

Efflorescences and Economic Growth in World History: Rethinking the “Rise of the West” and the Industrial Revolution*

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Words are just words, but they bedevil our efforts to write a meaningful history of the world when they limit our discourse, and therefore our understanding of patterns and trends. I would like to suggest that we are missing a word for the opposite of “crisis.” The trends that we commonly encounter in comparative and global histories are: growth, stagnation, stability, and crisis. Yet this vocabulary is stunted, and biased in a way that has made it difficult to recognize the dynamics of premodern societies.

Growth comes in several flavors, to be sure: There is Kuznetzian “modern economic growth” (Kuznets 1966), in which growth encompasses increases in both income per capita and total output, and is rapid

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(total growth in excess of two percent per annum) and self-sustaining, driven by accelerating technological progress. This is sometimes labeled “Schumpeterian growth” to emphasize the creative destruction of older technologies and the constant stream of innovations implemented through market competition among firms (Parker 1984).

Such distinctively modern growth is then contrasted with two other varieties, both of which are held to be relatively inconsequential variations on basic stability: There is “mere” extensive growth (Jones 1988), in which a society’s total output grows, but this is only because population and/or territory increase. Productive technology remains stable or only incrementally changing. In extensive growth, new resources in the form of added labor or land are added to the economy, but population and total output grow at roughly the same rate, so that per capita income is stagnant. There is also “Smithian” growth in which gains from specialization produce higher productivity and hence higher incomes per capita as well as total growth. These gains can come from specialization across different societies that accompanies increased long-distance trade, from regional or urban/rural specialization accompanying increased domestic trade and urbanization, or from increased occupational specialization accompanying increased population density and local circulation of goods and services. However, again there is no major technological improvement; gains therefore remain modest, are quickly counterbalanced by population growth, and cease when specialization, trade, or density in a given society reaches a plateau.¹

These terms rather rigidly divide societies into two kinds: Modern societies experience “modern” or Schumpeterian growth with high growth rates, steadily rising per capita incomes, and technological change; “other” societies may experience episodes of total or per capita growth based on adding resources or Smithian gains, but these rarely amount to much more than gradually creeping growth in a context of technological stagnation. Thus when population growth continues after the period in which Smithian or extensive gains are achieved,

¹ Wrigley (1987, 2000) has clearly shown that Adam Smith himself believed that such growth from specialization, far from producing a modern breakout from economic constraints into exponential growth, instead led to an asymptotically limited growth trajectory, such that once a country “had acquired that full complement of riches” allowed by its soil, climate, and situation relative to other nations, it would “advance no further,” and the condition of its laboring classes would become “hard” in this “stationary” state (cited in Wrigley 2000, 127).

these societies face a Malthusian constraint, and enter a period of “crisis” in which incomes decline, state authority is often contested or fails, religious heterodoxies clash with orthodox faiths, trade declines, and other conflicts intensify. Crises—sharp declines in economic well-being—also can arise from wars, climatic reversals, and harvest failures. In Manichean fashion, this view of “histoire immobile” (Le Roy Ladurie 1977), with slow or slight growth interrupted by periodic crises (with echoes in Marx’s “Asiatic mode of production”) is sometimes held up as the baseline condition always prevalent in premodern societies, so that by contrast any substantial macro-economic growth accompanied by rising per capita incomes is labeled as a distinct break with the past, hence as “early modern” or even “modern” (Komlos 2000). In the words of Eric Jones, summarizing this view as expressed by R. M. Hartwell, “Growth in history, according to Max Hartwell, is binary: zero and one; nothing of note and then everything” (Jones 1994, 14).²

To be sure, even countries experiencing modern economic growth have their crises—the depressions and panics of industrialized capitalist societies, the political revolutions of the nineteenth and twentieth centuries. However, in the world before 1800, we are generally presented with a conceptual vocabulary that emphasizes an absence of meaningful growth—a world of “crises” and “stability/stagnation” (albeit in more sophisticated treatments with episodes of extensive and/or Smithian growth)—as opposed to the purely “modern” advent of dynamic growth involving productive urban centers sustained by major increases in productivity and high and rising per capita incomes.

This dichotomy of economic dynamics is also matched with a dichotomy of regions: Europe is seen as the region of the world in which modern economic growth originated and spread most rapidly; non-Europe is seen as the set of regions where modern economic growth was wholly absent prior to European intrusion and influence.³ Although “non-Europe” is vast and heterogeneous, and so very hard to deal with, a convenient ideal/typical stand-in has been “Asia,” or in

² This dichotomy was also widely adopted in modern Chinese historiography of China (Brook 1999). In the West, a highly influential view of the late imperial Chinese economy as entering a high-level but static equilibrium was provided by Mark Elvin (1973). Recently, Gang Deng (1999) has suggested Chinese economic and political practices created a “locked-in” equilibrium that extends back over 2,000 years.

³ A forceful proponent of this view is Landes (1998). For excellent summaries and critiques of this view, see Thomas and Wigen (1997), Blaut (1993), and Lieberman (1999).

particular, China. As a vast, unified, land-based empire, with a technology and political structure that was assumed to have been largely continuous and stable since the early Han, or at the very least since the fourteenth century revival of the Chinese empire after Mongol rule ("Ming-Qing" China), China provided a perfect conceptual foil for the Europe of small and competing states, focused on seaborne trade and conquest, with a technology and political structure continually shaken by seventeenth- and eighteenth-century revolutions.⁴ This ideal/typical China could be taken as a reasonable exemplar for a general "Asian" type of stable, technologically and politically stagnant, large, and unified empire, including the Ottomans in the Middle East, and the Mughals in the Indian subcontinent. This ideal-typification of Asian empires made for a clear dichotomy between "Europe" and non-European societies, which complemented that between the realm of "modern economic growth" and its absence.

That this model still has considerable influence is clear from a recent analysis of China's long-run economic performance by Angus Maddison (1998). Maddison estimates that both population and total grain output in China rose by about five-fold between 1400 and 1820; he thus declares the entire period was one of "extensive" growth, albeit punctuated by periodic crises (14, 32).⁵

Of course, these dichotomies have been under attack for several decades. In its older form as the "transition from feudalism to capitalism," the simple notion of a transition from wholly premodern to modern economic organization has nearly been jettisoned in favor of more

⁴ Many China scholars also adopted the term "Ming-Qing" or used as an equivalent "Late Imperial China" to describe the putatively stable and coherent social formation that Frederic Wakeman, Jr. denoted in his introduction to Wakeman and Grant (1975, 1), saying "social historians [had] begun to realize that the entire period from the 1550s to the 1930s constituted a coherent whole."

⁵ These data might be thought to settle the issue, and demonstrate the validity of the differences described above. In fact, Maddison's pronouncement of extensive growth seems to influence his data—his table of grain output per capita on page 32 yields a suspiciously identical level of 285 tons per thousand population in 1400, 1650, 1750, and 1820. While we will return to issues of China's growth below, it might be of interest at this point to note that China's rate of population growth was not at all constant, but fluctuated enormously—by Maddison's own estimates (169), China's population grew not at all from 1280 to 1500, then by 60 percent in the next century. Net population growth was again nil from 1600 to 1710, but then showed a gain of 150 percent in the century to 1820. There then followed another period of no population growth to 1900. Such dramatic bursts of population increase, separated by long stretches of stagnation, argue for something like the *opposite* of crises—periods with great bursts of productivity—rather than a steady and uninteresting span of centuries of uniform extensive growth.

complex notions of gradual recomposition and multiple political, economic, and social shifts and changes in European societies (Hall 1999; Mann 1986). Indeed, some historians have dismissed the notion of an Industrial Revolution altogether, along with the distinction between modern and premodern growth. Thus Rondo Cameron (1997) argues that successive, similar waves of growth occurred throughout history, building on each other; Eric Jones (1988) points to recurrent episodes of growth in per capita incomes, going back many centuries; and Jan de Vries (2001, 193) has attacked the notion of disparate “premodern” and “modern” growth patterns to argue that extensive, Smithian, and Schumpeterian growth coexisted “in both the pre-industrial past and the modern present,” although their proportions have varied over space and time.

Yet I wish to argue that this attack has not gone far enough, nor have the changes proposed been sufficiently radical. Circumventing or abolishing the old dichotomies is not enough; if we move simply from saying that everything changed with the onset of industrialization, to saying that nothing really changed because there was always some growth, then we wash all the variation out of global and long-term history. We need to consider more complex dynamics than either a once-and-for-all shift from non-growth to growth, or economic growth as a gradual and universal process that occurs everywhere and always. Otherwise, we shall never be able to grasp what really changed with the development of industrialization, or why.⁶

Moreover, the old dichotomies were reinforced by views of social structure that need to be rigorously examined and discarded if we are to let the full heterogeneity of temporal, regional, and global history flower in our narratives. For example, whether looking at feudal Europe (Hilton 1978) or precolonial India (Habib 1969), or more generally at Asian despotisms, scholars used to assume that in agrarian societies with feeble cities, elites could extract all but a bare subsistence minimum from the peasantry, and then spend it on idle luxury while enforcing a strict political, economic, social, and religious hier-

⁶ John A. Hall (2001) has sagely warned against “throwing the baby out with the bathwater,” that is, of retreating from Eurocentrism into a complete relativism or a universalized “modern” or “early modern” world in which the significance of European power projection and material gains after 1850 are minimized or overlooked. The enormous asymmetry of power projection and material gains across nations in the last two centuries may be considered as good or evil, and as distorting perceptions of histories and cultures; but nonetheless it happened, had enormous significance, and is something to be explained (cf. O’Brien 2000).

archy that justified their predations. Under such conditions, capital accumulation and investment, and thus growth and progress, were impossible. Conversely, any breakdown in those hierarchies, such as the growth of free cities, or of merchant classes propelled by trade, would lift the fetters and lead to progress and growth. Such things, it now seems absurd to say, were thought to happen only in Europe, and constituted being “modern” (or perhaps “early modern”). Where the hierarchies were preserved, it was felt that no growth could occur. Thus a stable political/cultural formation, such as the ideal-typic Ming-Qing China, would also logically face economic stagnation, or at best some extensive and Smithian growth. Yet the notion that pre-industrial societies in general, or non-Western premodern societies in particular, were always treading near the edge of subsistence is badly mistaken. As Sanjay Subrahmanyan (1998, 100) succinctly puts it, one of “our major errors [has been] associating ‘modernization’ . . . with prosperity.” This error has blinded us to the degree and pervasiveness of premodern prosperity and growth.

The breakdown of hierarchies, and the onset of progress, were also once encapsulated into two great breakthroughs in Europe: the Industrial Revolution and the French (and other European) revolutions. The former gave rise to a massive urban working class, thus altering the economic hierarchy; the latter eliminated the privileges of hereditary aristocracy and rulers, thus destroying the old political hierarchy. After the eighteenth century, Europe could thus escape its feudal, agrarian heritage and move quickly to become fully modern, and enjoy the full benefits of modern economic growth.

I apologize if such a blunt and boldfaced recapitulation of old belief-schemas is embarrassing or seemingly absurd. Virtually all historians and sociologists have now abandoned these frameworks (although not all—in two recent bestsellers, by distinguished and prominent academic scholars David Landes [1998] and Jared Diamond [1997], one can recognize features of the above discourse). Yet it is important to recall these viewpoints, because I believe that in response to attack these dichotomies have only been stretched, and not snapped; they need to be destroyed altogether.

The most important attacks on these dichotomies in the last two decades have established two points, although the first was established much sooner, and the latter is still just being recognized. First, it has been widely realized that well before the Industrial and French revolutions, European societies and economies departed from the ideal-typical view of “feudal” economically and technologically stagnant agrarian societies dominated by a predatory elite that wasted all surpluses.

Rather, as early as the eleventh century A.D., northern European agriculture was improved by the adoption of wind and water power, heavy plows and rigid horse-collars; from at least the twelfth century onward the urban trade centers of Venice, Genoa, the Rhenish imperial cities, and the Hanse blossomed into a trans-European set of urban networks that combined management of urban and rural market-oriented craft production (“proto-industrialization”) with a flourishing intra-European and extra-European global trade; and from at least the sixteenth century national rulers brought their unruly agrarian elites to heel by building bureaucratized central (“absolutist”) governments that provided a rule of law and framework for the protection and accumulation of private property and capital. Whether described as the birth of a European capitalist “world-system” (Wallerstein 1974), or as the era of global expansion and trade (Bentley 1996, Subrahmanyam 1999), or more simply as the “Dawn of Modernity” (Levine 2000), Europe prior to A.D. 1800 has been demonstrated to show many of the characteristics of “modern” growth, or of “modern” political and social structures, in gestation. Thus, European histories of this period increasingly refer to this era as “Early Modern Europe.”⁷

This viewpoint has been given a strong fillip by quantitative economic history, which has documented that even in England, the putative home of the Industrial Revolution, no sudden break in economic growth rates is visible in the eighteenth century (Crafts and Harley 1992, Clark 2000). Instead, prior to what is an undeniable onset of rapid and “modern” economic growth in the nineteenth century, we see a gradual and fairly continuous growth curve stretching back to the sixteenth century, involving improvements in agricultural techniques (crop rotations, fertilizing, drainage, selective animal and crop-breeding); urban construction, transportation, and market integration (North 1981, Persson 1988, Komlos 1989, Clark 1991, van Zanden 2001). If we look back across the growth interruption caused by the Black Death, the entire period from at least the twelfth century onward shows strong evidence of growth in commercialization, urbanization, population, and output (Britnell 1993, Britnell and Campbell 1995, Levine 2000). Indeed, certain scholars have argued that one of the leading economies of this period—the Dutch “Golden Age” economy

⁷ Different authors differ considerably about when the “early modern” period starts. Levine explicitly argues for a date shortly after A.D. 1000; others argue for dates ranging up to 1500. See Goldstone (1998) for discussion of the range of usage of “early modern.”

of the late sixteenth and early seventeenth centuries—was “the First Modern Economy” (de Vries and van der Woude 1997).

The second point, which has only in the last few years been winning many converts, is that every one of the above trends that are observed in Europe and labeled as proof of “early modern” character—technical improvements in agriculture and production providing rising total output and per capital productivity (including aggressive transformation of the natural landscape); vast urban-based regional and global trade networks supporting wealthy merchant classes; and increasingly centralized and bureaucratized political regimes that created ordered territories and subordinated elites—are also widely evident outside of Europe prior to the eighteenth century, in China, Japan, Southeast Asia, India, and the Ottoman Empire, and often earlier and in a higher state of development (Elvin 1993, Goody 1996, Subrahmanyam 1996, Wong 1997, Zurndorfer 1997, Frank 1998, Goldstone 1998, Rawski 1998, Berry 1999, Lieberman 1999, Reid 1999, Thompson 1999, Pamuk 2000, Pomeranz 2000a). Therefore, historians of these regions have become quite comfortable in referring to these regions, in the years from perhaps A.D. 1000 or 1300 to 1800, as also “early modern.” Thus Alexander suggests that “the epoch of the Tang-Song dynasty in China (seventh to thirteenth centuries) . . . is . . . the beginning of the early modern” (1998, 217.) A decade ago, I argued (Goldstone 1991) that instead of western Europe’s political and social dynamics being driven by capitalist development, while Chinese and Ottoman (and Japanese) events were driven by dynastic cycles within institutionally stagnant economies, one could show that all the major agrarian bureaucratic societies of Asia shared in basically similar dynamics regarding population growth, inflation, social mobility, state finances, elite competition, and popular unrest, lasting at least from the sixteenth through the mid-nineteenth centuries.

Of course, there is no insistence that all regions of the globe moved in exact parallel in all these dimensions; linkages and similar causal dynamics did not make for lockstep patterns or simple repetition. Different mixings of institutions, beliefs, and contingent events created significant local and regional variation on major themes. Thus scholars now speak of multiple “early modernities,” or even “multiple modernities” (Eisenstadt and Schluchter 1998; Wittrock 1998, 2000; Eisenstadt 2000). Yet the basic fact is that the concept of “modern,” which was once used to highlight a specific condition of extremely rapid economic growth and other institutional features only evident in the nineteenth century in some advanced European nations (constitutional government, secularism in regard to state authority, nation-based citizenship),

has now been stretched with the modifier “early” to encompass almost all of the world’s societies from America to Vietnam, and in most cases all the way from 1000 to 1800.

In one sense, this stretching has been enormously valuable. It has broken down rigid dichotomies that presented Europe after 1800 as modern, leaving the rest of the world and the rest of history as “other.” It is now recognized that instead of mere “stagnation” and “crisis” as the normal condition of all times before 1800 and all regions outside of Europe, the reality is that economic development, large-scale urbanization and trade, and political centralization and territorial control were ongoing and expanding throughout the globe from at least the turn of the millennium. Yet there remains considerable debate regarding how, if almost all societies of the world were “early modern” for 800 years, that period should relate to world history. On the one hand, once one starts looking back in time for evidence of growth, urbanization, long-distance trade, and political centralization, there seems no limit to how far back such trends go. Scholars such as Levine (2000) and Woodside (1998) have suggested pushing the “early modern” back through the Middle Ages in both Europe and China, so that “early modernity” begins almost immediately with the fading of antiquity. On the other hand, going forward, if early modernity begins in the Tang or with Domesday, and is globally pervasive by the sixteenth century, why and how does the “modern” world only emerge belatedly and still relatively locally in the nineteenth and twentieth centuries (Wittrock 2000)?

We may grant, for example, that global trade networks linked Venice, Constantinople, Samarkand, Malacca, and Hangzhou in the fourteenth century (Abu-Lughod 1989, Waley-Cohen 1999), and that circuits of silver tied together Seville, Amsterdam, Acapulco, Manila, Edo, Guangdong, and Beijing in the seventeenth century (Flynn and Giráldez 1995, Flynn 1996); but does that make all of these times and places equally “early modern?” After all, global trade links also connected the Roman Empire and Han China as well as the Hellenistic central Asian kingdoms between them prior to the birth of Christ (Bentley 1998). We may grant that economic growth, urbanization, technological progress, and state centralization were global trends in the sixteenth through eighteenth centuries; but how then do we make sense of the particular emergence of industrial fossil-fuel powered engine technologies, or modern experimental and theoretical science, or constitutional governance, only in a few countries in northwestern Europe, and their relatively slower spread to other regions?

In sum, while I laud (and hope to have contributed to) the recognition of important parallels in major economic and political processes

all across Eurasia prior to industrialization, this recognition under the general rubric of “early modernity” only abolishes certain old errors, and does not resolve the still troubling problem of the “Rise of the West” (Stokes 2001). At a baseline, it establishes that there is no necessary or sufficient connection between such widespread phenomena as urbanization, widespread domestic and international trade, and the growth of centralized and bureaucratized territorial states, and the subsequent emergence of industrialization and constitutional government. The latter must therefore be what I have called the outcome of a “peculiar path” (Goldstone 2002), or an unusual conjuncture, rather than of a general pathway that leads from “early” to “full” modernity. As Joel Mokyr points out, the lack of a transition to industrialization in the Netherlands and other advanced pre-industrial states “was not the exception. Britain was” (1999b, 18). The pattern of change in Britain was *not* simply an accelerated version of a more general and widespread trend to modern economic and political organization.

Indeed, although it is far too early to call it a consensus, there is a growing chorus of voices that argues that (1) no other place in the world besides Europe was moving toward a modern industrial economy during the “early modern” era; (2) even within Europe, no other society besides Great Britain was moving firmly in that direction; (3) even within Britain, such movement was chiefly the result of a contingent and conjunctural pattern of events arising in the seventeenth and eighteenth centuries and not an inevitable development from earlier centuries of economic growth and prosperity; and (4) even in Britain any departure from earlier patterns of growth stretching back to the high Middle Ages is not evident until well into the nineteenth century (Lieberman 1999; Mokyr 1999a, b; Bekar and Lipsey 2001; Clark 2000; Goldstone 1998, 2000a; O’Brien 2000; van Zanden 2000).

I have therefore suggested that since there is no strong connection between phenomena that are now loosely labeled “early modern” and specific features of the “modern” world (e.g., industrialization, accelerating economic growth propelled by scientific and technological progress, the end of traditionally sanctioned political authority), the term “early modern” is misleading. The unity of the global social processes from 1300 to 1800 can be more accurately embraced under the label “late preindustrial” or, if one wishes to avoid privileging industrialization, as simply “late premodern.” Indeed, a sensible periodization of world history might run from “ancient” (3500–500 B.C.) to “classical” or “axial” (500 B.C.–A.D. 500) to medieval (A.D. 500–1350), to late premodern (1350–1900) to modern (1900–), taking rather arbi-

trary 500-year intervals, except for using the Black Death to separate the end of the medieval from the late premodern.⁸

Still, any such broad periodization is unhelpful if it does not overcome the dichotomy between “growth” and “non-growth.” What we need is not just better labels or endpoints for periods of history, but new terms to more accurately describe the dynamics of societies within and across such periods. To say that “growth” as opposed to stagnation is “modern,” and then because we can find such growth going back to the Middle Ages we should label the period since the Middle Ages as “early modern,” seems to me to perpetuate a misconception, instead of overcoming it. I believe we can find “growth”—in the sense of simultaneous growth in per capita and total incomes, reflecting technological and institutional innovations—all the way back to classical and even ancient times. Indeed, the agricultural revolution itself, and the onset of the iron age, were both profound technological breakthroughs that changed society; modernity is as rooted in those changes as in any broad global shifts that took place between 1000 and 1800. Yet I trust most would shrink from thereby calling the agricultural revolution the beginning of “very early modernity.”

So let me propose another term: “efflorescence,” intended as the opposite of “crisis.” Where a crisis is a relatively sharp, unexpected downturn in significant demographic and economic indices, often accompanied by political turmoil and cultural conflicts, an “efflorescence” is a relatively sharp, often unexpected upturn in significant demographic and economic indices, usually accompanied by political expansion and institution building and cultural synthesis and consolidation. Such “efflorescences” typically involve both Smithian and Schumpeterian growth, in a mutually reinforcing fashion. They are often seen by contemporaries or successors as “golden ages” of creativity and accomplishments. Moreover, they often set new patterns for thought, political organization, and economic life that last for many generations.

The role of “efflorescences” in understanding world history is to replace the dichotomy between “stagnation” (seen as typically premodern) and “growth” (seen as typically modern). Rather, I shall argue that throughout history, all societies have experienced periods of

⁸ This periodization owes much to the thoughtful presentation of Jerry Bentley (1996), while differing slightly. It is also, by chance, very similar to the periodization of Eurasian history based on Inner Asian state formation proposed by Di Cosmo (1999).

efflorescence, as well as extensive growth, stagnation, and crises—but that these processes are all distinct from Kuznetzian “modern” economic growth founded on the continual and conscious application of scientific and technological progress to economic activity.

In the next two sections, I wish to use the concept of efflorescences to further dissect—and destroy—the dichotomies discussed above: “Europe” vs. “Asia” and “Modern Economic Growth” vs. “Stability.”

IN SEARCH OF “NATIONS”: POLITICAL STRUCTURES IN EUROPE AND ASIA C. 1700

If we look at Europe in the early eighteenth century, near the end of the “early modern” period, we would expect to see any “early modern” trends to be well established. We have already spoken of urbanization, economic growth, involvement in global trade, and territorial centralization and government bureaucratization as trends in this period that are evident both inside and outside of Europe. We could also add the spread of printing and literacy (which, thanks to information on commercial publishing in Qing China, we also know to be comparably expanding there [Brokaw 1996, Rawski 2002]), and the growth of large, professional, infantry-dominant, artillery-supported militaries relying on gunpowder weapons (Parker 1988, McNeill 1989, Di Cosmo 2002) as additional pan-Eurasian late pre-industrial trends. We could also add vernacularization, also recently shown to be as widespread outside of Europe as inside (Pollock 1998, Rawski 1998, Lieberman 1999).

However, for this section I would like to focus on one element of a putatively “early modern” Europe still often used to contrast with Asia—namely, the growth of national states. Europe, it is argued, began from the Renaissance and Reformation onward to develop the basis for nationalism in the early modern period through a shift away from a cosmopolitan universal language that spanned and united European elites (e.g., Latin) toward regional vernaculars that separated national elites but joined the latter to their own national populations (Gellner 1983). Such linguistic and cultural integration was reinforced by religious divisions that united the beliefs of sovereigns and subjects, officially declared in the “*cuius regio, eius religio*” policy of the Peace of Augsburg in 1555 and confirmed in the Peace of Westphalia in 1648. Moreover, as constant wars among nations continued, dynastic and religious claims to loyalty were eventually ground down to affiliations with relatively compact, centralized, nation-based states.

This is a commanding picture; unfortunately its abstract schema of development is belied by the facts, for even around 1700 almost nowhere in Europe can one find centralized, national states, based on a common linguistic and religious culture. The dominant political formations in Europe at that date remain the multinational and/or multireligious empires (the United Kingdom, Denmark/Norway, Austria-Hungary, Russia, Prussia), and loose confederations (Switzerland, United Provinces).

In the British Isles, Catholic Ireland was ruled as a virtual subject territory of aliens by the English, while Scotland remained a separate nation, united with the English Crown only from 1707 and still prone to Jacobite Rebellions up to 1745. This is not even to mention the status of the British Crown Colonies in the New World as imperial possessions. In Spain, Castile remained dominant but not lord of a unified nation. The constitutional separateness of the Aragonese kingdoms was only ended in 1714, while linguistic differences (an active Catalan society) remained. Basque, Catalan, Galician, and other regions remained antagonistic while Castile continued to draw much wealth from direct control of its Caribbean and Latin American possessions; the varied regions of peninsular Spain only gained a “national” identity when resisting the French invasion of the early nineteenth century (Perez-Diaz 1998: 255). The lowlands between France and Germany consisted of territories under foreign Hapsburg control in the south, and a confederation of united provinces in the North. Even the latter, despite periods of strong leadership by Holland and noble stadholders, was not a centralized national state. Indeed, in 1700 the Dutch stadholder was also King of England, Scotland, and Ireland. A truly national government and national identity spanning the regent elites and ordinary citizens in the United Provinces was not aimed at until the Orangist Revolution of 1747, and not achieved until after the Patriot Revolution at the end of the eighteenth century (Israel 1995). Similarly, despite a strong Swiss national identity stemming from the Middle Ages, there was no centralized Swiss state, nor a Swiss language or religion; instead Switzerland remained an anomaly: a confederation of Catholic and Protestant, German- and French- and Italian-speaking cantons.

In by far the largest part of Europe, east of the Rhine, nothing even resembling national states was in the process of formation before the nineteenth century. The four major empires: the Prussian (with scattered noncontiguous possessions in the Netherlands, parts of Germany, and Poland); Austro-Hungarian (with numerous nationalities from

Italy through Germany, Hungary, Poland, and the Balkans); Russian (just about to humble Sweden and build its Baltic “window to the west” to complement its expansion into the Caucasus and Siberia); and Ottoman (about to embark on another round of expansion, defeating Russia in 1711 and later securing Crete) empires controlled the bulk of the European land mass from the Urals to the Rhine and from the Mediterranean to the Baltic. The fading powers of Sweden and Poland (the latter controlling the Ukraine and Lithuania as well as ethnically Polish lands) held their territories, although the latter would be divided and swallowed by the first three empires mentioned above before the end of the century. Denmark’s Crown controlled Norway as well as Denmark for another century; while in Italy a hodgepodge of powers led by the Bourbon kingdom of Naples and the Savoy kingdom in the north held bits and pieces of what would not be for another century and a half the Italian nation. Minor principalities, electorates, duchies, marks, bishoprics, counties, and such continued to dot the landscape of Germany and northern Italy (Tilly 1992, Spruyt 1994).

Across the entire map of Europe, only two regions even approach the ideal of a centralized nation-state united in language, religion, and collective cultural identity: France and Portugal. With regard to France, however, it is questionable whether the unity of elite and national culture truly held. Aside from the fact of Bretons, Normans, Provençals, and other speakers of Occitan and regional tongues still holding to strong regional identities and cultures, and the disunity of *pays d’élection* and *pays d’état* (the latter still having independent provincial estates able to resist centralizing authorities), and the vast welter of local, regional, and urban privileges and customs that made it a constant challenge to rule France as one nation (Collins 1995), the French elites thought of themselves less as bearers of a distinct national culture, and more as universal cosmopolitans (Giesen 1998). In eighteenth-century Europe, not unlike thirteenth-century Europe, titled elites across the continent spoke a common tongue—Parisian French in lieu of Latin. Frederick the Great made no secret of his disdain for German, and the Russian court spoke the language heard in Versailles, not the streets of Moscow. French scholars of the Enlightenment sought to develop a universal ideal of absolute monarchy that could hold across Europe, not an identity rooted in a specifically French nationhood. Louis XIV may have striven for French glory, but it was a glory of his rulership and his dynasty, a *gloire du roi*, to be augmented by imperial conquests in the Netherlands and the Rhineland, not a *gloire de la nation*—a phrase that would not make sense until after his passing.

In short, a comprehensive tour of Europe c. 1700 reveals only one society that is oriented to a national, centralized state, harmonized culturally and linguistically with its people—and that is Portugal (although even that somewhat diluted by the size and wealth of its Brazilian colony). Elsewhere, multinational empires, multilingual confederations, and aspiring universal monarchies were the norm.

What of Asia? In the Middle East, the Ottomans collided with the Safavid Persians, although Nazir Shah would soon rise from Afghanistan and terrorize them both (Subrahmanyam 2000). In India, the Moghul empire began to dissolve following the death of Aurangzeb, leaving a subcontinent fractured among various warring sultanates, mini-empires, and kingdoms. Burma, Thailand, and Vietnam asserted their national character, as did Korea although under varying degrees of Chinese influence (Woodside 1998, Lieberman 1999). Japan remained a defiantly independent and homogenous nation, perhaps the closest thing to a culturally and political unified nation-state in Asia, although still relatively decentralized under the *daimyo/han* system of regional lords. By contrast, the Manchus ruled a vast multinational empire, much like that of the Austro-Hungarians, with a multinational civil service and military presiding over Chinese, Manchu, Mongolian, and Tibetan subjects. Yet this crystallized only after more than a century of war against China, Korea, and various Mongol and Central Asian khanates and empires.

In sum, as late as 1700, one is hard-pressed to make the distinction between a “Europe” of national states and an “Asia” of united empires as any more than a badly anachronistic application of nineteenth-century ideal types. As Rawski (2002) correctly points out, in the eighteenth century the dominant political forms in Eurasia, from the British Isles to the China Sea, were multinational empires, not national states. “Modernity” would have to wait.⁹

⁹ P.H.H. Vries (2002) has elegantly detailed the problems in the conventional arguments for growth stemming from Europe’s division into competing states, namely that a plurality of states prevented any one state from stifling innovation, and that competition among states prodded rulers to tolerate, even encourage, innovation. Vries shows that neither of these contentions holds—despite the plurality of states, most of them *did* stifle innovations in thought and practice quite strongly; despite competition, most states did not encourage innovation, except in regard to military practice, which usually benefited the state at the expense of the broader economy. Most competitive practices prior to 1800 were mercantilist, assuming that there was a fixed stock of wealth or trade for states to capture and divide, rather than showing any awareness of possibilities for economic growth. In any event, the contrast between a Europe of plural competing states and a “non-Europe” of large

The emergence of national states is a global, nineteenth-century process, developing in Egypt, Thailand, and Japan as much as in the monarchies and empires of Europe (and arguably still quite incomplete in such “modern Western” nations as Canada and Belgium). I make this point only to illustrate once again how very similar the mix of varied European polities was to the mix of polities found in other parts of Eurasia. We have already learned that in the early eighteenth century the advanced regions of northwest Europe and East and South Asia were comparable in living standards, in the extent of production for market and domestic and international trade, and in the progress of printing, vernacularization of literatures, and centralization of territorial rule (Pomeranz 2000a, Das Gupta 1994, Wong 1997, Blussé and Gaastra 1998, Lieberman 1999, Pollock 1999, Wills 2001). The basic temporal, economic, and political patterns of the expansion and contraction of power followed similar rhythms and causal foundations, as the balances of population and resources, of elite mobility and administrative stability, and of price inflation and its effect on state finances, were basically similar from England to the Ottoman Empire to China (Lieberman 1999, Goldstone 1991). Even the ideal that elite power and privileges must be limited to protect the welfare of ordinary peasants, and the belief that the ruler’s legitimacy was bound to the well-being of *all* his subjects, far from being a “European” viewpoint, was also found in indigenous Islamic, Confucian, and other Asian traditions that intermixed across the Eurasian continent. Though Europeans reviled Turkish despotism, from 1600 to 1800 the Ottomans increasingly legitimized their rule through principles of justice that explicitly made the sultan the guardian of the property and rights of the rural and urban producers against the abuses of the military elite (Ergene 2001). Wong (1997, 79) points out that, “in China, a state staffed by a civil service bureaucracy ruled a vast society according to rules and regulations created by a policy-making process that limited the arbitrary actions of the ruler.” As late as the nineteenth century, when the Qianlong emperor admitted the Torghuds (central Asians fleeing from Russian expansion) into China, this was widely celebrated as evidence of his ability to provide for the welfare of all the peoples—whether ethnic Chinese or not—in his domain (Millward 2002).

inert empires is vastly overdrawn: Most of Asia and the Middle East had a plurality of competing states for much of their history, and in Europe the dominance of the “modern state, with its direct rule, its monopoly of the legitimate use of violence and of taxation . . . was a creation of the nineteenth century” p. 112.

Still, we do not want to leave an indelible impression of overarching sameness from the Black Death (or before) to the nineteenth century, from the Atlantic to the Pacific. Important dynamics of change over time, and major cultural variations across time and space, prevailed. We can understand at least one important part of these variations by focusing on key periods and places that I wish to label “efflorescences” in history.

BEYOND PREMODERN STABILITY VS. MODERN GROWTH:
EFFLORESCENCES IN GOLDEN AGE HOLLAND, MEDIEVAL
NORTHWESTERN EUROPE, THE HIGH QING IN CHINA,
AND EIGHTEENTH-CENTURY ENGLAND

A number of scholars, most notably Eric Jones (1988, 1994) have argued that substantial episodes of growth in per capita incomes occurred prior to British industrialization. Jan de Vries (1994) and Akira Hayami (1986) have argued that an alternative mode of development—which they label an “industrious” instead of “industrial” revolution—can provide such growth. Pointing to Golden Age Holland and Tokugawa Japan, as well as Song China, these scholars argue that intensive orientation of households to the market, and specialization and division of labor, can unleash substantial growth. And they acknowledge that this is not merely “Smithian” growth, but cannot be disentangled from “Schumpeterian growth,” since market growth and specialization also encourage innovation and reward new technologies. Thus Golden Age Holland innovated in shipping; warehousing; finance; and glass, beer, and textile production, and greatly expanded the use of wind power (de Vries and van der Woude 1997). Tokugawa Japan innovated in agricultural techniques and tools, and expanded its silk production to replace Chinese imports (Hunter 2000); Song China developed extensive water power and iron works and shipping (Hartwell 1966, Jones 1988). One could add that similar innovations in power and agriculture marked the high Middle Ages in Europe. One could further note that eighteenth-century England’s advances in textile spinning machinery and metallurgy were also wonderful preindustrial inventions, similar to those already mentioned in their impact, but not unprecedented in world history (Elvin 1973, 1988; Hartwell 1962).

Were these episodes, and others like them, truly an onset of “modern” economic growth? As we noted above, every single one of these episodes—Golden Age Holland, Tokugawa Japan, Song China, the High Middle Ages in Europe, and eighteenth-century England—have

advocates who claim that they were “early modern” in character, and marked an onset of “modern” patterns of growth. If we are to better understand the nature of preindustrial efflorescences, and the odd emergence of self-sustaining and accelerating growth in nineteenth-century England, we need to appreciate the achievements of the former rather than overlook them in light of the latter. Let us look in somewhat more detail at Golden Age Holland (c. 1570–1670); the High Middle Ages in northwestern Europe (c. 1150–1250); China during the high Qing (c. 1680–1780); and England during the “Industrial Revolution” (1760–1830).

Golden Age Holland

In a series of bold publications, Jan de Vries (2000, de Vries and van der Woude 1997) has asked us to rethink our conceptions of the Industrial Revolution, and the roles of Great Britain and the Netherlands in modern economic growth. He has made two striking claims: First, that even without the coal-fired and steam-powered industrialization of Britain’s nineteenth-century industrial revolution, seventeenth-century Holland had already experienced a century of sustained per capita income growth combined with population expansion and urbanization; it thus had broken free of Malthusian constraints to experience a “modern” style of economic growth. Second, because this growth was a different variety of “modern” economic growth than the classic smoke-belching factory, iron and coal transformation of Britain, there must be a variety of different paths to “modern” economic organization, and the industrialization of Britain should not be privileged as the critical path or necessary model for economic modernization.

De Vries marshals considerable quantitative evidence to back these claims; yet the fit between the evidence and his bolder interpretive sweeps deserve some skeptical scrutiny. When closely examined, the standard of living during the Golden Age proves to be merely stable during a period of population increase, not strongly growing. What’s more, Holland does not surpass its pre-Reformation, “premodern” levels of real wages until its population declines, producing an inverse Malthusian “benefit.” Thus the claim of an escape from Malthusian conditions seems to be overstated.

In addition, while Golden Age Holland did indeed experience an “efflorescence” of invention, intensification and productivity growth in agriculture, and stable per capita incomes despite substantial population growth, such a pattern is neither uniquely Dutch nor “modern” by global standards. Western Europe in the twelfth and thirteenth

centuries, Imperial China from 1680 to 1780, and even classical Greek civilization experienced demonstrable periods of rising population combined with rising or stable per capita incomes, underpinned by intensification and increased productivity of land and labor in agriculture, urbanization, and increased commercial activity. What all of these “high” or “golden” periods failed to do, however, was to sustain a sharply rising level of per capita income past two or three generations of population growth. Thereafter, innovation ceases or provides diminishing returns as vested interested and conservative states or churches halt the pace of change in knowledge and technology (Mokyr 1994, 1999a; Goldstone 1987); the result is a stagnation or decline in living standards often leading to political as well as economic decay.

De Vries argues that Dutch Golden Age growth is “modern” by relying on the strawman dichotomy between “premodern” and “modern” growth elucidated above. For de Vries, premodern growth is at best extensive, so that economic growth is constrained by population levels. If population is falling, one can have rising per capita income, but if population is growing, per capita income is stagnant at best, and likely to fall. Massive structural change, such as major increases in urbanization, cannot be sustained at the same time as increases in real incomes. Since Golden Age Holland combined sustained population increase, massive structural change toward urbanization, *and* simultaneous rises in gross domestic product (GDP) per capita, which are in turn traced to technological innovations in manufacturing, food processing, warehousing/transportation, agricultural intensification, and energy use (both peat and wind power augmenting human and animal muscle), Holland was out of the Malthusian trap. Its economy and growth pattern were therefore “modern,” even if not industrial. De Vries then goes even further and argues that having proved the existence of “modern” growth that was not tied to British-style industrialization, we must acknowledge that there are a diversity of paths of “modern” growth.

However, in contrast to de Vries’ assumption, the notion that “Malthusian” economic conditions—defined as conditions in which any productivity increases are always matched or exceeded by population growth, so that population growth across several generations is always accompanied by flat or declining per capita income—are typical of all economies prior to industrialization is wrong. In fact, pre-industrial agrarian economies typically went through cycles that included extended periods in which both population and per capita incomes grew substantially. Such periods included increased urbanization and agricultural intensification, and involved advances in manufacturing,

transportation, and increases in trade that raised productivity and total output. This was usually the result of generating new knowledge and new solutions to problems of production (Tainter 2000, Mokyr 2000), that in turn provided the basis for further specialization, gains from trade, economic expansion, and investment in infrastructure. Such episodes can be traced back to at least 3000 B.C., with the sudden emergence of massive population mobilization in Mesopotamia and Egypt for city and monument construction, often seen as linked to the initial emergence of writing technology and the gains it offered to government and economic organization (Gellner 1989, Dudley 1991). Both the Mycenaean era and the Classical Age of Greece are seen in archaeological records to show periods of rising population, rising urbanization, and rising per capita incomes (Morris forthcoming). Italy and the Mediterranean under the Antonine emperors of Rome are widely acknowledged to have been both more populous and more prosperous than under the early Caesars, and to comprise a full market economy with levels of agrarian productivity comparable to high medieval and even early eighteenth-century levels (Grantham 1999). The Abbasid Caliphate and Song China are additional examples of premodern efflorescences (Jones 1994); there were likely many more throughout Eurasia and the New World that gave rise to the complex civilizations we refer to as the great empires.

However, increasing population growth, density, and social complexity also created vulnerabilities, such that epidemics, government fiscal problems, elite competition, and social unrest could undo complex organizational and ecological networks (including cities, roads, irrigations systems, trade networks, centralized governance) leading to depopulation, disorder, and “dark ages” (Tainter 1988). In sum, properly understood, premodern economic history is neither agonizingly slow but steady growth, nor stagnation punctuated by periodic crises. Rather, it is more like a series of pulsations, with periodic “efflorescences” leading to intensive rounds of per capita income growth, urbanization, extensive regional and international trade, and considerable population growth accompanied by stable or rising incomes and economic, political, and cultural specialization and complexity; these are followed by periods of decline or collapse in which population falls or stagnates, and living standards decline until postcollapse recovery.

So I would ask of de Vries: Do we really call all of these cases “modern” economic growth? Of course, de Vries would immediately reply that the scale, duration, and scope of growth in the Dutch Golden Age was greater than any of these prior incremental growth periods, so that the Dutch case was unique. However, in the following paragraphs,

using de Vries's own graphs and data, I show that the economic growth in Golden Age Holland, when properly baselined, was not nearly so great as de Vries suggests, but rather was comparable to other episodes of premodern growth.

First, let me concede that Holland did wonderful, innovative, productivity-raising things in both its agrarian and non-agricultural economy during the Golden Age. One should never want to lessen that achievement. In textiles, brewing, glassmaking, shipbuilding, printing, canal and irrigation works, land reclamation, peat/energy use—not to mention microscopes, physics, chemistry, and so on—Holland was the vanguard of Europe, leading the way in productivity-enhancing advances. Yet one still has to quantify that achievement in terms of living standards, and ask what really was done.

What does de Vries's data show about shifts in real wages and GDP? Let us look at de Vries's data, shown in Figure 1. Holland's "Golden Age" clearly appears in the divergence from England's wage pattern from 1570 to 1680. In both England and the Netherlands, real wages fell dramatically from c. 1500 to 1570, but then wages diverged, falling

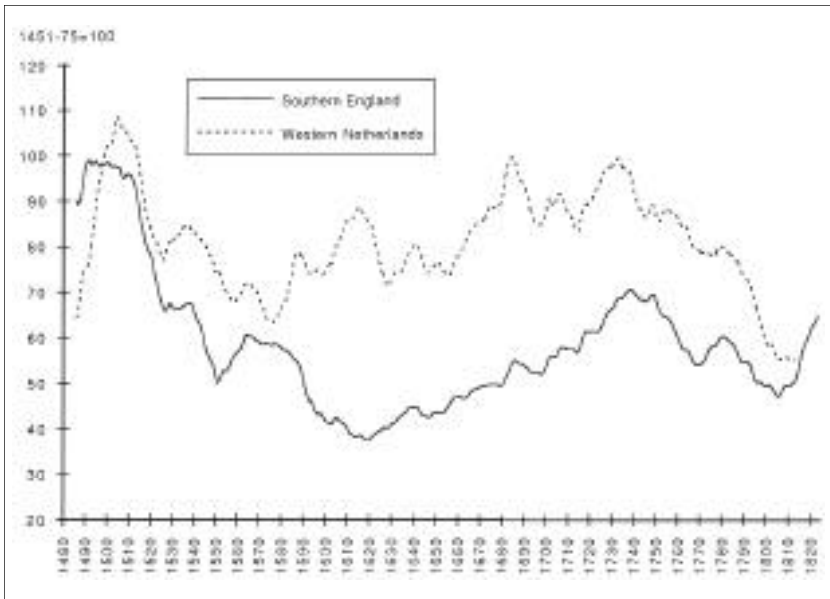


FIGURE 1. Real wage indices for building craftsmen in southern England and the western Netherlands, after de Vries (2000).

almost 50 percent further in England, but rising by 50 percent from 1570 to 1670 in the Netherlands, even though the Netherlands' population also grew by nearly 50 percent in this century. This 50-percent rise in real wages despite rising population nicely matches de Vries's estimate of the rise in agricultural productivity for the same period, of roughly 0.4 percent per year. What's more, even though Holland suffers demographic and economic setbacks after 1670, real wages remain high and well above English levels all the way to 1730, after which *both* Dutch and English real wages sharply decline, albeit Dutch wages remain higher to 1810 (despite the British "Industrial Revolution" of 1760–1830). Holland thus has an early "divergence" from the English pattern, shows sustained population growth and per capita income gains, and maintains its exceptionally high wage levels even through its own economic crisis, and through Britain's early industrialization. This outstanding performance, attained by technological advances in food and material processing, increased specialization in agriculture and industry, and expanding international commerce, constitutes what de Vries labels "modern" economic growth.

Yet was this clearly a 50 percent increase in per capita incomes? It depends to an extraordinary degree on exactly where one places the baseline and the endpoint for that measurement. If we are simply free to arbitrarily pick the lowest point in the real wage curve as our baseline, then looking at the English real wage curve, we find that from its low point in 1620 at index level 40, it rises to index level 70 by 1730—an increase in "per capita GDP," to figure as de Vries does, of 75 percent in 110 years. That far exceeds the 50 percent per capita increase of Holland's Golden Age—why isn't this the "golden age" of pre-industrial Britain? The reason is that much of this gain is simply an increase from crisis conditions in the early seventeenth century, and not a genuine gain over earlier income levels.

Yet much the same can be said of Holland. If we look very carefully at Figure 1, we see that there is basically no change in the real wage series from 1530 to 1660; the curve simply fluctuates up and down around the 75 index level. Almost all of the 50 percent increase in per capita income is achieved by contrasting the maximum trough year of 1570 with the peak achieved in a huge upsurge in wages from 1660 to 1690. However, it must be noted that the Netherlands' population growth suddenly ceased in the 1670s, and so too did growth in nominal wages (de Vries 2000, 457). The apparent "increase" in real wages from 1660 to 1690 reflects neither increases in population nor in compensation paid to workers—it is an artifact of population—and hence agricultural demand, suddenly stagnating while nominal wages

remained rigidly fixed. Indeed, as the result of war and plague, linked to the British Civil Wars and the French Frondes, population in England and France dropped sharply after 1660, thus letting grain prices fall throughout northwestern Europe. Since grain prices dropped, while Dutch nominal wages remained fixed, the real wage index shows a sharp rise. As de Vries himself notes, “almost all the real wage developments in this interval [after the 1660s] were the result of price movements.” Thus to measure the GDP gains in the Netherlands solely by looking at the difference in the real wage index between the trough of the 1570s with the peak in the 1690s is to confound two different processes: up to the 1660s there is marked growth in both population *and* in nominal wages, giving a rough stability in real wages. From the 1670s, real wages rise only because both population and nominal wages *cease* to change, and grain prices decline. Again, if one is free to pick one’s favorite start- and endpoints simply for the sake of argument, one could say that from a peak index value of 85 in 1620, Holland’s real wages fell to an index value of 75 in 1660; thus we should look at the middle of the seventeenth century as a period of declining real wages, and have to speak of the “myth of Holland’s Golden Age.”

In fact, we should set aside any arguments based on arbitrary endpoints, and focus on longer-term trends. These are three: First, from 1530 to 1660, Holland shows both a sustained growth in population and in nominal wages. Second, during this period real wages in Holland are essentially stable, and are at considerably higher levels than in other European countries—this despite a more than 50 percent increase in total population and a doubling in percent of urban population (de Vries 2000, 454). Third, this stable and relatively high real wage level is sustained at a time when most other societies in Europe that are facing similar population growth, such as England and France, are facing substantial wage declines. These are extraordinary achievements of the Dutch economy, and they could only be produced by significant improvements in agricultural productivity, urban specialization, and commercialization, manufacturing, and transport.

I therefore accept the claim that Holland’s real wage level diverged in a positive direction from the experience of England. But we need to be clear and precise about this achievement. It was not a matter of sustaining a multifold increase in real income simultaneously with a multifold increase in population. Rather, the achievement was to maintain a stable and historically high level of real wages (and presumably in the broader economy real incomes) during a period in which population increased by just over one-half and the urban percentage of population doubled. It is that achievement which we need to seek if history offers

any parallels, in order to judge the uniqueness or “modern” character of Holland’s Golden Age economic performance.

Before we turn to that matter, we should note that, indeed, Holland’s real wages also stayed high for a century after the Golden Age. Yet this was clearly, as de Vries himself notes, a matter of complete nominal wage rigidity after 1675 (2000, 459) combined with a Europe-wide decline in grain prices. In the long run, such wage rigidity may not have been a blessing for the Dutch economy. Its textile production in Leiden, a leading sector of its economy for generations, collapsed virtually completely in the early eighteenth century. While de Vries maintains that the constraints on the Dutch economy were not at all Malthusian in character, his own data shows that throughout the entire period from 1520 to 1800, no sustained rise in real incomes took place *except* in a period when population was declining (1670 to 1740). This strikes me as at least somewhat Malthusian, or if one does not like that term, as somehow not “modern” to say that over nearly three centuries no sustained increase in real income above earlier levels could take place without a marked population decline.

If the Dutch achievement was not to dramatically increase per capita incomes despite population increase, but merely to sustain a relatively high level of per capita income despite that increase, it becomes fairly easy to find parallel cases of economic performance—both within and outside of Europe.

The High Middle Ages in Northwestern Europe

In another essay, this one focusing on urbanization and how it was agriculturally constrained, de Vries (1999) makes much of the remarkable late medieval expansion in northern Europe in the twelfth and thirteenth centuries. In the eleventh century, two-field systems, difficulties in clearing forests and tilling heavy soils, and shortages of man and animal power created a situation of low productivity, low market participation, and the classic manorial economy. With yields in the neighborhood of five hectoliters per hectare (a yield ratio of roughly 2.5), “it is no wonder” as George Grantham relates, that cities were merely small fortified towns and “the Frankish kings and ecclesiastical officers literally ate their way from manor to manor” (cited in de Vries 1999, 134). Yet by the thirteenth century, over the course of a century and a half agricultural yields had risen 100 percent to 8 to 10 hectoliters per hectare. While it is notoriously difficult to precisely date the medieval productivity revolution, if we say that agrarian yields doubled over the course of 175 years, say from A.D. 1050 to 1225, that provides precisely

the 0.4 percent annual gain in productivity (though in this case of land, not labor) that de Vries tells us was attained during the Golden Age in Holland, and that he offers as evidence of “modern” productivity growth. Indeed, it should not surprise us that pointing to such growth, social scientists such as Michael Mann (1986, 378), Alan Macfarlane (1987), and David Levine (2000) have confidently argued that “modern economic growth” began in the High Middle Ages shortly after 1000.

While it is more difficult to calculate the rise in productivity per person, since we lack precise information on the amount of land cleared and total population and output figures remain controversial, there is no doubt that this improvement in yields coincided with a substantial increase in total population, urbanization, commercialization, and energy use (Britnell 1993). The story of the medieval economic “revolution” is well known (White 1962, Cardwell 1969, Britnell and Campbell 1995, Mokyr 1990): adoption of the heavy plow and iron tools allowed clearing forests and tilling richer, heavier soils; an extraordinary proliferation of water-powered mills provided power for grain processing and petty manufactures; the numbers and efficiency of draught animals greatly increased; and urban population for Europe as a whole reached ceilings not exceeded until the nineteenth century (approximately ten percent of total population). In some ways the building of hundreds of vast and extraordinary cathedrals (Pacey 1992), the support of a huge non-productive class of ecclesiastic and military elites (residents of monasteries tilled the soils, but nuns, priests, and itinerant monks did not), and the growth of cities to population percentage levels not reached again until 1500 or even 1800 (de Vries 1999, 139) speaks more to the vast increase in agricultural output per person than crude measurements of annual fractional percentage point increases. The high medieval civilization of the thirteenth century was indeed a “high” or “golden age” of its own, resulting from improvements in agricultural intensity and techniques and tapping new sources of power (mainly water but also wood and charcoal from the felled forests). Resources were freed to produce truly unprecedented—for northern Europe—levels of urbanization, monumental construction, and military/political/religious elites.

Certainly, prior to the fourteenth century, medieval northern Europe breaks through any Malthusian barriers with the improvements in its technology and productivity. In sustaining an overall doubling of population (Livi-Bacci [1992, 31] estimates Europe’s population at 30 million c. 1000 and at 74 million c. 1340), with increased urbanization, commercialization, technical innovation, and agrarian improvement,

by the same standard applied to the Dutch Golden Age the late medieval efflorescence should be considered a comparable episode of remarkable growth.

Yet while it may be unexceptional to consider both Golden Age Holland and Medieval Europe as extraordinary episodes of pre-industrial growth that—at least temporarily—break Malthusian bonds, it is little appreciated that an even more impressive, if structurally similar, pattern of growth arose in Qing China.

The High Qing in China

In the seventeenth century, with the Ming dynasty in China facing rebellion and fiscal decay, one of the more powerful nomadic groups from “outside the walls” was emboldened to seek power in China proper. Over the previous decades, these Manchus, although based in the thinly settled northern regions of Manchuria, had been extending their power into the lowlands of northern China, and integrating Chinese, Mongolian, and Manchu groups into multi-ethnic military groups called “banners” after their insignia. They had also built up their knowledge of Chinese practices, and when in 1644 the Ming emperor was in dire straits, they were invited into China to help fight against the anti-Ming rebels. However, once in Beijing, the Manchus chose to seize power. After defeating the rebels, the Manchus turned on the Ming loyalists, and fought for several decades to subdue all resistance in China. They also fought against Mongol khanates to the West, and incorporated Tibet and parts of Central Asia, creating a vast, multi-ethnic empire. They identified their rule by the dynasty name “Qing.”

The Qing created much more than just another Chinese dynasty. Although they retained many Ming institutions for governance inside China proper, they augmented those institutions with oversight by bannermen and intensified personal rule by the emperor and drastically reformed the constitution of the military and the imperial household (Rawski 1998). Perhaps more importantly, Qing conquest created a dramatic change in the social and economic structure of the most important areas of southern China, leading to the collapse of huge bondservant and subservient tenant-farmed estates, and the restoration of a largely free and independent peasantry. While some who have commented on this shift see it as inimical to progress (Mazumdar 1998, Gates 1996, Huang 1990), I am inclined to agree with Li (1998) and Rawski (2002) that the combination of a large-scale shift to a free peasantry, combined with a shift from direct to more market-oriented

control of that peasantry by the central state and local elites, was an essential component in the vast increase in market specialization and participation by independent, profit-maximizing peasant households that fueled the Qing economy.

In addition, Qing expansion, both before and after the conquest of China proper, created a territorial polity many times larger than that of the Ming, embracing a diversity of peoples and cultures, mainly Manchu, Mongolian, Central Asian (Uighurs and others), and Tibetan. These vast territories were ruled by separate administrative units, forged for the task. The result was a novel multifaceted, multinational administration and military, organized on different lines than had ever been seen in China before (Di Cosmo 1998, Rawski 1998).

The Qing also created a cultural infusion, as Mongol, Manchu, and Tibetan influences shared space with Chinese rituals and texts in the ceremonial and administrative life of the rulers. Chinese intellectuals and civil servants were also forced to re-evaluate their own history, culture, political organization, and actions in the face of the overwhelming Manchu conquest of their homeland.

The settling of new territories, the freeing of the peasantry, the expansion of international trade, and the colonization of new lands in Manchuria and the far West all created opportunities for economic expansion. The introduction of New World food crops and new tropical products from expansion into the south and southwest (Yunnan and Guangdong) provided additional new resources (Marks 1997). Manchu sponsorship of official scholarship opened new opportunities for re-examining the past, and the foundation of new schools of inquiry, most notably the new philology (Elman 1984; Elman and Woodside 1994). The result was that after the initial losses and turmoil of the conquest (Struve 1984), there arose a period of remarkable expansion, energy, growing wealth, and intellectual ferment from roughly 1680 to 1780.

Indeed, although it is often overlooked in light of the attention given to eighteenth-century Britain, the economic growth of eighteenth-century China was nothing short of astonishing—in fact it contributed far more to the increase in world GDP during that century than did growth in Britain (Sugihara 2000). This increase in total output is sometimes considered “merely” extensive growth, driven by increases in population and territory. Yet this is to misunderstand, and grossly underrate, the Qing achievement. Most of the new territory gained was agriculturally poor steppe and arid land in north and central Asia; supporting a far larger population therefore required substan-

tial productivity-raising innovation and restructuring of the economy of China proper. In the early seventeenth century, China's population was perhaps 150 million, only slightly exceeding prior maximum levels. The upheavals of the late Ming rebellions and the Manchu conquest hindered growth in most of the seventeenth century, so that by 1700 the population still did not exceed 160 million. Then in the course of the eighteenth century it more than doubled, from some 160 million in 1700 to 350 million in 1800—an unprecedented gain of nearly 200 million people (Lee and Wang 1999, 6, 27). Yet standards of living were apparently *higher* in the eighteenth century than they had been a century earlier. Sustaining such a massive population increase without a substantial decline in living standards implies a lifting of Malthusian constraints—something usually associated only with “modern” economic growth. Thus to dismiss the early and high Qing economic increase as “merely” extensive growth misstates an extraordinary achievement.

It is sometimes alleged that Qing economic growth was a matter of increasing land productivity by vastly increased labor inputs, an “involutionary” development, in which increased population numbers and density were sustained at the cost of declining labor productivity and hence declining incomes (Huang 1990). Yet it appears that through the early and mid Qing, both land *and* labor productivity increased. Li's (1998, 86) research on the most densely populated region of China, the Yangzi delta, maintains that the labor input per unit of land was roughly constant from medieval times until the 1950s. Increased agricultural output was achieved by increased application of capital, not labor, mainly in the form of fertilizer inputs. These were chiefly cottonseed, rapeseed, and soybean cakes imported in exchange for manufactures—by 1750, some three billion kilograms of fertilizer imports per year (115). In addition, the cultivation of mulberry leaves for silkworms and the production of silk and cotton textiles greatly expanded, fueling a regional specialization and dynamic import/export economy in which textile exports reaped increasing grain and fertilizer imports. The net effect was that in the eighteenth century, the Yangzi delta had *both* the highest population density in China *and* the highest per capita output (Li 1998; Pomeranz 2000a, b).

For example, in the Lower Yangzi, “real wages in farming rose sharply in cash and moderately in kind. One study even claims that whereas it had required as many as four to five adult laborers in the early seventeenth century to earn enough to support even one additional adult, by the mid eighteenth century just one or two workers could make enough to support an additional person” (Lee and Wang

1999, 40). Improvements in consumption and welfare can be documented. Pomeranz (2000a, 39) relates that the average estimates for *China as a whole* of calorie consumption in the eighteenth century are 2,386 calories per adult equivalent per day (1,837 per capita per day); this is comparable to English estimates for the mid-*nineteenth* century. This favorable nutritional foundation led to long lives: estimates of life expectancy at birth in various regions and population strata range from 34 to 39 years for the mid- to late-eighteenth century; this exceeds European levels everywhere except for southeast England, which are about equal (Wong 1997, 28; Lavelly and Wong 1998; Pomeranz 2000a, 37).

Nor was quality of life only apparent in terms of food and health—consumption of a wide variety of products met or exceeded the most advanced European levels. While many peasants wore ramie and hemp garments in the seventeenth century, by the eighteenth century they had switched to cotton and silk; Pomeranz has shown that in the lower Yangzi cotton cloth consumption per capita c. 1750 was nearly as high as that in England in 1870 (Pomeranz 2000a, 141). Household furnishings—benches, tables, mirrors, beds, chests—also were comparable to those in Western European probate inventories (Pomeranz 2000a, 145). Consumption of non-necessities such as sugar, tea, and tobacco also evidently met or even exceeded advanced European levels. In short, “China in the latter part of the eighteenth century seemed—both to its own members and to most, though not all, visitors from abroad—a very rich society” (Pomeranz 2000b, 29).

Needless to say, the combination of very high living standards, by global norms, simultaneously with a population increase of over 100 percent, and more importantly of almost 200 million persons, over the eighteenth century, is an enormous conundrum for world history (Wong 1997). This implies that in the century from 1700 to 1800, China added to its numbers a population equivalent to *twice the total population of Europe c. 1700* (which was about 95 millions [Livi-Bacci 1992, 31]) while attaining a *higher* standard of living than almost anyplace in Europe. It is hard to exaggerate this achievement, probably unequaled in pre-industrial history. Far from being in a Malthusian trap, the ability of eighteenth-century China to double its population while raising living standards to levels of pre-industrial prosperity almost unmatched elsewhere in the world suggests that any Malthusian constraints had been lifted in the high Qing. Sugihara (2000, 2), with good reason, labels this a Chinese “miracle” more impressive than anything in eighteenth-century Europe.

In order to suggest that Malthusian or involutory conditions

applied in the eighteenth century, one would have to argue that living standards were much higher in the seventeenth century. This hardly seems plausible both because of the massive disorders and military conflicts that stretched from the 1620s to the 1680s, and because of the many reports of Chinese who complained of or reveled in the rising mass consumption of goods and luxuries in the eighteenth century.

Moreover, it is sharply contradicted by demographic records for Beijing, which show male life expectancy at birth at 27.2 years during 1644–1739 vs. 33.6 during 1740–1839 (Lee, Campbell, and Wang 1993). While these figures may be strongly affected by the disruptions of the Qing conquest in the first decade after 1644, the data still strongly suggest improving, not declining, living standards as we move from the late seventeenth century to the late eighteenth.

It thus seems undeniable that during the high Qing, China achieved one of the world's great episodes of combining population increase with steady or rising per capita incomes, achieving in the process some of the highest levels of pre-industrial well-being yet seen anywhere in the world. We will discuss below how this was likely achieved, but for a moment one should pause and simply note the magnitude of this achievement.

Yet such wealth and energy did not last. After 1750, no further new crops, resources, or major technical or institutional innovations provided new resources. As population growth began to fill up the frontiers and upriver and northern plains regions, the regional specialization in which the Yangzi delta produced silk and cotton goods in exchange for rice and fertilizer (to augment its own rice production) was diminished by new regional centers of textile and craft production that reduced the need for delta products (Pomeranz 2000b). The innovative administrative structure of the Qing became gradually overmatched and then overwhelmed by the increase of population density and size within fixed administrative units. By the late eighteenth century, religious orthodoxy and banditry combined to produce the White Lotus revolts, whose suppression began to drain the imperial treasury. In the early nineteenth century, Europeans became more demanding and aggressive, while internal discord continued to grow. Weakened by the Opium Wars, the imperial regime barely survived the greatest rebellion of the century, the Taiping (Jones and Kuhn 1978).

We thus have to understand two key characteristics of the high Qing. On the one hand, it was much more than a mere revival of the Ming dynasty, another simple turn in the dynastic cycle. It was more expansionary, institutionally innovative, and ethnically diverse than a

simple dynastic revival would imply; indeed, economically the high Qing saw one of the great bursts of increases in total output, with gains in both population and per capita consumption, in pre-industrial history. To simply draw a line of continuity between Ming and Qing, calling the period from 1368 to 1911 the “Ming/Qing” as if it was a homogenous unity, is an error.

At the same time, the expansion, wealth creation, and dynamism of the high Qing was not a path to “modern” growth. Quite the reverse; in its last century the Qing began to falter and was overwhelmed, sinking into ecological, administrative, and economic downspins due to its inability to cope with ongoing massive population growth. Yet as we shall see, there is no need to choose between seeing the Qing as simply “late imperial” or “early modern”—when in fact neither seems a good fit to its full dynamics. Rather, the high Qing marked a fairly typical case of “efflorescence,” a sharp and fairly sudden burst of economic expansion and creative innovation that occurred periodically in all premodern societies of the globe.

In Golden Age Holland, the Cathedral Age, and the high Qing, we find similar macro-level phenomena—population approximately doubles, while per capita income remains stable or slightly increased, at relatively high premodern levels. In addition, we find high levels of urbanization, trade, and specialization, attesting to improvements in agrarian and non-agricultural productivity. As we shall see below, the same was also true of eighteenth-century England.

England in the Eighteenth Century

The Industrial Revolution, in its classic formulation by T. S. Ashton (1948) was set in the years 1760–1830, years that saw the spread of mechanized cotton spinning, coke smelting and rapidly expanding coal and iron production, and new commercial organization for the production of ceramics and other consumer goods. Yet economic historians continue to be puzzled by the lack of per capita economic growth in this period. The latest data on farm wages and estimates of both aggregate economic growth and total income have continually lowered the achievements of these years. Recent analyses of real wages by Feinstein (1998) and Clark (1999), although using quite distinct sources, have agreed in finding that little increase in real incomes is evident until the 1840s. Clark calculates that real GDP per capita for England and Wales rose by a total of only 10 percent from 1730–39 to 1810–19, before rising another 15 percent in the next four decades. Since the

population of England and Wales doubled in this period (from roughly 6 to 12 million), the macro-economic achievement of England from 1725 to 1825 was approximately the same as that of Qing China from 1680 to 1780, namely a doubling of population while maintaining a stable or slightly rising standard of living, although on a much, much smaller scale.

It is thus no wonder that Clark (2000, 1) comes to a similar conclusion as this paper: "the Industrial Revolution was most likely the last of a series of localized growth spurts stretching back to the Middle Ages, as in the Netherlands from 1500 to 1650, and northern Italy in the fourteenth century."

Yet excepting eighteenth-century England, none of these "efflorescences" was followed by self-sustaining and accelerating economic growth. Rather, two characteristics separate all these efflorescences from the kind of self-sustaining industrial growth that would transform the world after 1830. First, the initial wave of productivity-raising innovations occurs over a limited time period, no more than a century or so, after which the rate of innovations sharply diminishes or peters out entirely, leaving only diffusion of the new best practice to provide further intensive growth. Mokyr has referred to this as technological "inertia," or "Cardwell's law." That is, as new productive practices and forms of commercial organization spread, vested interests among political and economic elites who have gained from them acquire an interest in perpetuating those practices (Mokyr 1990, 1994). In addition, the technological sunk costs, and the "fit" among various technologies, create a complex equilibrium that may be hard to alter. Thus the normal tendency is for an efflorescence to create a number of interlocking practices that are initially fruitful, but then tend to stabilize and be actively defended. Only a major social or political upheaval is then likely to create new opportunities for major episodes of growth. In addition, as Grantham (1993, 1999) has demonstrated, the spread of best practice techniques is sharply limited by the reach of markets; peace and good transport and growing urban markets support diffusion of best practice through intensified effort, investments, and trade. However, further increases in population or a growth in disorders, which undermine surplus and the populations' real purchasing power for beyond-basic consumption, can produce deintensification of production in the countryside, leading to economic stagnation or decline. Population declines due to war or disease can also undermine demand-driven growth, leading to deintensification of rural production and declines in trade, output, and urbanization. Therefore these "efflores-

cences” tend to reach a ceiling—a new and higher ceiling to be sure—but then to suffer stagnation or decline. It is no coincidence that later generations tend to look back to these periods as “golden ages.”

Second, in none of these efflorescences does one find total GDP growth rates—driven by a combination of population growth and per capita income growth—much exceeding one percent a year. Holland’s golden age, for example, even if we exaggerate by taking de Vries’s chosen minimum trough to maximum peak change in real wages as indicative of the total increase in per capita output, saw increases over the century from 1570 to 1670 of approximately 50 percent in population and a maximum of 50 percent in per capita output. This provides a total GDP increase of 125 percent over the century, or an annual total GDP growth rate of 0.8 percent per year. If we recognize that for the most part, real wages fluctuated around a constant level from 1530 to 1660 while population grew by something over 50 percent, then the annual increase in total GDP was under 0.4 percent.

An annual GDP growth rate of nearly one percent per annum, or even 0.5 percent per annum, should not be downplayed; both are well in excess of pre-industrial norms. A one percent per annum growth rate is sufficient to double a population in size at a constant real income in 70 years, or over the course of two generations. Over the same period, it is sufficient to raise the standard of living of a society by 50 percent or more if its population grows by 50 percent or less. In contrast to the more prevalent periods of negative growth in population, or of barely perceptible total output increases in the neighborhood of 0.1–0.2 percent per annum that are more typical of pre-industrial growth (as prevailed in the English midlands and the Paris basin in most of the late pre-industrial era [Allen 1988, Hoffman 1996]), these are “golden ages” indeed.

England in the eighteenth century has long been held to be different, and thus scholars were once startled at the lack of evidence for exceptional economic growth much before the mid-nineteenth century. Again, this surprise comes from holding to the false dichotomy of “modern” growth vs. “premodern” stagnation. If one examines economic growth in England from 1760 to 1830, it is absolutely true that growth was slow, but it was comparable to that in other preindustrial “efflorescences.” And that, in my view, is precisely what the period from 1760 to 1830 was—an era of pre-industrial growth. I shall provide more detail to support this view below. Suffice it to say that I have argued vehemently elsewhere (Goldstone 1998, 2000a) that the modern age only begins with the widespread deployment of steam engines

in manufacturing and transportation, and the general adoption of steam power in spinning, machine production, steamboats, and railways develops only from the 1820s to the 1850s. The Arkwright water-powered spinning machines, and Cort's puddling and rolling processes for ironmaking, were indeed productivity-raising innovations. But they unleashed no new sources of power on society; nor did they necessarily have any self-sustaining power to push further innovations. They too are completely self-limiting and unsustainable. If British advances in textile manufacturing remained wholly dependent on water power, they would have soon run out of available energy (Pacey 1992, 165–166; Cardwell 1972, 102–103); we would have seen the deployment of small scattered mill towns, in New England style, and not the rise of manufacturing colossi like Birmingham and Manchester. In fact one of the first sales of James Watt's steam engines was to Richard Arkwright for the purpose of pumping water up chutes to let fall on his paddle wheels to keep his spinning factories going during periods of low natural stream flow (Debeir, Deléage, and Hémerly 1991, 101). Similarly, puddling and rolling of iron would have soon run out of energy if smelting remained dependent on charcoal for fuel, and even smelting with coke would have run into sharply diminishing returns without steam pumps to clear water out of the deep mines that provided that essential fuel. Nor could high-quality iron and steel have been produced cheaply in high volume without steam; a second early use of Watt's engine was by Wilkinson's ironworks to drive the bellows that kept a constant flow of air to smelters. "The combined use of steam power and iron construction enabled the factory-based textile industry to break through the limits that reliance on traditional resources would otherwise have placed on it" (Pacey 1992, 166). If the "wave of gadgets" of the eighteenth century using traditional sources of power and raw materials (excepting the Newcomen/Watt engine, which was a different line of development) was all that had emerged in eighteenth-century Britain, we would now be speaking only of another "golden age" lasting into the early nineteenth century, but not of any lasting and dramatic improvements in output or income growth compared to other efflorescences in earlier eras.

I fully agree with Mokyr's (1999a, 21) contention that the key defining characteristic of "modern" economic growth is its self-reinforcing, accelerating character, based on the systemic exploitation of scientific knowledge and its application to production. In other words, the old dichotomy between modern "growth" and premodern "non-growth" is both mistaken and highly misleading. The difference between premodern and modern economies is not the crude one of

growth or non-growth, but of more subtle differences in the degree to which growth can be accelerated and sustained (Wrigley 2000, 125). Mokyr (1999b, 12) has stated, regarding Holland's golden age, that "the advanced technology that helped propel the Dutch economy into unprecedented and even 'embarrassing' riches in the seventeenth and eighteenth centuries was still mostly the traditional, pragmatic knowledge at the level of artisans: . . . mechanically clever, well-designed techniques, but without much of an epistemic base in the deeper natural phenomena that made them work. As a consequence, technological progress ran into diminishing returns." Much the same could be said of the eighteenth-century advances in Britain's textile and iron manufacturing, thus leading earlier work by Landes (1969) and others to the confused notion that science was irrelevant to the Industrial Revolution proper.

Self-sustaining growth is not a matter of this or that cluster of innovations, or of overcoming one particular bottleneck; rather it is a matter of developing a particular approach to production and technological innovation. This view has long been argued in studies of contemporary economic growth, where knowledge and innovation are seen as the critical motors of self-sustaining growth (Romer 1986, Nelson 1996); it is long overdue to incorporate changes in social attitudes to the creation and acquisition of particular kinds of knowledge—as Mokyr (2000, 2002) eloquently argues—in our conceptions of what underlay the sudden onset of self-sustaining and accelerating growth in the nineteenth century.

The Industrial Revolution in England has been misunderstood largely because it has been misdated, due to twin confusions regarding the nature and incidence of economic growth, and the special character of steam-powered (and thus science-powered) growth after the nineteenth century. If we think that pre-industrial societies lacked periods of invention and relatively rapid growth in output and productivity, and that therefore "modern" growth is any markedly visible economic growth borne by such innovation, then we shall be greatly puzzled that Holland achieved such growth as early as the seventeenth century, or that the eighteenth century growth rates of Britain, home of the Industrial Revolution, seem relatively modest. The solution to the puzzle lies in realizing that efflorescences, or periods of limited but exceptional innovation, productivity increase, and acceleration of economic growth are not uncommon in world history. If we recognize them by their two key characteristics—the period of growth is limited and followed by absolute stagnation or decline, and even during the "golden age" total GDP growth is never sustained at over one percent

per year—then we can recognize seventeenth-century Holland, high Qing China, and eighteenth-century Britain as “efflorescences” of this type.

The reasons for the emergence of such efflorescences will have to be a separate and complex inquiry. Karel Davids (1995) has perhaps gone as far as anyone in identifying the reasons for shifts in technological leadership. Certainly, it appears that two factors are critical: efflorescences tend to occur (1) during periods when international trade and sustained contact lead to a mixing of cultures and ideas; and (2) in places that are centers of international trade, in which people, goods, and techniques are focused on meeting multiple commercial demands. One could add as a third factor that (3) such efflorescences also seem more likely during periods of reconstruction following a collapse or massive challenge or change in government or society that unleashes new energies or social groups or provides integration and order over larger territories. This was certainly the case for Holland during its emergence from Spanish rule and development into a global trade center in its golden age, for England following its Revolution of 1688 and triumph as an Atlantic imperial power, and for Qing China. Conversely, efflorescences seem unlikely toward the end of periods of long-unchallenged social and political order, when conformity to existing practices is enforced by custom and elite command (Goldstone 1987), or in societies isolated from cross-cultural influences.¹⁰

Yet we should be clear that the three factors above may be necessary but are certainly not sufficient; many societies have followed major challenges or collapses by a conservative reconstruction that involves increased conformity to past practices and walling-off from external influences—the Habsburg domains in southern Europe and the Ottoman empire after their seventeenth-century political crises are cases in point (Goldstone 1991). Moreover, trade does not always have the same stimulative effects; growing dependence on a few key commodities or trade relationships can leave regions limited and vulnerable to global shifts, as with the eighteenth-century collapse of Dutch manu-

¹⁰ While Tokugawa Japan may seem a counterexample, as a “closed” economy that nonetheless underwent an efflorescence in the eighteenth century, this greatly underestimates Japanese contact with the outside world during the “trade ban” imposed by the Shogunate. Although Japanese were forbidden to go abroad, Chinese traders continued to bring a large volume of trade to Japan, and Japanese exports of silver in return for Chinese silks, as well as importation of cotton and textile technology and agricultural seeds and techniques from Korea and China continued to grow throughout the seventeenth century (Sugihara 1996, 36–38). In addition, while Dutch physical contact was limited to Nagasaki, from that port Western ideas and books entered elite circles.

facturing cities (Israel 1995, 1010) or the decimation of Gujarat's coffee trade after 1714 due to civil war in Yemen (Das Gupta 1994, II:41). In short, the general problem of the origins of efflorescences or "golden ages" in history remains a largely unexplored arena, especially compared to the considerable literature on decline and collapse (Eisenstadt 1967, Cipolla 1970, Tainter 1988).

THE RISE OF THE "WEST?"

I hope it has been established that at the macro level—the growth of total output, including increases in total population and income per capita—the experience of Qing China in the eighteenth century, more specifically from 1680 to 1780 if we wish to allow for the evident decline in the later eighteenth century, was in every respect comparable to that of "Golden Age" Holland or of England during the "Industrial Revolution" of the eighteenth century. In all of these cases, population roughly doubled while per capita income remained stable or rose slightly, reaching some of the highest levels observed in the pre-industrial world. If anything, the palm for macro-economic achievement should go to the Qing for being able to sustain this on a far, far larger scale, involving hundreds of millions of people, than tiny Holland or England whose populations were barely a few percent of Qing China's. The Qing should thus stand out as one of the remarkable episodes of economic growth in world history.

The means by which the Qing accomplished this feat are varied and complex. Clearly, they involved a new system of administration that integrated vast new regions of central and eastern Asia, Mongolia, and Manchuria into a single orbit; the expansion of private, property-holding, market-oriented peasants throughout the south in lieu of the vast gentry and landlord estates of the late Ming; and (especially after 1680) the expansion of international as well as domestic trade (Wills 1993, 2001; Deng 1997). The introduction and spread of New World crops, intensified rice-growing and settlement throughout the Middle and Upper Yangzi and the Pearl River basins, the spread of cotton cloth production to North China through the innovation of underground cellars that provided moisture so that the cloth fibers wouldn't become brittle and break, and intensified production of silk cocoons and textiles as well as huge ranges of ceramics for a variety of domestic and export markets further contributed (Marks 1997, Finlay 1998, Bray 1999, Pomeranz 2000a).

Yet after 1750, as with other premodern efflorescences, this complex

structure began to decay, overburdened by continuing rapid population increase without further innovation. Ecological constraints began to set in, regional competition for self-sufficiency eroded the complex inter- and intra-regional patterns of trade, and regions poorer in resources and soils grew most rapidly in population (Elvin 1993, Frank 1997, Pomeranz 2000b). This was not a “failure,” as some critics of Imperial China’s economy might allege, but the normal course of things, the other side of the coin of such exceptional periods of remarkable growth as were attained in the high Qing. Holland underwent a similar decline from 1740 to 1800 (look back at Figure 1); China, however, had no opportunity to recover before the twentieth century.

The real puzzle is why England, which was undergoing a similar macro-economic pattern as Qing China, managed to avoid such a decline, and instead created self-sustaining growth after 1830. Two slightly different answers have recently been put forth: Ken Pomeranz (2000a) argues that it was primarily New World resources, providing timber, grain, and cotton, that allowed Europe, and England in particular, to avoid ecological constraints. E. A. Wrigley (1988) and Goldstone (1998, 2000), following Nef (1964), have placed more emphasis on the heavy use of coal and particularly steam power—although Pomeranz concedes its importance as well.

I am now more inclined to say that no resource constraints or advantages should be given credit or blame for England’s unusual path of development, or China (or Holland’s) different routes. The presence of accessible coal is often granted a key role in England’s development. Yet England’s nineteenth-century growth, after all, was based on *both* cotton and coal, and while England had coal in plenty, cotton was completely absent and England depended entirely on imports. China had lots of cotton and lots of coal, although, as Pomeranz (2000a, 65) argues, much of that coal was somewhat distant from the major manufacturing regions of the lower Yangzi and the south. Resources—whether it be American or Indian cotton, English or Belgian coal, Latin American or Japanese silver, and Swedish timber or iron—are all commodities that were bought and traded on a global scale in the nineteenth century. Had China made an early industrial breakthrough based on cotton, we would now no doubt be wisely saying that Britain had no hope of being an industrial leader in cotton production because of its distance from any sources of that crucial fiber. Similarly, had rich coal deposits been found in Brittany rather than Britain, it seems likely that British industrialization would have proceeded much on the same course it did, with coal shipments coming from Brest

instead of Newcastle, without any falsely correlated conclusions about national resources.

The ultimate bottleneck in pre-industrial economies was actually quite simple—it lay not in land, or other raw materials, but in energy (Cardwell 1972, 102; Malanima 2001). Given sufficient energy, land could be enriched by irrigation and applications of distantly produced fertilizers; fibers could be imported and economically worked into finished products; grains could be harvested and threshed with far less manpower; bricks and other construction materials could be cheaply fired and moved; construction and transportation bottlenecks overcome. Wherever breakthroughs in energy use occurred—in wind or water power, in peat or coal or charcoal or coke use—gains generally followed.

Two problems faced all pre-industrial economies in regard to energy: amount and concentration. The amount of mechanical energy available to any pre-industrial economy was limited to water flows, animals or people who could be fed, and wind that could be captured. In any geographically fixed area, this amount was strictly limited, as well as—for wind and water power—highly variable. One had to make do with the rivers and elevations at hand for water power; winds are inconstant, and muscle power can never grow faster than agricultural output plus gains from trade to sustain the population. Heat energy was largely limited by forest cover, or the lack thereof. The greatest leaps in power were improvements in sail and boat design to improve wind-powered transport, and in water and windmills (whose technology changed little between the thirteenth and eighteenth centuries).

Aside from limited amounts, power could not be concentrated in a single location. To place a hundred water-powered mills, they had to be spread along existing rivers, rather than concentrated at a single center. Horsepower could only be captured by harnessed teams, awkward at over a dozen animals. Slaves or paid workers could be coordinated in the hundreds, or thousands, making monumental construction and concentrated handicraft manufacturing possible; but again this power source could not grow faster than the sustenance provided by agriculture and trade. As a result, while towns could exist for concentrated warehousing, crafts production, and consumption, vast urban centers focused on the use of power for factory manufacturing, such as Manchester and Birmingham—with all their consequences for urban work forces and pressures for democratization—were simply not possible without the mechanized generation of power provided by steam engines.

A single breakthrough solved the problem of both bottlenecks—the steam engine as perfected between 1770 and 1830. I would grant that the steam engine *per se* was not the only nor essential way to break through this bottleneck. Electric engines, developed from the experiments of Faraday with electromagnetic induction in the 1820s and 1830s, could have been the basis for concentrated power, and later diesel or internal combustion engines could have done the trick (Bekar and Lipsey 2000). But regardless of the precise type of engine, what mattered was some way to take the abundant fossil fuels scattered throughout the earth as concentrated energy sources, and turn their potential into useful work.¹¹ As Maxine Berg (1994, 207) has noted, it was not the spinning machinery itself (in operation since 1770) that made England supreme, but rather the application of steam power to spinning, to water and surface transport, to brick-making, grain-threshing, iron-making, shoveling, construction, and all sorts of manufacturing processes that transformed Britain's economy.¹²

¹¹ It is interesting to speculate on alternative paths to exploitation of fossil-fuel energy that did not go through development of the atmospheric pressure steam engine developed by Newcomen and Watt. It is conceivable that Faraday's work on electromagnetic induction, coupled to waterwheels, could have produced usable low-power electric motors, and that subsequent efforts to find alternative ways to power such motors would lead experimenters to use pressurized steam, instead of water flow, to drive rotating turbines to drive electric generators. That is in fact the main method of electricity generation today. That path would skip the step of creating piston-type engines to turn heat energy into work. However, such inventions as steamships, autos, trucks, farm combines, steam shovels, and other mobile powered vehicles would not have been practical on electric power (indeed still are largely not practical today); some sort of self-contained, mobile engine for converting fossil-fuel energy to usable power *in situ* seems a large part of our industrial development. While internal combustion and diesel engines do this as well or better than steam engines, it is hard to envisage the development of the metallurgy and engineering skills to build such engines—or a practical path to investment in their development—without prior experience of the much simpler to build and operate atmospheric steam engines that preceded them. Indeed, it took almost a century of development simply to move from Newcomen's first atmospheric steam engine to the first high-pressure steam engine developed by Trevithick, and then another century before development of the internal combustion engine.

Thus, while one can conceive of alternate pathways, the simplest practical mechanism for turning heat into usable power was the atmospheric piston engine of Newcomen. Without the scientific knowledge to conceive that such an engine was possible, and without the opportunity to manufacture and deploy such an engine despite its inefficiencies in circumstances making that deployment practical (the value of pumping water out of tin and coal mines in England providing that opportunity for the Newcomen engine, *viz.* Pacey 1990, 113), the development and utilization of fossil fuel for work seems unlikely to have taken off.

¹² Even putting aside coal and steam power, one may well ask why China did not accomplish a "premodern" efflorescence based on adapting water power to the mechanical manufacture of cotton textiles. Certainly for this China had all the raw materials and all the

It is difficult to overstate the advantage given to the first economy or military/political power to devise a means to extract useful work from the energy in fossil fuels—the invention of gunpowder, or even the mastery of fire in prehistoric times (Goudsblom 1992) may be the only appropriate parallels, with the caveat that transforming heat energy from fuels into useful reliable, controllable work was far more complex than the first two. It should be pointed out that the substitution of coal for wood and charcoal in generating heat is no major breakthrough; dried wood and crop residues are similar to bituminous coals in energy densities (at 15–20 megajoules per kilogram), and charcoal (at 28–32 Mj/kg) is similar in energy density to anthracite (Smil 1994, 12). Countries that lacked coal reserves were nonetheless often able to sustain fuel sources by planned reforestation with faster-growing trees, as for example Japan (Totman 1993), or relying on plentiful forests as could Russia and the U.S. What mattered was being able to turn the heat into useful work, at which point the amount of energy from wood or coal available becomes meaningful. The average capacity of Watt's late eighteenth-century steam engines was roughly five times that of contemporary waterwheels, and they could be located, multiplied, and concentrated without regard for the flow and drop-head of streams (Smil 1994, 164).

As a result, England was able to make enormous advances in regard to its use and manipulation of energy—on a scale rarely appreciated today. Circa 1700, the entire world's use of biomass energy for fuel amounted to perhaps 250 million tons of oil equivalent (Mtoe). By 1850, this had grown by perhaps 20 percent to 300 Mtoe. By contrast, energy produced from coal in 1700 totaled only about 5 Mtoe, but grew by 1400 percent to 70 Mtoe in 1850; and what is even more striking is that over 70 percent (50 Mtoe) of that coal was extracted by Britain to power its engines. Energy from coal thus rose from some two percent of the world's available fuel energy c. 1700 to nearly 20 percent by c. 1850; and most of this increase was captured by Britain alone. Another way

needed technology (designs for water-powered machinery to spin hemp or ramie are evident from centuries earlier [Elvin 1973]). This is a controversial question, and I have tried to answer it in terms of cultural factors that limited China's female labor force deployment in production outside the household (Goldstone 1996). However, a critical point for the present essay is that even if China *had* made the step of deploying water-powered spinning, that by itself would *not* have launched an industrial revolution. To do so would have required a systematization of knowledge regarding air pressure, power, and its application to constructing heat engines. Unlike water-powered spinning, there is no evidence of an independent trajectory of that sort in China.

to make this global comparison is to note that from 1700 to 1850, the world's population nearly doubled from 680 million to 1.24 billion (Livi-Bacci 1992, 31). Yet the rise in total available fuels outside of British coal was only from 250 Mtoe to 320 Mtoe; thus available fuel energy per capita fell from 0.37 toe/cap to 0.26 toe/cap. In contrast, in England, where population tripled in this period from 6 to 18 million, power per capita *also* more than tripled from 0.8 toe/cap in 1700 to 2.8 toe/cap in 1850. The bottom line: In 1700, England (and almost all British coal was used in England) had a relatively high availability of fuel energy per capita, and a relatively high living standard by global averages, at roughly twice (0.8 vs. 0.37) the global average per capita fuel energy. But this is no surprise; we expect England in 1700, like Holland or other advanced areas like the Yangzi delta, to have a higher energy use. What is startling is that by 1850 the average English person has at his or her disposal *more than ten times* the amount of moveable, deployable fuel energy per person used by the rest of the world's population. Yet another way to grasp this change: In 1700, England annually used on the order of 5 Mtoe, or less than a twelfth of the 67 Mtoe fuel energy used in Qing China (assuming for the latter a population of 180 million and annual per capita energy use at the world average of 0.37 toe). By 1850, England's 18 million inhabitants were using nearly as much fuel energy (50 Mtoe vs. 78 Mtoe) as the 300 million inhabitants in all of Qing China. Nor was that the end. By 1900, perhaps the peak of England's global power, British coal was providing roughly one quarter of the entire fuel energy output of the world; this for a population—including Scotland and Ireland—that constituted less than three percent of the world population. (All figures regarding coal and biomass energy are from Smil 1994, 186–187.)

Yet to focus on the steam engine as the pivotal breakthrough is again too narrow. It was not the steam engine alone that changed things; rather the steam engine was just one product of an entire engineering culture that changed the way society approached problems of production. If there is an Industrial Revolution, it thus begins in the early nineteenth century with the application of steam power and of modern principles of physics, mechanics, and chemistry (primarily the physics of gases developed by Boyle, and Newton's laws of force and motion to calculate energies and work in machines) to manufacturing and transportation on a significant scale. It is only at this point that economies grow not merely by investment, nor input growth, nor specialization and innovation by craftsmen, nor a few major but self-limiting innovations, but by the widespread application of science to industry (and agriculture) through the intentional cooperation of

entrepreneurs, those who seek basic knowledge, and a new class of engineers whose purpose it is to make the discoveries of the latter useful to the former (Bekar and Lipsey 2000).

The confusion on dating the Industrial Revolution comes from the fact that this new style of growth did not come out of nowhere; its lineaments were being drawn at the very same time that the economies of Britain and the rest of Europe were undergoing normal pre-industrial patterns of growth and contraction, Malthusian challenge and response. The new science that would be the essential foundation for modern growth was being developed in the sixteenth and seventeenth centuries, in the work of Bacon, Copernicus, Galileo, Kepler, Torricelli, Pascal, Boyle, Descartes, and Newton. Yet at that point, it had no relevance to economics, and both Holland's golden age and the neo-Malthusian difficulties of the rest of Europe and Asia were normal pre-industrial patterns. In the late seventeenth and eighteenth centuries, scientific knowledge begins to spread, and individual entrepreneurs and artisans who mix with the lecturers and demonstrators of the new natural philosophy start to experiment with machines that will put the new ideas to useful work. In Britain, Savery and Newcomen develop their crude atmospheric engine in this way, as does Watt in his improvements of that engine and his partnership with Boulton to market it. Yet the atmospheric engine, though increasingly deployed in limited sectors of the economy, still has no widespread impact. In the eighteenth century, it is the type of artisan/craft improvements and minor, self-limiting breakthroughs of a traditional "efflorescence" that are visible in manufacturing—especially in textile machinery—while Britain's economy as a whole is still in a solidly pre-industrial mode.¹³ In France and Germany, this is even more true, and traditional agrarian crises in the eighteenth and even mid-nineteenth century underline the dominance of pre-industrial patterns (Goldstone 1991, Komlos 1998, Komlos and Heintel 1999). It is for this reason that as late as the eighteenth century, many Europeans consider India and China

¹³ Pacey (1992, 165) notes: "The new textile factory system had so far (c. 1790) no connection at all with the developments in steam power and ironmaking. . . . It originated in a different region of England [and remained] very much a regional industry. . . . The machinery in the silk mills and in Arkwright's early cotton mills was largely built of wood and driven by waterwheels (or in a few cases by horse gins). The factory buildings and the waterwheels themselves were of traditional construction and were merely enlarged versions of the structures that country millwrights had been building for centuries. Thus the new textile industry . . . was still using the old preindustrial resource base—timber, horses, water power—in complete isolation from the . . . new resource base—iron, steam power, coal."

more technically “advanced” than Europe; the cost and quality of India’s cottons are considered unlikely to ever be matched in England (Chauduri 1990, 297), and China is widely admired for its advanced bureaucracy, the productivity of its agriculture, and the unsurpassed quality of its manufactures (Marks 1997, 285; Blue 1999).¹⁴ It is only toward the mid-nineteenth century, with rail and mass utilization of coal and steam power in manufacturing, transportation, construction, and agriculture, plus the application of scientific knowledge to such areas as synthesis of dyes and materials, that “modern” economic growth appears.

Behind all this complexity, however, lies a simple cultural transformation, and I believe it is this that marks the difference between England’s and Qing China’s nineteenth-century development. In this respect, I would fully endorse the argument of David Landes that “culture makes all the difference” (1998, 516), and the similar stress placed on culture by Deepak Lal (1998). However, in sharp contrast to their position, which argues for a general advantage to a holistic and broadly European culture of “individualism” or other special “European” qualities, I would more cautiously suggest that this transformation was *not* a long-standing feature or inherent trend of European culture, nor a European-wide cultural phenomena. Although of course it draws on older and non-British elements—in the same way that the European science and mathematics of the seventeenth century drew on older and non-European Indian, Arabic, and classical Greek achievements—it was a newly emergent and localized cultural shift or variation that was neither particularly likely nor broadly “European.” One key cultural element is the emergence of what my colleague Patrick Carroll-Burke (2001) has called “engine science,” and its development into the foundations of scientific work in Britain. The second, as Margaret Jacob (1997) has argued, was the development in Britain of a broader “scientific culture” strongly tied to work with “engines.”

¹⁴ “In his *General History of China* (English edition, 1737), Jean-Baptiste du Halde singled China out for achievements that seemed remarkable from a European point of view. [It is interesting to note, in light of the enormous emphasis given to the uniqueness of European printing or book culture, that] one item in the reports of his fellow Jesuits that captured his attention was ‘the great number of Libraries in *China* magnificently built, finely adorn’d, and enrich’d with a prodigious Collection of Books.’ Halde regarded the widespread existence of sumptuous and well-stocked libraries as something to celebrate, even envy. [In late Ming China, c. 1600,] books were being produced and consumed in such volumes that their collection and storage became problems that had to be solved, and libraries housing anywhere from hundreds to tens of thousands of fascicles (*juan*) emerged as part of that solution” (Brook 1996, 93).

“ENGINE SCIENCE” AND SCIENTIFIC CULTURE

The atmospheric engine, whose development led to the true steam engine, is only possible if one grants certain facts—that it is possible to create a vacuum, and that the pressure of the earth’s atmosphere against such a vacuum is powerful enough to do useful work—and then uses those facts in the design of practical machines to do work. Yet these facts are not self-evident; indeed the possibility of a vacuum continued to be denied by Cartesian philosophers until late into the seventeenth century. Moreover, the spread of such knowledge to those who would use it for practical economic purposes cannot be assumed.

The basic facts came out of the research on vacuums, gases, and atmospheric pressure by Robert Boyle, whose lab was also home to Denis Papin, and by Torricelli, Pascal, and von Guericke. Boyle astounded observers with his experiment (number 33 in *New Experiments Physico-Mechanical*, published in 1660) demonstrating that a piston fitted into an evacuated cylinder would be drawn into the cylinder with sufficient force to raise a hundred-pound weight (Jenkins 2000, 161).¹⁵ However, the experiment itself was not properly understood by Boyle or his contemporaries—Boyle ascribed the results to the force created by particles of air that were coiled up like tiny springs or balls of wool, which would exert force to “spring back” if pushed out of place, rather than to the thermal motion of air particles. But this was a far better explanation than the competing notion that no mere mechanical force could cause such a weight to be lifted by itself; rather, said one of Boyle’s major critics, an active “Spirit of Nature” was acting to lift the weight in order to maintain God’s plan of the world (in which no vacuums should be sustained).

While these facts could have been discovered and applied anywhere, the use of those facts for building practical engines reached its earliest high development in Britain. This is in large measure because the development of scientific culture took a particular turn in Britain, taking off from the general European innovation in the seventeenth century of a certain way of seeing the world—seeing with “engines” or “engine science.” Carroll-Burke points to several kinds of “engines” that gained wide acceptance in Europe from the seventeenth century

¹⁵ For some reason, both Cardwell (1969) and Pacey (1992) give precedence to the German Otto von Guericke in demonstrating that a piston in an evacuated cylinder could raise substantial weights. However, Guericke’s experiment was carried out in 1661 (Pacey, 1992, 86), while Boyle had already published the accounts of his experiment with the evacuated cylinder raising weights in 1660 (Jenkins 2000).

onward: graphs, scopes, meters, chambers, and engines (machines). Boyle himself described his air pump as an “engine” for examining the force of the atmosphere (Jenkins 2000, 161). A crucial step in the shift from mere observation, collation, and taxonomy—which were part of all major civilizations of Eurasia and the New World, and their basis for astrology, astronomy, medicine, and botany/zoology (cf. Elvin 2002 on China and Bayly 2000 for India)—to science and engineering was the replacement of crude observation by the use of “engines in the [that were] crucially generative in the practice of making scientific knowledge” (Carroll-Burke 2001, 602).

As Shapin (1994), Shapiro (1983), and others have noted, crude observation can be widely untrustworthy—magicians, drugs, optical illusions, problems of lighting, can all deceive the senses. Building trust in facts comes from a focus on shared, testable propositions. However, there were different approaches to how to reach such propositions, and the seventeenth century was marked by a divergence between Cartesian deductive logic and British empirical studies as the foundation for scientific knowledge. Certain propositions can be established by rigorous logic. This was the procedure of mathematicians and philosophers from Aristotle through the schoolmen even to Descartes. But yet another way is to focus on a set of procedures for “manufacturing” facts. This is, for those who adopted the practices and spread them, what engine science provided.

As both Descartes and Locke pointed out, it is crucial to separate the “apparent” or secondary qualities of things from “inherent” or primary qualities. That is, a wooden ball feels light in the hand after picking up an iron one, but heavy after picking up a handful of feathers; paper can look white at midday, or red at dusk, depending on the light falling on it; something can feel “hot” or “cold” compared to what was last touched, and so on. However, weight measured by a spring or balance, and temperature measured by a column of mercury or expanding/contracting coil, remains the same despite different observers. The realization that certain kinds of measurements are sound foundations for reasoning, while other kinds of observations are misleading, was crucial.

A pivot of modern physics was the acceptance of Newton’s cosmology, which gave the foundation to his key concepts of force and the measurement of work. Yet this cosmology, of universal gravity and inertial space, and the celestial organization of a heliocentric system, was not easily demonstrated. On the face of it, persuading anyone that they are actually spinning around on the surface of the globe at some 1,000

miles per hour and are held from being thrown into space only by a mysterious force called “gravity” that comes from all matter and acts instantaneously over vast distances throughout the universe seems as tough a sell as any fantasy. (Galileo was repeatedly frustrated by his inability to persuade his critics that the earth was in fact in motion, and Huygens, one of Newton’s few peers in mathematics and physics, steadfastly refused to admit the unexplained force of gravity as a sound basis for understanding motion at the earth’s surface.) Clearly these are not readily “observed” facts, but inferences from a long chain of reasoning and measurements. How Westerners came to believe this “fact”—which had been suggested in many other societies from ancient Greece to Medieval Islam without gaining mass adherence—is of enormous importance.

A fascination with instruments was global from the twelfth century onward; Chinese astronomical instruments and Jesuit-crafted surveying and astronomical instruments from Qing times remain on display in Beijing today (Waley-Cohen 1999, 6). Yet there is a great gap between a fascination with instruments and reliance on them as the primary means of generating agreed-upon knowledge, even to the exclusion of immediate unassisted observation and cognition. Such reliance on instruments and engines to generate natural knowledge became a pan-European practice among scientific elites in the early century. Yet it became especially developed in England. There, we find the probable first appearance of the designation “philosophicall apparatus” in a letter of 1649 from Samuel Hartlib to Robert Boyle (Gabbey 1993, 141). Nehemiah Grew, in his catalogue of *Natural and Artificial Rarities belonging to the Royal Society* published in 1681, set out a distinct category for “instruments relating to Natural Philosophy.” These were instruments designed and used to “search for truth” in contrast to those instruments used for practical observation and measurement (Gabbey 1993, 141; Warner 1990, 83–84). To a degree unmatched on the continent, throughout Britain the scientific apparatus became a staple not only in scientific inquiry, but also in the general teaching and lecturing of the public with regard to the new findings of natural philosophy (Jacob 1988).

Thus turning reliance on “engines” for understanding the world into a general aspect of culture, and turning it to practical improvements for commercial ventures, became nearly a British monopoly by the mid-eighteenth century. The reasons for this are too complex to enter into here; suffice it to say that a combination of religious prejudice and preference for abstract logic combined to erode the availabil-

ity and appeal of mechanical demonstrations and experimentation on the continent, leading to what Mokyr labels “an intellectual bifurcation of the seventeenth century,” with British science becoming more experimental and commercially pragmatic, while continental science became more abstract, deductive, and formal (Mokyr 1999a, 52). The widespread study of Newton, for example, was delayed or diminished by up to a century on the continent—Spanish universities “were still resisting any attempt to teach Newton’s physics as late as the 1780s” (Perez-Diaz 1988, 271). Even the Dutch Reformed Church found his cosmology too sacrilegious to easily tolerate (Feingold 1996; Davids 1995, 360; Israel 1995, 895–97). Only the Anglican Church initially embraced Newton and proclaimed from the pulpit the order of the universe as maintained by universal gravity and uniform mechanical laws, allowing a middle-class popular culture based on interest in mechanical demonstrations and physical laws to spread (Jacob 1988, 112; Jacob 2000, 323; Black 2000, 155). While modern science thus had wide European roots, the branch of engine-based scientific inquiry spread freely into popular culture only in England from the mid-seventeenth to the mid-eighteenth century.¹⁶

Rather than seeing modern science as a “tide of mechanism” that swept across Europe (Dobbs 2000, 38), it would be more accurate to see natural philosophy, experimentation, and other forms of inquiry in the seventeenth and eighteenth centuries as flowing in a series of distinct

¹⁶ David Landes (1983, 1998) and Alfred Crosby (1997) have long called attention to the importance of precision measurement in the eventual rise of Europe. Yet they draw far too automatic and inevitable a path of development from skill in manufacturing or interest in measuring devices to the specific use of such devices made in the reasoning processes of the seventeenth century engine science. For example, Galileo’s precise measurements of motion, designed to establish a sound footing for mechanics, were made with small water clocks, of a basic design available worldwide for many centuries (he basically opened and closed a spout when balls were released and stopped, then weighed the water that had emerged as his measure of “time”). Mechanical clocks did not even have an accuracy that merited minute hands, much less second hands, before the eighteenth century. Pendulum clocks of the seventeenth century were more accurate, but the pendulum was only investigated and developed in that century as part of the European study of engines for generating observations. Moreover, the countries that pioneered in exact measurement in the Middle Ages and Renaissance—Holland, Switzerland, Germany, Italy—were no longer in the forefront of developing engine science after 1700. And when precise measuring tools were brought by the Jesuits to China, the Chinese had little interest in harnessing them to an ontological revolution. Not that this mattered greatly, for in the area of cartography, medieval Chinese mapmakers had long achieved levels of precision measurement that exceeded anything found in sixteenth-century Europe (Goldstone 2000b). In sum, it was what seventeenth-century natural philosophers and eighteenth-century British engineers did with precise measurement that mattered. While Landes and Crosby are correct that later developments benefited from medieval and Renaissance improvements in measurement, those developments were in no way inevitable simply from the availability of such measurements.

channels through Europe, sometimes crossing and mingling, to be sure, but still with some streams developing far more strongly in some areas of investigation and geographic regions than in others, and some petering out or being overwhelmed. For example, throughout the seventeenth century “natural history . . . remained essentialist and descriptive, reflecting none of the dominant characteristics of the Scientific Revolution, except for an emphasis on direct observation” (Osler 2000, 19). The mechanical philosophy as developed by Cartesians remained unable to provide exact measurements of force, and its cosmology of vortices was wholly mistaken; as the eighteenth-century Newtonian lecturer Jean Desaguliers remarked: “When M. Descartes’s philosophical Romance . . . had overthrown the Aristotelian Physicks, the World receiv’d but little Advantage from the Change” (cited in Jacob 2000, 316).

If all Italian schoolchildren had been taught Galilean mechanics after 1600; or if the Dutch had embraced Newton as a cultural icon; or if the experimental investigations of Torricelli in Italy, Pascal in France, and von Guericke in Germany had been continued instead of each marking the end of experimental physics in those countries for a century and more—then we should not be so concerned to focus on the lineage by which the experimental and theoretical works of Boyle and Newton were widely disseminated in Britain and became freely available to skilled craftsmen and entrepreneurial inventors such as Savery, Newcomen, Watt, and Trevithick. But in fact throughout the continent the stream of experimental physics and Newtonian mechanics was diverted and eventually halted by reactions from the Catholic and even the Dutch Reformed Church in the late seventeenth and early eighteenth centuries (Jacob 1997, Feingold 1996, David 1995); the British became the leading, indeed nearly the only, developers of experimental and mechanical engine-centered science.

As Margaret Jacob (1988, 1997; Dobbs and Jacob 1995) and Ian Inkster (1991) have shown, the scientific culture of England, steeped in engine culture, gained enthusiastic adherents broadly among English craftsmen, artisans, and entrepreneurs. The result was that England became the site where modern engineers—craftsmen who specialized in turning the principles of natural philosophy into mechanisms useful to entrepreneurs for production, relying on precise measurements with scopes, graphs, and instruments—originated and flourished. It was this engineering culture and the engineers it spawned who not only developed the steam engine, but its improvement and wide applications, as well as the improvement and application of a host of other inventions and borrowed ideas. John Smeaton greatly improved the efficiency of

water power through precise measurements, and it was James Watt who first precisely measured and created standard units of power (we owe the unit of "1 horsepower" to his work). The notions of optimizing, perfecting, and continuously improving production through engineering created a peculiarly British superiority in production that gradually spread throughout its economy, transforming it beyond recognition by 1850. Practical skills acquired in the construction of engines also made England the leading site in Europe for the manufacture of all kinds of machinery (Cardwell 1972, 145). It is therefore no accident, to return to the importance of engines and energy and their interweaving with English culture, that today's global scientific terms for the *measurement* of energy (the Joule, named for James Prescott Joule), of work (the Newton), and power (the Watt) all bear the names of Englishmen.

To focus on the steam engine in particular, we can trace every stage of its development, and every advance for over 150 years, to experimentation and invention in Britain. Boyle first published his account of a piston lifting great weights through air pressure on an evacuated chamber in 1660. In 1675, Denis Papin came to work as Boyle's assistant, and after experimenting with steam pressure invented the pressure cooker (Papin then went to work at the Royal Society, where he was elected a Fellow in 1680). In 1699, Thomas Savery of Devonshire patented the first workable engine to raise water by means of vacuum pressure, and in 1712 Thomas Newcomen installed the first working piston-driven atmospheric engine. While Papin, Huygens, and others before him had suggested designs for using steam and pistons to do work, it was Newcomen and his partner Cawley—the former a blacksmith, the latter a plumber—who solved the practical problem of developing a mechanism to turn valves on and off in the right sequence to create the flows of steam and water that made a workable engine.

Newcomen engines were deployed throughout Britain to pump out mines, and at several other mines in Europe; a number of other engineers—J. K. Hell in Austria and Ivan Polzunov in Russia, for example—experimented with plans or improvements to the Newcomen engine. But their efforts came to naught for lack of followers and craftsmen to realize their designs and carry on their work (Pacey 1992, 156; Strandh 1979, 118–120). The next steps in improving steam engines were all taken in Britain, first in a series of fruitful inventions by Watt for increasing efficiency and creating smooth rotary power from the 1760s through the 1780s. Then the high-pressure steam engine, and its application to powering a mobile engine, were developed in 1800–1804 by Richard Trevithick. Many other British inven-

tors and engineers were involved in solving the practical problems of designing and manufacturing and harnessing steam engines to transportation and manufactures. But what is remarkable is that every step in this process raised daunting obstacles to engineering ingenuity, and only in Britain, over the 150 years from 1660 to 1810, were each of these obstacles successively overcome. The result was that by 1800, “although in the sciences (particularly mathematics and chemistry) France was far advanced over England . . . in the construction and development of steam engines, the French like the rest of the world looked continually for guidance to Britain. Brugge [Thomas Brugge, Danish Astronomer Royale c. 1789] confirms that even the best French engineers were largely dependent on what they . . . could pick up from visits to England” (Crosland 1969, 129).

Let me be clear—I have no wish to say that a simple “Scientific Revolution” or even a simple European “Industrial Revolution” is what separated East and West, modern and premodern. Steven Shapin’s (1996, 1) witty introduction to his book *The Scientific Revolution*—“There was no such thing as the Scientific Revolution, and this is a book about it”—could well be paraphrased by economic historians, to wit: there was no such thing as the Industrial Revolution and this is an essay about it. What Shapin means is that a sudden, holistic break with past and non-Western approaches to nature and revelation did not occur; rather the styles of experiment and reasoning and their products that we now recognize as “scientific” emerged only slowly and haltingly from the welter of classical, medieval, and global traditions of alchemical, astronomical, astrological, medical, zoological, and religious inquiry in which all prior contemplation of nature had been enmeshed. Newton may have been a leader of what we now call a “scientific revolution” in anachronistic salute to its later significance, but Newton himself spent most of his time and energy using his mathematical, physical, and celestial theories to uncover patterns of Biblical revelation (Dobbs and Jacob 1995). Similarly, the “Industrial Revolution” was no sudden and holistic break with past and non-Western traditions of crafts, marketing, and economic enterprise, no sudden fruit of European science. Rather, European “engine science” was one particular offshoot of Eurasian natural inquires; and the rather odd and unusual development that it took in Britain, becoming elevated by the Anglican Church into a Newtonian cosmology of divine order, and hence integrated into popular artisanal, middle-class, and entrepreneurial culture and focused on improving commercial processes, was a further odd branching still. It was by no means a necessary and inevitable outcome of a broader “scientific” revolution or of European craft

and mercantile development—quite the contrary, it was one unusual stream of development, without parallel elsewhere, in the broader array of European social and cultural change. Yet in England this branching led to particular novel techniques and ways of approaching production problems that had such unexpected but significant results that, in hindsight, we speak of an industrial “revolution” to describe its consequences.

The growth of engine science and its spread into popular culture, and the emergence and activity of economic entrepreneurs, were also undoubtedly facilitated by other elements of seventeenth- and eighteenth-century English culture and institutions. The particular interaction of the Anglican Church and dissident sects; the competitive yet exclusionary character of the English political and social elites; and the security offered by English contract and commercial and property law, along with the balanced, constitutional structure of British government—although none of these were without counterparts of some kind in Holland, Prussia, or Switzerland, only in England did they all combine in a particular way with an engineering culture to take unique advantage of opportunities to transform production and trade. These complexities cannot be properly examined here; let me simply say that while such factors have often received extensive attention, the role of a unique “engine science” approach to knowledge and production has been less noted, but was at least equally, if not more crucial, to this conjuncture.

The old dichotomy between the “West” and the “rest” confused this process—the emergence of a peculiar engine-based scientific culture in seventeenth-century Britain out of the broader European challenges to traditional Aristotelian/Scholastic thought, and its application to already-improved traditional practices—with more general macro conditions. England’s eighteenth-century economic growth was at one time presumed to be without parallel in the pre-industrial world; hence almost every aspect of seventeenth/eighteenth-century English society that contrasted with non-English conditions, from particular institutions such as the Bank of England (North and Weingast 1989), to England’s brand of Calvinism (Weber 1950), to its oligarchical but pluralist governance (Hall 1974; Baecher, Hall, and Mann 1988; Hoffman and Norberg 1994), was held to be responsible for general conditions of capital accumulation and economic growth. But the increasingly firm demonstration that England’s eighteenth-century economic performance was not at all unusual by world standards for premodern growth, but instead was fully equaled by that of sixteenth/early-seventeenth-century Holland, eighteenth-century China, and even thir-

teenth-century northern Europe, should clearly reveal the falsity of any arguments claiming that only eighteenth-century England had the proper macro-social or macro-economic characteristics for economic growth.

In addition, a further error arose in responding to the realization that episodes of European growth stretched back fairly clearly to the Middle Ages, by asserting a “pan-European” growth pattern that was assumed to move fairly smoothly into industrialization (e.g., Landes 1998, Levine 2000). In this view, “early modern” Europe, starting sometime around A.D. 1000 or 1350, paved the way for the emergence of “modern” Europe. Yet a broader comparative analysis must acknowledge that episodes of extraordinary pre-industrial growth—notably that of Qing China—also occurred outside of Europe; indeed Qing accomplishments arguably exceeded those of Medieval Europe, Golden Age Holland, or eighteenth-century Britain. Once we clear the decks and see the similarity of these “efflorescences” across time and space, we can no longer simply argue from any strong episode of growth prior to industrialization as leading naturally to that outcome. Growth that parallels the so-called “early modern” experience, entailing increases in population, living standards, urbanization, long-distance and regional commercial trade, and institutional and technological innovations can be found throughout history, from antiquity through classical times through medieval eras to the present, and throughout Eurasia and the New World.

Instead, industrialization, as many have come to acknowledge, was an oddity—a “peculiar path” (Mokyr 1999, van Zanden 2000, Goldstone 2002). It did not come spontaneously to Holland, or Italy, to name two early sites of technical, financial, and scientific prowess. It was a particular offshoot of European science, that by a path-dependent interweaving with circumstances in Britain produced a peculiar culture that affected both science and the technology of production in profound and unforeseeable ways. Only after its initial success in Britain did this combination of experimental science and its application to commercial processes spread again throughout Europe in the nineteenth and twentieth centuries.

The world, therefore, was not polarized between a single broadly “Western” “modernity” destined to be universal, and a residual “traditional” realm of stagnation or failure. Quite the contrary, the world had, as Eisenstadt and Schluchter (1998) insist, many “early modernities,” if by that we mean many different places and cultures that experienced efflorescences, each with comparable macro-economic success, albeit with its own unique cultural content and organizational frame-

works. We would only insist that such efflorescences were in no way what has generally been implied by the term “early modern”—namely a break from premodern characteristics and preludes to modern economic growth—for they stretched across the globe and time to antiquity and classical eras on all continents, and they generally (even in the West) did not give rise to modern economic growth. Rather efflorescences and reciprocal declines remained a normal characteristic of premodern economic dynamics from the dawn of history to the onset of the modern age.

Moreover, these multiple efflorescences were not closed national events; quite the reverse—they were strongly rooted in the mixing of cultures, ideas, people, and skills that came together in trade and political expansion to create new syntheses in institutions and techniques. This was as true for classical Greece as for Song China, as for Golden Age Holland, as for Petrine Russia. It just so happened that in the background of one of these efflorescences—that of eighteenth-century England—there lurked a particular cultural content, a peculiar engineering culture, that combined with that otherwise normal efflorescence to create wholly novel breakthroughs in energy use, with remarkably transformative effects in a variety of fields.

What this should imply is that there is no universal or European “modernity” for the world to adopt or combat; rather there is a particular strand in European culture, engine science, that is extremely useful for generating natural knowledge and improving production processes. Other cultures have adopted that strand, to a greater or lesser degree; to be sure its cosmology threatens elements of other cultures, just as it threatened the Catholic/Classical tradition in which it originally appeared. But just as the Christian tradition has accommodated and survived, so will others. Indeed, nothing could be more normal than to expect “multiple modernities” to flourish, as the peculiar thread of “engine science” and all it implies, and non-European cultures, reach their various accommodations (Eisenstadt 2000, Wittrock 2000).

Although space does not permit much treatment of further issues here, it should at least be noted that the idea that broad European civilizational traits were responsible for “growth,” which was absent outside of Europe, must be discarded. Yet this leaves open the problematic issue of whether particular political or social traits of certain regions of Europe conduced to the rise of “engine science,” or if not, at least facilitated its integration into European economy and society. I have already pointed out that some such characteristics, such as the notion that Europe had a unique “competing nation-state” political framework, are rather anachronistic “ideal-types” when projected back to the

sixteenth through nineteenth centuries, during which the multinational crown (United Kingdom, Denmark/Norway), or empire (Russia, Austria-Hungary, Prussia) or subnational principality (Italy, much of Germany) were dominant. Moreover, while a degree of liberty or pluralism is, by definition, essential to overcoming the efforts of entrenched elites to squelch changes in culture and social organization, such liberty is neither necessary (as shown by Russia and the Soviet Union) nor sufficient (as shown by the long pluralist and relatively free history of Switzerland since the Middle Ages) for engine science to develop.

It thus may be that far from a necessary development of European civilization, the rich development of engine science was the chance outcome of specific, even highly contingent, circumstances that happened to arise in seventeenth- and eighteenth-century Britain. For example, I have argued elsewhere (Goldstone 2002) that the spread of experimental and Newtonian ideas throughout Britain could have been dramatically altered if William III's intervention in English politics in the Revolution of 1688 had failed. Had James II been successful in aligning England with Catholic France, helping Louis XIV to crush the freedom of Holland in return for Louis's support in placing Catholic leadership in the key political and cultural positions in Britain, what might have followed? Newton was one of the leaders of the anti-Catholic opposition at Cambridge, and one can well imagine that James would both dismiss Newton and either abolish the Royal Society or move to place Catholics (even Jesuits?) in charge of the Society. What then? While the Revolution of 1688 has long been discussed as playing a pivotal role in sustaining English political and religious freedoms, it may have been equally crucial to sustaining Britain's peculiar trajectory of engine science. At the least, it seems that one can readily imagine European histories in which, absent specific developments in Britain, natural philosophy develops all across Europe only as it developed on the continent from 1650 to 1750, with a focus on Cartesian logic and mechanics (in which there was no vacuum, no gravitational force, and no mathematization of mechanics); and steam-powered industrialization does not occur.

CONCLUSION

The approach taken in this paper, of seeing all premodern history as punctuated by a large number of "anti-crises," or "efflorescences," or "golden ages" argues that growth and prosperity were not monopolies

of the modern or Western (or even “capitalist”) worlds. Rather, at many times and places in history opportunities were created and seized, most often under conditions of amplified cultural and commercial exchange and the renovation and extension of political institutions, to innovate, raise productivity, and provide sustained population growth and urbanization simultaneously with rising and high levels of per capita income. Such efflorescences, however, tended to set new institutional and economic frameworks which themselves developed into an equilibrium or inertial state, in which new technological innovations slowed or ceased, and economic and political elites sought to defend existing social patterns. Such inertial states were prone to decay, Malthusian stresses (which were temporarily lifted during efflorescences), and the collapse of complexly interwoven economic and political structures. The entire pattern, broadly repeated, allowed various civilizations to periodically ratchet upward to support ever-larger populations at higher standards of living, despite intervals of decline.¹⁷

The alternation of intervals of “progress” and “decline” were thus wholly normal and common processes across civilizations. In this dynamic, there is no great puzzle—though it is often pondered (Jones 1988, Blue 1999)—of why the Song breakthrough did not lead to continuous development in China, or why we find growth in Europe all the way back to the Middle Ages prior to the so-called “Industrial Revolution” of the eighteenth century, or how Tokugawa Japan could attain a high premodern standard of living and yet not be on track to achieve an Industrial Revolution of its own. All of these false conundrums arose from the errant dichotomizing of global economies into periods and regions of “growth” and “non-growth,” such that once a society makes a transition from the trap of “non-growth” into “growth,” it is no longer

¹⁷ I do not mean that standards of living for all members of society always “ratcheted upwards.” Persistent inequality tended to limit long-term gains for the average worker. Thus in England, farmworkers’ wages show no long-term improvement between 1375 and 1725, although there are intervening ups and downs driven by population cycles (Clark 1999, Zanden 1999). England’s total population may also have been similar in 1350 and 1750 (Levine 2000, 241–242). Nonetheless, it appears from the long-term growth of cities, the size of bureaucratic and mercantile groups, and improvements in the consumption of consumer goods such as housing, textiles, pewter plates and cutlery, that while average workers may not have fared greatly differently in the fourteenth and eighteenth centuries, at the later time English society also supported a much larger and wealthier middle class and elite stratum. Similarly, eighteenth-century France, with its large and wealthy urban/landlord elite, was considered by contemporaries as a far richer society than medieval or Renaissance France, even if the living standards of peasants was unchanged, and that of agricultural day laborers dependent on wages was probably lower. Thus societies as a whole seem to become richer in successive “efflorescences,” even if this may not be evident at the lower levels of the social pyramid.

in a premodern state, and continued and eventually modern growth must follow. This is false. Growth was widespread in prehistory, but in a pattern that was periodic and efflorescent, rather than self-sustaining and accelerating.

We have suggested that the major bottleneck to self-sustaining and accelerating growth lay in the volume and concentration of energy available for mechanical work. Windmills, animal breeding, forestry, water mills, and sailing ships gradually increased the amount of solar, gravitational, and bioenergy available for useful work, but the major breakthrough of this bottleneck only came with the creation of engines specifically designed to convert fossil fuel energy to useful work, in eighteenth-century England, and the application of such engines to a wide variety of agricultural, manufacturing, transport, and military operations, first in England and then diffusing to Europe, North America, and Eurasia. The significance of this breakthrough, which emerged from and then reinforced a peculiar engineering culture that deflected England from continental European trajectories, afforded such vast advantages in manipulable power to England and then Europe as to give the illusion of a holistic "Rise of the West." In fact, engine science was a fairly particular strain within broader European culture, that could be adopted and integrated by other cultures (as was soon done by Japan and later by other Eurasian cultures), rather than the result of any broad civilizational advantages of "Europe" as a whole.

Timothy Brook wisely argued that it would be difficult to understand the place of China (and other civilizations) in world history until such time as "the 'rise of the West' begins . . . to look more like a local phenomenon rather than a global destiny" (1999, 157). Insofar as the rise of "engine science" and steam power were peculiar local phenomena, he was exactly right.

REFERENCES

- Abu-Lughod, Janet. 1989. *Before European Hegemony: The World System A.D. 1250–1350*. New York: Oxford University Press.
- Allen, Robert. 1988. "The Growth of Labor Productivity in Early Modern English Agriculture." *Explorations in Economic History* 25.1: 117–146.
- Ashton, T. S. 1948. *The Industrial Revolution, 1760–1830*. Oxford: Oxford University Press.
- Baechler, Jean, John A. Hall, and Michael Mann, eds. 1988. *Europe and the Rise of Capitalism*. Oxford: Blackwell.
- Bayly, C. A. 2000. "South Asia and the 'Great Divergence.'" *Itinerario* 22.3/4: 89–103.

- Bekar, Clifford, and Richard G. Lipsey. 2000. *Science, Institutions, and the Industrial Revolution*. Unpublished ms., Lewis and Clark College/Simon Fraser University.
- Bentley, Jerry H. 1996. "Cross-Cultural Interaction and Periodization in World History." *American Historical Review* 101.3: 749–770.
- . 1998. "Hemispheric Integration, 500–1500 C.E." *Journal of World History* 9: 237–253.
- Berg, Maxine. 1994. *The Age of Manufactures, 1700–1820*. New York: Routledge.
- Berry, Mary Elizabeth. 1999. "Was Early Modern Japan Culturally Integrated?" In *Beyond Binary Histories: Re-Imagining Eurasia to 1830*, ed. Victor Leiberman, 103–128. Ann Arbor: University of Michigan Press.
- Black, Jeremy. 2000. *A New History of England*. Phoenix Mill, U.K.: Sutton.
- Blaut, James. 1993. *The Colonizer's Model of the World: Geographical Diffusionism and Eurocentric History*. New York and London: Guilford Press.
- Blue, Gregory. 1999. "China and Western Thought in the Modern Period." In *China and Capitalism: Genealogies of Sinological Knowledge*, ed. Timothy Brook and Gregory Blue, 57–109. Cambridge: Cambridge University Press.
- Blussé, Leonard, and Femme Gaastra, eds. 1998. *On the Eighteenth Century as a Category of Asian History: Van Leur in Retrospect*. Aldershot, U.K.: Ashgate.
- Bray, Francesca. 1999. "Towards a Critical History of Non-Western Technology." In *China and Capitalism: Genealogies of Sinological Knowledge*, ed. Timothy Brook and Gregory Blue, 158–209. Cambridge: Cambridge University Press.
- Britnell, Richard H. 1993. *The Commercialisation of English Society 1000–1500*. Cambridge: Cambridge University Press.
- , and Bruce M. C. Campbell, eds. 1995. *A Commercialising Economy*. Manchester: University of Manchester Press.
- Brokaw, Cynthia. 1996. "Commercial Publishing in Late Imperial China: The Zou and Ma Family Businesses." *Late Imperial China* 17.1: 49–92.
- Brook, Timothy. 1996. "Edifying Knowledge: The Building of School Libraries in Ming China." *Late Imperial China* 17.1: 93–119.
- . 1999. "Capitalism and the Writing of Modern History in China." In *China and Capitalism: Genealogies of Sinological Knowledge*, ed. Timothy Brook and Gregory Blue, 110–157. Cambridge: Cambridge University Press.
- Cameron, Rondo E. 1997. *A Concise Economic History of the World*, 3rd ed. New York: Oxford University Press.
- Cardwell, D.S.L. 1969. *Turning Points in Western Technology*. New York: Science History Publications.
- Carroll-Burke, Patrick. 2001. "Tools, Instruments, and Engines: Getting a Handle on the Specificity of Engine Science." *Social Studies of Science* 31.4: 593–625.

- Chaudhuri, K. N. 1990. *Asia Before Europe*. Cambridge: Cambridge University Press.
- Cipolla, Carlo M., ed. 1970. *The Economic Decline of Empires*. London, Methuen.
- Clark, Gregory. 1991. "Land Productivity in English Agriculture, 1300–1860." In *Agricultural Productivity in the European Past*, ed. B.M.S. Campbell and Mark Overton, 211–235. Manchester: Manchester University Press.
- . 2000. "The Meaning of the Industrial Revolution." Unpublished ms., Department of Economics, University of California, Davis.
- . 2001. "The Long March of History: Farm Laborers' Wages in England 1208–1850." Unpublished ms., Department of Economics, University of California, Davis.
- Collins, James B. 1995. *The State in Early Modern France*. Cambridge: Cambridge University Press.
- Crafts, N.F.R., and C. K. Harley. 1992. "Output Growth and the Industrial Revolution: A Restatement of the Crafts-Harley View." *Economic History Review* 45: 703–730.
- Crosby, Alfred. 1997. *The Measure of Reality: Quantification and Western Society 1250–1600*. Cambridge: Cambridge University Press.
- Crosland, Maurice, ed. 1969. *Science in France in the Revolutionary Era, Described by Thomas Brugge*. Cambridge, MA: Society for the History of Technology/MIT Press.
- Das Gupta, Ashin. 1994. *Merchants of Maritime India, 1500–1800*. Aldershot, U.K.: Variorum.
- Davids, Karel. 1995. "Shifts of Technological Leadership in Early Modern Europe." In *A Miracle Mirrored: The Dutch Republic in European Perspective*, ed. Karel Davids and Jan Lucassen, 329–365. Cambridge: Cambridge University Press.
- Debeir, Jean-Claude, Jean-Paul Deléage, and Daniel Hémerly. 1991. *In the Servitude of Power: Energy and Civilization through the Ages*. Trans. John Barzman. London: Zed.
- Deng, Gang. 1997. *Chinese Maritime Activities and Socioeconomic Development c. 2100 B.C.–A.D. 1900*. Westport, CT: Greenwood Press.
- . 1999. *The Premodern Chinese Economy: Structural Equilibrium and Capitalist Sterility*. London: Routledge.
- de Vries, Jan. 1994. "The Industrial Revolution and the Industrious Revolution." *Journal of Economic History* 58.1: 249–270.
- . 1999. "Great Expectations: Early Modern History and the Social Sciences." *Review: Fernand Braudel Center* 22.2: 121–149.
- . 2000. "Dutch Economic Growth in Comparative Historical Perspective, 1500–2000." *De Economist* 148.4: 443–467.
- . 2001. "Economic Growth before and after the Industrial Revolution: A Modest Proposal." In *Early Modern Capitalism*, ed. Maarten Prak, 177–194. London: Routledge.

- , and A.M. van der Woude. 1997. *The First Modern Economy: Success, Failure, and Perseverance of the Dutch Economy, 1500–1815*. Cambridge: Cambridge University Press.
- Diamond, Jared. 1997. *Guns, Germs, and Steel*. New York: W. W. Norton.
- Di Cosmo, Nicola. 1998. "Qing Colonial Administration in Inner Asia." *International History Review* 20.2: 287–309.
- . 1999. "State Formation and Periodization in Inner Asian History." *Journal of World History* 10.1: 1–40.
- . 2002. "Did Guns Matter? Firearms and the Qing Formation." In *The Qing Formation in World Historical Time*, ed. Lynn Struve. Cambridge, MA: Harvard University Asia Center.
- Dobbs, B.J.T. 2000. "Newton as Final Cause and First Mover." In *Rethinking the Scientific Revolution*, ed. Margaret J. Osler, 25–40. Cambridge: Cambridge University Press.
- , and Margaret Jacob. 1995. *Newton and the Culture of Newtonianism*. Atlantic Highlands, NJ: Humanities Press.
- Dudley, Leonard. 1991. *The Word and the Sword*. Cambridge, MA: Basil Blackwell.
- Eisenstadt, Shmuel N., ed. 1967. *The Decline of Empires*. Englewood Cliffs, NJ, Prentice-Hall.
- . 2000. "Multiple Modernities." *Daedalus* 129.1: 1–30.
- , and Wolfgang Schluchter. 1998. "Introduction: Paths to Early Modernities—A Comparative View." *Daedalus* 127.3: 1–18.
- Elman, Benjamin. 1984. *From Philosophy to Philology: Intellectual and Social Aspects of Change in Late Imperial China*. Cambridge, MA: Council on East Asian Studies, Harvard University.
- , and Alexander Woodside, eds. 1994. *Education and Society in Late Imperial China, 1600–1900*. Berkeley: University of California Press.
- Elvin, Mark. 1973. *The Pattern of the Chinese Past*. Stanford: Stanford University Press.
- . 1988. "China as a Counterfactual." In *Europe and the Rise of Capitalism*, ed. Jean Baechler, John A. Hall, and Michael Mann, 101–112. Oxford: Blackwell.
- . 1993. "Three Thousand Years of Unsustainable Growth: China's Environment from Archaic Times to the Present." *East Asian History* 6: 7–46.
- . Forthcoming. *The Retreat of the Elephants. China's History in an Environmental Perspective*. Boulder, CO: Westview Press.
- Ergene, Bogaç A. 2001. "On Ottoman Justice: Interpretations in Conflict (1600–1800)." *Islamic Law and Society* 8.1: 52–87.
- Feingold, Mordechai. 1996. "Reversal of Fortunes: The Displacement of Cultural Hegemony from the Netherlands to England in the Seventeenth and Early Eighteenth Centuries." In *The World of William and Mary: Anglo-Dutch Perspectives on the Revolution of 1688–89*, ed. Dale Hoak and Mordechai Feingold, 243–261. Stanford: Stanford University Press, 1996.

- Feinstein, Charles H. 1998. "Pessimism Perpetuated: Real Wages and the Standard of Living in Britain during and after the Industrial Revolution." *Journal of Economic History* 58.3: 625–658.
- Finlay, Robert. 1998. "The Pilgrim Art: The Culture of Porcelain in World History." *Journal of World History* 9: 141–187.
- Flynn, Dennis O. 1996. *World Silver and Monetary History in the 16th and 17th Centuries*. Aldershot, U.K.: Variorum.
- , and Arturo Giráldez. 1995. "Born with a Silver Spoon: The Origin of World Trade in 1571." *Journal of World History* 6: 201–221.
- Frank, Andre Gunder. 1998. *Reorient: Global Economy in the Asian Age*. Berkeley and Los Angeles: University of California Press.
- Gabbey, Alan. 1993. "Between *ars* and *philosophia naturalis*: Reflections on the Historiography of Early Modern Mechanics." In *Renaissance and Revolution*, ed. J. V. Field and Frank A.J.L. James, 133–145. Cambridge: Cambridge University Press, 1993.
- Gates, Hill. 1996. *China's Motor: A Thousand Years of Petty Capitalism*. Ithaca, NY: Cornell University Press.
- Gellner, Ernest. 1983. *Nations and Nationalism*. Oxford: Blackwell.
- . 1989. *Plough, Sword, and Book*. Chicago: University of Chicago Press.
- Giesen, Bernhard. 1998. "Cosmopolitans, Patriots, Jacobins, and Romantics." *Daedalus* 127.3: 221–250.
- Goldstone, Jack A. 1984. "Urbanization and Inflation: Lessons from the English Price Revolution of the 16th and 17th Centuries." *American Journal of Sociology* 89: 1122–1160.
- . 1987. "Cultural Orthodoxy, Risk, and Innovation: The Divergence of East and West in the Early Modern World." *Sociological Theory* 5: 119–135.
- . 1991. *Revolution and Rebellion in the Early Modern World*. Berkeley: University of California Press.
- . 1998. "The Problem of the 'Early Modern' World." *Journal of the Economic and Social History of the Orient* 41: 249–284.
- . 2000a. "The Rise of the West—or Not? A Revision to Socio-economic History." *Sociological Theory* 18: 157–194.
- . 2000b. "Whose Measure of Reality?" *American Historical Review* 105: 501–508.
- . 2002. "Europe's Peculiar Path: Would the World be 'Modern' if William III's Invasion of England in 1688 had Failed?" In *Counterfactual History*, ed. Ned Lebow, Geoffrey Parker, and Philip Tetlock. New York: Columbia University Press.
- Goody, Jack. 1996. *The East in the West*. Cambridge: Cambridge University Press.
- Goudsblom, J. 1992. *Fire and Civilization*. London: Allen Lane.
- Grantham, George. 1993. "Division of Labour: Agricultural Productivity and Occupational Specialization in Pre-industrial France." *Economic History Review* 46.3: 478–502.

- . 1999. "Contra Ricardo: On the Macroeconomics of Europe's Agrarian Age." *European Review of Economic History* 3: 199–232.
- Habib, Irfan. 1969. "Potentialities of Capitalist Development in the Economy of Mughal India." *Journal of Economic History* 29.1: 32–78.
- Hall, John A. 1986. *Powers and Liberties: The Causes and Consequences of the Rise of the West*. New York: Oxford University Press.
- . 2001. "Confessions of a Eurocentric." *International Sociology* 16.3: 495–503.
- Hall, John R. 1999. "The Transition to New Thinking about the Emergence of Capitalism." Paper presented at the conference "On the Origins of Modern World," University of California, Davis, October.
- Hartwell, Robert M. 1962. "A Revolution in the Iron and Coal Industries during the Northern Sung." *Journal of Asian Studies* 21.2: 153–162.
- . 1966. "Markets, Technology, and the Structure of Enterprise in the Development of the Eleventh-Century Chinese Iron and Steel Industry." *Journal of Economic History* 1: 29–58.
- Hayami, Akira. 1986. "A Great Transformation: Social and Economic Change in Sixteenth- and Seventeenth-Century Japan." *Bonner Zeitschrift für Japanologie* 8: 3–13.
- Hilton, Rodney. 1978. *The Transition from Feudalism to Capitalism*. London: Verso.
- Hoffman, Philip T. 1996. *Growth in a Traditional Society: The French Countryside, 1450–1815*. Princeton: Princeton University Press.
- , and Kathryn Norberg, eds. 1994. *Fiscal Crises, Liberty, and Representative Government, 1450–1789*. Stanford: Stanford University Press.
- Huang, Philip C. C. 1990. *The Peasant Family and Rural Development in the Yangzi Delta, 1350–1988*. Stanford: Stanford University Press.
- Hunter, Janet. 2000. "The Roots of Divergence? Some Comments on Japan in the 'Axial Age,' 1750–1850." *Itinerario* 22.3/4: 75–88.
- Inkster, Ian. 1991. *Science and Technology in History*. New Brunswick, NJ: Rutgers University Press.
- Israel, Jonathan. 1995. *The Dutch Republic: Its Rise, Greatness, and Fall 1477–1806*. Oxford: Clarendon Press.
- Jacob, Margaret C. 1988. *The Cultural Meaning of the Scientific Revolution*. New York: Alfred A. Knopf.
- . 1997. *Scientific Culture and the Making of the Industrial West*. New York: Oxford University Press.
- . 2000. "The Truth of Newton's Science and the Truth of Science's History: Heroic Science at its Eighteenth-Century Formulation." In *Rethinking the Scientific Revolution*, ed. Margaret J. Osler, 315–332. Cambridge: Cambridge University Press.
- Jenkins, Jane E. 2000. "Arguing about Nothing: Henry More and Robert Boyle on the Theological Implications of the Void." In *Rethinking the Scientific Revolution*, ed. Margaret J. Osler, 153–179. Cambridge: Cambridge University Press.

- Jones, Eric. L. 1988. *Growth Recurring: Economic Change in World History*. Oxford: Clarendon Press.
- . 1994. "Patterns of Growth in History." In *Capitalism in Context: Essays on Economic Development and Cultural Change in Honor of R. M. Hartwell*, ed. John A. James and Mark Thomas, 15–28. Chicago: University of Chicago Press.
- Jones, Susan Mann, and Philip A. Kuhn. 1978. "Dynastic Decline and the Roots of Rebellion." In *The Cambridge History of China*, vol. 10, *Late Ch'ing, 1800–1911*, Part 1, ed. Denis Twitchett and John K. Fairbank, 107–162. Cambridge: Cambridge University Press.
- Komlos, John. 1989. "Thinking About the Industrial Revolution." *Journal of European Economic History* 18.1: 191–206.
- . 1998. "Shrinking in a Growing Economy? The Mystery of Physical Stature during the Industrial Revolution." *Journal of Economic History* 58: 779–802.
- . 2000. "The Industrial Revolution as the Escape from the Malthusian Trap." *Journal of European Economic History* 29: 307–331.
- , and Markus Heintel. 1999. "The Threat of a Malthusian Crisis in the Habsburg Monarchy." *Journal of Interdisciplinary History* 30: 91–98.
- Kuznets, Simon. 1966. *Modern Economic Growth: Rate, Structure and Spread*. New Haven: Yale University Press.
- Lal, Deepak. 1998. *Unintended Consequences*. Cambridge, MA: MIT Press.
- Landes, David. 1969. *The Unbound Prometheus*. Cambridge: Cambridge University Press.
- . 1983. *Revolution in Time*. Cambridge, MA: Belknap Press.
- . 1998. *The Wealth and Poverty of Nations*. New York: W. W. Norton.
- Lavelly, William, and R. Bin Wong. 1998. "Revising the Malthusian Narrative: The Comparative Study of Population Dynamics in Late Imperial China." *Journal of Asian Studies* 57: 714–748.
- Lee, James, Cameron Campbell, and Wang Feng. 1993. "The Last Emperors: An Introduction to the Demography of the Qing (1644–1911) Imperial Lineage." In *New and Old Methods in Historical Demography*, ed. Roger Schofield and David Reher, 361–382. Oxford: Oxford University Press.
- Lee, James, and Wang Feng. 1999. *One Quarter of Humanity: Malthusian Mythology and Chinese Realities*. Cambridge, MA: Harvard University Press.
- Le Roy Ladurie, Emmanuel. 1977. "Motionless History." *Social Science History* 1.2: 115–136.
- Levine, David. 2000. *At the Dawn of Modernity*. Berkeley and Los Angeles: University of California Press.
- Lewis, Martin W., and Kären E. Wigen. 1997. *The Myth of Continents: A Critique of Metageography*. Berkeley: University of California Press.
- Li Bozhong. 1998. *Agricultural Development in Jiangnan, 1620–1850*. New York: St. Martin's Press.
- Lieberman, Victor. 1999. "Transcending East-West Dichotomies: State and

- Culture Formation in Six Ostensibly Separate Areas." In *Beyond Binary Histories: Re-Imagining Eurasia to 1830*, ed. Victor Leiberhan, 19–102. Ann Arbor: University of Michigan Press.
- Livi-Bacci, Massimo. 1992. *A Concise History of World Population*. Trans. Carl Ipsen. Cambridge, MA and Oxford, U. K.: Blackwell.
- Macfarlane, Alan. 1987. *The Culture of Capitalism*. Oxford: Basil Blackwell.
- Malanima, Paulo. 2001. "The Energy Basis for Early Modern Growth, 1650–1820." In *Early Modern Capitalism*, ed. Maarten Prak, 51–68. London: Routledge.
- Mann, Michael. 1986. *The Sources of Social Power*. Cambridge, U.K.: Cambridge University Press.
- Marks, Robert. 1997. *Tigers, Silk, and Silt: Environment and Economy in Guangdong, 1250–1850*. Cambridge: Cambridge University Press.
- Mazumdar, Sucheta. 1998. *Sugar and Society in China: Peasants, Technology, and the World Market*. Cambridge, MA: Harvard University Asia Center.
- McNeill, William H. 1989. *The Age of Gunpowder Empires 1450–1800*. Washington, DC: American Historical Association.
- Milward, Alan S. 2002. "The Torghuds, the Mongol Legacy, and the 'End of History' in Early Modern Central Eurasia." In *The Qing Formation in World Historical Time*, ed. Lynn Struve. Cambridge, MA: Harvard University Asia Center.
- Mokyr, Joel. 1990. *The Lever of Riches: Technological Creativity and Economic Progress*. Oxford: Oxford University Press.
- . 1994. "Progress and Inertia in Technological Change." In *Capitalism in Context: Essays on Economic Development and Cultural Change in Honor of R. M. Hartwell*, ed. John A. James and Mark Thomas, 230–254. Chicago: University of Chicago Press.
- . 1999a. *The British Industrial Revolution*. 2nd ed. Boulder, CO: Westview Press.
- . 1999b. "The Industrial Revolution and the Netherlands: Why did it not Happen?" Paper presented at the 150th Anniversary Conference Organized by the Royal Dutch Economic Association, Amsterdam, December 10–11.
- . 2000. "Knowledge, Technology, and Economic Growth during the Industrial Revolution." In *Technology and Productivity Growth*, ed. Bart van Ark and Gerard Kuper. The Hague: Kluwert.
- . 2002. *Gifts of Athena*. Princeton: Princeton University Press.
- Morris, Ian. Forthcoming. "Archaeology, Standards of Living, and Greek Economic History." In *The Ancient Economy: Evidence and Models*, ed. J. Manning and I. Morris. Stanford: Stanford University Press.
- Nef, John. 1964. *The Conquest of the Material World*. Chicago: University of Chicago Press.
- Nelson, Richard. 1996. *The Sources of Economic Growth*. Cambridge, MA: Harvard University Press.
- North, Douglas. 1981. *Structure and Change in Economic History*. New York: W. W. Norton.

- , and Barry Weingast. 1989. "Constitutions and Commitment: Evolution of Institutions Governing Public Choice in Seventeenth-Century England." *Journal of Economic History* 49.4: 803–832.
- O'Brien, Patrick. 2000. "The Reconstruction, the Rehabilitation, and Reconfiguration of the British Industrial Revolution as a Conjuncture in Global History." *Itinerario* 22.3/4: 117–134.
- Osler, Margaret J. 2000. "The Canonical Imperative: Rethinking the Scientific Revolution." In *Rethinking the Scientific Revolution*, ed. Margaret J. Osler, 3–24. Cambridge: Cambridge University Press.
- Pacey, Arnold. 1990. *Technology in World Civilization*. Cambridge, MA: MIT Press.
- . 1992. 2nd ed. *The Maze of Ingenuity: Ideas and Idealism in the Development of Technology*. Cambridge, MA: MIT Press.
- Pamuk, Şevket. 2000. "The Ottoman Empire in the Eighteenth Century." *Itinerario* 22.3/4: 104–116.
- Parker, Geoffrey. 1988. *The Military Revolution*. Cambridge: Cambridge University Press.
- Parker, William N. 1974. *Europe, America, and the Wider World*. Cambridge: Cambridge University Press.
- Pérez-Díaz, Victor. 1999. "State and Public Sphere in Spain during the Ancient Regime." *Daedalus* 127.3: 251–279.
- Persson, K. Gunnar. 1988. *Pre-Industrial Economic Growth*. Oxford: Blackwell.
- Pollock, Sheldon. 1998. "Indian in the Vernacular Millennium: Literary Culture and Polity, 1000–1500." *Daedalus* 127.3: 41–74.
- Pomeranz, Kenneth. 2000a. *The Great Divergence: China, Europe, and the Making of the Modern World Economy*. Princeton, NJ: Princeton University Press.
- . 2000b. "Re-thinking the Late Imperial Chinese Economy: Development, Disaggregation and Decline, circa 1730–1930." *Itinerario* 22.3/4: 29–74.
- Rawski, Evelyn S. 1998. *The Last Emperors: A Social History of Qing Imperial Institutions*. Berkeley: University of California Press.
- . 2002. "The Qing Formation and the Early Modern Period." In *The Qing Formation in World Historical Time*, ed. Lynn Struve. Cambridge, MA: Harvard University Asia Center.
- Reid, Anthony. 1999. *Charting the Shape of Early Modern Southeast Asia*. Chang Mai, Thailand: Silkworm Books.
- Romer, Paul. 1986. "Increasing Returns and Long-Run Growth." *Journal of Political Economy* 44.5: 110–137.
- Shapin, Stephen. 1994. *A Social History of Truth*. Chicago: University of Chicago Press.
- . 1996. *The Scientific Revolution*. Chicago: University of Chicago Press.
- Shapiro, Barbara. 1983. *Probability and Certainty in Seventeenth-Century England*. Princeton: Princeton University Press.
- Smil, Vlacav. 1994. *Energy in World History*. Boulder, CO: Westview Press.

- Spruyt, Hendrik. 1994. *The Sovereign State and its Competitors*. Princeton: Princeton University Press.
- Stokes, Gale. 2001. "The Fates of Human Societies: A Review of Recent Macrohistories." *American Historical Review* 106.2: 508–521.
- Strandh, Sigvard. 1979. *A History of the Machine*. New York: Dorset Press.
- Struve, Lynn. 1984. *The Southern Ming 1644–1662*. New Haven: Yale University Press.
- Subrahmanyam, Sanjay. 1990. *The Political Economy of Commerce: Southern India 1500–1650*. Cambridge: Cambridge University Press.
- . 1996. "Introduction." In *Merchants Networks in the Early Modern World*, ed. Sanjay Subrahmanyam, i–xxvi. Aldershot, U.K.: Variorum (1998).
- . 1998. "Hearing Voices: Vignettes of Early Modernity in South Asia, 1400–1750." *Daedalus* 127.3: 75–104.
- . 1999. "Connected Histories: Notes toward a Reconfiguration of Early Modern Eurasia." In *Beyond Binary Histories: Re-Imagining Eurasia to 1830*, ed. Victor Leiberhan, 289–316. Ann Arbor: University of Michigan Press.
- . 2000. "Un Grand Dérangement: Dreaming an Indo-Persian Empire in South Asia, 1740–1800." *Journal of Early Modern History* 4.3–4: 337–378.
- Sugihara, Kaoru. 1996. "The European Miracle and the East Asian Miracle: Towards a New Global Economic History." *Sangyo to Keizai* 11.2: 27–47. Nara Industrial University.
- . 2000. "The East Asian Path of Economic Development." *Discussion Papers in Economics and Business* (graduate school of Economics and Osaka School of International Public Policy) Discussion Paper. Osaka University, Osaka.
- Tainter, Joseph A. 1988. *The Collapse of Complex Societies*. Cambridge: Cambridge University Press.
- . 2000. "Problem Solving: Complexity, History, Sustainability." *Population and Environment* 22.1: 3–41.
- Thompson, William R. 1999. "The Military Superiority Thesis and the Ascendancy of Western Eurasia in the World System." *Journal of World History* 10:143–178.
- Tilly, Charles. 1992. *Coercion, capital, and European states, A.D. 990–1992*. Cambridge, MA: Blackwell.
- Totman, Conrad. 1993. *Early Modern Japan*. Berkeley: University of California Press.
- Vries, P.H.H. 2002. "Governing Growth: A Comparative Analysis of the Role of the State in the Rise of the West." *Journal of World History* 13.1: 67–138.
- Wakeman, Frederic, Jr., and Carolyn Grant, eds. 1975. *Conflict and Control in Late Imperial China*. Berkeley: University of California Press.
- Waley-Cohen, Joanna. 1999. *The Sextants of Beijing: Global Currents in Chinese History*. New York: Norton.

- Wallerstein, Immanuel. 1974. *The Modern World-System*. New York: Academic Press.
- Warner, Deborah Jean. 1990. "What is a Scientific Instrument, When did it become One, and Why?" *British Journal of the History of Science* 23: 83–93.
- Weber, Max. 1950. *General Economic History*. Glencoe, IL: The Free Press.
- White, Lynn, Jr. 1962. *Medieval Technology and Social Change*. New York: Oxford University Press.
- Wills, John E., Jr. 1993. "Maritime Asia, 1500–1800: The Interactive Emergence of European Domination." *American Historical Review* 98: 83–105.
- . 2001. *1688: A Global History*. New York: Norton.
- Wittrock, Björn. 1998. "Early Modernities: Varieties and Transitions." *Daedalus* 127.3: 19–40.
- . 2000. "Modernity: One, None, or Many? European Origins and Modernity as a Global Condition." *Daedalus* 129.1: 31–60.
- Wong, R. Bin. 1997. *China Transformed: Historical Change and the Limits of European Experience*. Ithaca, NY: Cornell University Press.
- Woodside, Alexander. 1998. "Territorial Order and Collective Identity Tensions in Confucian Asia." *Daedalus* 127.3: 191–220.
- Wrigley, E. A. 1987. *People, Cities, and Wealth: The Transformation of Traditional Society*. Oxford: Blackwell.
- . 1988. *Continuity, Chance, and Change: The Character of the Industrial Revolution in England*. Cambridge: Cambridge University Press.
- . 2000. "The Divergence of England: The Growth of the English Economy in the Seventeenth and Eighteenth Centuries." *Transactions of the Royal Historical Society*, 6th ser. 10: 117–141.
- Zanden, Jan Luiten van. 1999. "Wages and the Standard of Living in Europe, 1500–1800." *European Review of Economic History* 3: 175–198.
- . 2000. "The Great Convergence from a West-European Perspective: Some Thoughts and Hypotheses." *Itinerario* 22.3/4: 9–28.
- . 2001. "Early Modern Economic Growth: A Survey of the European Economy, 1500–1800." In *Early Modern Capitalism*, ed. Maarten Prak, 69–87. London: Routledge.
- Zurndorfer, Harriet T. 1997. "China and 'Modernity': The Uses of the Study of Chinese History in the Past and Present." *Journal of the Economic and Social History of the Orient* 40.4: 461–485.