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Patrick O'Brien
London School of Economics

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Patrick O'Brien
London School of Economics
and Political Science

Convenor of an International Network to Investigate Economic Outcomes
Flowing from the Revolutionary and Napoleonic Wars 1793-1815

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*A tribute to Ken Pomeranz, who asked, “Why wasn’t England the Yangzi Delta?”

(Kenneth Pomeranz, *The Great Divergence. China, Europe and the Making of the Modern World Economy* (Princeton: Princeton University Press, 2000), p. 13.

1. Past and Recent Representations of The First Industrial Revolution

In 1967 Marshal Hodgson (a godfather for global economic history) wrote these percipient words: “Without the cumulative history of the whole Afro-Asian Oikumene of which the Occident had been an integral part the western transmutation would be almost unthinkable”.¹ Alas, the recommendation by this eminent scholar of Islam to re-conceptualize the British Industrial Revolution within the wider spaces, longer chronologies and cultural frameworks of the long and interconnected history of Afro-Eurasia was not taken forward until Eric Jones published the first edition of the European Miracle in 1981.² Since then slowly but surely the bibliography of books, articles and debates relocating and reconfiguring the industrialization of Britain and the west as another long cycle in global economic history has proliferated and matured into a field that, along with accelerated trends towards a globalized economy, has revitalized interest in very long run structural development across the humanities and social sciences. Thus, it is timely to follow Hodgson’s advice and endeavour to ascertain if Britain’s famous industrial revolution can continue to be represented as a conjuncture in that process.

As an internationally renowned episode in Hanoverian history it is certainly the first and the most famous example of sustained industrialization on record. As an initial, precocious and celebrated case, generations of scholars have, however, exaggerated its Britishness (and its Englishness), reified its historiographical status and above all misrepresented what remains as a recognizable, explicable and not that remarkable discontinuity in the

¹ M. Hodgson, *Rethinking World History. Essays on Europe, Islam and World History* (Cambridge: Cambridge University Press, 2002) 68.

² E. Jones, *The European Miracle. Environments, Economics and Geopolitics in the History of Europe and Asia* (Cambridge: Cambridge University Press, 1981).

economic history of a well-endowed Island realm into a (if not the) paradigm case for liberal and neo-liberal models of economic development.

Industrialization is a highly significant historical process, drawn out or truncated over time which has occurred in local, regional, national, continental and global contexts. While its analysis now includes social, cultural, political and geopolitical as well as economic forces, its outcome can be parsimoniously encapsulated and graphically illustrated in statistical form as an interlude of accelerated economic transformation from an agrarian or organic to an industrial economy.³ Following Kuznets, in quantitative terms what the most recent wave of interpretations have observed and measured in novel ways is “structural change”, proceeding more or less rapidly until majorities of national workforces cease to be closely linked to and dependent upon primary products and become employed either directly or indirectly (through related activities such as trade, transportation, finance, information, consultancy, protection, welfare and other services) with the production and servicing of manufactured goods. Statistically trends towards industrial market economies can be tracked with reference to data displaying shares of workforces, employed in industry and related services who were to an increasing degree located in towns, and with far greater difficulty, in imperfect and potentially implausible tabulations of national accounts, spanning long chronologies of time displaying the shares of gross domestic products labelled as industrial outputs.

Although convincing arguments have been made for the Netherlands to be recognized as “The First Modern Economy”, nobody disputes that Great Britain became the first national economy to complete a transition to an

³ P. O’Brien, ed., *Industrialization Critical Perspectives on the World Economy*, 4 vols (London: Routledge, 1998).

industrial economy.⁴ For more than a century the realm's famous transformation has been narrated and explained under such labels as *The First Industrial Revolution*, *the First Industrial Nation*, or simply as *The Industrial Revolution*. Anglo-American historians have analysed the decades and cycles of rapid change in British economic history for a range of sub-periods running from the mid-17th through to the mid-19th centuries and represented them in arresting metaphorical terms as: a watershed, turning a point, a take-off and latterly, as a little - leading to the great divergence. Claims have been published that the British Industrial Revolution was more significant and pervasive for human history, than the Florentine Renaissance, or the French Revolution.⁵ The Industrial Revolution continues to be represented not only as a profound discontinuity for the history of a Hanoverian kingdom, but also as a conjuncture of trans-national significance for the future of the world economy, which positioned and periodized European, American, Asian and African histories into a "before" and "after" a demarcated stage in the history of the "First Industrial Nation".⁶

Yet nothing approximating to a "paradigm" for industrialization, which rescued first Britons and over time growing proportions of mankind from the millennial afflictions of poverty, malnutrition, disease and early death endemic to existence in traditional agrarian societies could conceivably be constructed from the economic history of a small island located off the coast of Europe. Nevertheless, there is no case for derogating a range of innovatory economic achievements that came on stream over the century which succeeded Britain's

⁴ J. De Vries and A. Van Der Woude, *First Modern Economy. Success, Failure and Perseverance of the Dutch Economy 1500-1815* (Cambridge: Cambridge University Press, 1997).

⁵ P. Mathias and J.A. Davis, ed., *The First Industrial Revolutions* (Oxford: Blackwells, 1989): 1-24 and J. Goldstone, "Efflorescences and Economic Growth in World History: Rethinking the "Rise of the West" and the Industrial Revolution," *J. World Hist.* 13 (2002),: 323-92.

⁶ G. Clark, "The Industrial Revolution" in P. Aughion and S. Durlaff (eds.) *Handbook of Economic Growth*, Vol. 2. (Oxford, Elsevier, 2013).

decisive victory in the Seven Years War 1756-63. Defined historically as *the* century which included discernible and irreversible accelerations *in rates of increase* of real income per head and in shares of the increment both to rates of growth in output per capita and labour productivity emanating from structural changes with urbanization promoting technical progress, it seems merely polemical to engage in semantic attempts to *purge* the label Industrial Revolution from academic discourse and public consciousness.⁷ Considered, as Hodgson advised, in a long stream of world history, on all the indicators, that economic historians have constructed and reconstructed since the publication of Ashton's classic study in 1948, the transformation (although protracted by subsequent standards) became rapid enough to carry the national economy forward to the position of competitive superiority that the kingdom briefly enjoyed in relation to all other European, American and Asian economies during its long Victorian boom (1846-73).⁸

Britain's naval and commercial hegemony, along with the productivity of its agriculture had, however, been recognized by its Western rivals early in the 18th century.⁹ Thereafter, Europeans accorded deference to clear comparative advantages exemplified by agriculture as well as several dynamic sectors of British manufacturing while retaining strong reservations about the social and political consequences of the nation's pattern of urbanization and structural change. Thus a plethora of acceptable and calibrated historical data (complemented by a bibliography of impressions recorded by visitors from the mainland and the United States), justifies the representation of the transformations that became clear after the Seven Years War as preparatory

⁷ R. Cameron, "The Industrial Revolution Fact or Fiction?" in F. Crouzet and A. Clesse, ed., *Leading the World Economically* (Amsterdam: Dutch University Press, 2003), 169-194; and J. Mokyr's comments, pp.357-59.

⁸ N. Crafts and K. Harley, "Output Growth and the British Industrial Revolution: A Restatement of the Crafts-Harley view," *Econ.Hist.Rev.* 45 (1992), 703-30.

⁹ P. Langford, "The English as Reformers. Foreign Visitors' Impressions 1750-1850," in T. Charles et al, eds., *Reforms in Great Britain and Germany 1750-1850* (Oxford: Oxford University Press, 1999) 101-19.

stages for a precocious transition to an industrial economy.¹⁰ After all, that century of British history witnessed the development of novel techniques of production; the construction, if slow diffusion, of engines to harness a new and eventually dominant source of energy (steam), the extension of improved modes of internal transportation (canals, turnpikes and railways) the extension of more efficient forms of business and commercial organization, the spread of responsive systems of financial intermediation and distribution; the widening and closer integration of commodity and factor markets and the diversification of consumption. For generations of historians of Britain, all this occurred at a pace and upon a scale that in retrospect has been regarded as extraordinary, if not revolutionary for its time and location.¹¹

Nevertheless, as they become more cosmopolitan in their outlooks, historians of the First Industrial Revolution have become less inclined to ignore not merely its European, but its Chinese, Indian and African antecedents. Modern interpretations are now, moreover, less likely to exaggerate elements in English political institutions, social structure, and culture that not long ago formed the foundations of explanations for the nation's precocious, relative and short-lived economic supremacy. Only "Whig" economists and a few economic historians continue to reify selected features and factors behind Britain's particular transition towards the first industrial market economy into a paradigm that embodied optimal institutions and progressive cultural traits for enterprise and technological innovation that could be readily transferred to those rival but retarded economies on the mainland, provided that they too

¹⁰ G. Riello and P. O'Brien, 'The Future is another Country: Offshore Views of the British Industrial Revolution', *Journal of Historical Sociology*, 22/1 (2009), pp. 1-29

¹¹ R. Church and E. Wrigley, *The Industrial Revolutions*, 11 vols (Oxford: Blackwells, 1994) and R. Floud and P. Johnson, eds., *The Cambridge Economic History of Modern Britain*, Vol 1 Industrialization 1700-1860 (Cambridge: Cambridge University Press, 2004) and R. Floud, et al, *The Cambridge Economic History of Modern Britain*, Vol/1 (Cambridge: Cambridge University Press, 2014).

became rational enough to adopt best practice (i.e. British) technologies, modes of economic organization and legal frameworks for production.¹²

In short, a modern wave of historical scholarship has been concerned to educate students to become aware of the European, Asian, African, American and Imperial dimensions of the British Industrial Revolution; and to observe the rather rapid convergence of Western economies to comparable levels of per capita income and labour productivity in terms of the path dependent potential of each national economy. Diffusion models which, in effect, elevated the status of Britain's transition from a precocious to a paradigm case are no longer regarded as an illuminating way to comprehend the industrialization of mainland Europe, the United States and East Asia let alone as a basis for policy recommendations to countries still struggling to industrialize. They have been degraded into consoling but simplistic narratives purveyed by nationalistic communicators of British exceptionalism.¹³

Narrated, interpreted and contextualized as a conjuncture within a long-run chronology formed by the ebb and flow of global history, the universal status of the British Industrial Revolution has been reconfigured to embody a range of mechanical innovations of world significance (e.g. the steam engines of Newcomen and Watt, Cort's path breaking technique for puddling iron, Arkwright's water frame, the weaving machines of Kay and Cartwright), all of which can be represented as more or less novel and indigenous to the Islands. Other achievements of the period, such as the invention of roller spinning by the son of a Huguenot refugee; Wedgwood's "China" emulated in the

¹² Among them are: D. Landes, *The Wealth and Poverty of Nations: Why some are so rich and some so poor* (New York: Little Brown, 1998) and D. North, *Institutions, Institutional Change and Economic Performance* (Cambridge: Cambridge University Press, 1990) and D. Acemoglu and J. Robinson, *Why Nations Fail* (New York: Crown Publishers, 2012).

¹³ Hodgson, *Rethinking World History, Part 1*; C. Rider and M. Thompson, eds., *The Industrial Revolution in Comparative Perspective* (Malabar, Fla. 2002) and S. Broadberry and K.O'Rourke, eds., *The Cambridge Economic History of Europe* (Cambridge: Cambridge University Press, vol. 1, 2010).

Potteries, painted by young women born in Staffordshire, but in colours and designs derived from Classical Greece; or the techniques used to manufacture, bleach, dye, and print cotton cloth made in Lancashire from organic raw materials cultivated on slave plantations and finished from knowledge and skills brought to high levels of perfection, in India, the Ottoman dominions, Sweden and France are no longer acclaimed as peculiarly “English”.¹⁴ Economic history has acquired a cosmopolitan perspective and it now seems futile to separate out “indigenous” from “foreign” components embodied in the myriad of manufactured goods produced and consumed in England during the reign of George III.¹⁵

Fortunately, the last thirty years of research has allowed us to escape from the bunkers of national archives, to model, to amalgamate, to aggregate and compare a variety of transitions to modern economies, and above all, to assign conjectural, but plausible, weights and potential importance to *major* forces behind the accelerated growth of Britain’s per capita output and labour productivity from 1763 to 1846.¹⁶ Thus, causes or origins accorded significance that have now matured into reconfigurations of The First Industrial Revolution include: first and foremost, the kingdom’s productive and responsive agriculture, combined with its abundant and accessible endowments of coal and other minerals; foreign trade (promoted and sustained by massive and cost effective state, investment in naval power); the rise of material consumption and, last in sequence, but not least in significance technological discovery and innovation. As usual, emphases accorded to inter-related and

¹⁴ I. Inkster, *Technology and Industrialization* (Aldershot: Variorum Press, 1998) 40-58, and G. Riello, *Cotton. The Fabric that Made the Modern World* (Cambridge, Cambridge University Press, 2013).

¹⁵ M. Berg, *Luxury and Pleasure* (Oxford: Oxford University Press, 2005).

¹⁶ N. Crafts, “Productivity Growth in the Industrial Revolution: a New Growth Accounting Perspective” *J.Econ.Hist.* 64 (2004), 521-35 and S. Broadberry et al, *British Economic Growth, 1270-1870* (Cambridge: Cambridge University Press, 2015)

inseparable forces behind any macro and complex conjuncture in history never settle into a consensus. These factors (if not their ordering or weights) are now, however, widely discussed as major causes in textbooks for the study of the kingdom's economic history.¹⁷ Thus, the most recent interpretations utilizing macro data from demographic records and concepts and statistics derived from energy accounting have reconfigured the First Industrial Revolution as a prolonged two-stage historical process. Stage One exposes and forces and factors that carried a favourably endowed and located island economy to a plateau of possibilities for sustained modern economic growth based upon the cyclical growth of continuously higher levels of total factor productivity of the kind that became increasingly visible for segments of the English economy after 1763.

Stage 1.1 Natural Endowments and National Institutions for their Exploitation

For centuries before the Seven Years War, the British Isles had been blessed with a geography and an agricultural sector with clear potential to frame and support structural change. That potential included high ratios of livestock to grain output and very good (but not extraordinary) yields per arable hectare cultivated. Above all, and compared with most other regions of Europe and clearly with India and China, English agriculture was distinguished by high levels of output per worker.¹⁸ Given the Isle's entirely fertile soils, favourable climate, and lush grass, how were these prior but basic natural advantages for a highly productive agriculture exploited? Supporters of an entirely traditional

¹⁷ J. Mokyr, *The Enlightened Economy. An Economic History of Britain, 1700-1850* (New Haven: Yale University Press, 2009). A recent and helpful survey is by E. Griffin, *A Short History of the Industrial Revolution* (Basingstoke: Palgrave Macmillan, 2010) and Broadberry et al., *British Economic Growth 1270—1870*.

¹⁸ B. Van Bavel and E. Thoen, eds., *Land Productivity and Agro Systems in the North Seas Area, Middle Ages – 19th century. Elements for Comparison* (Turhout: Corn Publications, 1999) and Broadberry et al., *British Economic Growth* and J.L. Van Zanden, *The Long Road to the Industrial Revolution* (Leiden: Brill, 2008).

Anglocentric view continue to insist that a rather distinctive set of property rights and tenurial arrangements for access to land had appeared earlier on the Isles than on the mainland of Eurasia. Over centuries of time the evolution of this peculiarly English system of control over its natural resources was established, consolidated and maintained. Its essential advantages for long-term development consisted of: the formation of larger scale units of production, efficient markets for access to farmland, concentration of rents from the well-defined ownership of both land and other natural resources and, above all, a steady reduction in the extent and control by peasant families over land and labour. In time a rising and comparatively high share of the kingdom's cultivable acres became enclosed into larger scale farms. England's kin-based agrarian workforce was gradually transformed into waged labour employed either by capitalist farmers or later on, when demands emerged for manufactured commodities, rural labour became the nucleus and then the core of a proto industrial and eventually an urban workforce.¹⁹

Among agrarian historians following Arthur Young's inclinations to represent the kingdom's aristocracy and gentry as distinctively entrepreneurial, there has been a deferential celebration of unequal landownership as the benign outcome of market forces that promoted investment, cultures of improvement and the accumulation of capacities for efficient estate management embodied among those of noble birth who had acquired, by way of predation and inheritance (as well as purchase) an inordinate share of the nation's land and natural resources.²⁰

¹⁹P. Wallis et al., "Puncturing the Malthus Delusion. Structural Change in the British Economy before the industrial revolution, 1500-1800," *LSE Economic History Working Paper*, 240/2016 and M. Prak, ed., *Early Modern Capitalism. Economic and Social Change in Europe* (London: Routledge, 2001)

²⁰ For a refutation of this view vide: R. Allen, *Enclosure and the Yeoman* (Oxford: Oxford University Press, 1992). The agrarian history of England and Wales has been deeply researched. Vide: J. Thirsk (ed.), *The Agrarian History of England and Wales*, 8 Vols. (Cambridge: Cambridge University Press, 1967-2000),

Markets are recommended by economists as rational institutions for the transfer of property rights to land, forests and minerals into the private ownership and/or control of those who can manage their use for purposes of production most effectively. The system of agrarian property rights (already in place well before the times of the First Industrial Revolution) embodied advantages for the realm's precocious transition to an industrial economy, which included the outstanding capacities of British agriculture to release ("expel") labour to other sectors of the economy. Nevertheless, there can be no presumption that the early emergence and the linear evolution thereafter of markets for the sale and purchase of land and of contractual rules, for access to farms proceeded mainly as an efficient outcome of English individualism, or from the mere extension of markets.²¹ Political and legal histories of the frameworks surrounding property and tenurial rights to the Island's endowments of cultivable land and other natural resources reveal that they also emanated from far less "benign" historical forces which included conquest, internal colonization, the violent expropriation of ecclesiastical and common land, the systematic accumulation of power by closed aristocratic elites who, over time, severely attenuated rights of access to the Island's cultivable land, forests and minerals by smaller freeholders and peasant families.²² Their persistent predation, coupled with an intensifying "pull" from high wages potentially available to migrants from the countryside to London and other maritime cities, engaged with realizing gains from overseas trade and specialization, also provided England with flexible markets for waged

²¹ A. Macfarlane, *The Origins of English Individualism* (Oxford: Oxford University Press, 1979) and R. Britnell, *The Commercialization of English Society 1000-1500* (Cambridge, Cambridge University Press, 1993).

²² T. Scott, ed., *The Peasantries of Europe from the Fourteenth to the Eighteenth Centuries* (London: Longman, 1998), Allen, *Enclosure and the Yeoma* and W.G. Hoskins, *The Age of Plunder* (London: Longmans, 1976).

labour for centuries before mechanized urban industries demanded increasing shares of the nation's workforce.²³

From the times of the Norman Conquest onwards England's aristocratic elites had pushed agriculture in directions conducive to the attainment of higher levels of labour productivity and away from the disadvantages for rapid industrialization and urbanization associated with peasant proprietorial relationships and household units for production that survived on the mainland and remained omnipresent across south and east Asian societies.

More geographically reductionist accounts of the island's advantages for that early transition were also emphasized by physiocratic improvers who visited England in the eighteenth century.²⁴ Their perceptions that the Island's favourable environmental endowments (particularly lush grass) had encouraged the steady accumulation of sheep, cattle, pigs and, above all, horses, is now commonplace in agrarian history.²⁵ By the accession of the Stuart dynasty, if not before, the kingdom's exceptionally large population of animals provided the high value raw materials (wool, leather and bones), food in the form of meat and dairy produce, extra supplies of energy and flows of organic fertiliser that had carried the productivity of English agriculture towards the head of European league tables. From that plateau after more than two centuries, animal and arable farming combined with an intensified exploitation continued to lend sufficient support to accelerated population growth, proto-industrialization and rapid urbanization, while avoiding

²³ R. Allen, "The Great Divergence in European Wages from the Middle Ages to the First World War," Explorations in *Econ.Hist.* 38 (2001) 411-47.

²⁴ K. Pomeranz, "Beyond the East-West Binary. Resituating Development Paths in the Eighteenth Century World," *Journal of Asian.Studies.* 61 (2002) 539-90 and Langford, *The English as Reformers*"

²⁵ A. Wrigley, *The Path to Sustained Growth. England's Transition from an Organic Economy to an Industrial Revolution* (Cambridge: Cambridge University Press, 2016) and P. O'Brien and D. Heath, "English and French Landowners 1688-1789," in F.M.L. Thompson, ed., *Landowners, Capitalists and Entrepreneurs* (Oxford: Oxford University Press, 1994) 23-62, and Broadberry ed., *British Economic Growth* and M. Overton, *Agricultural Revolution in England: The Transformation of the Agrarian Economy* (Cambridge: Cambridge University Press, 1996).

Malthusian crises, economic stasis and dependence upon imports of food and raw materials from outside the British Isles.²⁶

Plausible statistical estimates recording the volumes of food, fuel and organic raw materials necessary to sustain the kingdom's gradual upward momentum towards an industrial and urbanized market economy have now appeared in print. To simplify the narrative I propose to represent England as the relevant geographical and national economic unit for analysis, to ignore cyclical trends and cycles and to "compress" the complex history of that momentum to base and end year estimates for the period 1600-1800.²⁷

Figures carefully validated and recently published by Wrigley show: (a) that England's population doubled over two centuries; (b) the numbers of people resident in towns of 5,000 plus inhabitants multiplied seven times to increase from a proportion of 6% from 24% of total population so that by 1800 41% of the increment to that aggregate resided in towns, with high rates of mortality which operated to maintain flows of migrants from villages and to dampen rates of increase in the land/labour ratio in the countryside; (c) meanwhile the share of labour force engaged in producing the food, fuel and organic raw materials required to sustain and employ workers detached from agriculture and forestry had declined from above 71% in 1600 to around 39% by 1817.²⁸

These and comparable ratios published by several economic historians can be calibrated into a third ratio based on the measured capacity of workers engaged directly with the production of foodstuffs, timber and other organic raw materials to sustain workers and their families employed in industry and

²⁶ P. O'Brien, "Path Dependency, or Why Britain became an Urbanized and Industrialized Economy Long Before France," in *Econ.Hist.Review*, 49 (1996) 213-49.

²⁷ J. Hoppit, "The Nation, the State and the First Industrial Revolution," *Journal of British Studies*, 50 (2011), pp. 307-31 and J. Van Düjn, *The Long Wave in Economic Life* (London: Allen and Unwin, 1983)

²⁸ A. Wrigley, *The Path to Sustained Growth. England's Transition from an organic Economy to an Industrial Revolution* (Cambridge: Cambridge University Press, 2016)

services. This proxy for agrarian productivity (dominated by producers of foodstuffs) may have risen by more than 80% over the two centuries preceding 1800.²⁹

Early modern economic and demographic regimes as depicted by most economic historians are characterized by malign Malthusian tendencies. Typically the capacities of national supplies of cultivable land available for arable and pastoral farming as well as the production of organic raw materials, including timber for fuel, cannot sustain more than moderate rates of population growth.³⁰ Thus the key preoccupation for agrarian historians has long been to explain how English agriculture and forestry coped with the intensified demands for food, fuel and industrial raw materials placed upon that sector by cycles and trends in population growth that occurred after 1600.³¹

Above all, agrarian historians have been impressed with the capacity of agriculture to sustain an extraordinarily rapid rate of urbanization, while releasing labour for work in manufacturing, mining and services. Although the architecture for an analytical narrative has been clear for some time, the cliometric ambition to specify, quantify and weight the major factors involved has not been satisfied.³²

Clearly the release of labour to work in other sectors of the economy and in towns extended markets for foodstuffs, raw materials and fuel. While shifts in

²⁹ D. Vollrath, "The Agricultural Basis of Comparative Development," in *Journal of Economic Growth*, 16 (2011), pp. 343-70; and Wrigley, *The Path to Sustained Growth*, and P. Wallis, "Puncturing the Malthus Delusion."

³⁰ K. Borowiecky and A. Tepper, 'Accounting for Breakout in Britain: the Industrial Revolution through a Malthusian Lens,' in *Journal of Macroeconomics*, 44 (2015), pp. 219-33 and J. Madsen et al, "Four Centuries of British Economic Growth: the Rates of Technology and Population", in *Journal of Economic Growth*, 15 (2010), pp. 263-90.

³¹ Broadberry et al (eds.), *British Economic Growth 1270-1870*.

³² G. Clark, "The Macro-economic Aggregates for England, 1209-2008," in *Research in Economic History*, 27 (2010), pp. 97-136.

the inter-sectoral terms of trade (measured long ago between industrial commodities and agricultural produce) reinforced incentives for investment and the diffusion of technologies, techniques and tenurial institutions required to: extend the cultivated area, encourage regional and local specialization and to raise productivities of the land, labour and capital producing food, raw materials and fuel, while improving the conduits connecting farmers with their local and urban markets.³³

Estimates (accepted as plausible by agrarian historians) suggest that wheat yields per acre cultivated with grain probably doubled between 1600 and 1800.³⁴ Neither the publication of books concerned to display information about best practice farming nor applications for patents for implements designed to raise the productivities of labour and for techniques to augment yields from land allocated to improved rotations for arable and pastoral farms display clear upward trends until after the 1760s. Thus, it remains difficult to ascertain when and to what degree a “vogue” for improvement among landowners and tenant farmers matured into what has been represented as an Agricultural Enlightenment, even if generations of visitors to the mainland continued to be as, if not more, impressed with English agronomy than English industry.³⁵

With new and more secure data now available to be reconceptualised, validated and calibrated, historians of the First Industrial Revolution may well become less impressed with the response to emerging prospects for industrialization from England’s well-endowed agriculture – favoured between

³³ P. O’Brien, “Agriculture and the Home Market for British Industry,” in *English Historical Review*, 41 (1985), pp. 773-800.

³⁴ M. Overton, *Agricultural Revolution in England* and L. Brunt, “Nature or Nurture? Explaining English Wheat Yields in the Industrial Revolution, c. 1770,” in *Journal of Economic History*, 64 (2004), pp. 193-225.

³⁵ P. Jones, *Agricultural Enlightenment, Knowledge, Technology and Nature* (Oxford: Oxford University Press, 2016).

1600 and 1800 by interludes of benign climate change and by the intensified concentrating in control over land, capital and labour exercised by the country's land aristocracy and its brigades of deferential tenant farmers.³⁶ They might, for example, observe just how much of the country's success in avoiding potentially malign Malthusian outcomes emanated from the intensified exploitation of England's truly massive accessible and transportable reserves of coal.³⁷

Without a known but under-exploited endowment of subterranean supplies of fuel, Malthusian pressures (exemplified by higher ratios of labour to cultivable land) could counterfactually have seriously reduced the albeit gradual momentum over the seventeenth and eighteenth centuries towards an industrial market economy by obstructing outflows of labour to better remunerated employment as waged labour in other sectors of the economy and particularly to work in towns. *Ceteris paribus*, an unfavourable shift in the land/labour ratio could (as Malthus predicted) have exercised several potentially unfavourable and significant effects on the economy's ongoing trajectory that included: malign mechanisms: altering the balance in the allocation of land away from pastoral towards arable agriculture; reducing the impetus to transform open fields and common pasture into larger scale tenant farms; raising levels of local expenditures on coercion and poor relief to maintain internal order in an over-populated countryside; increasing rural demands per capita for the kilocalories of food required for more labour intensive work involved in farming arable land. In short, and in the absence of a substitute for farm and woodland, these other forces would have reduced

³⁶ J. Ang et al., "Innovation and Productivity advances in British agriculture 1630-1850," in *Southern Economic Journal*, 80 (2013), pp. 162-86.

³⁷ R. Sieferle, *The Subterranean Forest: Energy Systems and the Industrial Revolution* (Cambridge: White Horse Press, 2001).

the gains from inter-sectoral and urban-rural trade, weakened incentives to invest in agricultural improvements and lowered the positive externalities that flow from the agglomeration or specialized range of economic activities in towns.³⁸

During the Revolutionary and Napoleonic Wars 1793-1815 a further but very marked shift occurred in the net barter inter-sectoral terms of trade between foodstuffs and raw materials on the one hand, and manufactured commodities on the other. This protracted interlude of warfare also witnessed a shift towards greater dependence on imports of temperate foodstuffs from Ireland and tropical foodstuffs (sugar, tea, coffee and organic raw materials and cotton fibres from the Americas and Asia).³⁹ These trends that became more marked as the industrialization and urbanization matured into its second stage when the process could be sustained to an increasing degree by the exports of cheap manufactured goods and commercial services in exchange for imported foodstuffs and raw materials.⁴⁰

Meanwhile factors behind the first and preparatory stage for structural change can be illuminated by simple counterfactual models and tested with some equally simplified arithmetical calibrations based on upon demographic statistics that are almost certainly more secure than the manufactured data derived from more familiar national accounts. These numbers set out below are taken from the Cambridge group's research into the growth, occupational structure and location of England's population and workforce which has served to foreground the degree of support that the century's famous protracted and

³⁸ A. Wrigley, *Energy and the English Industrial Revolution* (Cambridge: Cambridge University Press, 2010).

³⁹ P. O'Brien, "The Contributions of Warfare with Revolutionary and Napoleonic France to the Consolidation and Progress of the British Industrial Revolution," in *Department of Economic History Working Paper 50/2011*.

⁴⁰ R. Allen, *The British Industrial Revolution in Global Perspective* (Cambridge: Cambridge University Press, 2009).

precocious transition to an industrial market economy derived from its long known, massive and under-exploited reserves of coal.⁴¹

To reallocate labourers and their families from a traditional occupational and locational structure which utilized their energies for the production of food, raw materials and dry wood fuel, for household heat and a range of traditional manufacturing processes (metallurgy, glass, brewing, food processing) required either extensions to the areas of land producing all three organic outputs or increased yields from the established area of hectares cultivated. For economies fortunate enough to be endowed with subterranean forests, elastic supplies of coal could, however, substitute for land utilized to grow trees and alleviate the difficulties involved in raising yields on hectares long cultivated with crops, food, fodder and fibres.⁴²

Given a set of baseline estimates for the area of land available to be cultivated for the food, fodder, fibres and fuel consumed by the English population, virtually without access to coal in 1600, it has become possible to construct an estimate for the area of cultivable land that would counterfactually have been required to maintain the 1600 pattern and levels of consumption of food, fibres, fodder and fuel for a population that had doubled and a workforce seeking employment outside agriculture and forestry had multiplied by a factor of 5 two centuries later. Unfortunately the statistics are not available for outputs or areas of land producing fodder and fibres for 1600 or 1800. Wrigley has, however, constructed estimates for the areas of cultivable land that would counterfactually have been required to provide the

⁴¹ P. Malamina, "Energy Consumption in England and Italy 1560-1913," in *Economic History Review*, 69 (2016), pp. 78-103.

⁴² A. Kander et al, *Power and the People. Energy in Europe over Five Centuries* (Princeton: Princeton University Press, 2013).

urban population for 1800 with the same per capita volumes of grain and fuel that sustained their ancestors at the end of the Tudor regime.⁴³

I propose to assume that the per capita requirements of cultivable land required to meet the grain and fuel requirements for the population of rural England were exactly the same and to majorate Wrigley's estimates for urban England to refer to the entire population. On these assumptions, the outer bound saving that could conceivably be imputed to the substitution of coal for wood, grown and dried, comes 42% of the cultivable area. That estimated ratio should be reduced by the small amounts of coal utilized for domestic heat and manufacturing in 1600, but increased by the more extensive substitutions of coal for thermal purposes in manufacturing and also by the reduction in kilocalories required for work and health from the cheaper fuel that coal provided to households for warmth and cooking. Thus it may be safe to conclude that up to 40% of the incremental food and thermal energy required to carry the economy of England to the levels of productivity achieved in 1800 by its agrarian, industrial and service sectors probably emanated in some reductionist sense from rich and extraordinarily accessible natural endowments of coal.

Yes, its European competitors for a First Industrial Revolution and even China also possessed subterranean forests but not apparently of the same variety and quality nor nearly as cheap to transport to coastal cities. Britain began and completed a transition from organic to mineral sources of energy, basically for thermal purposes before the rest of Europe and some three centuries before Asian economies.⁴⁴ Coal consumption per capita multiplied six times between 1560-1800.⁴⁵

⁴³ Wrigley, *The Path to Sustained Growth*

⁴⁴ A. Kander et al, *Power and the People*

⁴⁵ P. Malamina, *Energy Consumption in England*

By the early nineteenth century English households and firms consumed around 15 million tons of coal a year, compared to 3 million tons for Europe as a whole. Estimates for tons of coal mined in China are not available and for reasons that are not settled, the large scale deposits in the Northern provinces of the Qing Empire remained underground until well into the twentieth century.⁴⁶ Mainland European and East Asian economies and towns continued to utilize traditional substitutes such as peat, wood, water, wind and human energy, when the advantages for earlier urbanization and industrialization from using the cheaper and more efficient thermal form of energy turned out to be substantial. As a substitute for wood fuel, coal allowed more land and other resources to be devoted to growing food, fodder and agrarian raw materials. Given that the energy from a ton of coal equals the energy from two tons of timber, and an acre of land produces two tons of dry wood, Britain's coal output for 1815 implies that 15 million acres (equivalent to 88% of its arable area) had counterfactually by then been released from forestry to grow grains, vegetables, industrial raw materials and to sustain even more livestock and to facilitate urbanization.⁴⁷

Heat-intensive industrial processes in metallurgy, glass making, brewing, refining sugar and salt, chemistry, in baking food and bricks etc., could all be conducted more cheaply with coal. The feedbacks and technological spin-offs from these industries to metallurgy and to the making of kiln's, pots, vats and containers became important for industrial development. While lower cost bricks and metals for the construction of houses in cities, towns and industrial

⁴⁶ E. Thompson, *The Chinese Coal Industry* (London: Routledge, 2003) and I. Inkster and P. O'Brien, eds., "The Global History of the Steam Engine," *History of Technology* 25 (2004) special issue on the steam engine.

⁴⁷ Sieferle, *The Subterranean Forest*; Wrigley, *Energy and the English Industrial Revolution* and A. Kander and P. Warde, "Energy Availability from Livestock and Agricultural Productivity in Europe," in *Economic History Review*, 64 (2011), pp. 1-29.

villages, saved capital which could be invested in social overhead facilities and/or manufacturing industry.

For organic systems of production, energy accounts constitute a heuristic and illuminating substitute for less secure national income data for the analysis of transitions to modern systems of production based upon inorganic sources of energy. At a time when technological progress, which augmented labour productivity remained slow and confined to a few sectors of industry, countries favourably endowed with fertile land, minerals, natural waterways and, above all, with a cheaper fuel closely linked to the development of a leading, network technology (steam power) enjoyed a head start in the “leap forward” to a second stage of development when they matured into urban industrial market economies via technological change.⁴⁸

Stage 1.2 The Nature and Economic Significance of Britain’s Political Development and the State’s Maritime Strategy for Security with Commerce Overseas

Debate about the precise nature and significance of foreign trade for the British Industrial Revolution continues. Views on that connexion range all the way from “trivial and dispensable” to “necessary and sufficient”.⁴⁹ Contemporary perceptions which maintained that commerce overseas through all kinds of mechanisms (not captured within a modern statistical frameworks, based upon national accounts), had been a significant component of British industrialization, have now been restored as entirely valid. For comparative

⁴⁸ V. Smil., *Energy in World History* (Boulder: Westview Press, 1994) and P. Malamina, *Pre-Modern European Economy. One Thousand Years (10th-19th Centuries)* (Brill, Leiden, 2009) and Malamina, “Energy Consumption in England and Italy.”

⁴⁹ J. Mokyr, ed., *The British Industrial Revolution* (Oxford: Oxford University Press, 1993) and K. Harley, “Trade Discovery, Mercantilism and Technology,” in R. Floud and P. Johnson (eds.), *The Cambridge Economic History of Modern Britain*, pp. 175-203.

economic history, they may even represent the most significant of Marc Bloch's salient contrasts between Britain and several of its European rivals.⁵⁰

Over the eighteenth century, the volume of British made commodities sold overseas multiplied four times, compared to a multiplier of over just two, between 1500 and 1700, Ratios of exports to gross national product increased from little over 4% in the reign of Elizabeth, to 6% after the Restoration, up to 8% at the Glorious Revolution and that quotient reached 12% in the reign of George III. At least half of the increment to industrial production, which came on stream over a long eighteenth century (1688-1815), was sold overseas. Shares of the outputs exported of the then most rapidly growing and technically progressive of British industries (cottons, woollens, metals, shipbuilding) became internationally outstanding. For the development of an economy, led by modernizing industries, the nation's multi-faceted involvement with the world economy can no longer be denied as an unmistakably significant precondition for the growth with structural change and diversification, that took place, before during and after the Industrial Revolution. Already by the close of the Seven Years War, something like half of the nation's workforce (de-linked from agriculture) depended directly and indirectly on markets overseas for its livelihood. Revenues from exports exchanged for strategic materials (pitch, tar, hemp, timber, bar iron; all vital inputs for: the naval defence of a mercantilist realm); for imported and taxable tropical foodstuffs such as sugar, tea, coffee and spices, consumed by

⁵⁰ J. Cuenca-Esterban, "The Rising Share of British Industrial Exports in Industrial Output," *J.Econ.Hist.* 57 (1997) 879-906. and G. Clark, et al., "The Growing Dependence of Britain on Trade during the Industrial Revolution," in *Scandinavian Economic History Review* 62 (2014) 109-36 and R. Allen, *The British Industrial Revolution in Global Perspective*.

“industrious” families, and, above all, for fibres for the rapidly growing cotton and the linen and silk industries.⁵¹

Over the period 1790 to 1820, net imports of farm produce (foodstuffs and organic raw materials) rose from about 20% to 40% of domestic farm output. *Pôles de croissance* (London, Bristol, Hull, Glasgow, Newcastle, Liverpool and other maritime cities) provided the infrastructures, skilled workforces and internal transportation and distribution networks to service internal as well as overseas trade. Their high wages attracted labour from the countryside. Cities and their hinterlands integrated into productive fiscal bases for the states rapacious demand for customs and excise duties, which were allocated to build up the naval power, deployed to defend British markets, colonial territories and assets overseas. Alas, we do not have estimates for the total values of commodities and services, exchanged across the world’s frontiers between 1660 and 1846, but Britain (not France, Portugal, and Spain, or the Netherlands, let alone China or Japan) obtained an inordinate share of the gains from international trade and commerce over that period of proto-globalization.⁵²

Some part of the growth in commerce that generated feedbacks and spin-offs for Britain’s transition to an industrial economy occurred because the world economy as a whole was led forward at a faster rate by the continued expansion of the Atlantic economy, coupled to the forging of closer

⁵¹ F. Trentman, *Empire of Things* (London: Penguin, 2016) and P. O’Brien and S. Engerman, “Exports and the Growth of the British Economy from the Glorious Revolution to the Peace of Amiens,” in B. Solow, ed., *Slavery and the Rise of the Atlantic System* (Cambridge: Cambridge University Press, 1991) 117-210 and Cuenca-Esterban, “The Rising Share of British Industrial Exports,” p 879-906.

⁵² J. Cuenca-Esterban, “Comparative Patterns of Colonial Trade: Britain and its Rivals,” in L. Prados De La Escosura, ed., *Exceptionalism and Industrialization. Britain and its European Rivals 1688-1815* (Cambridge: Cambridge University Press, 2004) 35-69.

commercial connexions between Europe and the Americas across the Indian and Pacific oceans with India, South East Asia, Japan and China. Indeed the British economy appears to have performed exceptionally well during a long upswing in global trade that succeeded the consolidation of the Manchu dynasty (1644-83) and the break-up of the Mughal Empire in India (1761-1818).⁵³

Did that occur (as new and old Whigish historians maintain) because Britain's institutions including its quasi-democratic system of Government, framework of laws surrounding commodity and factor markets and embedded cultures of enterprise, bourgeois virtues and enlightenment had become more hospitable to private investment and innovation than cultures and institutions conditioning the development of rival economies on the mainland, as well as the maritime provinces of Qing China and Tokugawa Japan?⁵⁴ Research into histories of continental economies and surveys of perceptions by contemporary European travellers to the Isles, has left historians more agnostic about the superiorities of anything like the full range of institutions conditioning the pace and pattern of the economic activity before the Industrial Revolution.⁵⁵ While rediscovered economic worlds of "surprising resemblances" across a range of advanced regions of Eurasia, also undergoing Smithian growth for those same centuries, has qualified both Vulgar-Marxian and Neo-Weberian perceptions that only certain countries and regions of North Western Europe (particularly England, and Holland) had proceeded

⁵³ A. Gunder Frank, *ReOrient. Global Economy in the Asian Age* (Berkeley: University of California Press, 1998) 63-171 and C. Bayly, *Imperial Meridian. The British Empire and the World* (London: Longman, 1989).

⁵⁴ C.P. Kindleberger, *World Economic Primacy 1500-1990* (Oxford: Oxford University Press, 1996), J. Mokyr, *The Enlightened Economy* and D. McCloskey, *The Bourgeois Virtues: Ethics of an Age of Commerce* (Chicago: Chicago University Press, 2006).

⁵⁵ R. Sylla and G. Toniolo, *Patterns of European Industrialization* (London: Routledge, 1991) and Riello and O'Brien, "Reconstructing the Industrial Revolution," 1-41 and P. Vries, "Does Wealth Entirely Depend on Inclusive Institutions and Pluralist Polity?" in *Tijdschrift Voor Social En Economische Geschiedenis*, 9 (2012), pp. 74-93.

along Smithian trajectories or Schumpeterian paths for development, leading to modern economic growth.⁵⁶

Both societies had certainly appropriated and defended increasing shares of the gains to be reaped from their mercantilistic engagements in global trade and commerce.⁵⁷ Nevertheless, one highly significant contrast between Britain and other pre-modern rivals (including Holland) for a First Industrial Revolution has, however, been clarified – namely, the nation’s geographically conditioned but politically sustained fiscal commitment to a naval strategy for the defence of an Island realm – which carried unintended, but benign consequences for the development of a public-cum-private maritime sector of the British economy, which together its responsive agriculture and with coal led the economy forward into a First Industrial Revolution.

Not long after the Hundred Years War (1337-1453) when England’s feudal armies had ignominiously retreated from centuries of dynastic warfare on the mainland, the Island’s kings, aristocrats and merchants began to conceive of naval power, funded and managed by the Crown, as the first line of defence against external threats to the security of their high stakes in the wealth of the realm and as the force necessary to back conquest and commerce with continents outside Europe.⁵⁸

That conception took a long time to evolve into a constitutional consensus because the locus of sovereignty and balance of internal power

⁵⁶ K. Pomeranz, *The Great Divergence. China, Europe and the Making of the Modern World Economy* (Princeton: Princeton University Press, 2000). For a survey and critique of the Pomeranz thesis, read P. Vries, *State Economy and the Great Divergence. Great Britain and China* (London: Bloomsbury Academic Press, 2015).

⁵⁷ P. O’Brien, “Mercantilism and Imperialism in the Rise and Decline of the Dutch and British Economies,” *De Economist* 148 (2000) 469-501.

⁵⁸ N. Rodger, *The Safeguard of the Sea. A Naval History of Britain, Vol. 1 600-1649* (London: Allen Lane, 1997).

among the realm's aristocratic elites remained unstable. Political maturity stability emerged after nearly two centuries of fiscal stasis, malign disputes over religion, persistent acrimony between Parliament and the Crown's over rights to levy taxes and, above all, from a reordering of the realm's ideology following an interregnum of destructive civil war and republican rule. After the Restoration of monarchy and aristocracy in 1660, Britain's elite managed to maintain a sufficient degree of consensus to establish an envied political coordinating mechanism, namely undemocratic Parliamentary governance by assemblies of wealthy inter-connected families, to safeguard and manage their property rights. With vicissitudes (including a Dutch coup d'état of 1688, and the unavoidable loss of political power over 13 distant American colonies in 1783), the Post-Restoration state became outstandingly successful in raising the funds (taxes linked to loans) required for external security, to maintain stability for a fundamentally *ancien regime*, for the protection of an established religion and for the maintenance of Europe's most blatantly inegalitarian system of property rights. Over time rights to own, expropriate and exploit natural resources and capital located within the kingdom became more effectively protected and politically coordinated by Britain's envied Parliament than for any other propertied elite in Western Europe, the Americas, Asia and Africa.⁵⁹

⁵⁹L. Prados De La Esocoura, *Exceptionalism and Industrialization* and P. Vries, *State, Economy and the Great Divergence: Great Britain and China 1680's-1850's* (London, Bloomsbury Academic, 2015). The nature of the post-Restoration state and economic implications that flowed from the Glorious Revolution of 1688 have been clarified by historians with the credentials in the history of that complex period required for their analysis and comprehension. Vide J. Hoppit, "Compulsion, Compensation and Property Rights in Britain, 1688-1833," in *Past and Present*, 210 (2011), pp. 93-128, and "The Nation, the State and the First Industrial Revolution," in *Journal of British Studies*, 50 (2011) and "Political Power and Economic Life," in R. Floud et al (eds.), in *Cambridge Economic History of Modern Britain*, Vol. 1, 1700-1860 (Cambridge: Cambridge University Press, 2004), ch. 12; P. Gauci (ed.), *Regulating the British Economy, 1660-1850* (Farnham, 2011) and N. Zahedieh, "Regulation rent seeking and the Glorious Revolution in the English-Atlantic Economy," in *Economic History Review*, 63 (2010), pp. 865-90.

Exceptional levels of external security, stability and good order supplied by this monarchical and aristocratic regime for its wealthier citizens rested ultimately upon the country's rapidly expanding fiscal and financial base. Between 1670 and 1815 total revenues from taxes rose by a factor of around 17, while national income increased by a multiplier of 3. The bulk of these formally sanctioned appropriations by Parliaments of "notables" were allocated by central government to service a national debt, incurred to fund no less than eleven wars against other European powers and economic rivals – mainly conflicts with France and Spain, but including four naval wars against its protestant neighbour - the Netherlands.⁶⁰

From a nominal capital of less than £2 million in the reign of James II, Britain's national debt grew to reach the astronomical sum of £854 million, or 2.7 times the national income for 1819. The shares of taxes devoted to servicing, what appeared to a majority of taxpayers as an incubus of royal-cum-public debt, jumped from modal ratios of 2-3% before the Glorious Revolution to 60% after the Napoleonic War.⁶¹

Castlereagh and other European statesmen who signed the Treaty of Vienna, were acutely aware of the costs of geopolitical strife. Yet the, by then, United Kingdom of England, Wales, Scotland and Ireland, enjoyed virtually complete security from external aggression and had acquired in the course of a century and a half of prolonged mercantilist rivalry and warfare, extraordinary shares of world trade and income from servicing global commerce and the

⁶⁰ J. Brewer, *The Sinews of Power: War, Money and the English State 1688-1783* (London: Unwin Hyman, 1991); A. Page, *Britain and the Seventy Years War 1744-1815* (Palgrave, Macmillan: Basingstoke, 2015) and R. Torres-Sanchez (ed.), *War, State and Development. Fiscal Military States in the Eighteenth Century* (Pamplona: Universidad de Navarra, 2007).

⁶¹ P. O'Brien, "The Political Economy of British Taxation 1660-1815," *Econ.Hist.Rev.* 42 (1988) 1-32.

largest European empire since Rome. By 1815 the realm's domestic economy also stood half-way through a First Industrial Revolution.⁶²

To thrive in a mercantilist economic order, riven with dynastic, imperial and economic rivalries, the Island state had allocated considerable resources to: preclude invasion, preserve internal stability and retain advantages over its equally violent European competitors in armed struggles for gains from global commerce and colonization. Even cliometricians now recognize that geopolitical conditions formed inescapable parameters within which state formation, institution, building and macro-economic growth occurred.⁶³ For the age of mercantilism post hoc analyses by economists of yesteryear based upon counterfactual scenarios concerned with competitive equilibria “distorted” by taxation, and more recently with theoretically ambiguous and unmeasurable “crowding out” effects that flowed from high levels of government borrowing look like interesting, but anachronistic exercises in applied econometrics.⁶⁴ They are surely irrelevant as responses to questions of whether the state had raised and allocated the resources that carried the kingdom and its economy to a plateau of safety, political stability and potential for future development attained and envied by the rest of Europe, at the Congress of Vienna. Since nobody then (or historians later) have elaborated upon alternative strategies which combined security for the realm and internal order with growth for the economy, the comparison of an entirely

⁶² P. O'Brien, “Fiscal Exceptionalism: Great Britain and its European Rivals from Civil War to Triumph at Trafalgar and Waterloo,” in D. Winch and P. O'Brien, eds., *The Political Enemy of British Historical Experience 1699-1914* (Oxford: Oxford University Press, 2002) 246-65.

⁶³ N. Voigtlander and H-J. Voth, “The Three Horsemen of Riches, Plague, War and Urbanization in Early Modern Europe,” in *Review of Economic Studies* 80 (2013) 774-811.

⁶⁴ J. Glete, *War and the State in Early Modern Europe* (London: Routledge, 2002) and A. Monson and W.Scheidel, eds., *Fiscal Regimes and the Political Economy of States* (Cambridge: Cambridge University Press, 2015).

explicable maritime strategy for security and development, pursued by the British state with strategies pursued by rival European and Asian powers, leads to the Panglossian conclusion that *virtually everything that was done looks unavoidable, was undertaken for the best in the worst of all possible worlds and paid off.*⁶⁵

Inaugurated under the republic, the costs incurred to support geopolitical security with economic power can be read from tabulations of the state's relative and persistently high levels of expenditure on the Royal Navy.⁶⁶ That sustained commitment provided the kingdom with the world's largest fleet of battleships, cruisers and frigates, manned by a virtually coerced workforce of underpaid able seamen, under the command of a highly motivated and well rewarded corps of professional officers.⁶⁷ The fleet was constructed and maintained in readiness for multiple missions at sea by an onshore workforce of skilled shipwrights, carpenters and other artisans and supported by an infra-structure of ports, harbours, dockyards, stores for victuals and spare parts, ordnance depots and other facilities under collaborative but well-coordinated public and private ownership and control.⁶⁸

Once the Island's huge fleet and extensive onshore infra-structure of human and physical capital were operating, primarily to keep ships of line strategically placed at sea as the first bastion of defence for the realm, at falling average costs the state deployed cruisers, frigates and other well-

⁶⁵ P.K. O'Brien, "The formation of states and transitions to modern economies: England, Europe and Asia," compared in L. Neal and J.G. Williamson, eds., *The Cambridge History of Capitalism*, Vol 1 (Cambridge: Cambridge University Press, 2014) 357-403.

⁶⁶ *Parliamentary Paper 1868-69 (XXXV)*, C. Chandaman, *English Public Revenue 1660-88* (Oxford: Oxford University Press, 1975). F. Dietz, *English Government Finance 1458-1641* (New York: Frank Cass, 1964).

⁶⁷ N. Rodger, *The Command of the Ocean. A Naval History of Britain, vol 2 1649-1815* (London: Allen Lane, 2004).

⁶⁸ R. Morris, *Naval Power and British Culture. Public Trust and Government Ideology* (Aldershot: Ashgate, 2004) and R. Morris, *The Foundations of British Maritime Ascendancy* (Cambridge: Cambridge University Press, 2011).

armed ships on mercantilist missions for the protection of British trade and its colonies; for predation on competitive and potentially hostile merchant marines; for the bombardment (actual or threatened) of enemy coastal cities and colonies.⁶⁹ Britain's evolving maritime strategy that in effect combined defence with trade and growth embodied all kinds of attendant and unintended spin-offs for internal order, for the protection of property rights and for the extension of domestic as well as colonial and foreign markets.

For example, the nation's fleet of durable, strategically placed and proficient ships of the line (floating fortresses) provided external security at a relative high level of efficiency compared to the logistical costs per joule of force delivered by larger European armies, recruited, mobilized, equipped, supplied with food and forage, and moved overland to battle grounds, places of siege and vulnerable borders to repel enemy attacks.⁷⁰

Its economically efficient offshore strategy for defence also allowed the British state to allocate greater proportions of its revenues (derived from a responsive fiscal and financial system) to support mercantilist and imperial missions pursued at sea, and at the same time to sustain surprisingly high levels of military expenditure.⁷¹ Paradoxically and throughout the period 1688-1815, expenditures on armies by the Eurasian state most committed to naval

⁶⁹ D. Baugh, "The Eighteenth Century Navy as a National Institution," in J.R. Hill, ed., *The Oxford Illustrated History of the Royal Navy* (Oxford: Oxford University Press, 1995) 120-60 and Page, *Britain and the Seventy Years War*.

⁷⁰ R. Harding, *The Evolution of the Sailing Navy 1509-1815* (Basingstoke: Macmillan, 1995) and J. Landers, *The Field and the Forge. Population, Production and Power in the Pre-Industrial West* (Oxford: Oxford University Press, 2003).

⁷¹ P. O'Brien and P. Hunt, "England 1485-1815," in r. Bonney, ed., *The Rise of the Fiscal State in Europe, c. 1200-1815* (Oxford: Oxford University Press, 1999) 53-100.

power, amounted to a modal 60% of the total allocated to the realm's armed forces.⁷²

Part of that military allocation included the costs of hiring mercenary regiments of Hanoverian, Swiss, Hessian and other soldiers for combat outside the kingdom; part consisted of subsidies and subventions to European allies willing to field troops to contain and thwart the designs of France and its allies on the mainland, and in India and the Americas. The most politically contentious part consisted of the commitment of English supplemented by dispensable Celtic troops to theatres of war on the continent, notably in 1702-12 and 1808-15. Strategic expenditures on the military forces of Britain's clients and allies restrained the ambitions of Bourbon states (France and Spain) and other antagonists from allocating funds to construct fleets with the capability required to mount serious challenges to the Royal Navy's defence of the realm and its effective protection of the nation's interest in overseas trade and investment.⁷³

Thus, a considerable proportion of revenues, surplus to requirements for the Royal Navy was allocated to British regiments, militias, volunteers and yeomanry on stations in the realm. They served as a less than credible second line of defence against foreign invasions, but were utilized consistently during a potentially unstable period of population growth, industrialization and urbanization, to preserve an aristocratic regime against subversion on its

⁷² *Parliamentary Paper 1868-69* (XXXV).

J. Ventura and H-J. Voth, "Debt into Growth. How Sovereign Debt Accelerated the First Industrial Revolution," in *National Bureau of Economic Research Working Paper* 21280 (2015) 1-29.

⁷³ D. Baugh, "Great Britain's Blue Water Policy 1689-1815," *Int.Hist.Rev.* X (1988) 33-58.

Celtic fringes and to protect English hierarchy and property rights against challenges to law and order.⁷⁴

From time to time prospects for internal trade within a less than United Kingdom came under threat from within those potentially seditious provinces of Scotland and Ireland; particularly the latter where a colonized Catholic population resented “English” property rights and the metropole’s discriminatory regulation of Irish commerce and industry.⁷⁵ With external security taken for granted, other public goods such as stability, good order, the maintenance of property rights and support for hierarchy and authority over potentially unruly employees became the key political-cum-economic interest for landowners, merchants, farmers, industrialists and other businessmen of Hanoverian Britain. On the whole the kingdom’s monarchical and aristocratic state met their concerns. When lobbied, it redefined legal rights for new forms of wealth by promulgating statutes for a national economy which superseded custom and common laws that might otherwise have been used to provide greater protection for the welfare of the nation’s workforce without assets, status and power, but threatened by market forces associated with industrialization and the modernization of agriculture.⁷⁶

For example, the institutions of the Elizabethan poor law for dealing with poverty, unemployment, vagrancy and labour migration maintained a repressive system of control over the labour of children, females and unskilled men. For less vulnerable artisans and industrial workers and especially for

⁷⁴ J. Cookson, “Service Without Politics? Army, Militia and Volunteers in Britain during the American and French Revolutionary Wars,” in *War in History* 10 (2003) 381-97 and P. O’Brien, “The State and the Economy 1688-1815,” in R. Floud and D. McCloskey, eds., *The Economic History of Britain since 1700, vol.1* (Cambridge: Cambridge University Press, 1994) 205-41.

⁷⁵ L. Cullen, *An Economic History of Ireland since 1660* (London: Batsford, 1987).

⁷⁶ P. Vries, *State, Economy and the Great Divergence. Great Britain and China 1680s-1850s* (London: Bloomsbury, 2015).

those courageous groups who formed “combinations” to challenge what they perceived to be adverse changes to a traditional and more moral economy, the punishments prescribed by Parliament for: the formation of unions; for riots against high prices of basic necessities; for resistance to enclosures and turnpikes; to attacks upon mills, barns, factories and labour saving machinery; for insubordinate and disorderly conduct as well as every kind of theft, became discernibly harsher, and increasingly subject to capital punishment.⁷⁷

Parliament’s antipathies to large standing armies in times of peace looks like Whig rhetoric because the actual numbers of troops, embodied militiamen and patriotic volunteers on station in Britain and Ireland year after year (particularly in wartime), were more than adequate to repress disturbances to the peace. For purposes of political stability, the maintenance of internal order, the protection of property and upholding hierarchies of all kinds, it is not at all obvious that on a per capita basis, that constitutional Britain commanded a smaller or less coercive force of troops than so-called “despotisms” on the mainland of Europe, who deployed armies (not capital intensive navies) to defend their more vulnerable frontiers. Famously, in 1808 the numbers of soldiers mobilized to combat Luddites in the Midlands and North of England, exceeded troops under Wellington’s command in the Peninsular.

With virtually no police at their command, the Navy allowed the political authorities (central, county and local) of Hanoverian Britain to allocate less of their revenues to external security and to provide an effective military presence and exemplary displays of the armed force required to maintain good

⁷⁷ J. Rule, *Albion’s People. English Society 1714-1815* (London: New York: Longman, 1992) and J. Humphries, *Childhood and Child Labour in the Industrial Revolution* (Cambridge: Cambridge University Press, 2010).

order, protect property and preserve authority among a population, becoming more urban and potentially “dangerous” by the year. England’s ungovernable people were eventually subjugated and cajoled into the culture of deference with xenophobia that characterized Victorian society.⁷⁸

Stage 1.3: The Discovery, Take-up and Diffusion of “English” Technologies

For several reasons, the invention and diffusion of a familiar list of machines, energy converters and industrial processes, long represented as “English” and defined as prime movers behind the national economy’s precocious transition, have been relocated from its historiographical position of prominence to contexts where their significance for global history has been reconfigured. That has occurred not only as the outcome of cliometric exercises displaying trends in total factor productivity that imply that the First Industrial Revolution can no longer be represented as a short sharp discontinuity based upon fundamental breakthroughs in industrial technologies, which were conceived as emanating from and developing within a singularly progressive set of Anglo-Saxon institutions and cultures.⁷⁹

Although several new technologies emerged and matured in Britain not long after the Seven Years War, their impact was confined to particular sectors of industry (cotton textiles, metallurgy, shipbuilding, transportation and the generation of energy from steam). Furthermore, technologies and

⁷⁸ J. Brewer and J. Styles, eds., *An Ungovernable People: the English and their Law in the Seventeenth and Eighteenth Centuries* (London: Hutchinson, 1980); C. Emsley, *Crime and Society in England 1750-1900* (Longman: London, 1987); Cookson, “Service without Politics,” and B. Hilton, *A Mad, Bad and Dangerous People. England 1783-1846* (Oxford: Clarendon Press, 2006).

⁷⁹ For debate on the numbers vide M. Berg and P. Hudson, “Rehabilitating the Industrial Revolution,” in *Econ.Hist.Rev.* 45 (1992) 269-35; P. Temin, “Two Views of the British Industrial Revolution,” in *Jnl.Econ.Hist.* 57 (1997) 63-83; N. Crafts and K. Harley, “Output Growth and the British Industrial Revolution: a Restatement of the Crafts-Harley View,” in *Econ.Hist.Rev.* 45 (1992) 703-30 and N. Crafts and K. Harley, “Simulating the Two Views of the Industrial Revolution,” in *Jnl.Econ.Hist.* 60 (2000) 819-41. For the very latest set of figures that await critical scrutiny of an audacious and laudable attempt to construct annual estimates for GDP per capita 1270-1870, vide Broadberry et al, *British Economic Growth*.

organizations that became first wonders and eventually the marks of a modern economy (machines, steam power, processes for making and shaping metals, chemicals, factories, etc.) but matured rather slowly over a century of so-called “revolutionary transition” after 1756.⁸⁰ Thus calibrations purporting to account in quantitative terms for the sources of British economic growth which are derived from exercises that “fit” production functions to extant, but imperfect data for national output and for inputs of land, labour and capital expose the persistence of an entirely traditional, gradual and extensive form of aggregated growth for GDP per capita, which emanated mainly from somewhat higher rates of capital accumulation and upswings in the scale and hours worked by a workforce undergoing structural change rather than innovations or even new sources of energy *per se*.⁸¹

Although these taxonomic exercises provide historical perspective, and serve to quantify the significance of “proximate” sources behind the growth of Britain’s domestic product.⁸² They also tend to ignore the historical evolution of conditions for the emergence and diffusion of technologies that created prospects for long-run and sustained upswings in rates of growth. Discoveries and their diffusion occurred in many regions of a connected, but not integrated Eurasian Oikumene.⁸³ In the British case and after protracted debate over relevant models and acceptable statistics, economic historians are now taking

⁸⁰ C. MacLeod, *Heroes of Invention, Technology, Liberalism and British Identity 1750-1914* (Cambridge: Cambridge University Press, 2007).

⁸¹ N. Crafts, “Productivity Growth in the Industrial Revolution: a New Growth Accounting Perspective,” in *Jnl.Econ.Hist.* 64 (2004) 521-35; N. Voigtlander and H.J. Voth, “Why England? Demographic Factors structural change and physical capital accumulation during the Industrial Revolution,” in *Journal of Economic Growth*, 11 (2006) and Broadberry et al, *British Economic Growth*. Clark’s data are utilized to support his definition of an Industrial Revolution that begins with a clear discontinuity in the growth of factor productivity – vide G. Clark, “The Industrial Revolution,” in P. Aghion and S. Durlaf (eds.), *Handbook of Economic Growth*, Vol. 2 (Amsterdam: North Holland, 2013), pp. 217-62.

⁸² J. Mokyr, “Accounting for the Industrial Revolution,” in Floud and Johnson, eds., *Cambridge Economic History of Modern Britain*, (2004), pp. 1-27.

⁸³ B. A’Hearn, “The Industrial Revolution in a European Mirror,” in R. Floud et al, *The Cambridge Economic History of Modern Britain*, vol. 1, 1700-1870, pp. 1-53.53.

into account both the quality of the data at their disposal to locate and demarcate chronologies, as well as reciprocal interactions between profitable opportunities provided by the appearance of new process and product innovations on the one hand, and capital formation for their development and exploitation on the other. Furthermore, they have concentrated analyses upon the sources of the incremental addition to a traditional and low rate of growth in real per capita incomes. These statistical exercises do suggest that the potential for technical progress which was present by the times of Newton, Newcomen and Kay had evolved to reach a vantage point around the time of the Victorian boom when its outcome for the growth of the economy could be retrospectively perceived and has latterly been measured as highly significant.⁸⁴ Thus, and without the early discovery, gradual development and slow take-up of technologies and improved modes of organization that augmented capital labour ratios and average levels of productivity for a majority of the workforce, the British economy could never have been acclaimed as the locus of a First Industrial Revolution.⁸⁵

The technologies that only gradually became operational and then dominant for the growth of British industry can be most heuristically represented by a chapter included in a longer and more complex historical narrative. That chapter would recognize their confined scope for transformation not only for all sectors of the national economy, but for England's leading sector of manufacturing itself. Older economic histories dealing with industries (other than those paradigm cases of revolutionary change, cotton textiles and iron) were aware of the decades taken and costs

⁸⁴ J. Madsen, et al, "Four Centuries of British Economic Growth: the roles of population and technology," in *Journal of Economic Growth* 15 (2010), pp. 263-90 and Tepper and Boroweicki, *Accounting for Breakout*.

⁸⁵ Allen, *The British Industrial Revolution in Global Perspective*; Broadberry, et al, *British Economic Growth* and N. Crafts, "The First Industrial Revolution: Resolving the Slow Growth/Rapid Industrialization Paradox?", in *Jnl. of European Ec. Assocrn.* 3 (2005) 525-34.

incurred to develop and adapt blueprints for invention through several stages of development and protracted periods of learning by using, until original and promising designs matured into marketable, prototype machines, processes and artefacts.⁸⁶ Historians with knowledge of particular industries appreciated that the forward planning and investment required to embody a backlog of known product and process innovations by British firms, long connected to markets for commodities, labour and capital, took decades to mature. Such firms had to be networked to suppliers of raw materials and to transportation and distribution services so that entrepreneurs exploiting new knowledge could realize external economies of scale and agglomeration by locating in Britain's industrial towns and maritime cities. The costs of system-wide investments required to develop, embody and relocate people and production in factories and towns turned out to be large multipliers of the original outlays borne by inventors and their networks supporting research and development into "potentially" useful and commercially viable knowledge in the first place.⁸⁷

As pioneer movers into unexplored realms and spaces for the exploitation of novel industrial products and technologies, British investors and entrepreneurs lacked examples of anything like a prior range experiments and experience from elsewhere, as well as access to a base of systemic and reliable knowledge of how, where and why things work that later in the nineteenth century exposed the problems, ramifications and potential for

⁸⁶ R. Church and A. Wrigley, eds., *The Industrial Revolution* 11 volumes (Oxford: Oxford Blackwells, 1994), vols 8-10.

⁸⁷ V. Ruttan, *Technology, Growth and Development: An Induced Innovation Perspective* (Oxford: Oxford University Press, 2001) part 2.

untried methods of production and novel products more rapidly and at lower cost.⁸⁸

Although British businessmen and investors lacked references to practice elsewhere and to a focussed and utilitarian body of science to inspire even greater confidence to undertake risky investments in new technologies, their direct support for research and development and for a more rapid and extensive diffusion of potentially useful knowledge already available, by the middle of the 18th century does not appear, with hindsight, to have been that “entrepreneurial”. Considered as a national group, British capitalists promoted and managed one of the slowest, and for the working classes, more miserable transitions to an industrial economy in world history.⁸⁹

Subsequent faster and often less socially malign industrial revolutions are marked by higher rates of saving and investment and a more rapid take up of advanced technology than they seem to have been willing to contemplate for a First Industrial Revolution. In the British case the ratio of gross investment to national income took more than a century to double from a rather low base point of around 6% in 1760.⁹⁰ In relation to countries that followed Britain, this again looks in retrospect, like unimpressive average and marginal propensities to save and invest in the social overhead and industrial capital required to promote faster urbanization.⁹¹

The slow rise in domestic capital formation required to exploit new technologies cannot, moreover, be attributed to the massive sums of

⁸⁸ J. Mokyr, *Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton: Princeton University Press, 2002) and M. Jacobs, *The First Knowledge Economy. Human Capital and the European Economy 1750-1850* (Cambridge: Cambridge University Press, 2014).

⁸⁹ R.C. Allen. “Engels Pause; Technical Change, Capital Accumulation and Inequality in the Industrial Revolution in Explorations,” in *Economic History* 46 (2009); Riello and O’Brien, “Reconstructing the Industrial Revolution,” and Jacob, *The First Knowledge Economy*.

⁹⁰ C. Feinstein and S. Pollard, eds., *Studies in Capital Formation in the United Kingdom 1750-1820* (Oxford: Oxford University Press, 1988).

⁹¹ Allen, “Engels Pause”.

otherwise surplus investible funds borrowed by the state for wars against France, Spain, the Netherlands and other European rivals and the United States. Counterfactually Government borrowing for purposes of waging war (in all eleven conflicts from 1652-1802) might, in theory, have “crowded out” some potential for higher rates of private capital formation, but the overall effect could equally well have been positive for structural change. The observed variations between years of war and interludes of peace in real rates of interest received by investors on low risk government securities floated and sold on the London capital market, does not suggest that Britain was an economy constrained by capacities to save. On the contrary, the overall supply of investible funds that appeared during all three major wars, 1756-1793, appears rather elastic with respect to additional demands from a state that offered both domestic and international capital markets attractive and secure paper assets. Government borrowing to wage war also promoted the development of financial intermediation in London and moves towards integration of a national capital market across the kingdom (linked to European money markets) which raised both the elasticity of the money supply and improved the allocation of investible funds.⁹²

To return to the analysis of strategic expenditures elaborated above, models of crowding out that neglect the benefits (and incentives for investment) provided by high rates of expenditure by the state upon external security, the protection of commerce and colonization overseas and a repressive but effective system for internal order, are seriously under-

⁹² P. O’Brien, *Contributions of Warfare with Revolutionary and Napoleonic France*; Prados De La Escoura, *Exceptionalism and Industrialization*, 35-69; N. Palma and P.O’Brien, “Mercantilist Institutions for the Pursuit of Power with Profit. Britain’s National Debt 1701-1819,” (forthcoming as L.S.E. Department of Economic History Working Paper); J. Ventura and H-J. Voth, *Debt into Growth. How Sovereign Debt accelerated the First Industrial Revolution*,” in *N.B.E.R. Working Paper*, 21280 and A. Digby (ed.), *New Directions in Economic History and Social History* (Basingstoke: Macmillan, 1992), pp. 37-48.

specified. Balance sheets (costs and benefits) flowing from expenditures upon these indispensable public goods would certainly be difficult to model and impossible to add up. Given that rather high levels of expenditure on the army and navy were necessary for state formation and the preservation of British institutions (particularly when periodic threats of invasion by sea appeared in wartime) the crowding out hypothesis needs to be reformulated as the problem of estimating the proportions of taxes and loans devoted to security and stability that could conceivably be defined as “unnecessary and wasteful” appropriations and allocations by a geopolitically located Hanoverian state. Few mercantilists of the period suggested that the depressing effects on private savings and investment flowing from the operations of the fiscal and financial system exceeded the benign effects of “crowding in” which they argued, depended upon the effective provision of external security, successful mercantilism, stability and internal order.⁹³ Adam Smith certainly appreciated that defence came before opulence and that unilateral withdrawal from the prevailing geopolitical order surrounding an Island state was never an option or, historians might well add, a counterfactual worth pursuing.⁹⁴

Once expenditures by the state are reconfigured as necessary (or at the least unavoidable) for macro-economic growth then, in retrospect, rates of development and take-up of advanced technologies and urban systems of production by businessmen and investors during as ostensibly revolutionary period for the discovery and diffusion of new technology, cease to appear anything like as entrepreneurial and historically remarkable as Anglo-American

⁹³ R. Stern and C. Wennerlind, eds., *Mercantilism Re-Imagines. Political Economy in Early Modern Britain and its Empire* (Oxford: Oxford University Press, 2013) and P. Vries, *State, Economy and the Great Divergence*; and T. Hutchison, *Before Adam Smith. The Emergence of Political Economy* (Oxford: Oxford University Press, 1988).

⁹⁴ K. Tribe, “Mercantilism and Economics of State Formation,” in L. Magnusson, ed., *Mercantilist Economics* (Boston: Kluwer, 1993).

historiography has, for too long, maintained.⁹⁵ At the time, most classical economists recognized there was nothing particularly “progressive” about the country’s aristocratic and wealthy elites. Majorities among the owners and controllers of property rights to the nation’s cultivable land, sub-soil minerals, urban sites and real estate, transportation systems, commercial and distribution networks, banks and other forms of financial intermediation, industrial buildings, plant and machinery, human and professional capital reinvested rather low proportions of the rents that accrued to them from industrialization and urbanization.

Predictably, generations of a patriotic history profession researching into the Island’s agriculture, commerce and industry and in touch with the records of firms and the biographies of exceptional men of wealth, have published what has now turned into a library of case studies that displays nothing less than an entirely favourable impression of British landowners, farmers, merchants, industrialists, bankers, professional experts and others with surpluses to save and invest in the new technologies and urban systems of production that came on stream after Britain’s decisive victory for external security with imperial hegemony in the Seven Years War. But did British capitalists or culture manifest a national *geist* or *kopf* for risk-taking and improvement that was very different from anything displayed by their ostensibly more cautious counterparts on the mainland.⁹⁶

⁹⁵Rates of diffusion could conceivably be, but imperfectly, captured by records of applications for patents. Vide C. Macleod’s papers, “Patents for Invention? Setting the Stage for the British Industrial Revolution?” in *Empiria, Revista de Metodologia de ciencias sociale*, 18 (2009), pp. 37-58, and with A. Nuvolari, “Patents and Industrialization – an historical overview 1624-1907,” unpublished paper for the *Strategic Board on Intellectual Property Policy* (2010).

⁹⁶ G. Stedman-Jones, *An End to Poverty. A Historical Debate* (London: Profile Books, 2004) and E. Rothschild, “The English Kopf,” in D. Winch and P.K. O’Brien, eds., *The Political Economy of British Historical Experience* (Oxford: Oxford University Press, 2002).

Of course, numerous and well documented examples of commendable foresight, perseverance, risk-taking, innovation and entrepreneurship, particularly for the leading industries, can be drawn from the rich historiography of the First Industrial Revolution.⁹⁷ Nevertheless, research by the current generation of economic historians has reconfigured business history within a statistical base in order to engage with potentialities for illumination derived from macro-economic modelling. This programme in economic history (as Robert Allen's recent synthesis shows), has seriously qualified (if not degraded) the notion that an insular "culture" ordering economic behaviour on the British Isles could be represented as exceptionally enterprising.⁹⁸ Looking retrospectively at The Industrial Revolution configured as a macro-economic event for a favourably endowed and profitably embedded economy expanding into a wider world economy, several statistically validated arguments now suggest that (within an environment of historically integrated domestic markets and unsurpassed protection by the Hanoverian state for commerce overseas, the take-up of new technology, investment in the construction of urban agglomerations and formation of the social overhead capital required to realize the potential of technologies that appeared after the Seven Years War, seems anything like as enlightened bourgeois or virtuous as other recent texts suggest.⁹⁹

This view is a post hoc but defensible representation because nothing in the macro-economic data currently available suggests that: (a) rates of return accruing to owners of property declined during the Industrial Revolution, (b)

⁹⁷ F. Crouzet, *The First Industrialists. The Problems of Origins* (Cambridge: Cambridge University Press, 1985) and McCloskey, *Bourgeois Virtues*.

⁹⁸ Allen, *The British Industrial Revolution*.

⁹⁹ On domestic market integration vide V. Bateman, "Markets and Growth," in *Early Modern Europe* (London: Pickering and Chatto, 2012); and Mokyr, *Enlightened Economy* and McCloskey, *Bourgeois Dignity. Why Economics Can't Explain the Modern World* (Chicago: Chicago University Press, 2010).

that gains from investment in the capital formation required for faster and more extensive industrialization, combined with urbanization were being steadily eroded by rises in real product wages that exceeded or even converged upon the observed increase in labour productivity, or (c) that warfare was anything other than an integral part (rather than a costly diversion) from the whole historical process. On the contrary, macro-economic trends (as currently measured for a British Industrial Revolution) all look promotional for higher rates of saving, investment and innovation. After falling below the 10% mark during the recession in economic activity that surrounded crisis and war with England's Thirteen Colonies in North America) average rates of return on all forms of capital other than agricultural land, fluctuated cyclically, but had doubled before the mid-nineteenth century. By then even real rents from farmed land (the sector in relative decline) had risen by nearly 50%. As for real wages, over the century that succeeded the Seven Years War, they passed through three cycles or phases: slow improvement (c. 1761-1800), virtual stasis (1800-20) and upswing (1820-51) and reached a point around mid-century which stood some 45% above their initial level.¹⁰⁰

Meanwhile, labour productivity had followed a different trajectory and displays a faster rate of increase to arrive at a level 87% above its base line average. Classical features of all industrial revolutions, namely, higher rates of growth in labour productivity, emanating from general purpose technologies, combined with increasing returns derived from the agglomeration of production in towns probably became more evident during The First Industrial Revolution than they had already been during Italian and Dutch Golden Ages or

¹⁰⁰ Allen. "Engles Pause," For Clark's data, see G. Clark, *A Farewell to Alms* (Princeton: Princeton University Press, 2007). Feinstein, "Pessimism Perpetuated: Real Wages and the Standard of Living in Britain during and after the Industrial Revolution," *Jnl.Econ.Hist.* 38 (1998) 625-58.

earlier efflorescences.¹⁰¹ Yet the British case was marked by a uniquely gradual rate of change, a slow take up of new technology and a “deplorably” low rate of investment in the housing and infrastructure of towns required to support a more rapid and less immiserising transition to industrial society.¹⁰²

This feature of the First Industrial Revolution rather than machinery and factories aroused condemnations from visitors from the mainland as well as previous generations of British reformers and social historians concerned with the health of towns and the conditions of those whose labour made the transition both possible and necessary.¹⁰³ Social amelioration and jack up in investment rates took a long time to emerge, partly because the fiscally emasculated state that emerged from the Napoleonic wars did not raise the taxes required to do much to help other than continue to protect the realm’s commerce and an over- expanded empire overseas; partly because average real wages (and aggregate demand) increased too slowly, but partly because British economic elites, with enviable capacities to save, reinvested such small proportions of the rising share of the “rentier type” income that they obtained from their stakes in inherited ownership of property rights during a period of transition to an urban industrial economy.¹⁰⁴ Commendable examples of enterprise behind the riskier and innovatory investments in industry and commerce that appeared during the period testify to the entrepreneurship of some Britons, but their laudable achievements must be conceived within the contextualized macro-economic frameworks, recently constructed by Allen,

¹⁰¹ J.L. Van Zanden, *The Long Road to the Industrial Revolution. The European Economy in Global Perspective* (Leiden: Brill, 2012) and J. Goldstone, “Efflorescences and Economic Growth in World History.”

¹⁰² M. Dauntton, *Progress and Poverty. An Economic and Social History of Britain 1750-1850* (Oxford: Oxford University Press) and N. Crafts, “British Industrialization in an International Context,” in *Jnl. of Interdisciplinary Hist.* 19 (1989) 415-28.

¹⁰³ J. and B. Hammond, *The Town Labourer, 1710-1832* (London: Longmans, 1925); Humphries, *Childhood and Child Labour* and Riello and O’Brien, “Reconstructing the Industrial Revolution.”

¹⁰⁴ O’Brien, “Aristocracies and Economic Progress under the Ancien Regime,” in P. Janssens and B. Yun-Casalilla, eds., *European Aristocracies and Colonial Elites* (Aldershot: Ashgate, 2005).

Clark, Crafts, Harley, Mokyr, Voth and other cliometricians whose publications have, in effect, reconfigured the Industrial Revolution as a precocious, but unremarkable and rather predictable transition in the long global history of knowledge formation.¹⁰⁵ Very few economists or economic historians now regard England's famous "revolution" as a paradigm for comparable changes that could be emulated elsewhere, or believe that labour productivities currently displayed by the world's industrial market economies would look different, but for the economic transformation that occurred in Britain between 1763 and 1846.¹⁰⁶

Furthermore, and in so far as the discovery and development of new technologies for industry, transportation and agriculture that appeared during this period can be connected to an evolving base of scientific knowledge and its promise of prospects for the manipulation of nature the accumulation of that kind of knowledge has been realistically depicted as Eurasian in its remote and European in its proximate origins.¹⁰⁷ Britain's advantages resided more in the development and improvement and diffusion of technology than in discovery itself.¹⁰⁸ Some historians continue, however, to argue that even in a European and much more plausibly, in an Asian context, British "culture" became more receptive to an intermingling of science with business, with religion and with politics than was the case elsewhere across Eurasia¹⁰⁹.

¹⁰⁵ Voigtlander and Voth, "Why England? Demographic Factors, Structural Change and Physical Capital Accumulation during the Industrial Revolution", and G. Clark, "The Industrial Revolution,"

¹⁰⁶ But see Landes, *The Wealth and Poverty of Nations* and idem, *The Unbound Prometheus. Technological Change and Industrial Development in Western Europe from 1750 to the Present Day* (Cambridge: Cambridge University Press, Second Edition, 2004) and Acemoglu et al, *Why Nations Fail*.

¹⁰⁷ A. Bala. *The Dialogue of Civilizations in the Birth of Modern Science* (Basingstoke: Palgrave Macmillan, 2006) and A. Pacey, *The Maze of Ingenuity Ideas and Idealism in the Development of Technology* (Cambridge: Mass., M.I.T. Press, 1994) and MacLeod, *Heroes of Invention*.

¹⁰⁸ J. Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress* (Oxford: Oxford University Press, 1990) and Prados de la Escosura, *Exceptionalism and Industrialization*.

¹⁰⁹ M. Jacob, *Scientific Culture and the Making of the Industrial Revolution* (Oxford: Oxford University Press, 1997); idem *The First Knowledge Economy*, and I. Inkster, *Potentially Global. A Story of Useful and Reliable Knowledge and Material Progress in Europe 1474-1914* (unpublished paper, University of Nottingham Trent).

Studies of several contexts for the discovery and diffusion of useful and reliable knowledge in France, Italy and even Spain, has, however, made it more difficult to accept Anglocentric assertions that the monarchies, aristocracies, ecclesiastical and political elites, and especially the military on the European mainland were somehow less “rational” and open to the potentialities of new knowledge than their counterparts off-shore.¹¹⁰ That debate now seems to be something of a hangover from religious controversies over the reformation, that gave rise to memorable, but unproven, theories about the positive connexions between Protestantism and entrepreneurship. Protestantism and hard work, as well as Protestantism and science, lifted uncritically from Max Weber’s and Robert Merton’s seminal hypotheses.¹¹¹ It will, moreover, surely be difficult to prove that the urban and commercial cultures of Europe’s (even Asia’s) maritime cities could be depicted as discernibly less rational, calculating and utilitarian than the cultures of elites residing in British towns or embodied in British educational institutions, or evident in British publishing and information flows.¹¹² Porter and Mokyr have made claims for the exceptionalism of a British enlightenment, that contrasts with another controversial interpretation of the “long 18th century” in British history as a period marked by the persistence of an *ancien regime* presided over by an

¹¹⁰ D. Wootton, *The Invention of Science* (London: Penguin, 2015) and W. Clark, et al., eds., *The Sciences in Enlightened Europe* (Chicago: Chicago University Press, 1999) and L. Hilaire-Perez, *L’invention technique au siècle des lumieres* (Paris: Albin-Michel, 2000), but Jacob, *The First Knowledge Economy* disagrees.

¹¹¹ J. Brooke, *Science and Religion. Some Historical Perspectives* (Cambridge: Cambridge University Press, 1991) and K. Davids, *Religion, Technology and the Great and Little Divergencies* (Leiden: Brill, 2013).

¹¹² But contrast the claims of Jacob, *The First Knowledge Economy* with P.O’Brien et al., eds., *Urban Achievements in Early Modern Europe. Golden Ages in Antwerp, Amsterdam and London* (Cambridge: Cambridge University Press, 2001) and vide C. O’Grada’s critique “Did Science Cause the Industrial Revolution?” in *UCD School of Economics Working Paper*, 14 (2014).

autocratic, aristocratic and confessional state. Cultural turns by nations, cities or elites towards progress are difficult to expose, let alone measure.¹¹³

Early in the eighteenth century, European visitors did, however, recognize that British industry was moving ahead in certain spheres of industrial technology. Indeed, several governments engaged in espionage in order to close gaps as they opened up, particularly for technologies with military potential.¹¹⁴ The appearance of British machines on the mainland even in Spain occurred rather rapidly before the outbreak of the French Revolution and the long interlude of destructive warfare that arrested diffusion to and across the mainland, from 1791 to 1815. Within Europe technological advances tended to appear, moreover, in branches of industrial production which had reached a certain scale and diversity in production. While in some well-known British cases (cotton and bar iron are prime examples) that occurred after processes of import substitution. Foreign products pioneered access and extended access to the realm and tempted British businessmen to press for protection and to engage in a search for indigenous ways of satisfying first domestic, then imperial, and eventually, foreign demand. The process involved the creation, by a sympathetic mercantilist state, of helpful matrices of legislation and fiscal incentives surrounding commodity and labour markets for Britain and protection for markets and imperial possessions overseas.¹¹⁵ We now know a great deal more about the institution of apprenticeship and prosopographical

¹¹³ R. Porter, *Enlightenment Britain and the Creation of the Modern World* (London: Allen Lane, 2001); and J. Clark, *English Society 1688-1832* (Cambridge: Cambridge University Press, 2002).; I. Inkster, *Scientific Culture and Urbanization in Industrializing Britain* (Aldershot: Ashgate, 1997).

¹¹⁴ J. Harris, *Industrial Espionage and Technology Transfer. Britain and France in the Eighteenth Century* (Aldershot: Ashgate, 1997).

¹¹⁵ P. O'Brien, et al., "Political Components of the Industrial Revolution: English Cotton Textile Industry 1660-1774," in *Econ.Hist.Rev.* 44 (1991) 395-42; J. Inikori, *African and the Industrial Revolution in England* (Cambridge: Cambridge University Press, 2002); and G. Riello, *Cotton. The Fabric that Made the Modern World* (Cambridge: Cambridge University Press, 2013).

surveys of artisans and craftsmen have revealed weak linkages to the patent system, but clear connexions to science and scientists.¹¹⁶

It is, moreover, widely recognized that technological innovation depended, to some considerable degree, on the prior accumulation of a skilled and mobile industrial workforce of artisans and craftsmen. To explain how, when and why the British economy managed to build up the range of aptitudes and skills required to promote and carry breakthroughs in scientific understanding and technological knowledge through a necessary stage of development to points of commercial viability has not been easy. Economic theory is not particularly helpful in explaining the formation of human capital, but economic history is generating promising findings from the records of England's urban guilds, and tracing their connexions to the rise, embodiment and maintenance of skills among European workforces.¹¹⁷ Alas, this not yet at a stage where contrasts across the continents, countries, regions and towns of mainland Europe can be discerned, measured and explained.

Contexts for human capital formation were, however, invariably urban. On the Isles, London, Bristol, Nottingham, Birmingham, Manchester, Glasgow and even Dublin all became important locations for the development of skilled workforces.¹¹⁸ Immigrant German, Flemish, Dutch and Huguenot craftsmen, merchants and financiers, clearly played an important role in starting and moving the process forward in Britain. Skilled men were attracted from the

¹¹⁶ S. Epstein, "Transferring Technical Knowledge and Innovating in Europe," Department of Economic History Working Paper 01-05 (2005) 1-39 and M. Prak and S. Epstein, *Guilds, Innovation and Economy in Europe* (London: Routledge, 2008).

¹¹⁷ The references to apprenticeship are cited in P. Wallis, "Labour Markets and Training," in Floud et al, *Cambridge Economic History of Modern Britain* (2014), pp. 178-2011. And The Pro-sopographical Studies by Mokyr, Meiszahl and others in J. Lerner and S. Stern, *The Rate and Direction of Inventive Activity Revisited* (Chicago: Chicago University Press, 2012) and vide M. Kelly et al, "Precocious Albion – a new interpretation of the British Industrial Revolution," in *Annual reviews of Economics*, 6 (2014).

¹¹⁸ C. MacLeod and A. Nuvolari, "Glorious Times. The Emergence of Mechanical Engineering in Early Industrial Britain," in *Brussels Economic Review*, 52 (2009), pp. 215-37, and P.M. Jones, *Industrial Enlightenment. Science, Technology and Culture in Birmingham and the West Midlands* (Manchester: Manchester University Press, 2009).

mainland to a kingdom that promised security from external aggression, religious toleration and from time to time, royal protection and subsidies. Those with interests in trade with the Americas, Africa and Asia, they could be assured of protection from the Royal Navy. Europeans settled and, as part of extended families and diasporas, maintained links with kin and communities embodying useful knowledge from all over Europe. In an age when the diffusion and adaptation of technology occurred basically through the migration of skilled and professional manpower, the obvious attractions of a domicile in English towns was reinforced by warfare and religious persecution on the mainland.¹¹⁹

2. Conclusions: Deconstructing and Reconstructing the First Industrial Revolution

After the Seven Years War when England's agriculture, coal mines and the state continued to support urbanization, structural change and occupational diversification, the economy reached a plateau of possibilities for an accelerated rate of economic growth, based increasingly on technological innovation.

This second stage of the Industrial Revolution carried the Island to the clear position of competitive advantage if retained between 1846-73 over the economies of mainland Europe, as well as an indisputable status of material superiority over the agrarian economies of south and east Asia.¹²⁰

That brief Victorian interlude had taken centuries to mature and was based to some significant degree upon natural endowments, locational advantages

¹¹⁹ Van Zanden, *The Long Road to the Industrial Revolution*.

¹²⁰ Vries, *State Economy and the Great Divergence*

and naval power. Investment in and patronage for technological innovation continued to depend upon the wealth and political support of elites, whose education, culture and confidence had become permeated by scientific views of prospects for the manipulation of nature and economic progress.¹²¹ Nevertheless it has become clear that only the long term accumulation of knowledge and skills embodied in England's urbanized workforce could have taken the range of European-wide breakthroughs in scientific knowledge, blueprints for production and prototype machinery to levels of commercial viability.¹²²

Over time and as historical outcomes flowing from the release of labour, food and fuel, as well as the agglomeration of a relatively young workforce in urban contexts actively promoted the accumulation of the human capital required for all three processes (discovery, development and diffusion) involved in technological innovation. For several decades the comparative advantages that the national economy derived from the skills embodied in its urban workforce emanated from men employed in a narrow range of industries (pre-eminently textiles, metallurgy, mining, shipbuilding and civil engineering). Although the mercantilist state did its best to prevent the emigration of skilled labour to rival economies, the attempt failed.¹²³ Furthermore, that early advantage was destined to pass away through the familiar workings of labour migration and investment in formal and informal systems of technical education.¹²⁴

¹²¹ O'Grada, "Did Science Cause the Industrial Revolution?"

¹²² Kelly et al, "Precocious Albion" and Kelly and C. O'Grada, "Ready for Revolution?" in *University College Dublin Working Paper*, 14 (2014)

¹²³ D. Jeremy, "Damming the Flood. British Government Efforts to Check the Outflow of Technicians and Machinery, *Business History Review*, 51 (1977), pp 1-34

¹²⁴ M. Berg and K. Bruland (eds.), *Technological Revolution in Europe. Historical Perspectives* (Cheltenham: Elgar, 1998).

In order to help scholars, publics, politicians and the mass media to comprehend The First Industrial Revolution and the rather rapid convergence of Western Europe into an inter-related and ultimately integrated set of successful industrial market economies, it is now appropriate to place the British transition within much longer time spans and wider geographical frames that include Africa, the Americas and East Asia, as well as the mainland. In Hodgson's long stream of time and recently revealed pre-modern "world of surprising economic resemblances", the Industrial Revolution can be re-contextualized as a precocious but not that remarkable a period in the global history for a tiny proportion of mankind's escape from diminishing returns endemic to all traditional economies. Real growth (florescence's) in labour productivity and incomes per capita had occurred in other places and other times for centuries prior to the Seven Years War.¹²⁵ Before long natural disasters, geopolitical shocks and Malthusian checks returned complex but organically based economies to stasis or imperceptible rates of growth. Geography ensured that the Isles were predestined to avoid the first affliction. In the wake of an interregnum of civil war and with a boost from an interlude of republican rule, a properly funded Royal Navy emerged to protect the economy from the second. Then a gradual diffusion of novel technologies and inorganic sources of energy turned out to be sufficient to confound Malthus and to produce a First Industrial Revolution.¹²⁶ Britain escaped first. Western Europe and its European offshoots overseas soon followed.¹²⁷ High and rising standards of living can now be observed in many regions of a rapidly integrating world economy. For a twenty-first century frame of historical

¹²⁵ For an eloquent, but highly polemicized elaboration of Hodgson's argument, see J. Hobson, *The Eastern Origins of Western Civilization* (Cambridge: Cambridge University Press, 2004).

¹²⁶ The Confounding of Malthus is the inspiration for Broadberry et al., *British Economic Growth 1270-1870* and for a discussion of Clark's "Malthusian Views," vide a special issue of the *European Review of Economic History* devoted to Clark's *Farewell to Alms*.

¹²⁷ Pomeranz, *The Great Divergence*.

reference, being first matters a lot less than the inequalities associated with capitalism, the North-South divide and the persistence of mass poverty.¹²⁸ For solutions to those problems there is no British model, no distinctively British enlightenment and no need for patriotic histories of a British Industrial Revolution, proclaiming Britain, Holland or any other nationalistically constructed location or culture to be its locus or origin, let alone as a paradigm for modern economic growth. Our colleagues in art history have shown us that the Florentines are no longer the proud possessors of the Renaissance. Modern Chinese and Japanese scholars now pertinently observe neither English (nor European) history can be represented global destiny.¹²⁹ Marshal Hodgson observed four decades ago that “without the cumulative history of the whole Afro-Eurasian Oikoumene of which the occident has been an integral part, the Western transmutation would be almost unthinkable.”¹³⁰ The British Industrial Revolution is not separable from the global, historical, geographical and geopolitical contexts in which it took place.¹³¹

¹²⁸ T. Piketty, *Capital in the Twenty First Century* (Cambridge, Mass: Harvard, 2015).

¹²⁹ R. Bin Wong, “The Political Economy of Agrarian Empire and its Modern Legacy,” in T. Brook and G. Blue, eds., *China and Historical Capitalism* (Cambridge: Cambridge University Press, 1999) 210-45, and K. Sugihara, “The East Asian Path of Economic Development: a Log Term Perspective,” in G. Arrighi, ed., *The Resurgence of East Asia* London: Routledge, 2003).

¹³⁰ M. Hodgson, *Rethinking World History* (Cambridge: Cambridge University Press, 1993), p. 68.

¹³¹ R. Allen, *Global Economic History* (Oxford: Oxford University Press, 2011) and other economic historians who have taken the global turn now agree?