] Alex J. Warden, *The Linen Trade, Ancient and Modern* (1864; rpt. edn., London, 1967), 32–40; George Grantham, "Agrarian Organization in the Century of Industrialization: Europe, Russia, and North America," in Grantham and Leonard, *Agrarian Organization in the Century of Industrialization*, 13–14; Jerome Blum, *Lord and Peasant in Russia: From the Ninth to the Nineteenth Century* (Princeton, N.J., 1961), 333–34. Note that Warden, writing in *The Linen Trade*, despaired of increasing British flax imports from the continent.

sources would have required an implausible thirty-fold increase in English flax production.

Cotton, the principal East Asian fiber source, is less labor intensive than flax, but it, too, is hard on the soil. The Lower Yangzi's huge imports of Manchurian soybeans went mostly to sustain cotton lands; so did most of Japan's vastly increased fishing after 1750. Europe, of course, eventually turned to cotton, too—not by growing it with imported fertilizer but by importing huge amounts of American cotton.

Thus fiber brings us to the more general issue of long-distance trade. As densely populated cores faced shortages of various land-intensive products, they sought them in less densely populated areas that could produce surpluses of timber, cattle, or grain but that produced few of the manufactures that cores had in abundance. Thus England and the Netherlands turned first to the Baltic (and the Mediterranean for cotton) and later to the New World; and the Lower Yangzi imported rice and timber from upstream, wheat and soybeans from Manchuria, and raw cotton from North China. The Yangzi Delta's trade for these primary products dwarfed anything elsewhere in the eighteenth-century world;[44] the Pearl River Delta was beginning to follow suit.

But this kind of trade tended to run up against limits: one more characteristic of East Asia, one of Europe. Where families in the peripheries were more or less free to allocate their own labor, an export boom and commercialization would often stimulate population growth, both from natural increase and immigration.[45] Moreover, as the best land filled up (or the most accessible forests were cleared), some labor would move into handicrafts: since most technology was not yet embodied in very expensive capital goods, and high transport costs on bulky items provided some protection for infant industries, this sort of import substitution was a much more "natural" process than today.[46] Together, these changes reduced raw materials surpluses for export and demand for imported manufactures.

This is precisely what happened in much of the Chinese interior in the late

[44] Food imports from the Middle Yangzi alone fed approximately 6 million people per year in the Lower Yangzi, and the soybeans that the Lower Yangzi imported could have fed at least another 3 to 4 million had most of them not been used as fertilizer. Even Shandong, a not particularly commercialized province with perhaps 23 million people in 1800 (Philip C. Huang, *The Peasant Economy and Social Change in North China* [Stanford, Calif., 1985], 322), imported enough food to feed 700,000 to 1 million people, and exported a like amount. By contrast, the Baltic grain trade fed about 600,000 people a year at its peak, and all of Europe's long-distance grain trade put together fed at most 2.5 million people at its pre-1800 peak. For numbers on these different flows, see Jan de Vries, *The Economy of Europe in an Age of Crisis, 1600–1750* (New York, 1976), 17, 56; Braudel, *Structures of Everyday Life*, 127; Adachi Keiji, "Daizuhaku ryūtsū to Shindai no shōgyō teki nōgyō," *Tōyōshi Kenkyū* 37, no. 3 (1978): 35–63; Xu Dixin and Wu Chengming, *Zhongguo zibenzhuyi de mengya* (Beijing, 1985), 277; Xu Tan, "Ming Qing shiqi Shandong de liangshi liutong," *Lishi dang'an* 57 (1995): 86; Marks, "Rice Prices, Food Supply, and Market Structure," 76–79; Yeh-chien Wang, "Food Supply and Grain Prices in the Yangtze Delta in the Eighteenth Century," in *The Second Conference on Modern Chinese Economic History*, 3 vols. (Taipei, 1989), 2: 423–30; Lu Hanchao, "Arrested Development: Cotton and Cotton Markets in Shanghai, 1350–1843," *Modern China* 18, no. 4 (1992): 493; Li Bozhong, *Agricultural Development*, 113–14, 209 n. 35.

[45] Rising incomes tend to lower death rates and sometimes raise birth rates, too; increased demand for wage labor often makes earlier marriages possible than if couples have to wait to inherit property.

[46] I present the argument in a more formal model, adjusted to various possible assumptions about prices and other variables in Pomeranz, *Great Divergence*, 285–92. The model draws heavily on the work of Joel Mokyr, *Industrialization in the Low Countries, 1795–1850* (New Haven, Conn., 1976).

eighteenth and early nineteenth century. The Middle and Upper Yangzi grew very rapidly,[47] reducing their rice and timber surpluses; some of the extra hands available began making coarse cloth that replaced shipments from the Lower Yangzi.[48] In North China, population growth was so rapid that it probably required the reconversion of some cash-crop land to grain production;[49] and at any rate, much more of the region's huge raw cotton crop was spun and woven locally, rather than sent south.

To some extent, the Yangzi Delta compensated by finding new, more remote markets (in Manchuria, Southeast Asia, and to some extent in the West) and by specializing more in fancier fabrics for elites, moving up the value-added ladder as an established industrial area should. Nonetheless, it faced serious economic pressures that inhibited any further specialization in industry. I estimate (based on admittedly spotty data) that the rice-buying power of a hypothetical Yangzi Delta weaver/spinner fell by 22 to 42 percent between 1750 and 1800 (probably closer to 42 percent) and about 10 percent more by 1840.[50] Population growth in the delta was almost zero over this century, while China as a whole roughly doubled. Lingnan's regional core experienced a milder version of the same trends.[51]

These trends might have been less pronounced if people had migrated from the increasingly full peripheries to the Yangzi Delta—as they "should" have, given its higher standard of living. This might have allowed primary product exports from the peripheries to stay higher for longer; it also should have lowered Yangzi Delta wages, making its manufactured exports more competitive.

Here, however, Chinese institutions and values did matter. Cloth production was an overwhelmingly female activity, and women almost never migrated alone. They moved as part of male-headed households, and most rural men were farmers. Most industry was rural, and there were few places to live in the countryside for somebody who had neither kin to move in with nor access to land; this was not a landscape with great landlords looking for "cottagers." Delta land was expensive, and even renting it often required a large deposit; thus poor couples from the interior had reasons to stay put unless they were completely landless.

On the other hand, Chinese institutions had been very successful (with government loans of seed, animals, etc.) in facilitating migrations of poor people toward areas with better land-to-labor ratios throughout the eighteenth and early nineteenth centuries: much better than in Europe, where institutional arrangements made land-rich Eastern Europe uninviting to any West European seeking a better life, while high migration costs limited poor people's migration to the pre-1800 New World to those willing to be indentured on terms that landowners found competitive with the chance to purchase slaves. As long as there was land to go to, facilitating those flows probably mattered far more to integrating labor

[47] G. William Skinner, "Regional Urbanization in Nineteeenth-Century China," in Skinner, *City in Late Imperial China*, 213; he then notes elsewhere the likelihood that this growth reduced the long-distance trade in rice between the eighteenth and twentieth centuries.

[48] Li Bozhong, *Agricultural Development*, 108; Yamamoto Susumu, "Shindai Shikawa no chi-iki keizai [Regional Development in Qing Dynasty Sichuan]," *Shigaku Zasshi* 100, no. 12 (December 1991): 7–8, 10–11; and for a general survey, Pomeranz, *Great Divergence*, 242–51.

[49] See Pomeranz, *Great Divergence*, Appendix F.

[50] See Pomeranz, *Great Divergence*, Appendix E.

[51] Pomeranz, *Great Divergence*, chap. 6 and Appendix E.

markets than any flows toward the Yangzi Delta would have. Thus, on the whole, Chinese labor markets may still have been somewhat better integrated than Europe's.[52] But as land frontiers disappeared, the difficulties of moving toward manufacturing or service jobs in highly developed regions became more significant. Meanwhile, the cultural ideal of the "man plows, woman weaves" household—which came to be realized far more often in the Qing dynasty,[53] although it was still often set aside where economic incentives to violate it were strong enough (as in the tea country)—meant that frontier families also produced cloth if possible. We thus see unfolding over time a phenomenon noted by Saito Osamu for Tokugawa Japan: the elaboration of a family division of labor that to some extent substituted for the deepening of geographic specialization.[54] As incomes rose in some of China's rice-exporting regions, and as Qing officials helped spread cotton growing and weaving in these regions, more families *could* keep their women employed inside, as they preferred; and, in doing so—rather than, for instance, doing more double-cropping of rice, as other Qing officials urged[55]—they reinforced the ecological pressures on downstream areas.

This filling up of China's peripheries also helps explain why nineteenth-century observers did not record the decline in consumption that comparing my 1750 figures with early twentieth-century ones at first seems to suggest. Most areas did not undergo decline (the North and Northwest are likely exceptions),[56] but the changing weights of different areas dragged down national aggregates. The Yangzi Delta alone probably held 16 to 21 percent of China's population in 1750, but less than 9 percent by 1850 and under 7 percent by 1950. The three richest of G. William Skinner's eight Chinese macro-regions were over 40 percent of the population in 1750 and around 25 percent in 1843.[57] If, for instance, those three macro-regions

[52] The same point could be made about other markets, too. The numerous ways in which both Europe and China differed from an ideal-typical market economy are important to bear in mind, lest we choose one Chinese barrier to growth and say "Aha! It was economic institutions after all!" It is also worth remembering that as an area like the Middle Yangzi—with perhaps 50 million people—began to develop its own proto-industry and internal trade, this was indeed a retreat from an integrated market on an even larger scale, including the Lower Yangzi, as I have emphasized here, but it also represented an elaboration of the division of labor and of Smithian dynamics on a scale that was still larger than that of any emerging national economy in Europe.

[53] Li Bozhong, "Cong 'fufu bing zuo' dao 'nan geng nu zhi,'" *Zhongguo jingji shi yanjiu* 11, no. 3 (1996): 99–107; Susan Mann, "Household Handicrafts and State Policy in Qing Times," in Jane Kate Leonard and John R. Watt, eds., *To Achieve Security and Wealth: The Qing Imperial State and the Economy, 1644–1911* (Ithaca, N.Y., 1992), 75–96.

[54] Saito Osamu, *Puroto-Kōgyō no jidai: Seiō to Nihon no hikakushi* (Tokyo, 1985).

[55] On Qing encouragement of cotton work in areas that did not have it, see Susan Mann, *Precious Records: Women in China's Long Eighteenth Century* (Stanford, Calif., 1997), 160–65, 176; on a failed campaign to increase double cropping in the Middle Yangzi, see Peter C. Perdue, *Exhausting the Earth: State and Peasant in Hunan, 1500–1850* (Cambridge, Mass., 1987), 131–35.

[56] Compare, for instance, the discussion of cotton in Fang Xing, "Lun qingdai qianqi mianfangzhi de shehui fengong," *Zhongguo jingji shi yanjiu* 2, no. 1 (1987): 79–94; and in Zhang Gang, "Qingdai Zhili shangpin jingji fenxi," *Hebei shiyuan xuebao* 3 (1985): 99; with Huang, *Peasant Economy and Social Change in North China*; Richard A. Kraus, "Cotton and Cotton Goods in China, 1918–1936: The Impact of Modernization on the Traditional Sector" (PhD dissertation, Harvard University, 1968); or Pomeranz, *Making of a Hinterland*. This is discussed at greater length in Pomeranz, *Great Divergence*, 140–42, 335–37.

[57] Calculated based on Skinner, "Regional Urbanization in Nineteeenth-Century China," 213; G. William Skinner, "Sichuan's Population in the Nineteenth Century: Lessons from Disaggregated Data," *Late Imperial China* 8, no. 1 (1987): 67–76; and Liang Fangzhong, *Zhongguo Lidai hukou, tiandi, tianfu tongji* (Shanghai, 1980), 395–413.

accounted for the overwhelming majority of the country's sugar consumption in the mid-eighteenth century—as they probably did—their falling share of China's population alone would account for almost all the decline between my figures and those in the John Buck surveys of the 1930s.[58] Living standards in many hinterlands may have continued to creep upward, but they were still far short of Yangzi Delta standards, and they came to dominate Chinese aggregates.

WE CAN NOW RECONSIDER how Britain escaped the Yangzi Delta's fate. One central factor was technological change—particularly steam and coal, which relaxed the land constraint in a more fundamental way than any other innovation before turn-of-the-century chemicals and electricity. But another part—at least as important as the small changes in numerous sectors that have been emphasized in recent decades—lay in its relations with its peripheries, which differed sharply from those we have just discussed.

The importance of these resources becomes even greater when we remember that, once begun, the mechanization of industry need not have been sustained, any more than previous bursts of growth had been; indeed, it could not have been sustained had what seemed to be pressing resource and environmental strains not been alleviated even while both population and per-capita consumption soared.

Western Europe's early modern trade with Eastern Europe was not squeezed by rising population and import substitution like that in the Chinese interior. East European serfdom and other institutions meant that agricultural improvement and population growth were slower than one would expect in a free-labor periphery: few people would immigrate from crowded but freer areas, and there was little of the wage labor that allowed people elsewhere to form families without inheriting land. Nor could peasants switch into handicraft activity on any great scale.

But these same institutions limited the response to export demand in the first place; they also limited the region's demand for imported manufactures, because so many people were very poor and/or outside the cash economy (even if their products were not). Thus the Baltic trade, for instance, leveled off after 1650, at a fraction of the size of China's long-distance staple trades.[59] This stagnation left slack export capacity waiting to be activated when changes in institutions, technology, and prices made the logic of selling grain to the West and buying its manufactures irresistible: but this mostly happened after 1860.[60]

In the crucial hundred years before 1860, the New World did much more to relax northwest Europe's land constraint: both its natural bounty and its history facilitated this. Old World diseases removed millions of indigenes, and much of the

[58] The effect of the regional redistribution of population alone would lower an average consumption of 4.3 pounds to about 2.5, and John Lossing Buck, *Land Utilization in China* (1937; rpt. edn., New York, 1964), reported average consumption of centrifugal sugar of 2.2 pounds. Sugar processed in other ways, plus what was eaten raw in producing areas (where sucking on cane was common) could easily make up the remaining difference.

[59] Z. S. P. Pach, "The East-Central European Aspect of the Overseas Discoveries and Colonization," in Hans Pohl, ed., *The European Discovery of the World and Its Economic Effects on Pre-Industrial Society, 1500–1800* (Stuttgart, 1990), 186–88, 190.

[60] Thomas, "Food Supply in the United Kingdom during the Industrial Revolution," 141–50.

labor force was replaced by slaves—who were imported at a cost that consumed about one-quarter of export earnings in late eighteenth-century Brazil and the Caribbean.[61] Moreover, these slaves often did not meet their own subsistence needs (unlike most coerced cash-crop workers in the Old World). Consequently, the circum-Caribbean slave region (from Brazil to the southern United States) became the first "modern"-looking periphery, with large bills for the import of capital goods (in this case, kidnapped ones) and for mass consumer goods (such as cheap cloth for slaves). Thus, unlike Old World peripheries, the New World kept expanding as a source of land-intensive exports, allowing Europe to become ever more specialized in manufacturing. (Manufactures were the bulk of the goods used to buy slaves in Africa, and they were also sold to North America, which earned much of the cash for its purchases with grain and timber for Caribbean plantations.[62])

In the long run, exports from free North America would be still larger, but that, too, mostly postdates 1860; and, as John McCusker and Russell Menard show, North American settlement was also tied for quite a while to the capacity to export.[63] For present purposes, consider how much New World commodities did to relax Britain's land constraint, even as early as 1830. Replacing Britain's 1801 consumption of Caribbean sugar with locally grown calories would have required 850,000 to 1.2 million acres of the best wheat land; by 1831—still before the great fall in sugar prices and quintupling of per-capita consumption that followed—the figure is 1.2 to 1.6 million. Enough wool to replace Britain's American cotton imports in 1830 would have required over 23 million acres: more than either Britain's total pasture and crop land[64] or E. A. Wrigley's circa 1820 figure for the impact of coal.[65] Thus Britain got an extended window in which to solve certain resource constraints partly because markets *did not* work in its peripheries as well as they did in East Asia, thanks to bound labor, colonial monopolies, and such factors.

Land-saving New World imports kept soaring as industrialization proceeded, keeping pace with the central contribution of fossil fuels. Britain's coal output

[61] Calculations based on slave prices from Joseph C. Miller, "Slave Prices in the Portuguese Southern Atlantic, 1600–1830," in Paul E. Lovejoy, ed., *Africans in Bondage: Studies in Slavery and the Slave Trade* (Madison, Wis., 1986), 70; numbers of slaves from Philip D. Curtin, *The Atlantic Slave Trade: A Census* (Madison, 1969), 216; and Armin K. Ludwig, *Brazil: A Handbook of Historical Statistics* (Boston, 1985), 314; Caribbean export figures from Noel Deerr, *The History of Sugar*, 2 vols. (London, 1949–50), 193–203 (British Caribbean), and 235–42 (French Caribbean); plus British import data from B. R. Mitchell, *British Historical Statistics* (New York, 1988), 462–64; Brazilian export figures for 1821–26 from Ludwig, *Brazil*, 107; and for 1796 and 1806 from Michel Morineau, *Incroyables gazettes et fabuleux métaux: Les retours des trésors américains d'après les gazettes hollandaises (XVI–XVIII^{e} siècles)* (New York, 1985), 177–78.

[62] Herbert Klein, "Economic Aspects of the Eighteenth Century Slave Trade," in James D. Tracy, ed., *The Rise of Merchant Empires: Long-Distance Trade in the Early Modern World, 1350–1750* (Cambridge, 1990), 291; James F. Shepherd and Gary M. Walton, *Shipping, Maritime Trade, and the Economic Development of Colonial North America* (New York, 1972), 43–44; David Richardson, "The Slave Trade, Sugar, and British Economic Growth, 1748–1776," *Journal of Interdisciplinary History* 17, no. 4 (1987): 765–66.

[63] John J. McCusker and Russell R. Menard, *The Economy of British America, 1607–1789* (Chapel Hill, N.C., 1985), 18, 23, 28–30.

[64] About 18 million acres when first systematically counted in the mid-nineteenth century, though probably higher earlier; see Mitchell, *British Historical Statistics*, 186.

[65] See Pomeranz, *Great Divergence*, Appendix D, for derivation of all figures on "ghost acreage."

would increase fourteen times from 1815 to 1900,[66] its sugar imports roughly eleven-fold,[67] and its cotton imports a stunning twenty times.[68] It also began to use huge amounts of American grain, beef, lumber, and other primary products; and the New World also became a vast outlet for surplus population from various parts of Europe. As these migrants brought with them European tastes, as technological progress created mechanical capital goods (rather than the enslaved human ones of an earlier era) in high demand across the Atlantic, and as independent New World governments emerged with their own reasons for paying the costs of frontier expansion, the various peculiar institutions that had helped create a flow of land-intensive New World exports were no longer important, but they had been crucial while the colonies and transatlantic trade were taking shape.

MANY READERS MAY RAISE ONE OF THREE related objections. All of them, in one form or another, hinge on the notion that no one resource is "vital": as scarcity raises prices, people will find substitutes. Thus I may seem to be placing too much emphasis on coal, or forgetting that, however useful land-intensive New World products may have been, the majority of such resources still came from within Europe. Lastly, I may appear to be issuing a "Club of Rome" report for 1790: suggesting that, without the New World and coal, Europe was headed for a Malthusian crisis, when it probably would have adjusted through some combination of lower fertility, lower consumption, and the use of land and energy-saving techniques. I agree that this would have been a far more likely outcome than actual catastrophe, although there were signs of serious soil exhaustion and other problems in various regions.[69] I would, however, argue that the ecological adjustments possible without New World resources or such modern inputs as chemical fertilizer (itself based on fossil fuels) were sufficiently labor intensive that their widespread adoption would have made nineteenth-century European economic history very different—more like that of the richer parts of East Asia, or some unusual European cases like Denmark, than like England. Let us now consider these objections.

Coal was central to earlier views of the industrial revolution. Only cotton, iron, steel, and railways were equally emphasized, and three of these four other main sectors depended on coal. Much recent literature has deemphasized coal. People have noted, for instance, that water powered more early factories than coal, and that most of England's coal was used for home heating and cooking. Even the calculations Wrigley uses to reaffirm the centrality of coal[70] cannot tell us what would have happened without the coal boom: presumably, it would have been some

[66] Mitchell, *British Historical Statistics*, 247.

[67] Calculated based on Mitchell, *British Historical Statistics*, 709–11.

[68] Mitchell, *British Historical Statistics*, 334–35. Imports peaked in 1912 at twenty-eight times 1815 levels.

[69] See Kjærgaard, *Danish Revolution* (Denmark); Ambrosoli, *Wild and the Sown* (parts of England); Piers M. Blaikie and Harold Brookfield, *Land Degradation and Society* (London, 1987) (parts of France and Germany). I take up the issue at more length in Pomeranz, *Great Divergence*, 215–25.

[70] Wrigley, *Continuity, Chance, and Change*, 54–55; see also Pomeranz, *Great Divergence*, 57–62.

combination of people being colder, buying more clothes, and producing less iron, rather than a complete blockage in any one sector.

But coal needs to be central to the story, for Wrigley's reasons and others. Water power may have kept expanding for a while, but it had inevitable geographic limits. Nor could it substitute for coal combustion in all sorts of chemical and physical processes (from brewing to metallurgy to dye-making), nor in fueling the railways and steamships that so greatly deepened the division of labor. In iron and steel, too, it is hard to see any adequate alternative to fossil fuels. Even under ideal conditions, all the woodland in England and Wales could have supported a maximum annual output of 87,500 to 175,000 tons of pig iron; but actual British output reached 400,000 tons by 1820.[71] Other sectors would also have grown more slowly without such cheap and adaptable energy. Even the steam engine itself was at first sufficiently bulky, fuel-hungry, and dangerous that it was only worth deploying to pump water from coal mines, where fuel was virtually free ("small coals" that were not worth transporting beyond the pit-head)[72]: without that use, and had the coal thus mined not then made fuel cheap more generally, further tinkering to improve the steam engine might not have seemed worth it. Coal does not explain the innovations it was used in, but without it no innovations could have made so much difference.

Similarly, one might object that arguments about New World resources have a weakness which parallels that of older arguments about overseas extraction and European capital accumulation: how can we call something decisive if other factors (for example, capital accumulation within Europe or domestic supplies of food) were larger? The question is important, and not only for this case.

If we are doing growth accounting for a single case, smaller factors are minor factors. But even here, defining categories creates questions. "New World farm goods imported to Britain, 1830" will look small next to "domestic farm production," but "fiber imports from the United States" would look quite large next to "all other fibers." And how specific we make our categories depends on complex judgments (and implicit counterfactuals) about the substitutability of different products, the importance of particular sectors for the larger economy, and so on. (Thus it seems much more likely that New World *resources* were crucial than that the New World profits stressed in some older literature was crucial[73]; there were other profitable investment possibilities, but it is less clear that there were other

[71] John R. Harris, *The British Iron Industry 1700–1850* (Houndmills, Basingstoke, Hampshire, 1988), 25, 56. G. Hammersley, "The Charcoal Iron Industry and Its Fuel 1540–1750," *Economic History Review*, 2d ser., 26, no. 2 (1973): 602–07, estimates the forest needs of iron production; calculations extending this are my own; see also M. W. Flinn, "Technical Change as an Escape from Resource Scarcity: England in the Seventeenth and Eighteenth Centuries," in Antoni Marczak and William N. Parker, eds., *Natural Resources in European History* (Washington, D.C., 1978), 139–64. On Britain's forest cover, see Michael Williams, "Forests," in Turner, *Earth as Transformed by Human Action*, 180–81. Flinn also points out that without coal, charcoal shortages could have hobbled the growth of English iron production *after* 1750 (p. 145); his emphasis is on showing that the earlier rate of output was sustainable, and that there was no worsening charcoal crisis that *caused* the development of coal-based iron-making. See also Pomeranz, *Great Divergence*, 60.

[72] For more details on the relationship of coal, steam, and land transport, see Pomeranz, *Great Divergence*, 61–62, 65.

[73] Most famously, Eric Williams, *Capitalism and Slavery* (New York, 1944); see also Immanuel Wallerstein, *Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century* (New York, 1974).

ways to get huge amounts of land-intensive goods.) Unless we assume that there *must* be affordable substitutes for anything, such judgments cannot be avoided, and there will be cases in which small increments make large differences.

How important coal and the New World will seem depends partly on how convinced readers are of the similarities I have suggested in other areas. First, the calculations above show that these phenomena were not small relative to some reasonable standards (such as Britain's domestic land base); secondly, they appear at the right time to explain a crucial divergence (once we see that this divergence dates to the hundred years surrounding 1800); thirdly, they relieved a constraint—the finite amount of land—which was otherwise very difficult to relieve within the knowledge base and institutions of the time; and finally, the examples of core regions in China and Japan and certain parts of Europe itself (such as Denmark) provide plausible examples of how societies lacking these advantages might have looked. We need not imagine that, without this relief, Europe would have suffered a Malthusian catastrophe, or that, with a slightly longer ecological window, China would have industrialized on its own. (No place need have done so, which is one reason why asking, "Why wasn't England the Yangzi Delta?" may be a useful corrective to ideas derived from the opposite question.) A European ecological crisis *could* have happened, but we can also imagine some more likely outcomes, which could have preserved eighteenth-century living standards but would have been unlikely to lead to thoroughgoing industrialization, and might even have impeded it.[74]

Without both fossil fuels and access to the New World, which together removed the need to manage land intensively, Europe, too, could have wound up on an "East Asian," labor-intensive path. Indeed, there are many signs of such tendencies in eighteenth-century Europe: in the decline of meat eating from roughly 1400 to 1800, in certain aspects of English agriculture and proto-industry, and in almost everything about Denmark.[75] The East-West difference in labor intensity was not essential but contingent; take away the "resource shocks" of coal and the New World and it is not hard to imagine continued European convergence toward a much more labor-intensive world, in which many more people worked on the land, increasing yields while preserving fertility through more marling, more careful manuring, and more gathering of crop residues. Progress along such a path might well have maintained or even slightly improved living standards, but it would not have brought Europe any closer to our energy-intensive, capital-intensive world. Indeed, to the extent to which additional laborers on the land really were productive—so that removing them from farm work would push up agricultural prices— and to the extent that such labor-intensive "solutions" to land constraints gradually decrease the rewards for solving the problem in a different way, they

[74] For examples of how successful labor-intensive adjustments might make industrialization more difficult later, see Pomeranz, *Great Divergence*, 285–97.

[75] Braudel, *Structures of Everyday Life*, 196; and Catharina Lis and Hugo Soly, *Poverty and Capitalism in Pre-industrial Europe* (Hassocks, Sussex, 1979), 13–14, on declining meat consumption; Ambrosoli, *Wild and the Sown*, and David Levine, *Family Formation in an Age of Nascent Capitalism* (New York, 1977), on English agriculture and proto-industry; Kjærgaard, *Danish Revolution*, on Denmark.

could have made breakthroughs like the Industrial Revolution and the nineteenth-century version of the Agricultural Revolution[76] progressively less likely with time.

THE PROCESSES THAT HAVE BEST BEEN CAPTURED in the recent literature on early modern growth and "how the West grew rich" are important, but most of them are also the parts that Europe *shared* with some other parts of the early modern world. Those shared processes alone could have led to a Lower Yangzi result (or a Danish, Dutch, or Flemish result) instead of an English one: not because of any institutional "failures" but due to basic ecological realities and to limits on the ability of labor and capital to substitute for land in the era before fossil fuels, synthetic fertilizer, and the like. To explain East-West *differences*, we need to look at how those constraints were relaxed in Europe. Part of the story—which I have largely neglected here—is technological innovation; since we cannot take that for granted, we cannot argue that, with similar resource bonanzas, China would have had its own industrial revolution. But neither was inventiveness alone sufficient to relax the land constraint and create self-sustaining growth between 1750 and 1850; and without the land saving that coal and the New World provided (without being very labor intensive), one can imagine the focus of inventive efforts themselves being very different. Thus understanding the "European miracle" (once we place it back in the nineteenth century) requires that we look again at some topics from earlier scholarly generations—coal, empire, English exceptionalism, and the *discontinuity* of the industrial revolution—as they appear in a Chinese mirror.

[76] See F. M. L. Thompson, "The Second Agricultural Revolution, 1815–1880," *Economic History Review*, 2d ser., 21, no. 1 (1968).

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