

# **What was Cotton? Fibers, Markets and Technology in the British Industrial Revolution<sup>1</sup>**

by

**John Styles**

**School of Humanities  
University of Hertfordshire  
Hatfield AL10 9AB  
e: [j.a.styles@herts.ac.uk](mailto:j.a.styles@herts.ac.uk)  
w: [www.spinning-wheel.org](http://www.spinning-wheel.org)**

**Paper presented at  
Penn Economic History Forum  
University of Pennsylvania  
2017**

---

<sup>1</sup> The author would like to thank Linda Baumgarten, David Celetti, Alice Dolan, Linda Eaton, Jane Humphries, Lesley Miller, the late John Munro, Chris Nierstrasz, Georgio Riello, Michael Sonenscher, Philip Sykas, and Melinda Watt. The research leading to these results has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP/2007-2013) / ERC Grant Agreement n. 249512.

## Introduction.

The late Eric Hobsbawm famously remarked ‘whoever says Industrial Revolution says cotton’.<sup>2</sup> But what was cotton? Like our English-speaking predecessors of the 18<sup>th</sup> century, historians find the English words ‘cotton’ and ‘cottons’ convenient labels for the huge diversity of textiles which have incorporated fibres from the fruit of the cotton plant. Yet until the very end of the 18<sup>th</sup> century, the vast majority of the ‘cottons’ manufactured in western Europe consisted only partly of cotton fibre, if at all. Many consisted of mixtures of cotton yarns with linen (flax or hemp) yarns, in various proportions. Some combined cotton with silk yarns, or woolen yarns, or worsted yarns. One type of heavily napped woolen cloth, woven in Wales and north-west England, was known as ‘cotton’, but contained no cotton fibre whatsoever. This ambiguity explains the tautology in a 1776 letter from a Bedfordshire gentlewoman to a friend in London asking her to buy a piece of printed cotton fabric. Writing just three years after cotton yarn from Richard Arkwright’s new spinning machines first began to be woven into all-cotton British calico, she was obliged to distinguish between the new printed fabric, woven wholly from cotton yarn, and printed fabric made from the established combination of cotton weft and linen warp. She wanted the newer, all-cotton variety, but finding the appropriate vocabulary to distinguish the one from the other was evidently a challenge. She asked for a printed cotton ‘of the new manufactory which are Cotten both ways,’ but then continued, somewhat confusingly, ‘it is a great deal lighter than a Cotton, and the colours look more lively.’<sup>3</sup>

Scrutiny of material differences between the various ‘cottons’ is not simply a matter of remedying taxonomic confusion. These differences were crucial for the timing and technological trajectory of the British Industrial Revolution in textiles. It is the materiality of ‘cotton’ textiles that is the focus of this paper. The paper is divided into four sections. The first reviews recent interpretations of the British Industrial Revolution in textiles. The second evaluates the evidence for economic inducements to innovation. The third examines demand for the various ‘cottons’, a key issue ignored in the leading interpretations. In conclusion, the fourth section considers the implications of demand for our understanding of technical innovation in spinning.

---

<sup>2</sup> Eric Hobsbawm, *Industry and Empire: The Birth of the Industrial Revolution*, London 1968: 34.

<sup>3</sup> Bedfordshire and Luton Archives and Record Service, M10/4/34: Williamson Muniments, correspondence, letters to Mary Williamson, 1775-8, Margaret Cater, Kempston Greys, Bedfordshire, to Mrs. Mary Williamson, London, 17 October 1776.

## 1. Explaining technical innovation.

Traditional accounts of the British Industrial Revolution tell the story of an Asian textile – cotton – transformed into a cheap, mass-produced British staple by means of cost-cutting mechanical inventions. Indeed, technology was centre stage in Adolphe Blanqui's 1837 *Histoire de l'Économie Politique en Europe*, the book which offered one of the first systematic applications of the term 'industrial revolution'. Blanqui insisted that Britain had recently undergone an economic revolution comparable to the social and political revolution experienced in France. In a chapter entitled 'On the economic revolution in England caused by the discoveries of Watt and Arkwright', he defined that economic revolution in terms of technology, or, to be more precise, in terms of just two machines:

Two machines, henceforth immortal, the steam engine and the spinning machine, overturned the old commercial system and, almost at the same moment, gave birth to material products and social questions unknown to our fathers ... Hatched in the brains of Watt and Arkwright, two men of genius, the industrial revolution took possession of England.<sup>4</sup>

Recent quantitative studies of the classic period of the British Industrial Revolution from 1760 to 1830, couched in national accounting terms, have suggested that overall rates of economic growth were significantly lower than had previously been assumed. Yet despite the tendency to downplay the significance of Industrial Revolution for the economy as a whole, economic historians continue to foreground those technological innovations on which the very notion of Industrial Revolution was originally founded. They do so with good reason, because the three transformative inventions in cotton spinning were made in Lancashire in a period of just twenty years from 1760 to 1780. Within another fifteen years, by 1795, they had been applied to the four other principal spun fibres – short-staple wool, long-staple wool, flax, and spun silk. There is room for debate about how much these inventions revolutionized the British economy as a whole, but for the industries concerned, the effects were rapid and transformative.

The question of why the crucial technological innovations were British is central to the two most recent (and influential) general treatments of the Industrial Revolution – Joel Mokyr's *The Enlightened Economy: An Economic History of*

---

<sup>4</sup> Adolphe Blanqui, *Histoire de l'Économie Politique en Europe*, Vol. 1, Paris, 1837: 207 and 209. Blanqui offers an exceptionally stark account of the transformative impact of technology, but it was rooted in the concept of industrial revolution first developed by his patron, Jean-Baptist Say, in his *Cours Complet d'Économie Politique Pratique* (Paris, 1828), vol. 1: ch. 19. For Blanqui, Say and the origins of the term 'Industrial Revolution', see Gareth Stedman Jones, 'Industrie, pauperism and the Hanoverian state: the genesis and political context of the original debate about the "Industrial Revolution" in England and France, 1815-1840' (Working Paper, Centre for History and Economics, Cambridge, 1997).

*Britain, 1700-1850* and Robert Allen's *The British Industrial Revolution in Global Perspective*.<sup>5</sup> Both books employ a distinction between micro- and macro-inventions, identifying James Hargreaves' spinning jenny of 1764-6 and Richard Arkwright's water frame, patented in 1769, as key macro-inventions in cotton spinning, along with Samuel Crompton's later spinning mule of 1779 which integrated the principles of the first two machines. However, the two books provide very different approaches to explaining macro-invention.

Mokyr insists that macro-inventions (in contrast to micro-inventions) are only very weakly related to economic forces, if at all. He presents macro-inventions as radical new ideas that emerge without clear precedent, but have dramatic economic consequences.<sup>6</sup> The roots of the key macro-inventions of the British Industrial Revolution, insists Mokyr, lay in what he calls 'the great synergy of the Enlightenment: the combination of the Baconian program in useful knowledge and the recognition that better institutions created better incentives'.<sup>7</sup> In other words, their origins were cultural, intellectual and institutional – they are to be found in a distinctively British combination of competitive markets and scientific research linked to practical applications. Mokyr's broad emphasis on the importance of 'useful knowledge' is unexceptionable, but in the process he appears to abandon the possibility of explaining the origins of particular macro-inventions, while sidelining evidence for pre-Enlightenment inventiveness.

Robert Allen, by contrast, offers an explanation for the key macro-inventions that is narrowly economic, rooted in the theory of induced innovation. He insists that technological change is directed by the relative prices of the factors of production. Eighteenth-century Britain was, he argues, an economy characterized by high wages, but cheap capital and very cheap energy, which rendered worthwhile the high costs of developing labour-saving macro-inventions and converting them into commercially useful technologies. To apply this approach to technical innovation in textiles, Allen focuses not on Richard Arkwright's water frame, but on James Hargreaves' spinning jenny, invented in Oswaldtwistle, Lancashire in the mid-1760s, which he characterizes as 'the Industrial Revolution in miniature'. In his book and an associated article, Allen offers a heroic cliometric comparison of the jenny's potential to reduce spinning costs in Britain, France and India.<sup>8</sup> He concludes the jenny more than paid for itself given high British wages for hand spinning and

---

<sup>5</sup> Joel Mokyr, *The Enlightened Economy: An Economic History of Britain, 1700-1850*, New Haven and London, 2010; Robert Allen, *The British Industrial Revolution in Global Perspective*, Cambridge, 2009.

<sup>6</sup> Joel Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress*, Oxford, 1990, 13.

<sup>7</sup> Mokyr, *Enlightened Economy*, 122.

<sup>8</sup> Robert Allen, 'The Industrial Revolution in Miniature: The Spinning Jenny in Britain, France, and India', *Journal of Economic History*, 69, 2009: 901-927. The precise date of Hargreaves' invention is uncertain. In 1822 Hargreaves' daughter dated it to 'the year 1766 or thereabouts'; quoted in Christopher Aspin, 'New Evidence on James Hargreaves and the Spinning Jenny,' *Textile History*, 1 (1968), 120.



relatively low British capital costs. It was not economically advantageous in France, where spinning wages were lower and the cost of capital higher, and it was certainly not viable in India, where wages were lower still and capital costs even higher.

Allen's quantitative analysis has been subjected to technical criticism, questioning the leisure-preference assumptions built into his calculations.<sup>9</sup> A more extensive critique of his insistence that hand spinning shared in a distinctively British high wage economy is offered by Jane Humphries and Ben Schneider.<sup>10</sup> They argue that earnings from spinning, which was performed overwhelmingly by women and children on a putting-out basis, were substantially lower than Allen claims and underwent no substantial increase in the course of the eighteenth century. 'Substituting inexpensive capital for high wages', they suggest, 'was not the driving incentive behind the crucial inventions in this key sector.'<sup>11</sup> Rather, they see technical innovation in spinning as a reaction to bottlenecks in the supply of yarn resulting from the low productivity of hand spinning and to the inconsistent quality of hand-spun yarn. The new technologies addressed these problems, while continuing to take advantage of low-paid female and child labour. For Humphries and Schneider, technical innovation was driven by low, not high wages.

---

<sup>9</sup> See Gragnolati, U., D. Moschella, and E. Pugliese, 'The Spinning Jenny and the Industrial Revolution: A Reappraisal', *Journal of Economic History*, 71, 2011: 458-63. For Robert Allen's reply, see his 'The Spinning Jenny: A Fresh Look', *ibid*: 461-4.

<sup>10</sup> J. Humphries, 'The lure of aggregates and the pitfalls of the patriarchal perspective: a critique of the high wage economy interpretation of the British industrial revolution', *Economic History Review*, 66, 2013: 693-714; J. Humphries and B. Schneider, 'Spinning the Industrial Revolution', University of Oxford, Discussion Papers in Economic and Social History, vol. 145, 2016.

<sup>11</sup> Humphries and Schneider, 'Spinning the Industrial Revolution': 38.

## 2. Spinning wages: high or low?

Robert Allen insists changes in relative prices of the different factors of production can explain the timing of macro-inventions. Given his characterization of eighteenth-century Britain as a high wage economy, it is the price of labour that is key here. Yet insofar as Allen uses spinning wages to explain the timing of the invention of the spinning jenny, it is in terms of centuries rather than years, or even decades. He offers only six of estimates for real English spinning wages between the 1580s and the 1760s, all but one drawn from estimates by contemporary commentators and none of them for spinning cotton.<sup>12</sup> On the basis of this evidence, he concludes that ‘a woman earned one-third as much as a man at the end of the sixteenth century or in the first half of the seventeenth. By 1750 her earnings had jumped to two-thirds of male earnings. These earnings were very high compared to those in other countries.’<sup>13</sup>

Allen’s use of evidence is defective in several ways. His international comparison relies principally on wage data for French spinning derived from Arthur Young, the English agricultural writer who toured France in 1787-9. Oddly, Allen’s references are not to Young’s own book, *Travels during the Years 1787, 1788, and 1789*, published shortly after his return to England, but to Constantia Maxwell’s collection of extracts from it, first published in 1929.<sup>14</sup> Nor does Allen reference the wages Young reported for cotton spinning, but rather Young’s averaging of all his observations of spinning earnings across France, including the spinning of flax, hemp, coarse wool, and fine wool, which often paid far less than spinning cotton, especially in remote, mountainous areas in south-central France. Young recorded relatively few observations for cotton spinning wages in France. Those he did report were mainly for Normandy, in the eighteenth century France’s counterpart to Lancashire for cotton manufacturing. Country spinners near Le Havre earned 16 sous per day, at Yvetot in the Caux 12 sous per day, at Rouen, described by Young as ‘the Manchester of France’, 8 to 12 sous per day, while good cotton spinners at La Roche-Guyon, to the south-east on the edge of the Normandy cotton spinning zone, earned 12 to 15 sous per day. Only at Angers, in Anjou nearly 200 miles to the south-west, did he report lower rates for spinning cotton of 5 to 8 sous per day.<sup>15</sup> The average of 13 sous per day he recorded for cotton spinning in Normandy

---

<sup>12</sup> R. Allen, ‘The high wage economy and the industrial revolution: a restatement’, *Economic History Review*, 68, 2015: 14-15. Allen’s data for these years is drawn from C. Muldrew, ‘“Th’ ancient Distaff” and “Whirling Spindle”: measuring the contribution of spinning to household earnings and the national economy in England, 1550–1770’, *Economic History Review*, 65, 2012: 504-11, 519.

<sup>13</sup> Allen, ‘The high wage economy and the industrial revolution: a restatement’: 15.

<sup>14</sup> Arthur Young, *Travels during the Years 1787, 1788, and 1789*, first edition, Bury St Edmunds 1792: 503; Arthur Young, *Travels in France during the Years 1787, 1788, and 1789*, ed. Constantia Maxwell, Cambridge 1950: 311. For the detailed exposition of this aspect of Allen’s argument, see Allen, ‘Industrial Revolution in Miniature’: 910.

<sup>15</sup> Arthur Young, *Travels during the Years 1787, 1788, and 1789*, second edition, Vol. 1, London, 1794: 550, 562-5. The second edition provides a table on earnings in manufacturing, not included in the first edition, which specifies spinning wage rates for different areas.

represented about 7d. a day in English money. 7d. per day is in the middle of the 4d. to 10d. a day (assuming a six-day week) Young had previously recorded at Manchester in 1771.<sup>16</sup> So it is not clear from Young's data that there was any difference in nominal wages for hand cotton spinning between the key cotton manufacturing districts in England and France during the years jennies were being introduced. Even if adjusted for the differential identified by Allen in the costs of living in France and England, it is unlikely that his extremely stark real wage differentials would hold. If Normandy is the appropriate French comparator, the price of spinning labour in Lancashire does not appear to have been relatively high at all.

Humphries and Schneider's analysis is grounded in a much more thorough exploration of the English evidence than Allen's. They construct an impressively large new dataset of spinners' earnings based on primary sources, covering the period from the late sixteenth to the early nineteenth centuries. Manuscript records of output actually achieved and wages actually paid are compared with the estimates published by contemporary elite commentators, previously historians' main source for spinners' work and earnings. Actual output and actual earnings are shown to have been substantially lower than those recorded by the commentators. This finding is then used to develop a critique of Allen's argument that spinning provided substantial improvements in women's (and families') real earnings over the period. Their new data suggests women's earnings from spinning were modest and any increase between the sixteenth and the eighteenth centuries was small, at best. In other words, there was no spike in spinning wages in the middle decades of the eighteenth century to induce the invention of the spinning jenny in the 1760s, as opposed to a half-century or a century earlier.

Nevertheless, as a contribution to the debate around induced innovation in eighteenth-century cotton textiles, the Humphries-Schneider dataset suffers from its own shortcomings. Most obviously, their dataset contains very few observations for spinning cotton before the mid-1760s, and none for cotton spinning in Lancashire (something also lacking in Allen's work). Indeed the whole dataset is biased towards the spinning of wool in the southern half of England. Yet there was considerable divergence in the fortunes of England's textile industries in the eighteenth century, by region and by fibre. There is no reason to believe that the wages paid for spinning yarn for wool-worsted serges in Devon, or for woollen broadcloth in Wiltshire followed the same trajectory as those for Lancashire cottons.

Moreover, Humphries and Schneider take little or no account of the count (ie. the fineness) of the yarn spun. This is a significant omission, because piece rates

---

<sup>16</sup> Arthur Young, *A Six Months Tour through the North of England*, Vol. 3, London 1770: 248. The exchange rate used here is 31.5d. per Écu, which would have been characteristic of the early 1770s; see John J. McCusker, *Money and Exchange in Europe and America, 1600-1775: A Handbook*, London, 1978: 97.

varied according to the count. For cotton, it was reported that in 1743 that each increase of one count in fineness raised the piece rate by 1d, although some years previously it had been by 0.75d.<sup>17</sup> Paupers spinning cotton at a workhouse at Marlborough in Wiltshire in the south of England in 1769 (included in the Humphries-Schneider dataset) were paid 6d. per lb. for their work.<sup>18</sup> If the 1740s report was correct, then they were spinning 6 count yarn, a very coarse yarn used mainly for candlewick. Two hundred miles to the north, in Lancashire, at the same date the rate being paid for spinning an average 15.5 count cotton weft yarn to be woven into printing fabrics was more like 19d. per lb. That is a huge difference, even when the slower speed of spinning required for finer counts is taken into account. Moreover in Lancashire the average count of yarns appears to have been rising as fabrics became finer and lighter. The average yarn count of the cotton weft held in stock by Joseph Hampson, a manufacturer of jeans, stripes and pillow fustians at Leigh between Bolton and Wigan in 1727, was 9.6. The average yarn count of cotton weft held by the Blackburn firm of Cardwell, Birley and Thornton's in 1769 for their checks and Blackburn greys was 15.5. Cardwell, Birley and Thornton's spinners must have earned considerably more than Hampson's, despite the speed penalty for finer yarn, especially as in 1769 they were being paid 1.25d. per hank.<sup>19</sup>

Humphrey and Schneider demonstrate that the wages actually earned by spinners were significantly lower than those estimated by élite observers, who tended to ignore the intermittent nature and low productivity of much spinning work. Consequently they exaggerated the earnings of women spinners. That is important if (like Humphries and Schneider) we are concerned with working women's welfare. But if our concern is induced technical innovation, then the question of whether spinners worked intermittently or full-time is not so important, unless work patterns changed significantly. What matters is the level of piece rates and their variation by time and place and fibre. Elite observers tended to offer estimates of what they understood a diligent, skilled, healthy young woman could spin per day, or per six-day week. In other words, they over-estimated the average spinner's physical capacity, and the regularity and intensity of their work. Nevertheless, as long as their exaggeration was fairly consistent, the evidence they provide can be useful, especially if we know it was collected systematically.

---

<sup>17</sup> E. Baines, *History of the Cotton Manufacture in Great Britain*, London 1835: 130-2.

<sup>18</sup> Wiltshire and Swindon History Centre, PR/Marlborough St. Peter and St. Paul/871/190: Parish of St. Peter and St. Paul, Marlborough, Account notebook giving details of the employment of the Marlborough poor in Cotton Spinning, 1751-1773.

<sup>19</sup> John Rylands Library, University of Manchester, Eng. Ms. 1199/1: Messrs. Cardwell, Birley and Hornby, of Blackburn: Stock book, 1768-1792, ff. 20-2; Lancashire Archives, WCW 1727: Chester wills, Joseph Hampson of West Leigh, chapman. It is hazardous to draw conclusions about long-term trends in piece rates from scattered observations like these, because we know that spinning piece rates were subject to frequent short-term fluctuations.

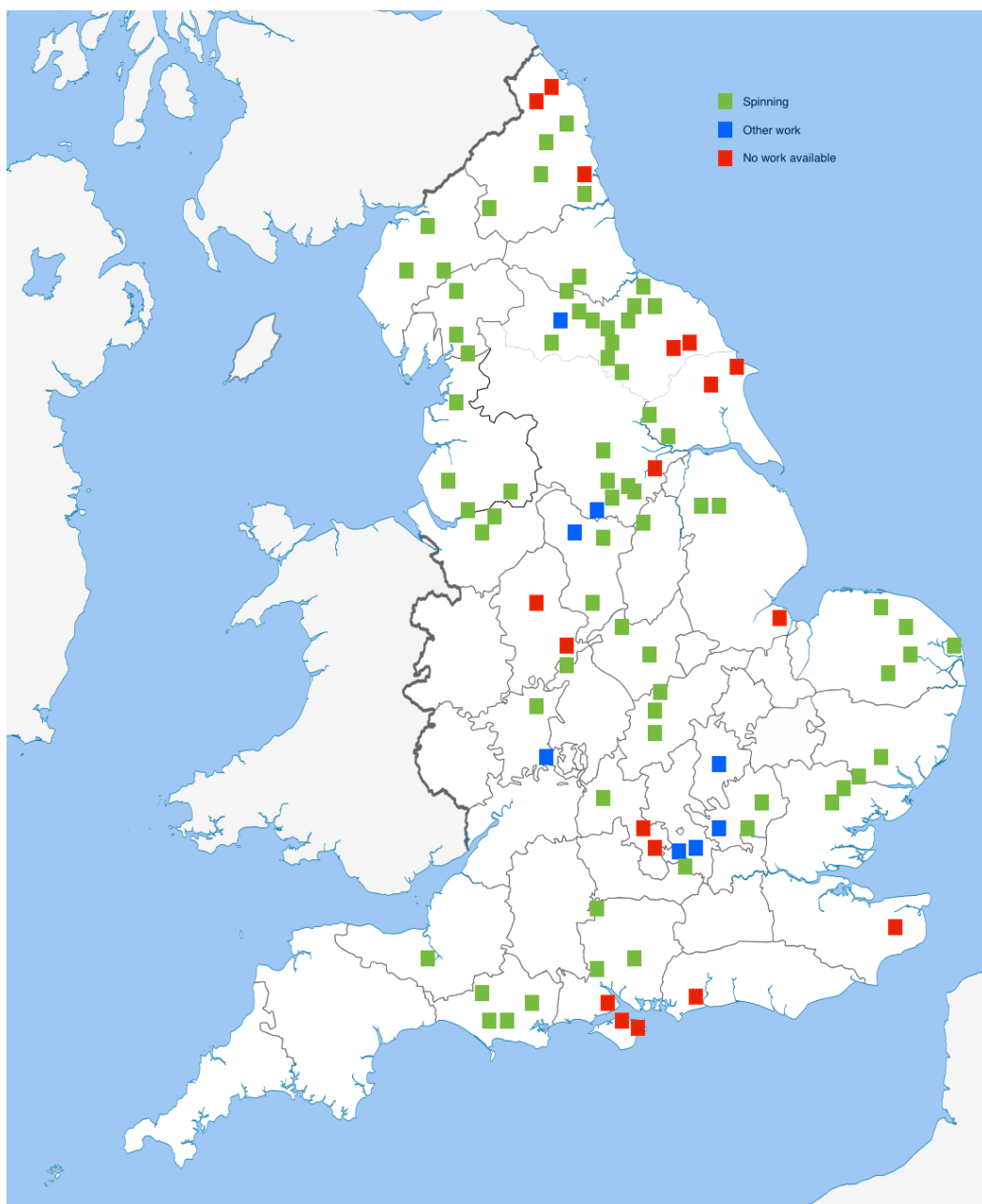
The first large-scale, systematic survey of English spinners' wages was undertaken by the agricultural writer Arthur Young between 1767 and 1771. During those years Young undertook a series of tours across the south, east and north of England, precursors of his French tours during the 1780s. On these journeys he observed agricultural practice and collected the opinions of improving landlords and farmers about farming techniques. The results were published in three books: *A Six Weeks Tour through the Southern Counties of England and Wales* (London, 1768), *A Six Months Tour through the North of England* (London, 1770), and *The Farmer's Tour through the East of England* (London, 1771). Young was interested not only in agricultural techniques, but more broadly in the rural economy and rural living conditions. According to the title page of his *Tour through the Southern Counties*, it is a book 'describing particularly the present state of agriculture and manufactures', but also 'the prices of labour and provisions in different counties' and 'the state of the working poor in those counties'. As a consequence, Young consistently recorded information about 'the employment of the poor women and children' in many of the places where he stopped to collect data from his local contacts. In the vast majority of cases that employment was spinning, and often Young tells us which fibres the spinners processed and the wages they were paid, whether adults or children.

Young's tours do not furnish a balanced sample of spinning across rural England at the end of the 1760s. His tours bypassed much of the West Country and the places for which he provides detailed information are those where he already had connections, or was able to establish them. Yet Young was admirably systematic in the way he approached his task, asking the same questions in each locality he visited. Indeed, in the history of social science statistics, Young has been identified as the initiator of the sample survey.<sup>20</sup> Usefully he often includes negative findings, although the answers he recorded are not always consistent. Together, Young's three English tours include observations on the availability of women's and children's manufacturing work for almost a hundred places scattered across broad swathes of rural England during a period of less than four years immediately after the invention of the spinning jenny and before its wide diffusion (Figs 1, 2 and 3).

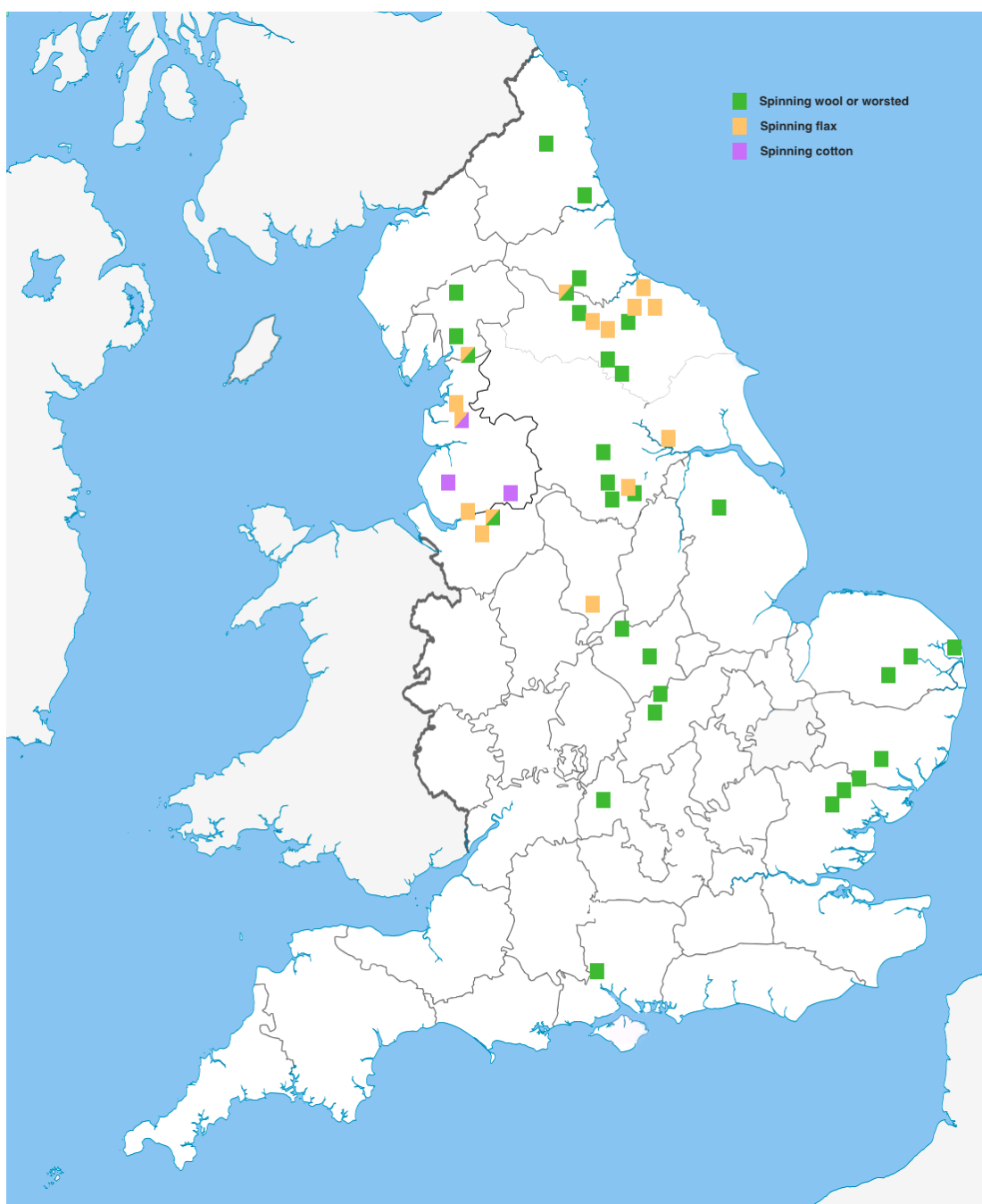
---

<sup>20</sup> See Liam Brunt, 'The advent of the sample survey in the social sciences,' *Journal of the Royal Statistical Society: Series D (The Statistician)*, Vol. 50, 2001: 179-89.

**Fig. 1. Availability of waged manufacturing work for women and children, England, late 1760s. Source: Arthur Young's tours of the North, South and East of England, published 1768-71.**



**Fig. 2. Availability of waged spinning work for women and children, by textile fibre, England, late 1760s. Source: Arthur Young's tours of the North, South and East of England, published 1768-71.**



**Fig. 3. Adult women's daily spinning wages, England, late 1760s. Source: Arthur Young's tours of the North, South and East of England, published 1768-71.**

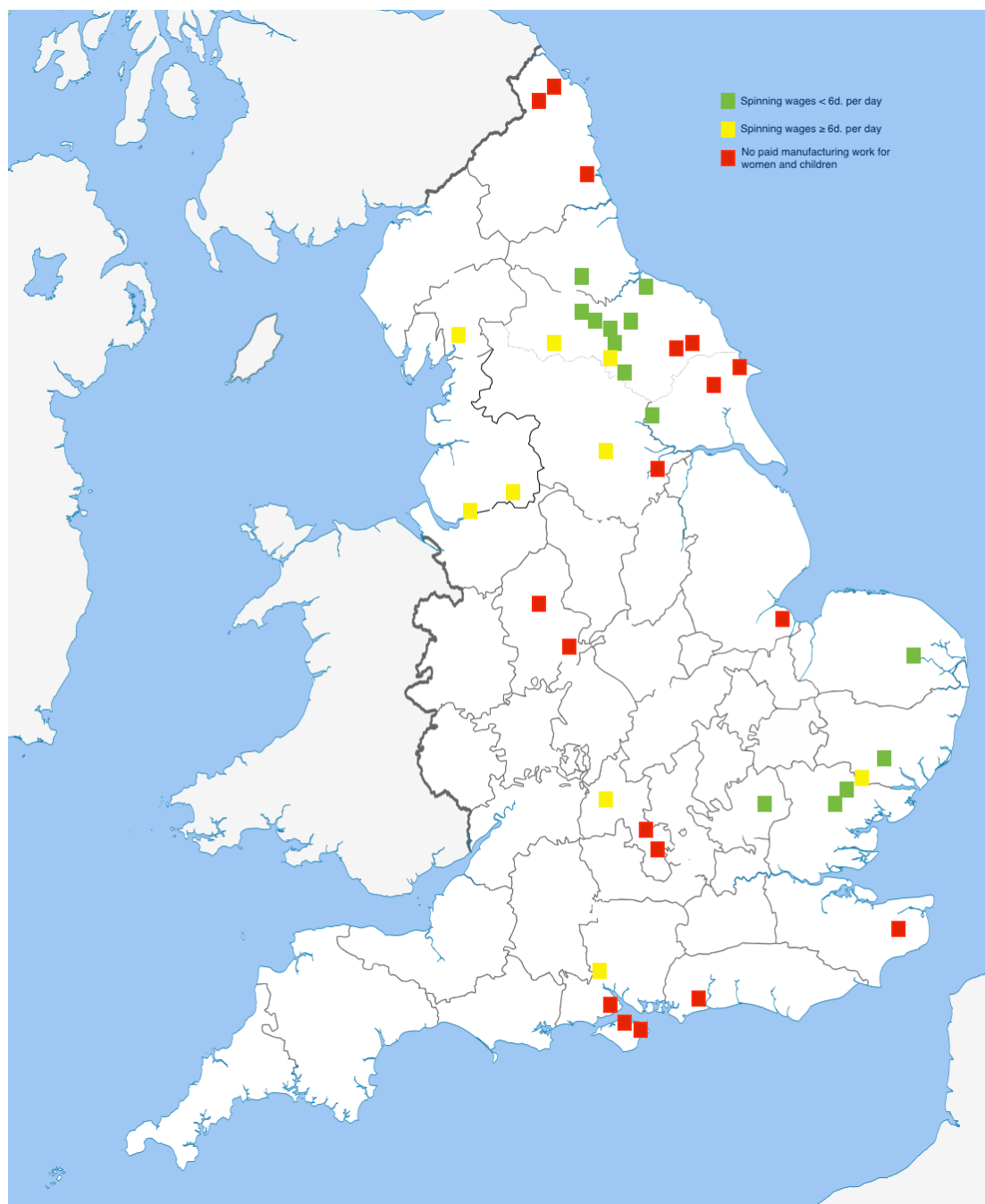


Fig. 1 maps Young's findings for the different kinds of paid manufacturing work available to women and children. Spinning predominated. Fig. 2 shows the different types of textile fibre spun in different localities. Short-staple sheep's wool (for woollens) and long-staple sheep's wool (for worsteds) were the most commonly spun fibres, although Young does not always distinguish between them. Cotton appears in only three places. Not unexpectedly, all three are in Lancashire. Fig. 3 maps those places where Young recorded the wages available to women who



spun, as well as showing places where there was no such paid work. Young's observations were, of course, based on estimates by his local patrician and farming contacts, not on actual earnings. Nevertheless, they serve to demonstrate that at a technologically critical period in the later 1760s there were major geographical variations not only in the availability of spinning work, but in the wages it could command. Higher wages for spinning characterised a zone in the north of England, extending across Lancashire, the western half of Yorkshire, and south Westmorland.

More surprisingly, if we compare Figs 2 and 3, we discover that the north of England high-wage zone was not restricted to spinning cotton, but included spinning flax and, especially, long-staple sheep's wool for worsteds. In other words, in this region in the 1760s the high wages for hand spinning that Robert Allen regards as the key incentive to technical innovation were not confined to cotton. So why was innovation in spinning initially focused so narrowly on cotton?

The traditional explanation, dating from the mid-nineteenth century and still often repeated today, is that John Kay's flying shuttle, patented in 1733, distorted the relationship between the spinning and weaving processes in cotton manufacture. The flying shuttle, it is argued, increased output per weaver, encouraging the growth of the Lancashire industry. The consequence was unprecedented pressure on the supply of yarn, which still relied on women working at the hand spinning wheel, resulting in rising wages.<sup>21</sup> Humphries and Schneider appear to concur, arguing it was bottlenecks in the supply of yarn that drove technological innovation. They do not name the flying shuttle as the source of these bottlenecks, but they offer no alternative.

Yet as early as 1835, Edward Baines, like other early historians of the Lancashire cotton industry, acknowledged that the flying shuttle 'was not much used among the cotton weavers until 1760'. Its affects are therefore unlikely to have been rapid enough to provide much stimulus to James Hargreaves' experiments with his spinning jenny, usually dated between 1764 and 1766.<sup>22</sup> Moreover, as Akos Paulinyi has calculated, the flying shuttle can have increased weaving output for most Lancashire cottons by no more than 30%, and generally much less, because the vast majority of Lancashire cotton fabrics were narrow and could be woven by a single weaver working the loom without the help of a flying shuttle.<sup>23</sup> The biggest potential savings from the flying shuttle lay in the weaving of broad fabrics, which previously required the work of two weavers. It is no co-incidence that John Kay was brought up in the Rossendale uplands above Bury in Lancashire, where the predominant form of textile production was broad bays – mixed woolen / worsted

---

<sup>21</sup> For a recent deployment of this argument, see Sven Beckert, *Empire of Cotton: A Global History*, New York, 2014: 65.

<sup>22</sup> Baines, *Cotton Manufacture*, 117.

<sup>23</sup> Akos Paulinyi, 'John Kay's Flying Shuttle: Some Considerations on his Technical Capacity and Economic Impact', *Textile History*, 17, 1986: 154.

fabrics – not narrow cottons. It was to the Rossendale baymakers, as well as their equivalents at Colchester in Essex, that he first supplied his new shuttles, not to Lancashire cotton weavers.

A more fruitful approach to understanding the invention of the spinning jenny is to place it in the context of the high spinning wages paid in the 1760s for hand spinning textile fibres of various kinds – not just cotton – in the zone across the north of England identified by Arthur Young. Hand spinning was undertaken predominantly by women. Systematic evidence about women's employment in the eighteenth century is notoriously poor, so establishing the geographical incidence of any one type of spinning can often only be done indirectly.

**Fig. 4. Lancashire and Cheshire: townships with woollen or worsted spinning, 1765-1789. Sources: Lancashire Record Office, Lancashire Quarter Sessions Files, QSB/1 and QSP; Greater Manchester Record Office, MS f338.4 W1, Worsted inspector's conviction book.**

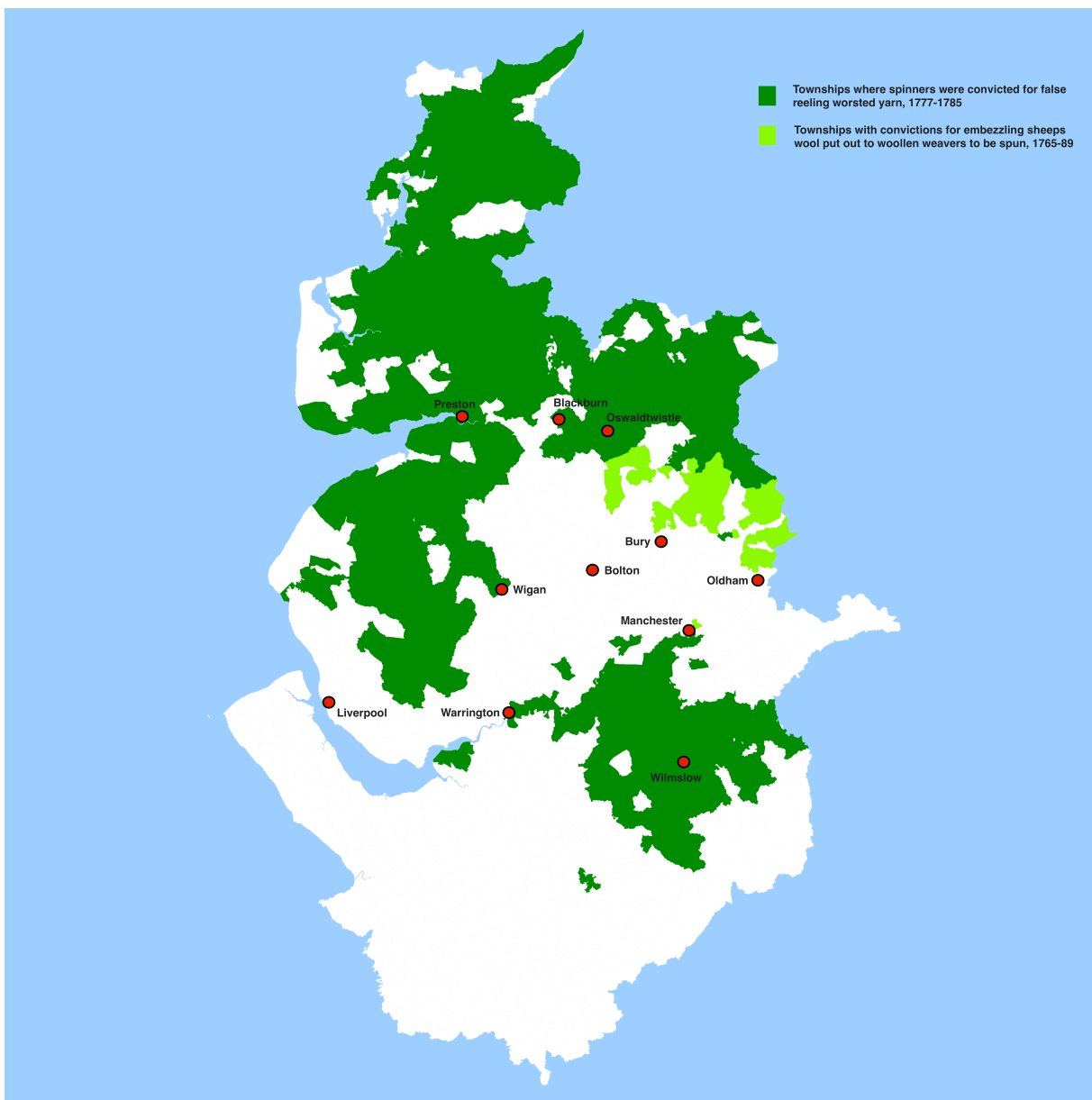


Fig. 4 maps the two available systematic sources for the geographical distribution of spinning in Lancashire and Cheshire from 1765 to 1789. The first source, and the most comprehensive, is summary convictions for frauds by spinners of worsted yarn (spun from long-staple sheep's wool). These convictions were undertaken under the first five years of the Worsted Act of 1777, which established a system of paid inspectors, modeled on the excise service, who were allocated

territories across the spinning townships.<sup>24</sup> The inspectors travelled these territories, measuring yarn and prosecuting offenders. The map records all the townships where at least one prosecution is recorded, indicating the extent of the worsted spinning zone. The second source, which is less comprehensive, is summary convictions for embezzlement of the short-staple sheep's wool put out to be spun by the woollen clothiers and baymakers of the Rossendale area of Lancashire, between 1765 and 1789. There were fewer of these convictions than those involving worsted spinning. Nevertheless, they serve to sketch the extent of the woollen spinning zone.

There are no equivalent sources for cotton or flax spinning, but the map makes it clear that the core area of Lancashire's cotton industry, between Blackburn, Bolton, Manchester and Oldham, was hemmed in to the north, the west and the south (as well as over the Yorkshire border to the east) by areas where worsted and woollen spinning offered an alternative employment for women at equivalent wages. To the south-west there was also flax and hemp spinning, especially around Warrington with its sail-making manufactory, which burgeoned during the 1740s and 1750s.<sup>25</sup> Like cotton, these were buoyant, rapidly expanding industries. Indeed, worsted manufacturing, with its core weaving area over the Yorkshire border around Halifax, was a more recent arrival in the north of England than cotton. Whereas Lancashire started making cotton fustians towards the end of the sixteenth century, worsteds emerged in Yorkshire on any scale only at the end of the seventeenth.<sup>26</sup>

Predominantly an export industry, Yorkshire worsteds grew very rapidly during the first half of the eighteenth century, probably faster than Lancashire cottons. In worsteds the ratio of spinners to weavers was especially high, so to secure a supply of yarn the Yorkshire manufacturers were obliged to source yarn from an enormous area up to 50 miles away across the West and North Ridings of Yorkshire, as well as adjacent parts of Lancashire and Cheshire.<sup>27</sup> This was a dynamic process. In the course of the eighteenth century, the worsted spinning

---

<sup>24</sup> John Styles, 'Spinners and the Law: Regulating Yarn Standards in the English Worsted Industries, 1550-1800', *Textile History*, 44, 2013: 145-170.

<sup>25</sup> See Jon Stobart, *The First Industrial Region: North West England, c. 1700-60*, Manchester 2004: 68-9, and Charles F. Foster, *Capital and Innovation* (Northwich, 2004): chapter 9, esp. 275-6 and 280.

<sup>26</sup> Herbert Heaton, *The Yorkshire Woollen and Worsted Industries from the Earliest Times up to the Industrial Revolution*, Oxford 1965: 258-276.

<sup>27</sup> John Sutcliffe, a Holdsworth, Halifax stuff maker, estimated in 1774 that in the Yorkshire worsted industry, there were 4 spinners to every weaver; John James, *The History of the Worsted Manufacture in England*, London 1857: 281. For Lancashire cottons, it was estimated that in 1760 'a weaver required three grown persons to supply him with weft'; Richard Guest, *A Compendious History of the Cotton-Manufacture*, Manchester 1823: 10. However, the 'three grown persons' included those preparing the cotton wool for the spinner, by picking, carding and roving, so Guest indicates the number of those actually spinning was roughly half this number. Sheep's wool for worsted spinning, by contrast, was supplied to the spinners ready-combed, so little or no further preparation was needed.

frontier expanded further and further away from the core weaving area in Yorkshire. The landowner and miniature painter Samuel Finney, looking back in 1785 at the history of his native township of Wilmslow in Cheshire, recalled that earlier in the eighteenth century the women and children were employed in making silk- and mohair-covered buttons. As fabric-covered buttons became less fashionable around mid-century, the work was replaced by worsted spinning introduced by manufacturers from Yorkshire.<sup>28</sup> Yet Wilmslow was only ten miles south of Manchester, the capital of the Lancashire cotton trade.

We may lack direct evidence about the precise extent of cotton spinning in Lancashire in the 1760s and 1770s. Nevertheless the distribution of woollen and worsted spinning, combined with what we know about flax spinning around Wigan and Warrington, indicates that the area devoted exclusively to cotton spinning was hemmed in and surprisingly small. There is a simple reason for this. The vast majority of the textiles that comprised the Lancashire 'cotton' industry before 1780 consisted mainly (checks and stripes), or at least half (fustians and cotton prints) of linen.

In the seventeenth century, Lancashire textiles incorporating cotton were usually described as fustians. In the eighteenth century, use of the term fustian came increasingly to be reserved for the traditional, heavy, often napped and ribbed fabrics that had predominated in the previous century, such as thickset, pillow fustian and jeans. The new, lighter products that emerged in the late seventeenth and early eighteenth centuries were rarely termed fustians, but were known by other names, such as dimities, checks, stripes and the 'Blackburn greys' used for printing. Yet these new Lancashire products remained, like the traditional fustians, mixtures of cotton with linen. Indeed, many of the checks and stripes contained a good deal more linen than cotton. In other words, the extension of the product range involved less cotton per yard of cloth on average than the old-style fustians, so the pressure to extend the cotton spinning zone was not as great as would otherwise have been the case. Some new, all-cotton fabrics were also developed at this time, most notably the famous cotton velvets, but they represented only a small proportion of the Lancashire industry's output.

The survival of five thousand fabric swatches left with babies at the London Foundling Hospital between 1742 and 1760, consisting largely of the newer, lighter part-cotton fabrics of the types manufactured in Lancashire, enables us to employ microscopic analysis to assess the fibre content of a significant proportion of the Lancashire industry's output on the eve of the Industrial Revolution (Figs 5, 6 and 7).<sup>29</sup>

---

<sup>28</sup> 'Survey of the Parish of Wilmslow' by Samuel Finney of Fulshaw, Esq., in T. Worthington Barlow, ed., *The Cheshire and Lancashire Historical Collector*, Vol. 2, May 1853: 6-7.

<sup>29</sup> For the background to the Foundling Hospital textiles, see John Styles, *Threads of Feeling: The London Foundling Hospital's Textile Tokens, 1740-1770*, London, 2010. The fibre analysis was undertaken with a Dino-Lite AM7013MZT USB microscope at x60 magnification.

**Fig. 5. A printed cotton from the Foundling Hospital textiles, 1759. Only the fluffy, horizontal loosely-spun weft threads are cotton. The smooth, shiny tightly-spun warp threads are linen. London Metropolitan Archives, A/FH/A/9/1/162: Foundling Hospital Billet Books, Foundling number 14713. © Coram.**



**'Purpill flowerd cotting ... cuft with worckt callico', 1759. Foundling 14713.**

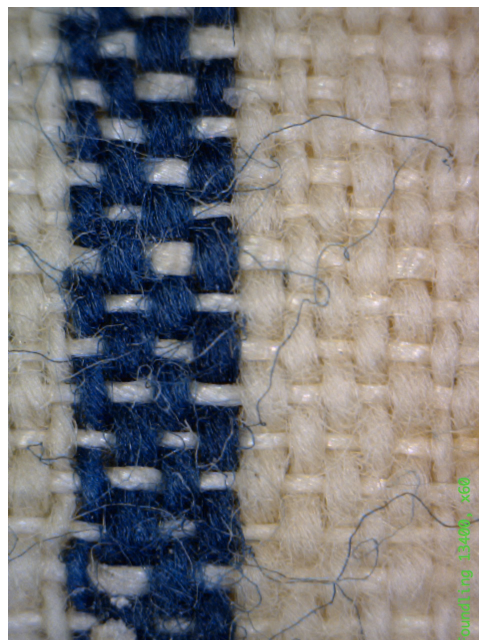


**'Purpill flowerd cotting', 1759, at x60 magnification. Foundling 14713**

**Fig. 6. A striped cotton from the Foundling Hospital textiles, 1759. The fluffy blue threads and white threads in the stripe are cotton. The smooth, shiny threads are linen. London Metropolitan Archives, A/FH/A/9/1/149: Foundling Hospital Billet Books, Foundling number 13400. © Coram.**



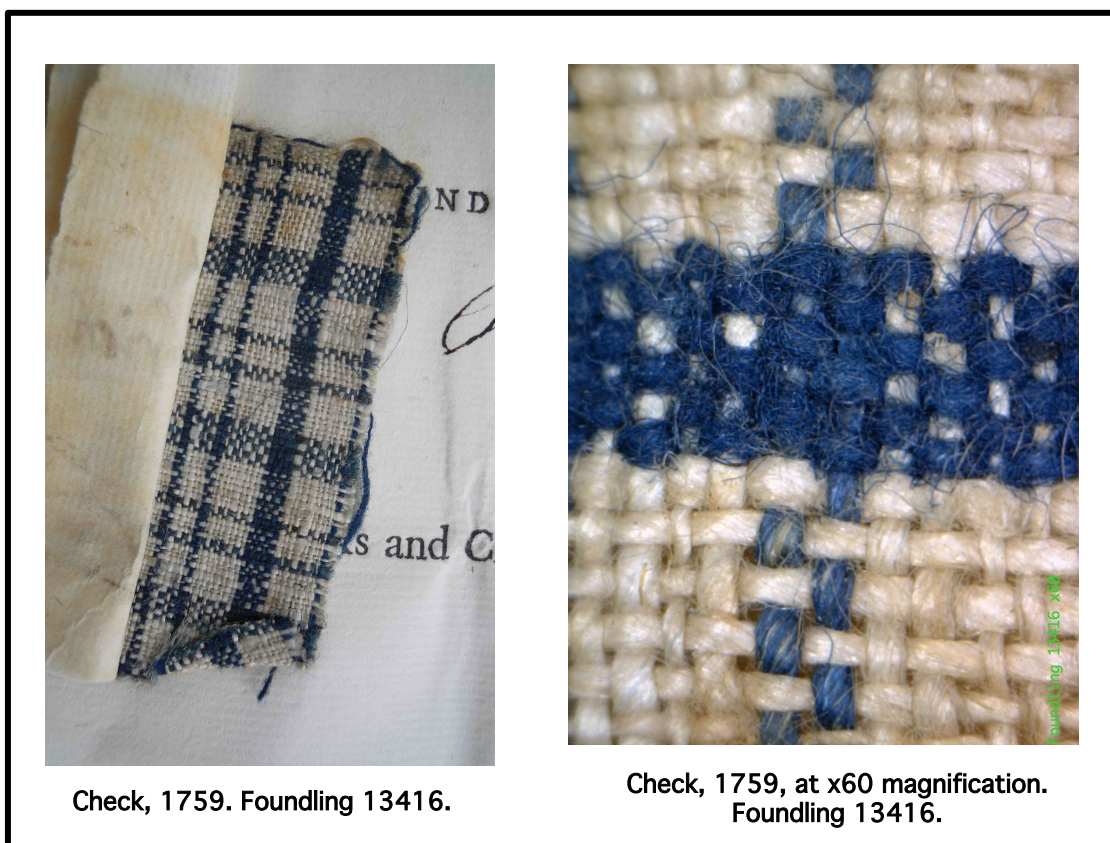
**'Striped cotten', 1759. Foundling 13400.**



**'Striped cotten', 1759, at x60 magnification. Foundling 13400.**



**Fig. 7. A check from the Foundling Hospital textiles, 1759. Only the fluffy, darker blue threads are cotton. The smooth, shiny white threads and light blue threads are linen. London Metropolitan Archives, A/FH/A/9/1/149: Foundling Hospital Billet Books, Foundling number 13416. © Coram.**



The analysis in Table 1 of a large sample of the kind of fabrics produced by the Lancashire ‘cotton’ industry in the London Foundling Hospital collection shows that less than half the yarn employed was cotton. Most of the printed fabrics were the half-cotton, half-linen cloth known as ‘Blackburn greys’, but the mixed-fibre checks and stripes tended to contain more linen yarn than cotton yarn, and many of the checks were all-linen. This pattern of fibre composition was typical; it recurs in surviving sample books for Lancashire checks, stripes and prints circulated by Manchester merchants in the 1760s, the 1770s and even the early 1780s.<sup>30</sup>

<sup>30</sup> Winterthur Museum, Delaware, USA, ref. 07 x 5: Henry Remsen, Jr. and Company, Pattern book of textiles, 1767; Metropolitan Museum of Art, New York, 156.4 T 31: The Benjamin and John Bower sample book, 1771; National Trust, Quarry Bank Mill, Styal: Pattern book of the firm of Robert and Nathan Hyde, of Manchester, 1771; Colonial Williamsburg Foundation Collection, Virginia, 1974-569: fold-out pattern card inscribed ‘Thomas Smith, Manchester, 23 August 1783’.



**Table 1. Fibre content of yarns in prints, checks and stripes made of cotton and/or linen in the London Foundling Hospital Billet Books, July 1759 and January 1760.**

<b>Fibre</b>	<b>Prints</b>	<b>Checks</b>	<b>Stripes</b>	<b>All</b>	
Warp cotton, weft cotton	7	-	-	7	(6%)
Warp silk, weft cotton	1	-	3	4	(4%)
Warp linen, weft cotton	42	1	5	48	(46%)
Warp linen, weft linen & cotton	-	12	8	20	(19%)
Warp linen, weft linen	*n/a	17	5	22	(21%)
Unclear	2	1	1	4	(4%)
<b>TOTAL</b>	<b>52</b>	<b>31</b>	<b>22</b>	<b>105</b>	<b>(100%)</b>

\* Prints on all-linen fabric are excluded, because the cloth was probably woven not in Lancashire, but in Ireland, Scotland, or Germany.

Source: London Metropolitan Archives, Foundling Hospital Billet Books, AF/149 (July 1759) and /166 (January 1760).

By the 1750s, the linen yarn used in these Lancashire-woven fabrics was spun, not by Lancashire women, but mainly in Ireland, Scotland and on the shores of the eastern Baltic. A much larger proportion of locally-spun linen yarn may have been used in seventeenth-century Lancashire fustians, but by 1782 the Manchester merchant Titus Hibbert insisted that English yarn was very little used.<sup>31</sup> As a consequence, the geography of spinning for the Lancashire industry was very different from the Yorkshire worsted industry. In Lancashire, less than half the yarn woven (the cotton) was spun within the region, so the spinning field was geographically far less extensive at any level of output than that of the Yorkshire worsted industry, which sourced almost all its yarn, both warp and weft, locally. At the same time, this pattern of yarn supply sustained the practice of devolving responsibility for spinning the cotton yarn to the weaver, which appears to have become widespread during the middle decades of the eighteenth century in the manufacture of the Lancashire 'cottons' with the highest proportion of cotton yarn – the traditional fustians and the Blackburn greys sent to London for printing.<sup>32</sup> The weaver was provided by the putting-out master with a ready-spun linen warp and unspun cotton wool for the weft. He was expected not only to weave the cloth, but also to arrange the spinning of the cotton weft yarn.<sup>33</sup> Spinning weft required less

<sup>31</sup> Mrs Hibbert Ware, *The Life and Correspondence of the late Samuel Hibbert Ware*, Manchester 1882: 98.

<sup>32</sup> This way of organizing spinning was not feasible for checks and stripes, even when they contained a large proportion of cotton, because at least part of their cotton yarn had to be dyed before it was woven. Dyeing tended to be concentrated in specialist plants, especially around Manchester; see J. Stobart, 'Textile Industries in North-West England in the early Eighteenth Century: A Geographical Approach', *Textile History*, 29, 1998: 8-9.

<sup>33</sup> This practice was probably borrowed from the baymaking industry of Rossendale, where it was widespread.

labour than spinning warp, especially the loosely spun, coarse weft characteristic of many Lancashire cotton-linen fabrics. Consequently, it was feasible for a weaver to have the cotton weft spinning undertaken locally, often mainly by his own family.

Blackburn greys were the principal fabric produced in the Oswaldtwistle area where James Hargreaves, the inventor of the spinning jenny, worked as a weaver. Between the 1730s and the 1760s, the domestic market for these printed half-cotton, half-linen fabrics expanded, while the supply of both linen yarn and cotton wool was becoming more erratic and more expensive.<sup>34</sup> Crucially for Hargreaves' invention of the spinning jenny, the Yorkshire worsted industry also boomed during the 1750s and early 1760s.<sup>35</sup> Oswaldtwistle was within the worsted spinning zone (Fig. 4) and good wages for worsted spinners are likely to have attracted women away from spinning cotton, just as they drew them away from button making at roughly the same period at Wilmslow, 30 miles to the south. In Oswaldtwistle that was a challenge faced directly by weavers like Hargreaves, because it was they who often bore the responsibility for having their employer's raw cotton spun into weft. As initially conceived, Hargreaves' spinning jenny spun only weft, it was domestic in scale, and it was optimised for use by children (Fig. 8). In other words, it was perfectly contrived to sustain the weaver-based model for processing weft in the face of competition for spinning labour in the locality, because it enabled weavers to rely more exclusively on family labour to convert the cotton wool their employers supplied into yarn.<sup>36</sup> Ironically, in view of Robert Allen's focus on factors of production, under this arrangement spinning labour was not directly priced. A notional payment for the spinning undertaken by a family's women and children was simply bundled into the weaver's contract.

---

<sup>34</sup> See John Styles, *The Dress of the People: Everyday Fashion in Eighteenth-Century England*, London and New Haven 2007: 111-27; Trevor Griffiths, Philip Hunt, and Patrick O'Brien, 'Scottish, Irish and Imperial Connections: Parliament, the Three Kingdoms, and the mechanisation of cotton spinning in eighteenth-century Britain,' *EcHR*, Vol. 61, 2008: 625-50.

<sup>35</sup> John Styles, "'Our Traitorous Money Makers": the Yorkshire Coiners and the Law, 1760-1783', in John Brewer and John Styles, eds, *An Ungovernable People. The English and their Law in the Seventeenth- and Eighteenth-Centuries*, London 1980: 189-90. For the especially rapid growth in Yorkshire worsteds in the decades up to the end of the 1750s, see Keith Sugden, 'An occupational analysis of the worsted industry, c. 1700-1851. A study of de-industrialization in Norfolk and the rise of the West Riding of Yorkshire', PhD thesis, University of Cambridge, 2015, chapter 6, and Elvira Willmott, 'Occupations in Eighteenth Century Bradford', *The Bradford Antiquary*, 3<sup>rd</sup> series, Vol. 4, 1989: 67-77.

<sup>36</sup> This interpretation of the impact of the spinning jenny has a long pedigree; see John Kennedy, 'Observations on the Rise and Progress of the Cotton Trade in Great Britain, Particularly in Lancashire and the Adjoining Counties (Read Before the Literary and Philosophical Society, 3<sup>rd</sup> November 1815)' in John Kennedy, *Miscellaneous Papers on Subjects Connected with the Manufactures of Lancashire*, Manchester 1849: 7, and T.S. Ashton, *The Industrial Revolution, 1760-1830*, Oxford 1997: 58, which insists the effect of small jennies 'was to strengthen, rather than weaken, the family economy.'

**Fig. 8. Reconstruction of a sixteen-spindle spinning jenny, based on the specification drawings in James Hargreaves' 1770 patent.**



An equivalent familial incentive to take up the jenny was absent in Normandy, the centre of French cotton manufacturing, where linen warp, cotton weft fabrics also predominated. Here spinning of cotton weft was not part of an integrated family textile economy, supplied with raw and semi-finished materials by a putting-out master, to whom woven cloth was returned in exchange for a single wage payment. In Normandy, cotton spinning was often a separate, small-scale commercial activity, conducted by the women who spun. Arthur Young described how they 'buy their cotton, spin it, and then sell the yarn'.<sup>37</sup> Most of the cloth (*Siamoise*) was loom-patterned, the equivalent of Lancashire checks and stripes, so yarn had to be dyed prior to weaving. In the early 1760s, Normandy was not a major

<sup>37</sup> Young, *Travels during the Years 1787, 1788, and 1789*, second edition, Vol. 1: 564. Also see André Rémond, *John Holker: Manufacturier et Grand Fonctionnaire en France au XVIII<sup>e</sup> Siècle, 1719-1786*, Paris 1946: 139-40 and William Reddy, *The Rise of Market Culture: The Textile Trade and French Society, 1750-1900*, Cambridge 1984: 131-2.

producer of heavy fustians or grey cloth for printing, while cotton spinning faced less competition for spinning labour from other fibres than in Lancashire. Indeed, in Normandy it was the spinning of non-cotton fibres, such as woollen yarn for cloth manufacturers at Darnétal and Elbeuf, that was threatened by cotton.<sup>38</sup>

Robert Allen is right, therefore, to argue that James Hargreaves' invention of the spinning jenny was an innovation associated with pressure in the market for spinning labour. Yet that pressure was not, as Allen would have us believe, an aspect of a distinctively British high wage economy which extended to women and children's earnings. It emerged in a specific locality at a specific moment. It affected spinners of a range of fibres, among whom those who spun cotton were not the most numerous. To explain Hargreaves' invention we need to focus beyond labour costs to the distinctive way spinning work was organized in Lancashire for the production of a key intermediate good – the cotton-linen Blackburn greys which supplied the London textile printing industry.

---

<sup>38</sup> Serge Chassagne, 'La diffusion rurale de l'industrie cotonnière en France (1750-1850)', *Revue du Nord*, 61, 1979: 101 and Alain Becchia, *La draperie d'Elbeuf, des origines à 1870*, Rouen 2000: 190.

### 3. British markets for cottons in the 18<sup>th</sup> century.

The origins of the spinning jenny suggest that analysis of technological innovation requires attention to products, their material composition and their markets. Yet product mix and demand find no place among Robert Allen's inducements to innovation.<sup>39</sup> This omission is especially odd, because it ignores Joseph Inikori's well-known argument that a mid-18<sup>th</sup> century rise in exports of Lancashire cottons – especially checks – to West Africa, where they were exchanged for slaves, was a crucial stimulus for the mechanization of British spinning.<sup>40</sup> Allen's approach is rooted in global comparisons, but his comparisons do not extend beyond factor prices. He is not interested in the material comparisons that were constantly being made by 18<sup>th</sup> century manufacturers, merchants and consumers in the course of global exchange.

It is, of course, notoriously difficult to establish the pattern of demand, especially domestic demand, for eighteenth-century British manufactured goods, due to a shortage of data. The new estimates for changes in demand for British (mainly Lancashire) cottons, set out in this section, divide the industry into different sub-sectors, along lines widely recognized by contemporaries. The estimates cover the four decades from the 1740s to the 1770s. These were the four decades before the mechanical inventions in spinning of the early Industrial Revolution began to have a marked effect on patterns of consumption in the 1780s. They are also the earliest four decades when the surviving digitized records of theft cases tried at the Old Bailey in London are sufficiently comprehensive to establish trends in the ownership of goods in the metropolis through time. The other principal sources employed are records of excise taxation and the 5,000 textiles surviving from 1741 to 1760 in the collection of the London Foundling Hospital.<sup>41</sup>

For most of these middle decades of the eighteenth century, all-cotton woven fabrics were either prohibited (if colour-patterned), or taxed extremely heavily (if undyed and imported). Both the Old Bailey trials and the Foundling textiles suggest that, in contrast to France where all printed textiles were banned, smuggling of printed calicoes and all-cotton stripes or checks into England was not significant. Less than 10% of printed textiles in the Foundling Hospital textiles were calicoes, and a good number of those may have leaked out of London printworks where they were processed for re-export. The British domestic market for 'cottons' in these years, whether printed or not, was largely a market for mixed fabrics consisting partly of cotton yarn and partly of linen yarn. These materials were mainly imported,

---

<sup>39</sup> This is not altogether surprising. Economic historians have been loth to accord an autonomous role to demand since Joel Mokyr's influential 'Demand vs. Supply in the Industrial Revolution', *Journal of Economic History*, 37, 1977: 981-1008. Mokyr, channelling Say, insists that aggregate economic growth can only derive from changes in supply – cost-reducing innovations – and that there is little evidence for changes in demand inducing or stimulating technological innovation.

<sup>40</sup> J. Inikori, 'Slavery and the Revolution in Cotton Textile Production in England', *Social Science History*, 13, 1989: 343-79.

<sup>41</sup> London Metropolitan Archives, A/FH/A/9/1/1-178: Foundling Hospital Billet Books, 1741-1760.

whether in the form of cotton wool from the West Indies, and to a lesser extent the Levant, to be spun in Britain, or as ready-spun linen yarn from the Baltic, Scotland, or Ireland. As with all the other mixed fabrics which proliferated in early-modern Europe, there was considerable potential here for substitution of one material for another, according to changes in prices, tastes and techniques.

**Table 2.**

**Patrick Colquhoun's breakdown of the use of raw cotton in British manufacturing, 1786-1787.**

1. Candlewick, packing, quilting, and other purposes	1,158,805
2. Hosiery branch	1,500,000
3. Silk mixtures / Linen and check mixtures	1,670,000
4. Fustians of all sorts	5,000,000
5. Calico in all its branches	7,500,000
6. Muslins of every species and quality	3,000,000

Source: Baker Library, Harvard University, Colquhoun mss. f. 11: 'The Application of the Raw Materials (as before stated) to the various Branches of the Manufacture is found to stand nearly as follows', 6 March 1788. Colquhoun calculated the quantities by averaging annual cotton imports for the two years 1786 and 1787.

In the Spring of 1788, the Scottish merchant and statistician, Patrick Colquhoun, compiled estimates of how cotton wool imported into Britain 'is supposed at present to be applied ... according to an estimate made by intelligent manufacturers' (Table 2).<sup>42</sup> Colquhoun was at the time a paid lobbyist on behalf of one interest group among those manufacturers – the calico and muslin makers – in its dispute with the East India Company and the fustian makers, so his figures have to be treated with considerable suspicion. Moreover, for many of his categories, quantities and the balance between cotton content and linen content had changed radically in the course of the 1780s. Nevertheless, if we substitute for his calico the mixed cotton-linens used previously for printing and ignore muslins, whose production emerged only in the 1780s, his headings capture the main segments of British cotton manufacturing in the middle decades of the 18<sup>th</sup> century. I shall use them (in a modified form) to structure my analysis.

<sup>42</sup> P. Colquhoun, *An Important Crisis in the Callico and Muslin Manufactory in Great Britain, explained*, ?London, 1788: 8. Colquhoun compiled four different estimates. Figure 5 is based on what appears to be the earliest, dated 6 March 1788. It provides the most detailed breakdown, which Colquhoun subsequently simplified and inflated for publication.

Table 3.

**Changes in production or ownership of the major categories of cottons, 1740-1779.**

	<b>1740s</b>	<b>1770s</b>	<b>Increase</b>
Candlewick, etc. – candles (Excise: <u>lbs</u> )	33m	45m	x 1.4
Cotton hosiery (Old Bailey trials)	21	123	x 5.9 (3.9)
Cotton mixtures – checks (Old Bailey trials)	55	166	x 3.0 (2.0)
Fustians (Old Bailey trials)	21	45	x 2.1 (1.4)
Printed fabrics (Excise: sq. <u>yds</u> )	2.1 m	6.3 m	x 3.0
Cotton wool annual imports	2.2 m	4.8 m	x 2.2
Linen yarn annual imports	3.1 m	8.3 m	x 2.7

NB. between the 1740s and the 1770s the total number of trials at the Old Bailey increased by x 1.5, from just under 4,000 to just over 6,000. The figures in brackets are deflated by a third to reflect this, although it is not clear whether there was a consistent relationship between changes in the total number of trials and the numbers of trials involving particular commodities.

Sources. Excise: CUST 145/20, Excise duties, receipts, payments and rates, 1684-1798; P. Deane and Cole, *British Economic Growth, 1688-1959* (Cambridge, 1964), 72. Old Bailey trials: Old Bailey Proceedings Online ([www.oldbaileyonline.org](http://www.oldbaileyonline.org)). Imports: TNA, CUST 3/40-79, 1740-79.

In Table 3 I have used Excise revenues and Old Bailey trial data to calculate the rate of increase between the 1740s and the 1770s in the production or ownership of types of cottons that represent earlier counterparts to each of Colquhoun's headings. Bear in mind that between the 1740s and the 1770s the total number of trials at the Old Bailey increased by 50%, so the increase in the number of trials involving cotton hosiery, checks and fustians might over-represent changes in ownership by roughly a third (the deflated figures in brackets are adjusted to take account of this possibility). Nevertheless, increases were substantial. Following Colquhoun, I have included parallel data for retained imports of cotton wool. Unlike Colquhoun, I have also provided data for linen yarn imports, because, in the period before the 1780s, cotton-linen mixes predominated. I shall consider each category in turn.

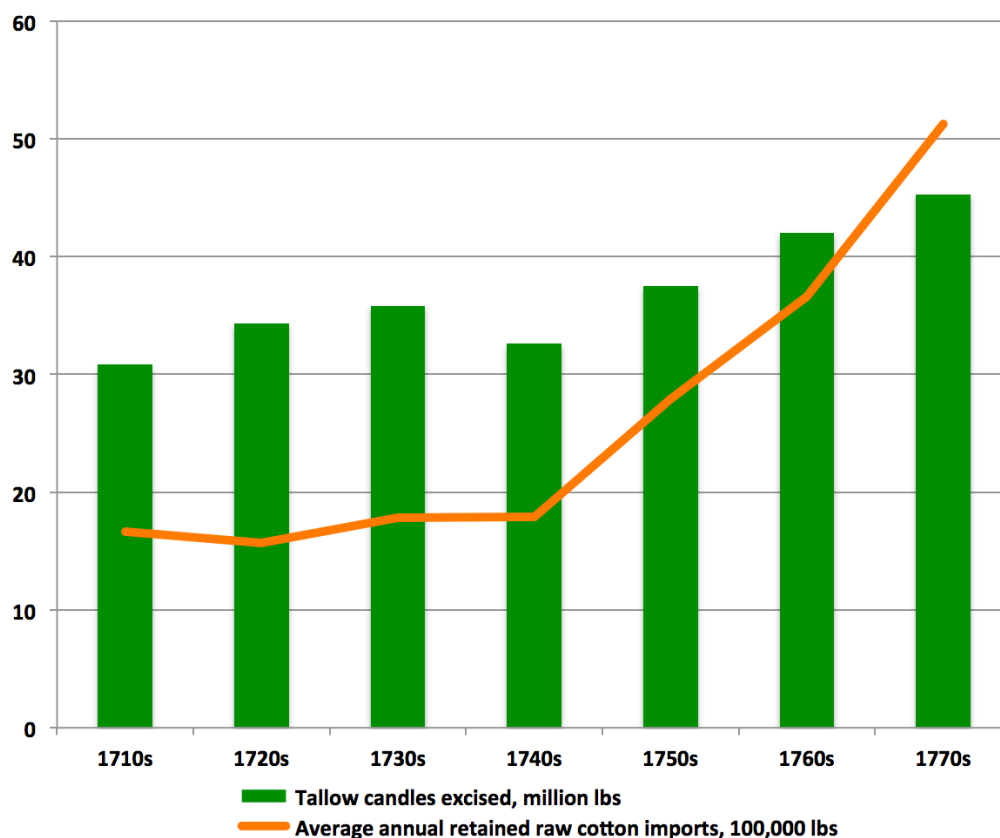
First, candles (Fig. 9). Cotton was the best (and most expensive) material for candlewicks, so the excise revenues from the duty on superior tallow candles provide a crude index of this use of cotton. As Edward Baines noted in 1835, candlewick must have accounted for a large and relatively unchanging proportion of cotton imports between the 1710s and 1740s, suggesting demand from other uses of raw cotton was limited and stagnant.<sup>43</sup> Thereafter candlewick's share declined progressively, indicating that it was only after 1740 that consumption of raw cotton for other purposes expanded rapidly.

<sup>43</sup> Baines, *Cotton Manufacture*, 216.



Fig. 9.

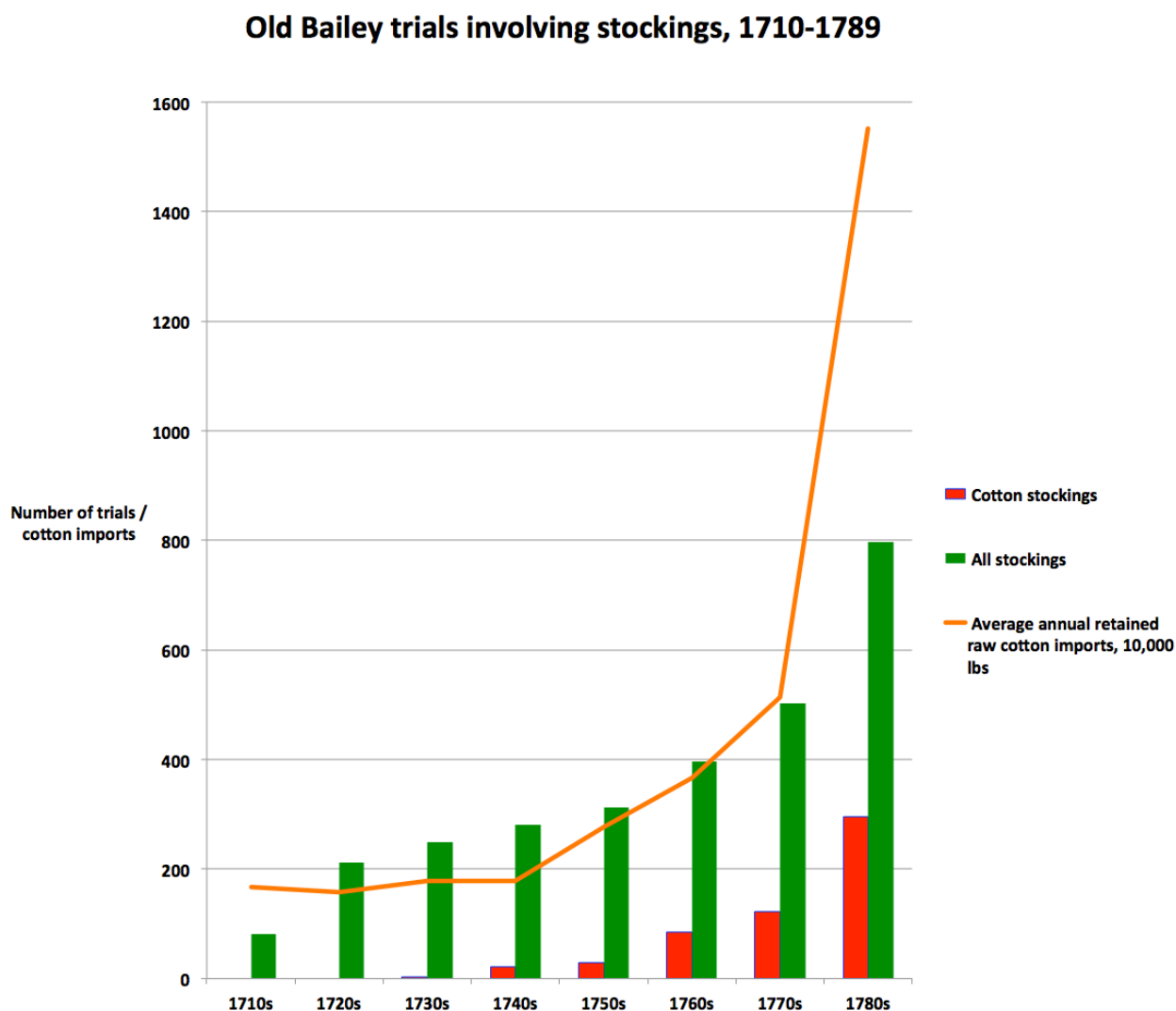
### Cotton wool imports and tallow candles excised, 1710s-1770s



Second, cotton hosiery (Fig. 10). Cotton stockings hardly figure at all at the Old Bailey before 1730. Rapid growth in their consumption had to wait for the invention of the Derby rib attachment for the stocking frame at the end of the 1750s (non-ribbed knitted stockings lacked elasticity). Thereafter consumption exploded, so that by the 1780s cotton stockings accounted for some 40% of all the stockings stolen in London, securing market share from stockings made both from worsted and from thread (linen), despite costing more. Not only was the nearly sixfold increase between the 1740s and the 1770s in Old Bailey cotton stocking cases larger than the increase in any other of our headings; it also involved a disproportionate amount of raw cotton, because the stockings were made entirely of cotton and their tightly twisted and doubled thread required relatively more cotton wool than the single yarns generally used in weaving piece goods.



Fig. 10.



Third, Colqhoun's silk mixtures and linen and check mixtures, for which checks will serve as my example (Fig. 11). There is little evidence for the use of checked fabrics made from linen and / or cotton in Britain during the 17<sup>th</sup> century. Early in the 18<sup>th</sup> century, however, checks were being woven in Lancashire and stolen in London. By the 1740s they were a well-established commodity in Britain, especially familiar as women's blue and white aprons, and their domestic market increased substantially over the next three decades. It is conventional for economic historians to categorize them as cottons, especially because they resembled an important group of Indian all-cotton fabrics that sold in vast quantities across early-modern east and south Asia, as well as in Africa. Yet among checks in the Foundling Hospital collection dating from 1759-60 (Fig. 12), the majority were made

entirely of linen, while almost all the rest were predominantly linen, with just a handful of cotton yarns to provide a stronger colour.

**Fig. 11.**

### Old Bailey Trials involving Checks, 1674-1779

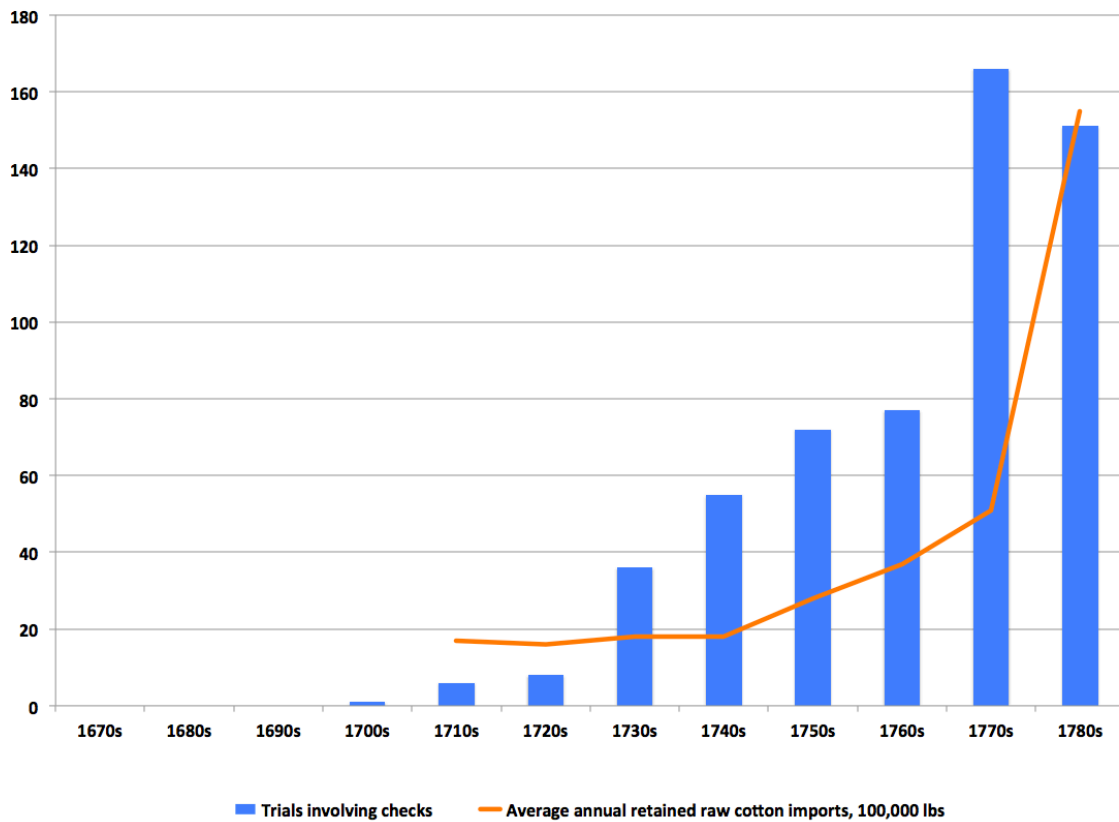
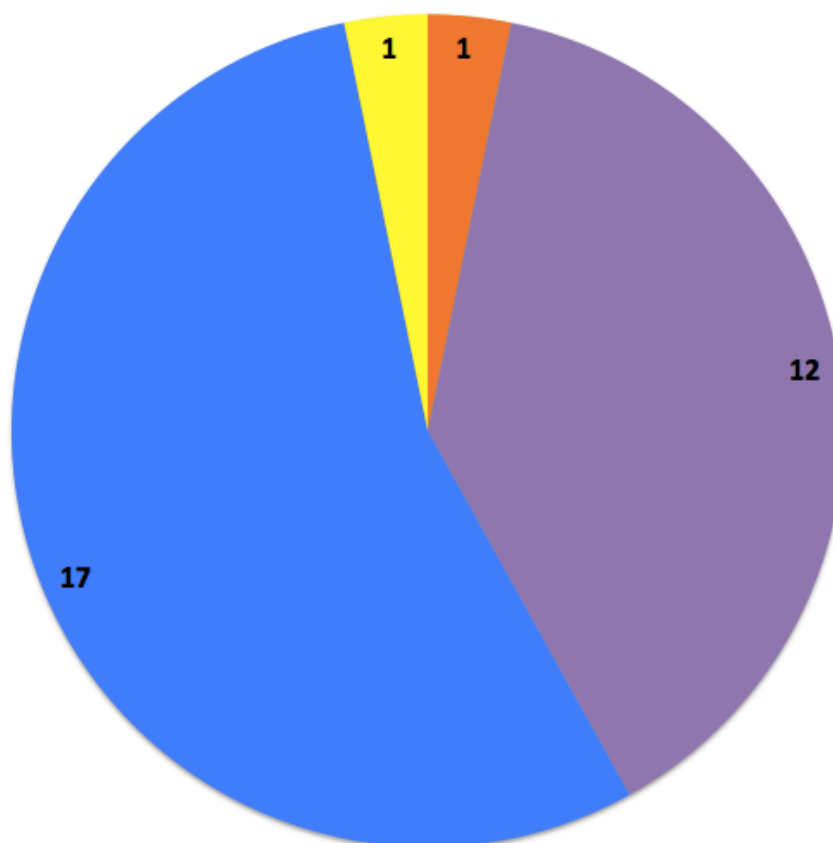


Fig. 12.

**Fibre content of yarns in checks,  
Foundling Hospital textiles, July 1759 and January 1760**



■ 50% linen / 50% cotton  
 ■ 50% to 100% linen  
 ■ 100% linen  
 ■ Unclear

Source: London Foundling Hospital Billet Books, /149 (July 1759) and /166 (January 1760)

Hardly any were 50:50 cotton:linen and none were all-cotton. The reason is simple. Improving the colour of the criss-cross pattern by including even a small proportion of cotton yarn increased the price of what were among the cheapest colour-patterned fabrics (Fig. 13). Both in England and in colonial British North America, linen checks sold for less per yard than cotton checks, and what were described as cotton checks were far from being all-cotton.

**Fig. 13. A cotton-linen check and the same check at x60 magnification.**



Cotton-linen check, probably  
Lancashire

Cotton-linen check, 1759, at x60  
magnification

Note how poorly the dye takes on the horizontal blue linen threads compared to the wide vertical blue stripe woven in cotton. The white threads are all linen.

Source: London Foundling Hospital, Billet Book A/FH/A/9/1/149, July 1759.

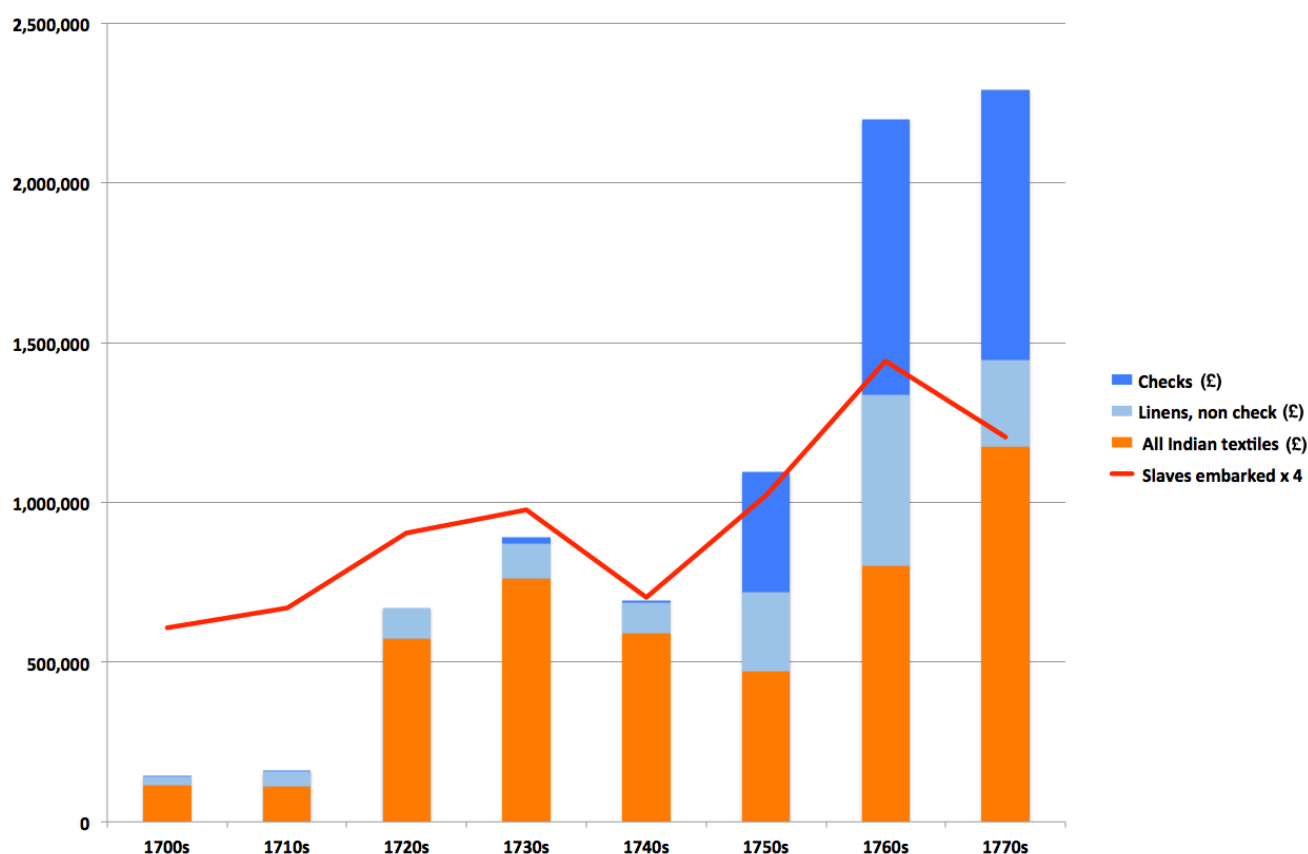
This finding casts doubt on Joseph Inikori's insistence that the huge increase from the 1750s in exports of British-made checks to West Africa to be exchanged for slaves was a crucial stimulus to the mechanization of British spinning.<sup>44</sup> The British checks exported to Africa were, like those sold in Britain, largely either all-linen or predominantly linen, so their cotton content was unlikely to have been a crucial stimulus for mechanical innovation. Inikori is correct to argue that a process of substitution was at work, but the key context was the failure in the middle decades of the 18<sup>th</sup> century of Indian supply of the loom-patterned textiles which were the principal commodity exchanged for slaves in Africa (Fig. 14). Before 1750, the British were already serving a small market for linens in West Africa. In the 1750s, as demand for slaves increased and supplies of Indian textiles declined, British (especially Liverpool) merchants provided both additional plain linens and developed a market for versions of the Lancashire linen and linen-cotton checks already selling on the domestic market. These checks were inferior adaptations of Indian designs, but lower in price by courtesy of their high linen content. Their

<sup>44</sup> Inikori, 'Slavery and the Revolution in Cotton Textile Production': 355 and 369.

cheapness was probably what sustained their market in Africa once Indian supply revived after 1760, although after 1770 their sales no longer increased.

**Fig. 14.**

**Africa: Slave embarkations and English exports of Indian textiles and linens / checks, 1700-1779.**

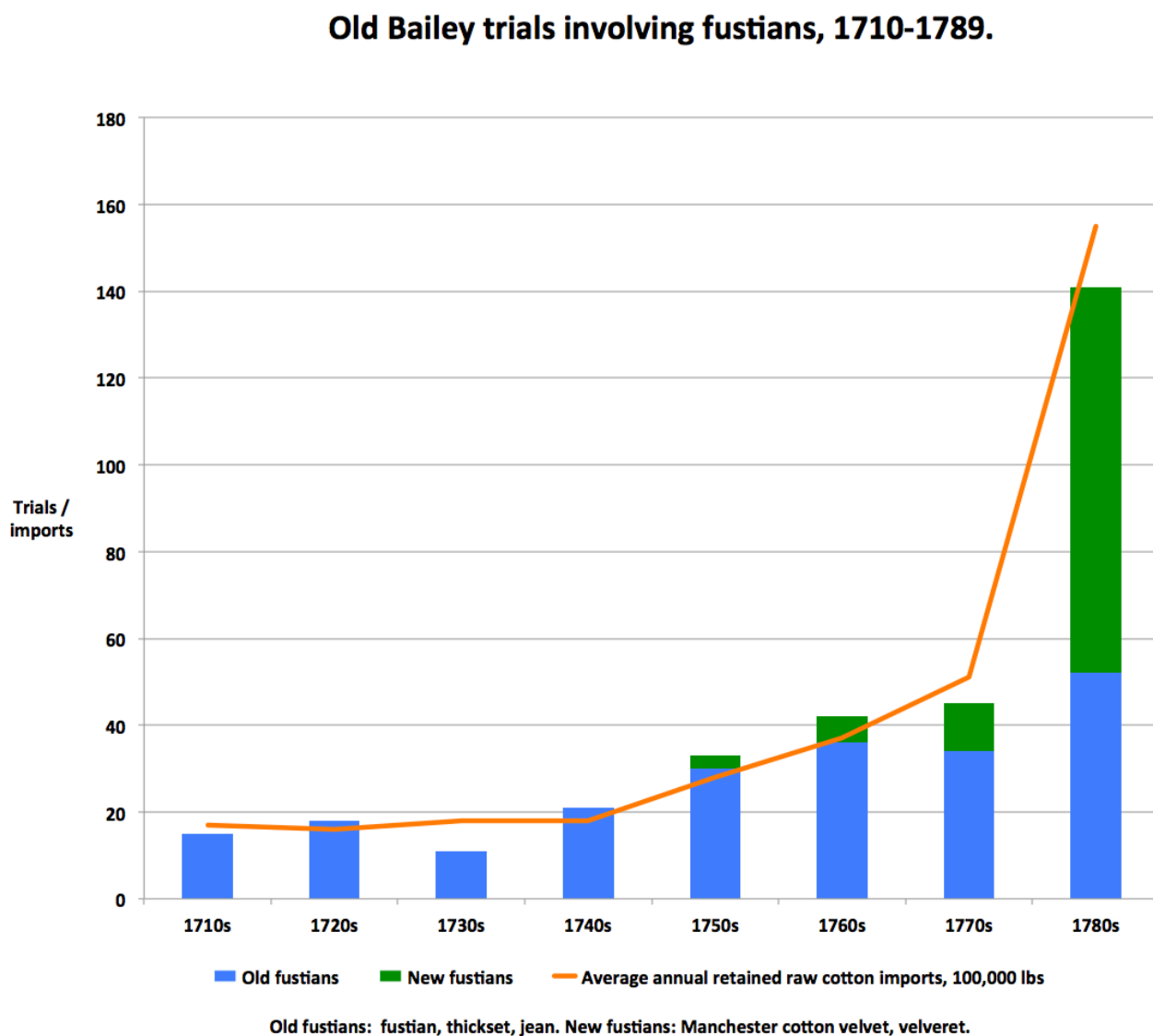


Sources: Exports: Anglo-African Trade, 1699-1808, Data Archiving and Networked Services (<https://easy.dans.knaw.nl/ui/home>). Slaves embarked on British vessels: Transatlantic Slave Trade Database (<http://slavevoyages.org/>)

Like checks, the last two categories of cotton textiles I have derived from Colquhoun – fustians and printed cotton-linens – were predominantly mixtures of cotton and linen. However, unlike checks, the two fibres were usually combined in these fabrics in a roughly 50:50 ratio, with a soft cotton weft yarn and a stronger, more twisted linen warp yarn. The Old Bailey trials suggest consumption of fustians barely doubled between the 1740s and 1770s, the slowest growth of any of Colquhoun’s textile categories. The new types of fustians introduced in the middle decades of the 18<sup>th</sup> century – cotton velvets, velverets and velveteens – did not make a strong showing before the 1780s (Fig. 15). These new fustians were to become widely used for men’s waistcoats and breeches, substituting for silk, worsted and leather, but they were relatively expensive, particularly the famous

Manchester all-cotton velvets woven with double cotton warps. In the Old Bailey trials, it is velverets that appear most frequently. They appear to have been cheaper, probably because they used a linen ground warp, but they still required a supplementary cotton warp for the pile.<sup>45</sup>

Fig. 15.

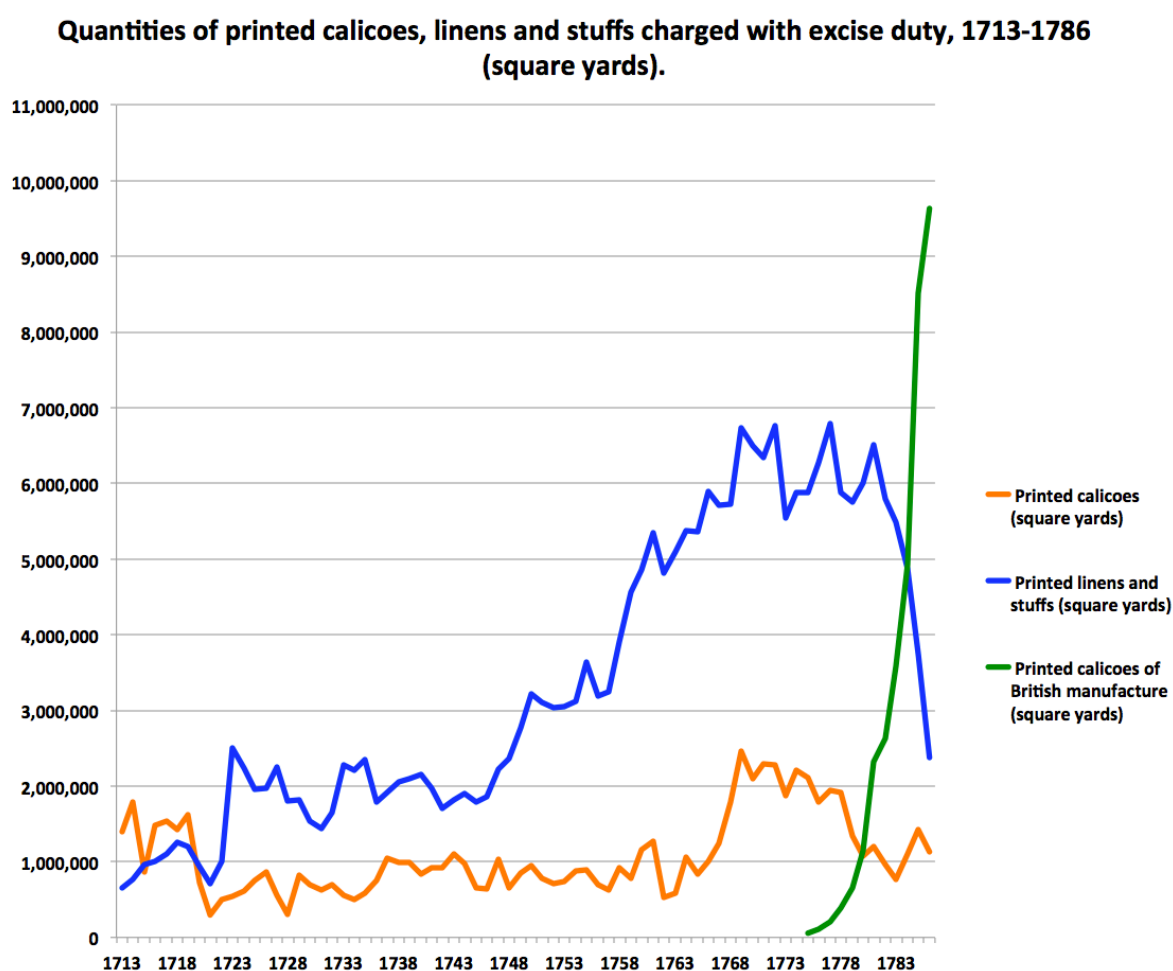


The final category of cotton textiles derived from Colquhoun's list is printed cotton-linen fabrics. There is no direct equivalent for this on Colquhoun's list,

<sup>45</sup> In the early 1750s Manchester velvets sold at 5s. 6d. to 8s. 6d. per yard, despite being little more than half a yard in width; Bibliothèque de la Union Centrale des Arts Decoratifs, Paris, G.C. 2: le Livre d'Echantillons de John Holker, c. 1750, swatch 55. For warps, see J.H.L. Bergius, *Neues policey- und cameral-magazin nach alphabetischer ordnung*, vol. 5, Leipzig, 1779: 77-9.

because by the late 1780s cotton-linens for printing had been almost entirely superseded by all-cotton, machine-spun calico, which Colquhoun put in a separate category along with muslin. Printed fabrics were subject to excise taxation, so we have reasonably comprehensive data on output (Fig. 16). Unfortunately, the excise data distinguishes only between printed calicoes, largely Indian and prohibited in the domestic market from 1722 to 1774, and printed linens and stuffs, a category which embraced both cotton-linen fabrics and all-linen fabrics. The excise data reveals a big leap in printing on these alternatives to calico in the immediate aftermath of the introduction of the prohibition legislation in 1722, followed by two decades of stagnation. Further expansion began in the 1740s, peaking at the end of the 1760s, but then collapsing in the 1780s in the face of competition from machine-spun British printed calico.

**Fig. 16.**



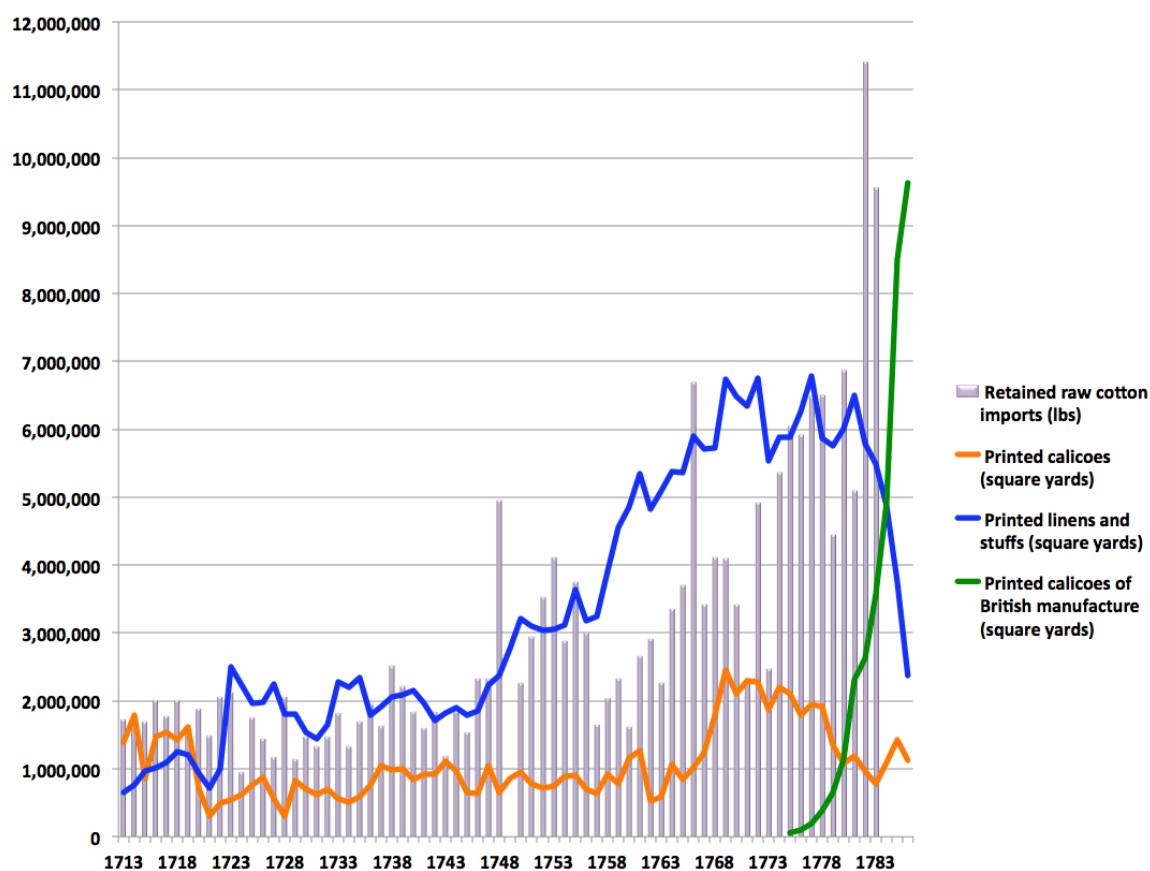
Source: TNA CUST 145/20, Excise duties, receipts, payments and rates, 1684-1798

What the excise data do not reveal is the relative shares of cotton-linen fabrics and all-linen fabrics in printing. If we add the figures for retained raw cotton imports to the chart (Fig. 17), we see that from the mid-1750s to the mid-1770s the

rise in output of printed fabrics consistently outpaced increases in the available supplies of cotton wool and, therefore, cotton yarn.

**Fig. 17.**

**Quantities of printed calicoes, linens and stuffs charged with excise duty,  
1713-1786 (square yards).**



Source: TNA CUST 145/20, Excise duties, receipts, payments and rates, 1684-1798

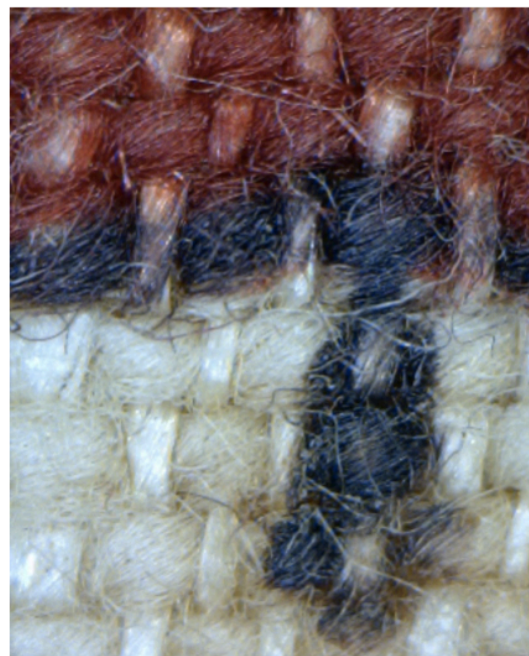
Unlike the check makers, the manufacturers of cotton-linen fabrics for printing did not have the option of reducing the proportion of cotton yarn in each piece of cloth. A 50:50 cotton to linen ratio, with a thick, fluffy, richly coloured cotton weft and a finer, smoother and less visible linen warp, was essential for producing the desired printed-cotton finish (Fig. 18).



**Fig. 18. A polychrome print on cotton-linen and the same print at x60 magnification.**



**Cotton-linen printed fabric, 1760**



**Cotton-linen printed fabric, 1760  
at x60 magnification**

Source: London Foundling Hospital, Billet Book, A/FH/A/9/1/166, Jan. 1760.

Old Bailey trials for printed cottons suggest that what happened instead was substitution of printed linens for printed cotton-linens. Women's gowns were one of the main outlets for printed fabrics.<sup>46</sup> Between the 1740s and the 1770s, the number of trials involving linen gowns increased two and a half times faster than trials involving cotton-linen gowns (Table 4). Linen gowns were cheaper than cotton-linen gowns (Table 5) and, although their weight, drape and aesthetic effect were different and in some respects inferior, technical innovations like the indigo cold vat process and printing with large copper plates made prints on linen increasingly desirable at this period. So, to return to the excise data for printed fabrics (Fig. 16), what we are actually observing in the aggregated figures (the blue line) from the 1750s and 1760s is an overall increase that conceals a shift away from printed cotton-linens towards printed linens.

<sup>46</sup> See, for an American example, L.M. Hawes, ed., *The Letter Book of Thomas Rasberry, 1758-1761*, Savannah, Georgia, 1959: 63-4.

**Table 4.****Old Bailey trials involving linen and cotton gowns, 1740-1779.**

	<b>1740s</b>	<b>1770s</b>	<b>Increase</b>
'Cotton' (cotton-linen) gowns (Old Bailey trials)	82	166	x 2.0
Linen gowns (Old Bailey trials)	50	250	x 5.0
Cotton wool annual imports	2.2 m	4.8 m	x 2.2
Linen yarn annual imports	3.1 m	8.3 m	x 2.7

NB. between the 1740s and the 1770s the total number of trials at the Old Bailey increased by x 1.5, from just under 4,000 to just over 6,000.

Source.

Old Bailey trials: Old Bailey Proceedings Online ([www.oldbaileyonline.org](http://www.oldbaileyonline.org)).

Imports: TNA, CUST 3/40-79, 1740-79.

**Table 5.****Values of Gowns by Material (in shillings), 1750-1778.**

	Average indictment value of gowns stolen in London, 1750-59 (n=227)	Average value of gowns pawned at York, 1777-78 (n=896)
Silk	19.9	5.9
Cotton (ie. cotton-linen)	6.5	4.5
Linen	5.3	3.9
Worsted	4.5	2.8

Source: Old Bailey Proceedings (<http://www.oldbaileyonline.org>), accessed 17 October 2015; York City Archives, Accession 38: Pledge book of George Fettes, pawnbroker, York, 1777-8. Sample consists of all gowns identified by material and valued individually.

#### 4. Spinning the Industrial Revolution.

What are the implications of this pattern of demand for understanding the spinning macro-inventions of the early Industrial Revolution – not just the spinning jenny presented by Robert Allen as ‘the Industrial Revolution in miniature’, but also Richard Arkwright’s water frame? The 1750s and 1760s, when these machines were conceived and initially developed, emerge as particularly challenging decades – indeed, almost a perfect storm. Stagnant demand for cottons from the 1720s to the 1740s was followed by strong growth in the domestic market for fustians, checks, cotton-linens for printing, and, especially from the late 1750s, cotton stockings. Overseas, new opportunities arose from a combination of contracting Indian supply and rising Indian prices, at a time when India remained the world’s foremost exporter of cotton textiles. Yet the capacity of Lancashire manufacturers to respond to these opportunities was hampered by acute shortages of raw and intermediate materials, and of spinning labour.

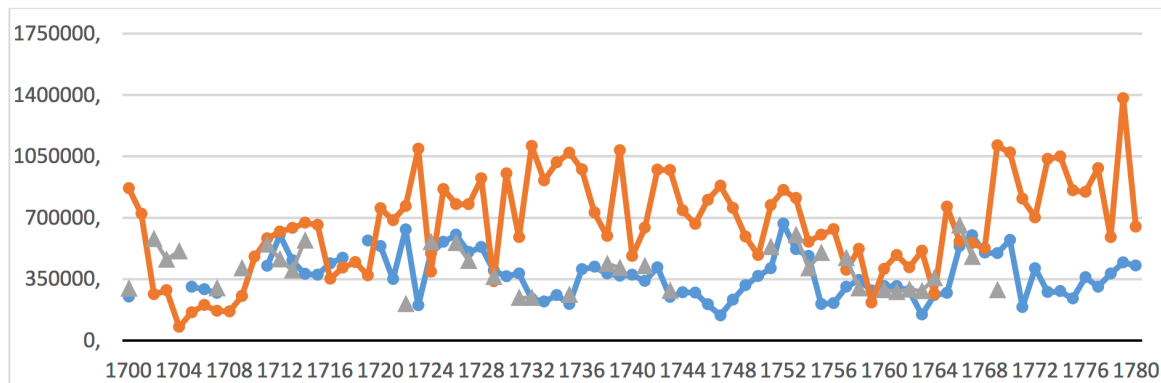
During the 16<sup>th</sup> and 17<sup>th</sup> centuries, Indian supply of a huge range of cotton and cotton-silk fabrics had proved remarkably elastic in response to fast-growing European demand. This was not to be the case in the 18<sup>th</sup> century. Production constraints, partly to do with warfare on the subcontinent in the middle decades of the century, resulted in a fall in imports by both the English (EIC) and the Dutch (VOC) East India Companies from the 1730s to the 1760s, subsequently reversed (Fig. 19). Prices continued to rise, however (Fig. 20).<sup>47</sup>

---

<sup>47</sup> C. Nierstrasz, *Rivalry for Trade in Tea and Textiles: The English and Dutch East India Companies (1700-1800)*, Basingstoke, 2015: chapters 4 and 5.

**Fig. 19. Textile imports from India, 1700-80, quantities (courtesy Chris Nierstrasz).**

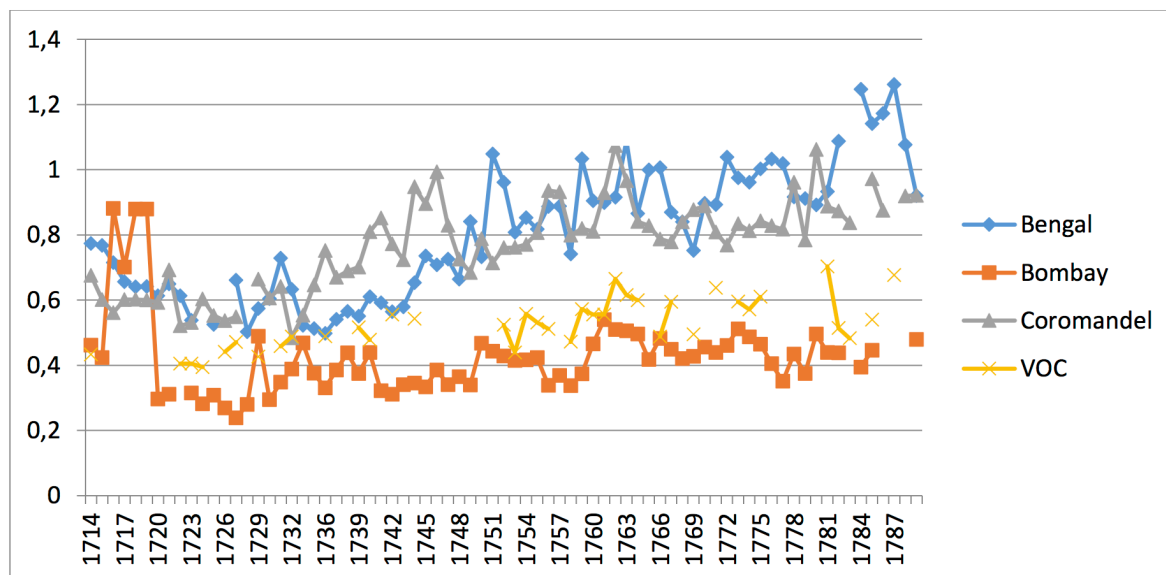
Total number of pieces of textile imported by the EIC and the VOC (1700-1800)



Sources: BGB database (Gray with triangles) and NA, VOC, *Generale staten* (Blue with dots) form the numbers of the VOC, whilst BL, L AG 1 6 8-19 (1713-1780) and Chaudhuri, *The Trading World of Asia*, 547, Table C.24 (1700-1713) form the numbers of the EIC (orange with dots).

**Fig. 20. Textile imports from India, 1700-80, prices (courtesy Chris Nierstrasz).**

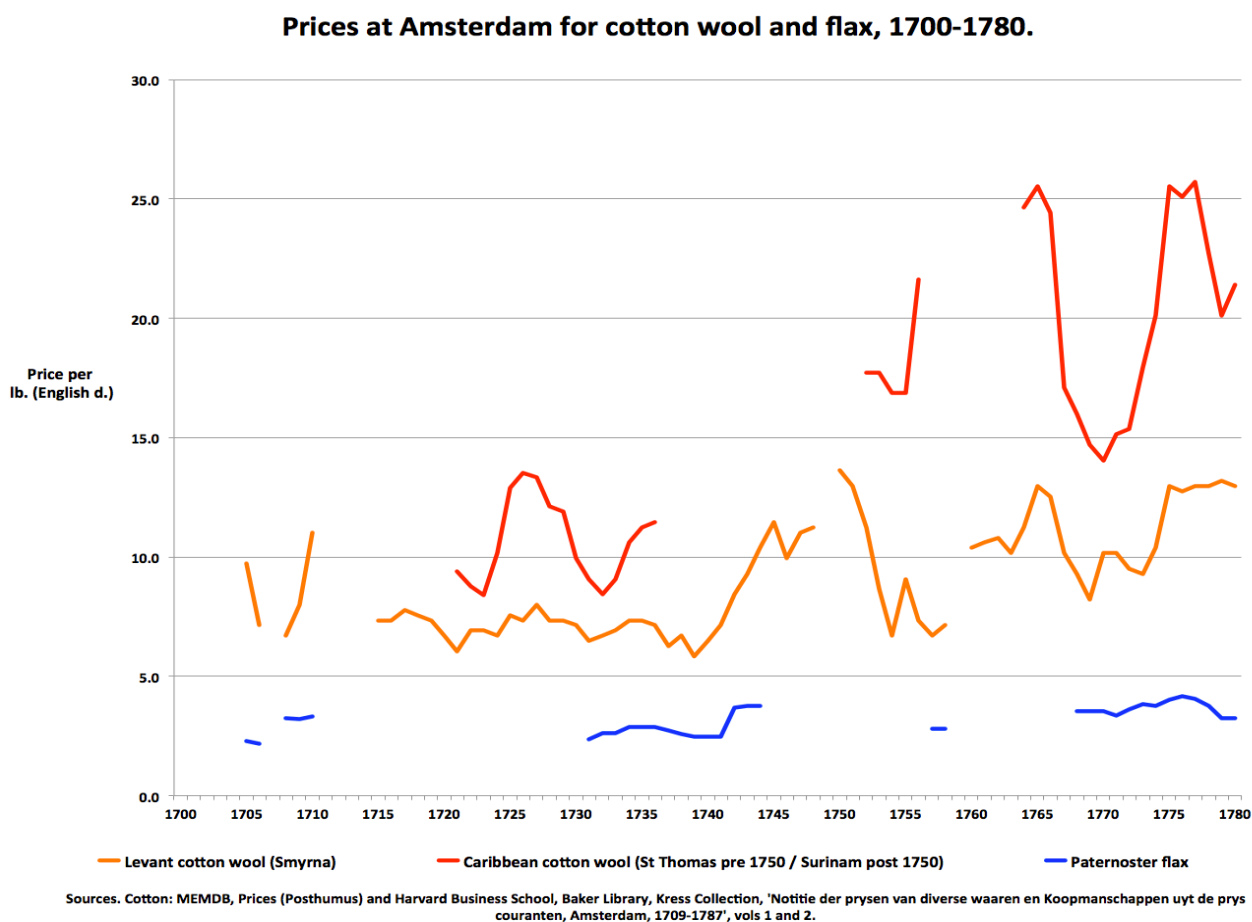
Purchase price of textiles in India, VOC and EIC (divided into Bengal, Bombay and Coromandel) in Pound Sterling per piece (1700-1799)



Sources: BL/L/AG/1/6/8-19 (EIC) and BGB (VOC) (1 pound=15 guilders except after 1769 when first a correction 16,35 percent was made before division with 15, this is according what the BGB database says on the correction of the currency)

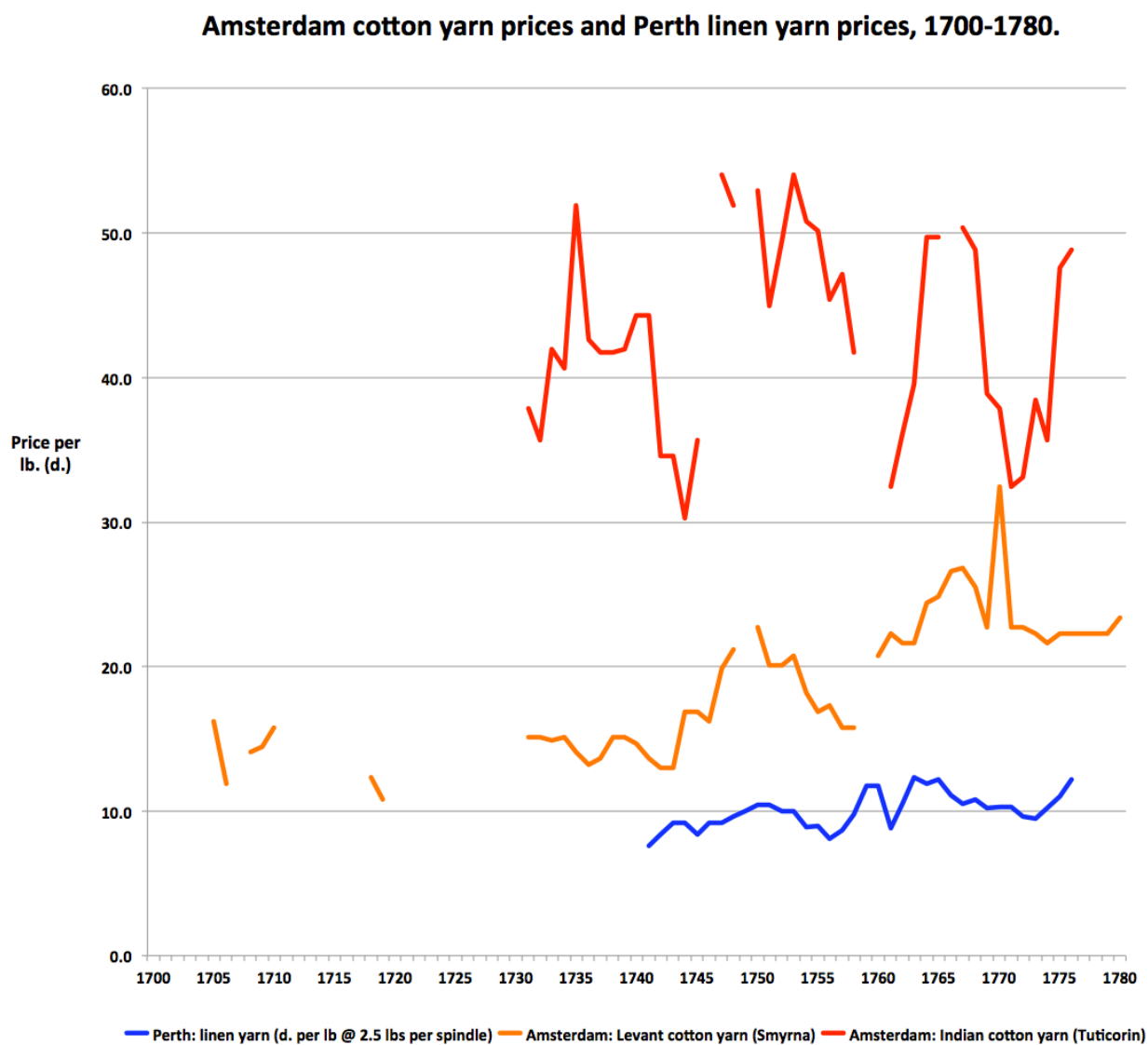
Nevertheless, during the 1750s and 1760s British producers of cottons were afflicted by their own problems securing raw and intermediate materials, which were largely imported. Raw cotton prices doubled in the course of the 1740s. They were subsequently extremely volatile, with very high peaks (Fig. 21).

**Fig. 21.**



Linen yarn prices rose too, especially in the 1740s and the later 1750s, following the same trajectory as raw cotton, but less dramatically. Linen yarn continued to be substantially cheaper than cotton yarn, selling at around half of its price per lb., or less (Fig. 22).

Fig. 22.

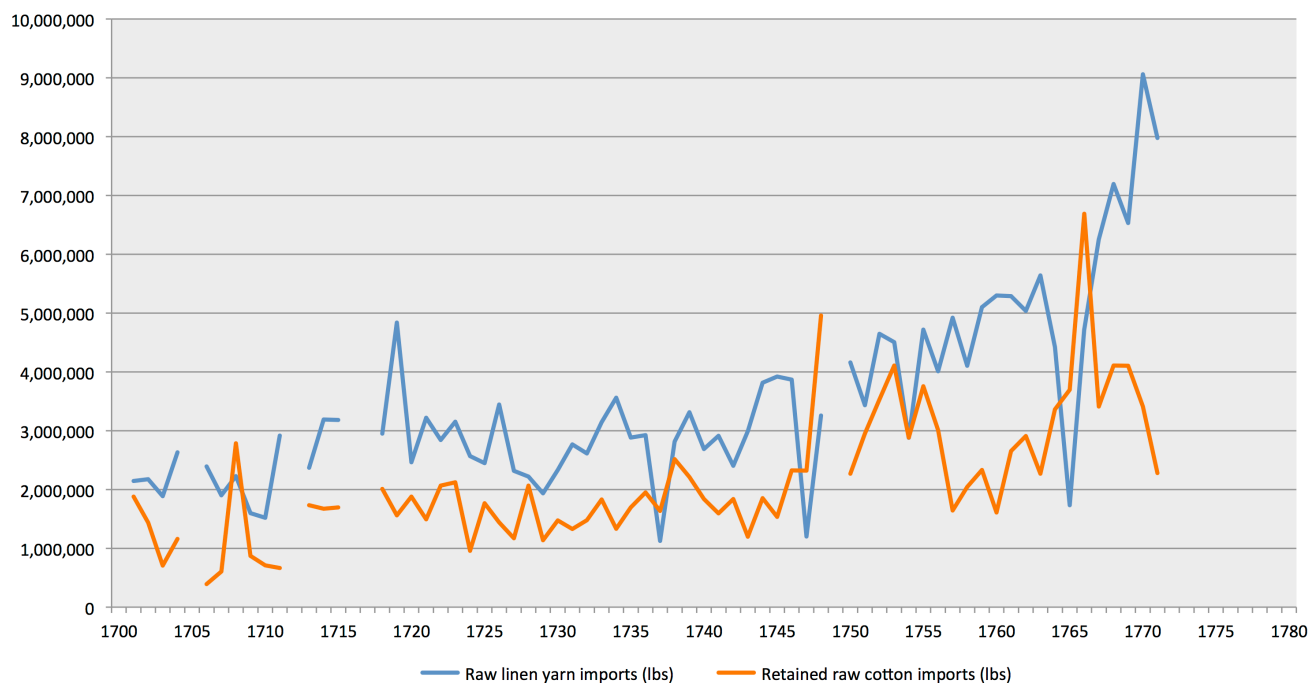


Sources. Cotton: MEMDB, Prices (Posthumus); Linen: Alexander Bald, *The Farmer and Corndealet's Assistant* (Edinburgh, 1780).

The supply of linen yarn in these decades grew faster than raw cotton (Fig. 23).

**Fig. 23.**

**Cotton wool imports and linen yarn imports, England, 1700-1780**



Source: Elizabeth Schumpeter, English overseas trade statistics, 1697-1808 (Oxford, 1960), Table XVI.

The exceptionally high cost of raw cotton at this period and the fact that it was spun locally in Britain provided strong inducements to mechanical innovation in cotton spinning. Mechanization offered not only the promise of reducing the cost of spinning labour in a fast-growing industry, but also of a more consistent, even, and therefore less wasteful yarn. However, most of the products we have discussed were mixtures of cotton with linen. Where trade-offs were possible between the two fibres, inducements to cut costs by mechanical means were reduced. With checks, for example, substitution of cheap linen yarn for expensive cotton was a feasible cost-reduction strategy.

In exploring the role of demand as an inducement to mechanical innovation, we therefore need to focus on those cottons where this kind of substitution by varying fibre content was more difficult. Three categories of cottons characterized by high demand but low potential for fibre substitution provided especially strong incentives for mechanical innovation:-

(1) What I have called in this paper the new fustians – the all-cotton Manchester velvets and the cheaper velverets. Although velverets often had inexpensive linen ground warps, their fibre content remained predominantly cotton. In addition to a cotton weft, they required a fixed proportion of supplementary cotton warps for their



velvet pile (typically in a 2:1 ratio of ground warps to pile warps). All these cotton velvet fabrics were relatively expensive and their sales were correspondingly limited before the 1770s. Nevertheless, they were regarded, at home and abroad, as a formidable technical achievement. The attempt to copy them was crucial for improvements in cotton spinning in France in the 1750s and 1760s, and similar considerations applied in Britain.<sup>48</sup>

(2) Cotton stockings. Of all the categories of cottons discussed in this paper, cotton stockings witnessed the fastest growth in consumption in the mid-eighteenth century, albeit from close to zero. Like the best cotton velvets, they were all-cotton products, but not subject to legislative restrictions. Produced mainly in and around Nottingham, they made heavy demands on cotton spinners in terms of yarn twist and evenness. Both of the early successful Lancastrian innovators in mechanical spinning – James Hargreaves and Richard Arkwright – took their inventions to Nottingham at an early stage in their development. Their migration has been explained in terms of push factors – hostility from Lancashire hand spinners and weavers in the late 1760s – but the evidence presented in this paper suggests a more important consideration may have been the pull of very rapidly growing demand from Nottingham hosiers for consistent yarn.<sup>49</sup>

(3) Printed cotton-linens. As we have seen, mixed cotton-linen fabric for printing incorporated expensive cotton weft yarn and cheaper linen warp yarn in a roughly 50:50 ratio. There was no potential here for cutting costs by changing the ratio and incorporating more linen yarn, so the response to the pressures of the 1750s and 1760s took other forms. James Hargreaves was a weaver employed by Blackburn manufacturers to make cotton-linen fabrics for printing. His spinning jenny of c.1765 produced weft for cotton-linens that was cheaper and more consistent, at a time when the lion's share of rising domestic demand for printed textiles was going to prints on all-linen fabric.<sup>50</sup>

However, there was also an incentive to innovation in printed cotton textiles from overseas. In the British colonies in the Americas, decorated, all-cotton Indian calicoes were not subjected to the prohibitions and tariffs imposed in Great Britain in the early decades of the eighteenth century.<sup>51</sup> All types of Indian textiles could be imported and used in the American colonies, as long as they were shipped from

<sup>48</sup> For the importance accorded to cotton velvets, see A. P. Wadsworth and J. de L. Mann, *The Cotton Trade and Industrial Lancashire 1600-1780*, Manchester, 1965: 174-5; J.R. Harris, *Industrial Espionage and Technology Transfer: Britain and France in the Eighteenth Century*, Aldershot, 1998: chapters 3 and 7.

<sup>49</sup> C. Aspin & S.D. Chapman, *James Hargreaves and the Spinning Jenny*, Helmshore, 1964: 16-19.

<sup>50</sup> For a critique of Robert Allen's recent interpretation of the origins of Hargreave's spinning jenny, see Styles, 'Fashion, Textiles and the Origins of Industrial Revolution' (<http://www.history.ac.uk/publications/east-asian-journal-of-british-history>).

<sup>51</sup> J. Eacott, 'Making an Imperial Compromise: The Calico Acts, the Atlantic Colonies, and the Structure of the British Empire', *William and Mary Quarterly*, 3<sup>rd</sup> series, 69, 2012: 731-762.

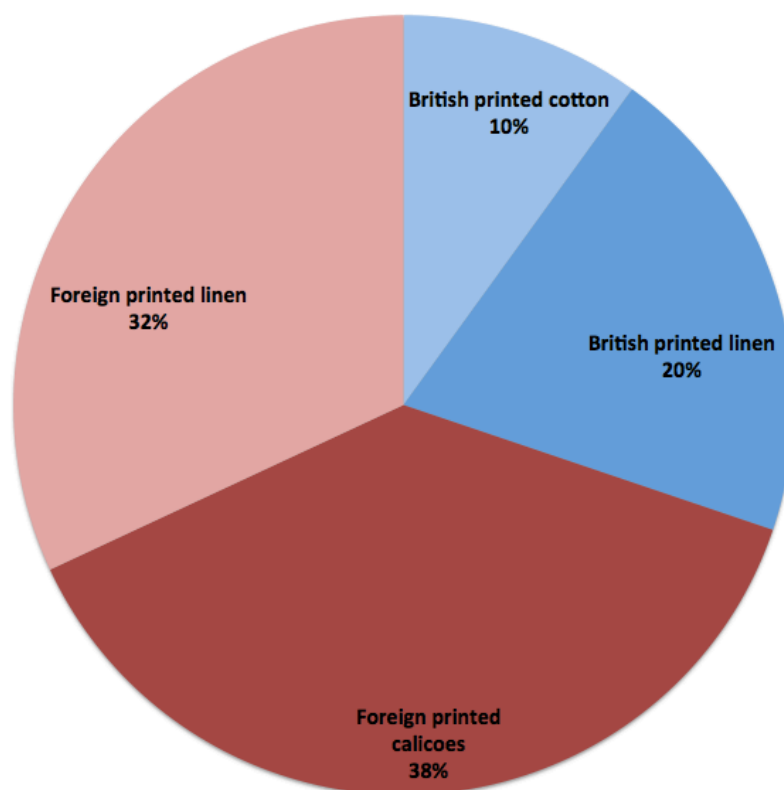


India via Great Britain. American consumers sustained a firm preference for prints on Indian all-cotton calico across the decades after 1722, when their British counterparts were required to make do with prints on linen-warp, cotton-weft cottons. They exercised that preference despite prints on calico being more expensive than equivalent prints on cotton. During the three years 1769 to 1771, which provide the most detailed information about imports available for the colonial period, prints on Indian all-cotton fabric (foreign printed calicoes) outsold British cotton-linen prints (British printed cotton) by almost four to one in the British colonies in North America (Fig. 24). The printed designs were often identical, because in both cases the textile printing was mostly done in the vicinity of London, not in India, nor in Lancashire.

Fig. 24.

### Imports of Printed Fabrics to British North America, 1769-71.

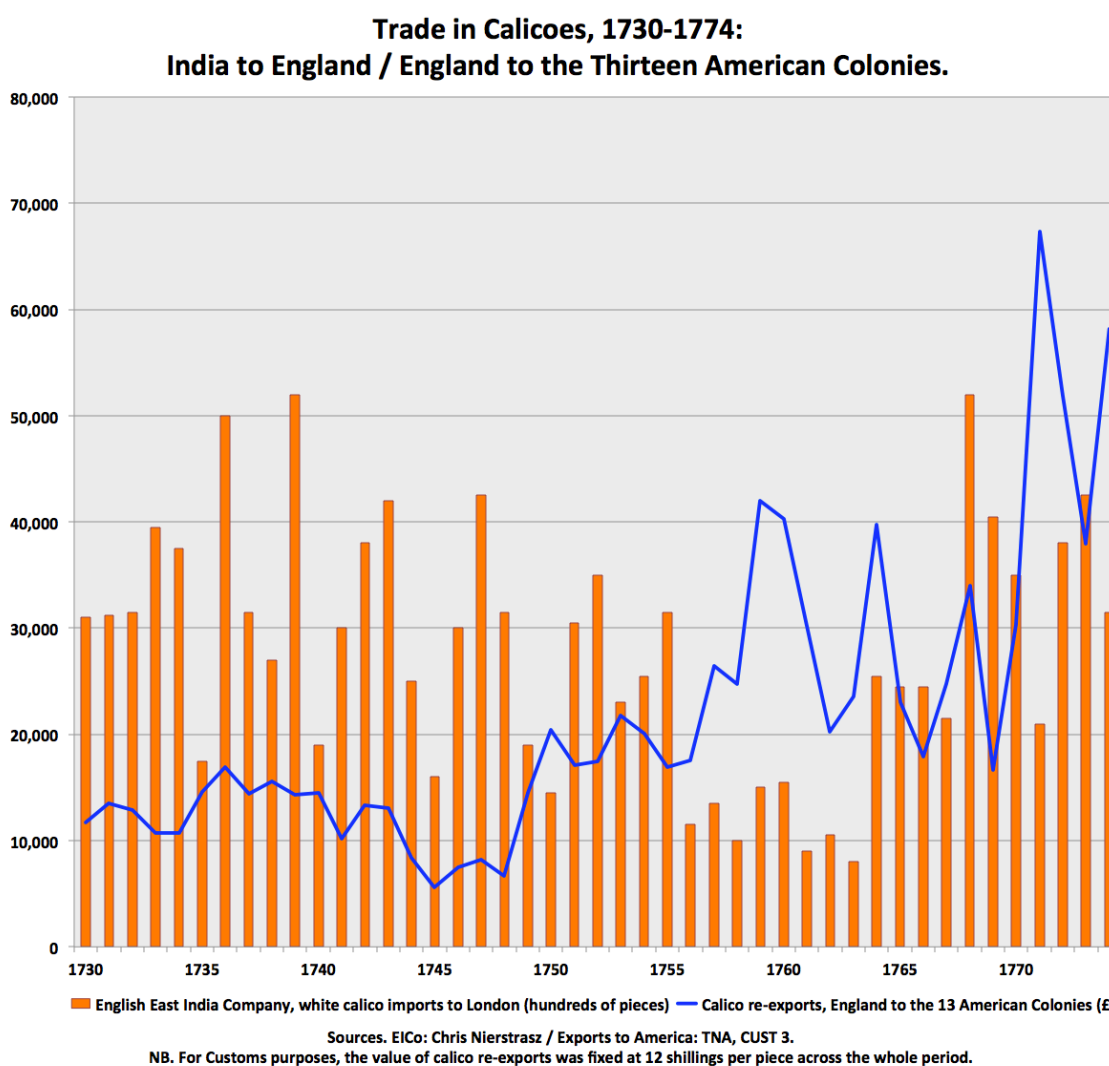
Source: TNA, CUST 16/1: Imports and Export America, 1768-1773.



By the mid-eighteenth century, North America had become the largest single market for Indian calicoes printed in Britain. Yet at the same time, supply problems in India meant the East India Company faced increasing difficulty supplying the plain white calicoes used for printing. The numbers of white calicoes supplied from India fell, reaching a low point in the early 1760s, and prices rose, yet American consumption kept on expanding (Fig. 25). It was, therefore, America, more than any other market, that demonstrated the potential profits the Lancashire cotton industry was foregoing due to its inability to produce cotton warps economically for printed fabrics. Lancastrians must have been well aware that their cotton-linen prints were very much second-best in America. The 1750s and 1760s saw the start of printing on cotton-linen in Lancashire and the beginning of large-scale direct exporting of fustians, checks, stripes and dimities from Lancashire to North America.<sup>52</sup> Lacking the capacity to spin cotton warps, Lancashire producers of cotton-linen fabrics for printing were at a marked disadvantage in the American market.

<sup>52</sup> P. Maw, 'Yorkshire and Lancashire ascendant: England's textile exports to New York and Philadelphia, 1750-1805', *Economic History Review*, 63, 2010: 738; Winterthur Museum, ref. 07 x 5: Henry Remsen, Jr., and Co. (New York), Pattern book [of textiles] received from Messrs. Benjamin & John Bower, merchants, Manchester, 1767.

Fig. 25.



It was Richard Arkwright, not James Hargreaves, who successfully responded to this opportunity, just as he responded to the opportunity provided by the expanding market for cotton stockings more effectively (and successfully) than his fellow Lancastrian innovator. Whether Arkwright began work on his spinning machine in 1767 with the objective of producing high twist cotton warp yarn is unclear, although his use of a spindle and flyer mechanism, which tends to put a high twist into yarn and was used for hand spinning of flax, suggests he did. He was certainly quick to set his new yarn to work making calicoes for printing. Within a few months of his first, horse-powered Nottingham spinning mill going into full production in late 1772, he was having the yarn it produced woven into calicoes.<sup>53</sup> Previously, in March of that year, he had already been experimenting with using the new yarn in ribbed stockings and velverets.<sup>54</sup>

<sup>53</sup> R.S. Fitton, *The Arkwrights: Spinners of Fortune*, Manchester, 1989: 26-37.

<sup>54</sup> Fitton, *The Arkwrights*: 31.

So did Robert Allen choose the wrong candidate for applying the theory of induced innovation? Was Richard Arkwright's water frame, not James Hargreaves' spinning jenny, the macro-invention that responded to shifts in prices of the key factors of production in the mid-eighteenth century, notably the price of labour in a high wage economy? As we have seen, the cost of labour in Lancashire for spinning all kinds of fibres was relatively high. For cotton, it appears to have been rising since the 1720s, partly, at least, as the quality of weft yarn improved. Arkwright was sensitive to labour costs, as his correspondence while establishing his first factory at Nottingham shows. Nevertheless, overcoming the previously insurmountable obstacles to spinning cotton warp at a commercially viable price represented a far more powerful incentive.<sup>55</sup> It was the textile equivalent of the European discovery of the secret of porcelain – a means of making something much desired in Europe (and America) that could previously only be imported from Asia.

Moreover, Arkwright's innovation was not simply a response to the economic opportunities of the 1750s and 1760s. As has often been pointed out, Arkwright invented relatively little. Like Apple's Steve Jobs, as described by Malcolm Gladwell, Arkwright was a tweaker – he made other people's inventions work effectively.<sup>56</sup> The immediate history of those inventions stretched back across the previous four decades, but their deeper genealogy lay in medieval Italy. In many respects they exemplify Mokyr's 'great synergy of the Enlightenment' – the combination of useful knowledge and institutional incentives. The influence of Baconian ideas, the liberality of the patent system and high tariff barriers against foreign manufactured goods all made eighteenth-century Britain a congenial environment for mechanical innovation in textiles. Yet the inventions Arkwright exploited were also grounded in the preoccupation of European states with economic competition and luxury manufacturing long before the Enlightenment.

Historians tend to view the Industrial Revolution retrospectively as the founding moment of modernity. In interpreting the textile innovations of the late eighteenth century, their perspective has been profoundly shaped by authors like Adolphe Blanqui and Edward Baines who wrote some of the earliest histories of cotton in the Industrial Revolution.<sup>57</sup> Theirs was a backwards view from a very particular moment – the moment in the 1830s when cotton had become a mass production, mass market textile, when prices of cottons had fallen so far that huge quantities of worsteds were being manufactured with cotton warps, and when cotton was supplanting linen for working people's shirting and sheeting for the first time, because it had finally become cheap enough to overcome its deficiencies in

---

<sup>55</sup> Fitton, *The Arkwrights*: 31

<sup>56</sup> M. Gladwell, 'The Tweaker: The real genius of Steve Jobs', *The New Yorker*, 11 Nov. 2011.

<sup>57</sup> Blanqui, *Histoire de l'Économie Politique*; Baines, *History of the Cotton Manufacture*.

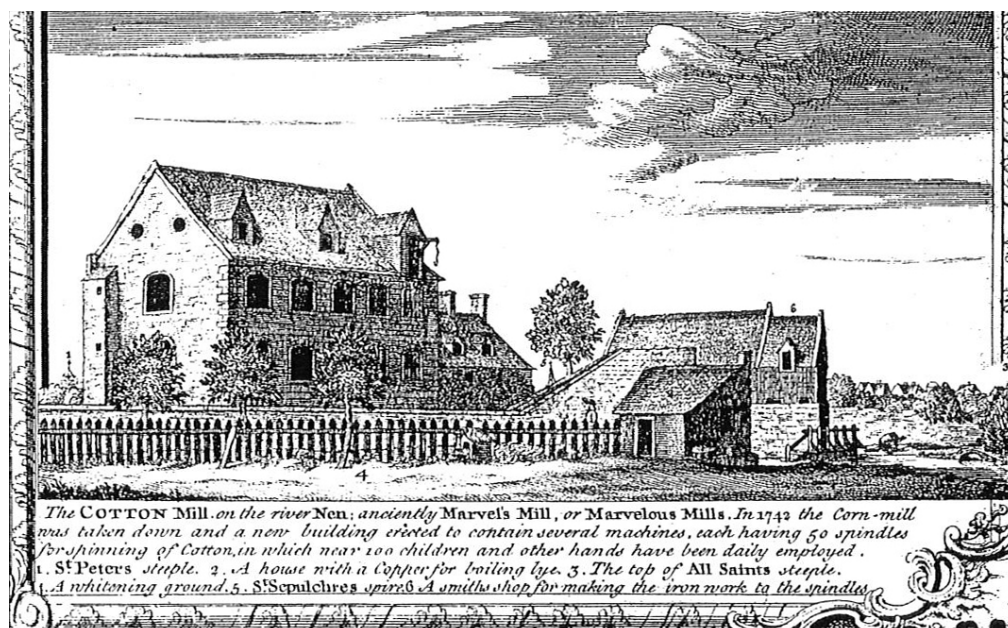
durability.<sup>58</sup> A different trajectory emerges if we adopt the opposite perspective to Blanqui and Baines and assess the innovations of the Industrial Revolution in terms of the broader textile landscape of early modern Europe from the sixteenth to the eighteenth centuries. Judged in terms of what we might call the ‘before’ picture, Richard Arkwright’s macro-invention appears less a first step on the road to mass production, and more the outcome of a long history of applying capital-intensive, mechanical solutions to quality and supply problems in luxury textile manufacturing.

The key component in Arkwright’s machine, the drafting rollers Adolphe Blanqui identified as ‘two small cylinders, rotating in opposite directions’, were first applied to cotton spinning in the 1730s by Lewis Paul, a London-born inventor of textile machinery. In 1738 Paul patented a spinning machine which incorporated a series of rollers for feeding the fibre to the spindles. It is unlikely that labour costs for cotton spinning represented a powerful incentive for this invention in the 1730s, when imports of raw cotton were stagnant, average counts of yarn were coarse, and what little evidence we possess suggests piece rates were lower than the 1750s and 1760s. Rollers were already widely employed in England in metalworking and in textiles, and Paul probably derived the idea of using them in his spinning machine from his previous, successful invention, a pinking engine. Paul’s patent claimed his spinning machine spun either cotton or wool, but when it was subsequently put to work at Birmingham, Northampton and elsewhere, it spun almost exclusively cotton. Although it never achieved great success, due to unresolved technical issues, it was not the complete failure it has sometimes been painted. At Northampton, Marvel’s Mill, a purpose-built, water-powered factory, employed a hundred workers on five of Paul’s machines, each with fifty spindles (Fig. 26). It continued in use from 1743 until about 1761, after Paul’s death and only eight years before Arkwright patented his spinning frame.<sup>59</sup>

---

<sup>58</sup> John James, *The History of the Worsted Manufacture in England*, London 1857: chapter 12; John Styles, ‘What were Cottons for in the Industrial Revolution?’ in Giorgio Riello and Prasanna Parthasarathi, eds, *The Spinning World: A Global History of Cotton Textiles, 1200-1850*, Oxford 2009: 307-26.

<sup>59</sup> David L. Bates, ‘Cotton-Spinning in Northampton: Edward Cave’s Mill, 1742-1761’, *Northamptonshire Past and Present*, Vol. 9, 1996: 237-51.



**Fig 26. Marvel's Mill, Northampton, 1746. The mill was purpose-built for the water-powered cotton spinning machinery invented by Lewis Paul.**

The fact that cotton became the focus of Paul's efforts in the 1730s, when cottons accounted for only a very small proportion of English textile production is significant. In late seventeenth and early eighteenth century England, cotton textiles were far from being the mass market commodities they were to become by the 1830s. Even in the middle decades of the eighteenth century, cotton gowns still remained semi-luxuries, less expensive than silks but more expensive than those made from other fibres (Table 5). Yet already, in 1722, their popularity had resulted in the prohibition of colour-patterned all-cotton fabrics.

Lewis Paul moved to Birmingham to start work on his new machine ten years later, in 1732, the year the patent expired on the water-powered silk throwing machinery installed by Thomas Lombe in his huge factory at Derby in 1719. Silk (other than silk waste) is not normally spun. Instead, the long, very fine filaments of silk fibre are unwound from the cocoon and then twisted together to produce a multi-filament yarn. In Italy, Europe's primary silk manufacturing centre before 1700, silk throwing was mechanized during the Middle Ages by means of the circular silk-throwing mill. These circular mills were initially driven by hand, but water-power was applied in Bologna as early as 1341. In Italy the machinery employed in these mills went on being refined and enlarged over the next three centuries.<sup>60</sup> The process culminated during the later seventeenth century in Piedmont, in north-west Italy, where 125 huge, multi-story, silk-throwing mills had been built by the start of the eighteenth century, housing sophisticated water-powered winding and throwing

<sup>60</sup> Carlo Poni, 'The Circular Silk Mill: A Factory before the Industrial Revolution in Early Modern Europe', *History of Technology*, Vol. 21, 1999: 65-85.

machinery and each employing on average over fifty workers.<sup>61</sup> The principal purpose of these throwing machines was to produce organzine – silk warp – which, like most warps, required a much higher twist to give it strength. From the mid-seventeenth to the mid-nineteenth centuries, Piedmontese organzine was the best in Europe, an indispensable raw material for weaving fine silk piece goods at Lyon and Spitalfields, and consequently the object of bitter technological rivalry in the continent's other silk manufacturing countries.

Silks were the pinnacle of early modern European élite fashion, the epitome of luxury. They were also a principal focus of capital-intensive mechanical innovation. From throwing mills to engine looms, stocking frames to draw looms, inventive effort in textiles was invested disproportionately in the machinery of silk manufacture, driven by mercantilist competition between the states of early modern Europe in this most fashionable of products.<sup>62</sup> Thomas Lombe's machines in his factory at Derby were pirated copies of the most up-to-date Piedmontese silk throwing equipment. That did not prevent him from being awarded a 14 year British patent and feted for reducing the country's dependence on imported thrown silk. On the expiry of his patent in 1732, a grateful parliament awarded him the enormous sum of £14,000 in lieu of its extension, encouraging others to use the technology. The lesson for entrepreneurs about the British state's support for mechanising primary processing of imported luxury raw materials could not have been clearer. The same year, Lewis Paul began work on his machine to make yarn from another imported luxury raw material – cotton. Circular, with a central drive shaft, it had striking similarities in design to Lombe's Italian silk throwing mill.<sup>63</sup>

The financial returns Lewis Paul secured from his invention were meagre compared to those enjoyed by Thomas Lombe. The real return came only four decades later, after Paul's death, when Richard Arkwright took Paul's drafting rollers and implemented them, not on circular frames like Lombe's Italian silk throwing machines, but on linear frames. He did so with more technical support, more determination and more sustained and skillful financial backing than Paul. The result was the ultimate macro-invention. It transformed cotton into a mass-market commodity. Yet its genealogy had a very different character. Its roots lay in the luxury textile industries of late Medieval and Renaissance Europe, while its development was driven by the commercial, colonial and mercantilist policies of the British state.

---

<sup>61</sup> Giuseppe Prato, *La Vita Economica in Piemonte a Mezzo il Secolo XVIII*, Turin 1908: 218.

<sup>62</sup> See John Styles, 'Fashion and Innovation in Early-Modern Europe', in Evelyn Welch, ed., *Fashioning the Early Modern: Creativity and Innovation in Europe, 1500-1800*, Oxford 2017.

<sup>63</sup> For the similarities between Lombe's and Paul's machines, see Richard L. Hills, *Power in the Industrial Revolution*, Manchester 1970: chapters 2 and 3.