Eighteenth-Century British Industrial Development and Nineteenth-Century British Industrial Dominance: A Case of Mutual Causation and Ongoing Innovation

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Today, the concept of industrialization seems obsolete, germane only to underdeveloped nations and disengaged from economic vigor, not to mention environmentally hazardous and potentially life-threatening. However, in the nineteenth century, Britain marveled at its status as the world’s preeminent industrial power, with contemporary Oxford historian Arnold Toynbee asserting in his renowned 1881 *Lectures on the Industrial Revolution in England* that industrialization was as crucial and definite an era in British history as the Wars of the Roses.\(^1\) Although industrialization has received acknowledgment as an historical era since Toynbee’s lectures, explaining Britain’s emergence as a major industrial power has been more intangible and controversial, requiring the pinpointing of factors which made industrialization possible and necessitating the identification of the context in which industrialization actually began.

Nineteenth-century Britain possessed numerous advantages which could have allowed it to become the world’s industrial leader. For example, Britain had a stable currency and reliable financial lender in the Bank of England.\(^2\) As seen in its past success with wool and fish


\(^2\) Robin W. Winks and Joan Neuberger, *Europe and the Making of Modernity, 1815-1914* (New...
products, Britain was a commercial nation, and the possibility of greater profits could have stimulated industrialization.³ Britain experienced a demographic surge in the nineteenth century, with its population doubling by midcentury and clustering in urban areas. A bigger population demanded more food and clothing, while a growing middle class desired luxury items such as china.⁴ Also, Britain contained vast reserves of coal and iron ore, in addition to internal waterways that created a natural transportation system. British political stability supplied a nourishing environment for innovation and enterprise.⁵ Finally, Britain witnessed the advent of the railroad, connecting raw materials to factories and factories to markets and consumers.⁶ These economic, demographic, geographic, political, and technological factors certainly enhanced British industrialization in the nineteenth century, but they were not responsible for Britain’s emergence as a major industrial power; indeed, railroad expansion did not transpire until after the mid-1800s. Instead, events of the preceding half-century are fundamental to explaining British industrialization. During the late eighteenth century, agricultural change, cotton’s ascendancy, and diversion of a key economic rival combined to allow Britain to emerge as a major industrial power in the nineteenth century.

Eighteenth-century agricultural change was the prerequisite for extensive industrialization in the nineteenth century. In fact, “agriculture was the indispensable foundation for industry, for there was no other

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⁵ Winks and Neuberger, 80-81.
⁶ Ibid., 74-75.
regular source of the nation’s food.” British agriculture’s improved yield and efficiency in the late eighteenth century had two significant effects: fewer agricultural laborers were needed, which gave industry a ready workforce, and greater internal productivity supplied industrial workers with food, which otherwise would have been imported. Agricultural progress was sufficient to sustain the population during the transition to industrialization and, therefore, Britain emerged as an industrial power without a significant portion of its population perishing from malnutrition. Overall, agricultural change after 1750 was so important because it allowed industrialization to both happen and flourish in the nineteenth century. If industrialization was reliant upon agricultural progress, then there would have been no agricultural revolution without adoption of the enclosure system.

Enclosure signaled agricultural change by consolidating common lands. Prior to the late eighteenth century, the majority of British farm acreage was common land in villages, divided between grazing and arable land. Common lands afforded equal opportunity to every family, acting as a sort of safety net. Since land was communally held, farmers were compelled to abide by a mandatory crop choice and schedule. Such rigidity meant agriculture was disinclined to change, neither planting different crops nor attempting new farming methods. However, starting in the 1750s, enclosure abolished common land and its associated rules,

replacing the communal system with individual farm ownership or tenant farming. Between 1750 and 1760, Parliament passed approximately 150 enclosure acts, most at the behest of powerful landowners who wanted to increase their land’s agricultural productivity. Profit may have motivated enclosure, but the end result was an agricultural revolution that would feed an industrializing nation.

Whether small farmers or large landlords, the independence that enclosure imparted let them pursue new crops and techniques which greatly increased yield. For example, nutrient-rich silage crops, such as clover and turnips, were introduced and prevented weeds from growing in fields, as well as sustaining bigger herds of livestock and thereby producing more manure for fertilizer. The silage crops also added nitrogen to the soil, which further boosted production. With enclosure, farmers could rotate crops, rather than limit themselves to permanent acreage for a specific crop like wheat. Yield per acre of wheat increased due to crop rotation, rising from 12 bushels per acre in 1750 to 20 plus bushels by 1800. Enclosure not only benefitted crops, but also relieved farmers, placing the burden of labor upon animals, whose numbers swelled because of more nutritious feed. In the latter half of the eighteenth century, horse power experienced a 27% growth rate and, in turn, served to enhance soil fertility by transporting loads of lime and sand to the fields. By 1800, British agriculture claimed an output per worker percentage growth of at least 60%. That eighteenth century efficiency would support industrialization’s growth, as it drew more workers away from agriculture into factories throughout the nineteenth century.

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12 Winks and Neuberger, 68.
Agricultural efficiency and enclosure directly contributed to Britain’s emergence as a major industrial power in the nineteenth century. Obviously, greater efficiency reduced the number of farmers required to feed the population and those displaced laborers needed other work, which would provide industry with a ready workforce as it simultaneously developed in the latter half of the eighteenth century. While the link between lost agricultural work and an available, cheap industrial labor supply has been well established, some historians have asserted British agricultural efficiency created a surplus to be sold on the international market. The notion of a surplus has been questioned, however, since between 1700 and 1800 British farmers were required to grow roughly 20 million bushels of grains to keep the population adequately fed. Regardless, agriculture did produce enough food to sustain the population during the transition to industry, a pattern that much of the rest of the world would not follow. Enclosure also stimulated the shift to industrialization by displacing agricultural laborers, particularly as tenant farmers’ rent doubled and even tripled from the enforcement of enclosure in the 1750s to the turn of the century. In sum, enclosure affected 7.35 million acres and worked in tandem with agricultural efficiency to eliminate farming employment. Many small independent farmers sold their land immediately before enclosure was implemented or afterwards were forced to get rid of their land because they could not support families on such small acreage without access to pasture. Eighteenth century agricultural change generated two factors – adequate food and displaced workers – essential to Britain’s position as an

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15 Harvie and Matthew, 10.
16 Timmer, 382.
17 Landes, 213.
18 Hudson, 74-75.
industrial power in the nineteenth century, yet those factors were useless without a product to spur industrialization.

Cotton was the product which stimulated British industrialization and, more specifically, the mechanization necessary to industrialize on a large scale. Indeed, “cotton textiles were the power which towed the glider of industrialization into the air.” Records of raw cotton imports from the late eighteenth century to the early nineteenth century verify that cotton acted as a root cause of Britain’s emergence as a major industrial power. For example, in 1765, Britain imported 4,636 pounds of cotton, while in 1785 cotton imports rose to some 18,887 pounds. Still, imports jumped dramatically by 1805, with approximately 68,208 pounds imported that year – proving industrialization was an outgrowth of the late eighteenth century’s innovation. Cotton made innovation possible because of its malleability, which wool and linen lacked; moreover, Britain had access to a cost-efficient supply of cotton from the American South by the last decade of the eighteenth century. This product became the basis of British industrial power in the nineteenth century, not only due to its natural properties and availability, but also as a result of parliamentary law and pervasive fraud.

Parliament unwittingly thrust cotton into industrialization with a series of prohibitive acts in 1720 and 1721, which banned the importation of Indian cotton – both unfinished and finished goods. Ironically, this ban was meant to protect British wool and linen cottage industry, as well as infant attempts to mechanize the spinning of wool. However, the British public wanted cotton because of its affordability, and wool did not adapt to mechanization, its fibers being too coarse and wiry at the outset; therefore, cotton

19 Harvie and Matthew, 14.
21 Harvie and Matthew, 14.
became the fiber of choice for mechanization. Rampant fraud in the cottage industry further encouraged cotton’s industrialization. Cottage workers often took raw goods “from one merchant and then [sold] the finished article to a competitor, stalling now one, now another, and they learned to set some of the raw material aside for their own use. Trying to conceal their embezzlement, weavers made thinner, poorer fabrics.” Such deception among cottage industry workers made employers aware of the benefits of regulation and, when cotton was mechanized, spinners and weavers would work in factories, under strict supervision throughout the entire day. The environment in the latter half of the eighteenth century was set for mechanization of the cotton industry and three inventions allowed industrialization, absorbed displaced agricultural workers into factories, and assured Britain’s industrial preeminence in the nineteenth century.

In 1829, Scottish social commentator Thomas Carlyle wrote about Britain’s “Mechanical Age,” describing it as “the age which, with its whole undivided might, forwards, teaches and practices the great art of adapting means to ends.” The “Mechanical Age” Carlyle described in the nineteenth century was initiated in the late eighteenth century with the mechanization of the cotton industry, whose three greatest inventions – the spinning jenny, the water frame, and the mule – were paramount examples of “adapting means to ends.” A surplus of farm laborers and frustrated cottage industry employers already existed, but the machines were lacking. However, in 1764, James Hargreaves invented the spinning jenny, followed by Richard Arkwright’s water frame in 1769, and finally Samuel Crompton’s mule in

22 Landes, 207.
23 Ibid., 208.
24 Ibid., 209.
1779. The mechanization of cotton textile production was transformed in an intense span of invention and the impact of these eighteenth century inventions and their link to Britain’s nineteenth century industrial power was not lost on contemporaries, as revealed in Andrew Ure’s 1835 *Philosophy of Manufactures*. A renowned Scottish scholar, Ure was amazed that the machines “enable[d] an operative to turn out a greater quantity of work than he could before – time, labor, and quality of work remaining constant, [and effected] a substitution of labor comparatively unskilled, for that which is more skilled.”26 Prior to 1764, each step in production was manual. Hargreaves’ spinning jenny exchanged hands twisting fibers into yarn for rotating spindles, directed by metal bars, while Arkwright’s water frame improved handwork by using a series of rollers to stretch out fibers into more durable yarn. Ultimately, Crompton’s mule combined the spinning jenny and the water frame, which permitted the spinning of the finest, top-grade yarn possible. These inventions lessened the time needed to spin 100 pounds of cotton to 300 hours by the 1790s, as compared to roughly 50,000 hours required manually for the same amount.27 Without doubt, cotton spurred industrialization, but changing the manner of work would change everything else.

By the 1790s, machinery had been invented to mechanize cotton textile production and therefore changed the manner in which people worked. Instead of home production, employees gathered into factory settings; rather than individual manufacture, factories introduced unified methods of production. Factories were necessary because of the massive

machinery that cotton production required, yet they also ensured Britain’s cotton textiles were the best and cheapest in the world – certainly, this is an example of the mutual causation in the eighteenth century that drove Britain to industrial power in the nineteenth century. Hargreaves’s spinning jenny and Arkwright’s water frame were responsible for raising production of cotton yarn tenfold by 1790, but the factory system made that increase possible. For example, the spinning jenny allowed mass production due to its simultaneous motions of anywhere from six to twenty-four spindles. While the jenny was usually powered by operators in a factory, Arkwright’s water frame made the leap from manpower to using another source of energy – water. His machine used power from a watermill to operate a spinning frame, containing about one hundred spindles, and produce yarn. Although Hargreaves’s invention did stimulate factory formation outside of the household, Arkwright’s water frame necessitated a factory be built next to a power source and hundreds of employees work at a location removed from the household, but, in many cases, still within their villages. In 1779, Crompton’s mule advanced power spinning further, being 30 times more productive than Arkwright’s water frame. Only eight years later, Edmund Cartwright invented a water-powered loom to weave cotton cloth. These two devices – Crompton’s mule and Cartwright’s loom – began a continual process of concentration of factories and mills. In fact, the expansion of the factory system generated more than 50,000 power looms within Britain by 1830. Cotton and related technology were the leading sector of British industrialization in the late eighteenth century and maintained that position into the early nineteenth century. However, cotton and its eighteenth-century-invented machines also served as catalysts to create more diverse in-

28 Winks and Neuberger, 71-73; Landes, 191-93.
industrial development in Britain that would extend into the early nineteenth century and ensure British industrial supremacy.

Some modern historians refer to eighteenth-century cotton textile production as the “self-sustaining process of innovation,” a process which propelled Britain to industrial supremacy in the early nineteenth century. The “productivity growth at the rate experienced in cotton textiles was achieved elsewhere, but the success of cotton … was intimately related to and dependent upon innovations and radical transformations in other branches of the primary, secondary, and tertiary sectors.”29 Thus, the technology used in cotton production, such as water power, spread to other infant industries in the late eighteenth century, including additional textile production like that of worsteds. Conversely, cotton demanded new technology to improve its quality and hence motivated engineering – such as fireproofing factories with metal columns and joists.30 In 1795, English writer John Aikin gave witness to cotton’s “self-sustaining innovation,” declaring:

The prodigious extension of the several branches of the Manchester manufactures has likewise greatly increased the business of several trades and manufactures connected with or dependent upon them. The making of paper at mills in the vicinity has been brought to great perfection, and now includes all kinds, from the strongest parcelling paper to the finest writing sorts, and that on which banker’s bills are printed. A considerable iron foundry is established in Salford, in which are cast most of the articles wanted in Manchester and its neighborhood, consisting chiefly of large cast wheels for the cotton machines …. The tin-plate workers have found additional employment in furnishing many articles for spinning machines; as have also the braziers in casting wheels for the motion-work of the rollers used in them; and the clock-makers in cutting them.31

29 Berg and Hudson, 32.
30 Harvie and Matthew, 15.
Aikin perfectly described the momentum that stemmed from cotton’s industrialization and mechanization. Indeed, momentum characterized the late eighteenth century, from agricultural changes that produced a ready-made industrial labor supply to the innovations that generated continually improved machinery in cotton and then were transferred to subsequent areas of British industry. Yet, momentum also combined with those root causes of industrialization – agriculture and cotton – in the late eighteenth century to create the final step in Britain’s climb to the summit of industrial power in the nineteenth century.

A commercial advantage, specifically on the international market, comprised the final step in Britain’s emergence as a major industrial power in the nineteenth century. Agricultural change and cotton production’s mechanization had set off a chain reaction – first a surplus of laborers, then a surplus of goods, and finally a needed market beyond domestic consumption for those goods. Even though Britain demanded cotton textiles, the mechanization of the industry saturated the domestic market by the end of the eighteenth century. For example, in 1795, Britain produced 40 million yards of cotton, far exceeding British home need. Furthermore, cotton prices decreased as output rose with mechanization, from 38 shillings per pound of cotton yarn in 1786 to 2 shillings per pound by the early 1800s. At the same time, industrial workers’ numbers grew, as seen in Manchester’s factory and related population – which increased from approximately 40,000 in the 1780s to about 70,000 by 1801. Cotton manufacturers attempted an early form of salesmanship on the home market, promoting cotton printed with national figures and attractive designs and encouraging customers to

32 Winks and Neuberger, 64.
fulfill their desire for more cloth. Unfortunately for those manufacturers, the domestic market had reached its threshold, and Britain had to find an external market for surplus goods to maintain the eighteenth century status quo and to progress into the nineteenth century. However, Britain was well-situated to capture the international market, as it could sell for less. Cotton mechanization dramatically lowered the cost of labor and improved the final product. British industrial cotton produced on Cartwright’s loom was of the same quality as the high-grade, non-mechanized Indian cotton textiles which dominated the international market, but it was much lower in price because of time-saving technical improvements. In addition, Britain acquired a dependable supply of raw cotton in the last decade of the eighteenth century from the American South, primarily due to the cotton gin and guaranteed slave labor, and could thus expand its market without fear of disrupting its raw material supply. Ultimately, Britain was able to gain a commercial advantage on the world market and deter industrial decline due to the diversion of a key economic rival in the late eighteenth century.

Between 1789 and 1815, Britain had a decided commercial advantage on the world market because France was embroiled in and diverted by the French Revolution and a series of subsequent wars. While agriculture provided the labor supply and cotton the product and the mechanization, the concurrent economic disengagement of France was perhaps the key factor in British emergence as a major industrial power in the nineteenth century. France, as well as the majority of the European continent, was consumed by war in the late eighteenth century and was greatly hindered in

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34 Griffiths, Hunt, and O’Brien, 891, 900-01.
36 Mokyr, 1:19.
either competing with Britain or replicating British technology, a situation which “helped determine the relative technological performance” of Britain in that period.\(^{37}\) By the mid-eighteenth century, Britain was about to experience agricultural change and see the rise of cotton and mechanization, but was still on equal footing with other major European powers – Spain, Portugal, France, and the Dutch. By 1850, Britain was acknowledged as the unrivalled industrial power and the “workshop of the world.”\(^{38}\) This distinction was due to Britain’s ability to seize the competitive advantage while the rest of Europe was occupied by war in the preceding century.

Nineteenth-century British thinkers were aware of the importance of the ongoing wars in Europe for British commercial advantage. In 1814, lawyer Patrick Colquhoun asserted that he believed “it [was] impossible to contemplate the progress of manufactures in Great Britain within the last thirty years without wonder and astonishment. Its rapidity, particularly since the commencement of the French revolutionary war, exceeds all credibility.”\(^{39}\) Oddly, many modern historians seem to disregard this eighteenth-century factor in the emergence of nineteenth-century British industrial superiority, preferring instead to focus on late nineteenth-century developments in railroad transportation – particularly in India and Africa – and the consequent boost to British industrial expansion.\(^{40}\) Nevertheless, the international vacuum from 1789 to 1815 was crucial in establishing British industrial dominance, and the British navy played a key role in maintaining Britain’s newfound competitive advantage.\(^{41}\)

Throughout that twenty-six year period, the British navy prevent-

\(^{37}\) Ibid., 1:33.
\(^{39}\) Quoted in Berg and Hudson, 26.
\(^{40}\) Usher, 125.
\(^{41}\) Hobsbawm, 111.
ed efforts from mainland Europe, especially France, to enter the international market via the seas. Accordingly, Britain was able to seize approximately 50% of the existing world trade in cotton textiles that it did not already control.42 While somewhat dubiously regarded today, British cotton producers at the time claimed that they supplied French troops with the cotton elements of their uniforms owing to British industrial supremacy.43 Regardless of boastful tales, Britain certainly expanded its market and relieved the pressure of surplus cotton textiles at home. For example, Britain consolidated control of India, captured markets in South Africa and the Dutch East Indies, and obtained a lucrative trade agreement with former Spanish colonies in Latin America.44 With the help of its navy, Britain was further enabled to claim the cotton trade with China by the 1790s. Overall, the vacuum created by mainland European wars allowed the worth of cotton exports to soar, from £13.6 million in 1786 to £24 million in 1796.45 Britain’s mechanization and the international market vacuum were a lucky coincidence, but they were fully utilized to continue the process of industrialization.

Based upon eighteenth-century agricultural change and mechanization of the cotton industry, British industrial dominance was indisputable by 1815. “As the only industrial power, [Britain] could undersell anyone else, and the less discrimination there was, the more she could undersell.”46 As ruthless as British industrial supremacy seems, it was simply a fact of the time. Continental European wars severely damaged the economy of rival European nations, and Britain prospered. If the conflicts from 1789 to 1815 did not create Britain’s competitive advantage, then

43 Ibid., 435.
44 Ibid., 436.
45 Ward, 56-60.
46 Hobsbawm, 196.
they certainly widened the competitive gap in Britain’s favor. Moreover, Britain made the most of the chaotic political and economic situation to strengthen its industrial standing around the world. Britain sought to sell its cheaper and better cotton textiles everywhere, without regard for protective tariffs or indigenous industries. Britain also protected its advanced machines, such as Crompton’s mule and Cartwright’s loom, with patents, which was an easier task in wartime due to a heightened sense of security and the naval blockade. Essentially, Britain preserved its lead on the international market by combining its cotton products with forcible sales. Britain could maintain that level of commerce into the nineteenth century because its textile factories could easily meet increased demand, its machines capable of doubling replication. In the late eighteenth century, Britain succeeded in cornering the international cotton market, a feat that was predictive of its standing as a major industrial power in the nineteenth century.

Before 1750, Britain was unquestionably agricultural and no modern industry existed; yet, in only a century, Britain would become the world’s industrial leader. Such astonishing and swift progress was made possible by three intertwined root causes which occurred in the late eighteenth century. Today, most historians agree that “Britain had the right combination at the right time” – and the right combination consisted of agricultural change, cotton’s ascendancy, and diversion of a key economic rival. The mutual causation of Britain’s industrial revolution neither exceeded previous nor surpassed later achievements in historical

47 Mokyr, 1: 33.
48 Winks and Neuberger, 83.
49 Ward, 60-61.
50 “The City in European History – Industrial Manchester in the Nineteenth Century.”
51 Winks and Neuberger, 83.
as well as its ability to advance without causing malnutrition, made it atypical of all subsequent world industrialization.\textsuperscript{52} Indeed, agricultural change, cotton and mechanization, and commercial advantage coincided and “surged up with a suddenness for which it is difficult to find a parallel at any other time or place.”\textsuperscript{53} The city of Manchester, England, serves to illustrate the intensity and power of British industrialization. In 1773, Manchester had no cotton mills and roughly 25,000 citizens; in 1802, it boasted 52 mills and a population of 95,000.\textsuperscript{54} Undeniably, Britain witnessed a transition to industrialization from the late eighteenth to early nineteenth century.

Explaining Britain’s emergence as a major industrial power requires pinpointing the root causes which made industrialization possible and necessitates the identification of the context in which industrialization actually began. As this paper has shown, eighteenth-century events were the combined root causes and context in which Britain emerged as an industrial power in the nineteenth century. While supported by modern historians, this view of British industrialization was first proposed by astute nineteenth-century British observers. In 1835, Andrew Ure observed that “when the first water-frames for spinning cotton were erected at Cromford, in the romantic valley of the Derwent, about sixty years ago, mankind were little aware of the mighty revolution which the new system of labor was destined by Providence to achieve.”\textsuperscript{55} A similar opinion is found in Richard Guest’s \textit{Compendious History of the Cotton Manufacture}, published in 1823. Guest noted that it was a “curious circumstance, that, when the Cotton Manufacture was in its infancy, all the operations ...
were completed under the roof of the weaver’s cottage. The course of improved manufacture which followed was to spin the yarn in factories.” Guest was amazed that “those vast brick edifices in the vicinity of all the great manufacturing towns in the south of Lancashire, towering to the height of seventy or eighty feet, which strike the attention and excite the curiosity of the traveler, now perform labors which formerly employed whole villages.” In 1881, Arnold Toynbee, who first defined British industrialization as a distinct era, affirmed “an agrarian revolution plays as large part in the great industrial change of the end of the eighteenth century as does the revolution in manufacturing industries.” As those contemporaries noted, agricultural change, cotton, and competitive advantage on the world market made Britain the premier industrial power by the advent of the nineteenth century. Yet, Britain would continue its industrial dominance because innovation in those three original root industrial causes created an environment for greater industrial advancement, in effect a chain reaction of infinite possibility.