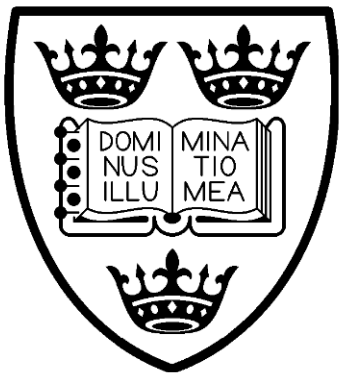

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PRICES AND PROFITS IN COTTON TEXTILES DURING THE INDUSTRIAL REVOLUTION

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Abstract

Cotton textile firms led the development of machinery-based industrialization in the Industrial Revolution. This paper presents price and profits data extracted from the accounting records of three cotton firms between the 1770s and the 1820s. The course of prices and profits in cotton textiles illumine the nature of the economic processes at work. Some historians have seen the Industrial Revolution as a Schumpeterian process in which discontinuous technological change created large profits for innovators and succeeding decades were characterized by slow diffusion. Technological secrecy and imperfect capital markets limited expansion of use of the new technology and output expanded as profits were reinvested until eventually the new technology dominated. The evidence here supports a more equilibrium view which the industry expanded rapidly and prices fell in response to technological change. Price and profit evidence indicates that expansion of the industry had led to dramatic price declines by the 1780s and there is no evidence of super profits thereafter.

Keywords: Industrial Revolution, cotton textiles, prices, profits.

JEL Classification Codes: N63, N83

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I. Introduction

The British Industrial Revolution in the last quarter of the eighteenth century is a key event in the emergence of modern economic growth. Years ago, Eric Hobsbawm noted (1968, 34) "Whoever says Industrial Revolution says cotton." Technological and organisational changes in the cotton industry were central to the emergence of a modern economy based on mechanized factory production. The cotton industry has been widely studied in an attempt to understand the industrial revolution.[2] This extensive literature notwithstanding, information about the course of prices, costs and profits that can be extracted from surviving account books of a limited number of firms has not been adequately examined. This paper attempts to fill this gap by presenting cotton textile prices, costs and profits from the 1760s to the early nineteenth century. Most of this data has been extracted from the accounts of three cotton textile firms that have been preserved in archives in Greater Manchester – one weaving firm, Richard Cardwell and Richard Birley and partners, and two spinners, Samuel Greg and partners, and William Grey and partners. This is, of course, a narrower coverage of the industry than one would hope for and care must be observed in drawing general conclusions. These data do, nonetheless, add important detail to what we know about cotton textiles in the Industrial Revolution.

The data presented here are, of course, useful in their own right. In addition, they can help us to understand the process of economic change in the leading industry in late eighteenth and early nineteenth century Britain. A common view of the Industrial Revolution identifies a shift in technology to mechanized factory production under capitalist control emerging in the cotton industry. The innovation created profits for capitalists and shifted the distribution of income in their favour. During the early nineteenth century the profits from factory capitalism were partially reinvested in spreading the factory system so that by the high Victorian era Britain's economy had been transformed. Cotton with its new technology and organisation originated a process of "development" with qualitative changes not present in simple "growth" within the pre-existing system. Joel Mokyr, one of the leading modern scholars of the industrial revolution, has spoken of cotton technology initiating a "'traverse' [in which] quantitative expansion and structural change were intertwined" (Mokyr, 1976, p. 372).[3] The traverse was carried out by capitalists in the new industries and was prolonged because capital market imperfection limited competition. The new order came about only as it was financed by profits from the innovation. The perspective owes much to Schumpeter's

[2] The literature is far too extensive to be usefully surveyed here. An early narrative that has hardly been exceeded is in Mantoux (1928, Part II Ch 1 and 2). For a recent overview see Allen (2009, Ch. 8). A sample of more detailed studies would include Fitton and Wadsworth (1958), Fitton (1989), Chapman (1967), Wadsworth and Mann (1931), Edwards (1967)),

[3] Although somewhat muted, this view is present in Mokyr's more recent overviews of the industrial revolution (Mokyr 1999, 81-103).

insights of the central role of entrepreneurship and industrial finance in economic development. In this view, discontinuous technological change initiated an Industrial Revolution that involved protracted diffusion of the improved technology. Shift to modern conditions was constrained by limited enterprise, secrecy in technological knowledge and pre-industrial constrains on capital mobilization.

Since the 1980s reassessments of national income growth (Crafts, 1985; Harley, 1999; Crafts and Harley, 1993; Antras and Voth, 2003) have concluded that acceleration of aggregate growth was slower than earlier research had suggested. The spectacular innovations of the late eighteenth century seem largely confined to the cotton textile industry, as the industry was too small - and its links to the rest of the economy too weak - to have had the aggregate effects suggested by the older narratives. The introduction of the factory system in cotton textiles should not be seen as a decisive change in the process of economic growth. Research within this view sees technological change as specific to the cotton industry and diffusing rapidly within the industry. Crafts and Harley feel that the period can be seen in conventional economic terms and use computational general equilibrium analyses to understand changes in the British economy (Harley and Crafts 2000). The profit opportunities initially created by new technology attracted rapid expansion of output which quickly drove down the price of cotton textiles. Low prices encouraged the widespread adoption of cotton clothing and furnishings but had little spill-over effect (except to woollen textiles).

Published histories of the cotton industry during the early Industrial Revolution contain surprisingly limited systematic information on the industry's prices and profits. Arkwright's water-frame, patented in 1769, and a decade later, Crampon's mule were major technological breakthroughs in spinning technology. Arkwright and his partners, as Schumpeterian innovators in the new technology, certainly reaped large profits for more than a decade under patent protection. Competitors challenged the patent monopoly and imitation began to drive down cotton prices and profits even before the patent lapsed in the early 1780s. With the end of patent protection, expansion of output as competition spread quickly lowered yarn prices. In 1787, the industry unsuccessfully approached the Board of Trade for protection from Indian imports. This can be taken as signalling that the era of super-profits had ended under pressure from the expansion of English production and the end of restricted supply from India. A petition by British producers for assistance stated:[4]

> Such is the state of the British Cotton Manufacture at present:- with establishments and mechanical powers capable of bringing forward

[4] In 1787 the new cotton industry underwent its first major crisis and petitioned the government for relief. Patrick Colquhoun from Glasgow led the delegation that went to London seeking government assistance. The notebook he prepared on that occasion has survived and provides an invaluable glimpse at the industry in the early days of its growth (Colquhoun Ms. Baker Lib. Harvard Business School. Mss. 442 1771-1789 c722). Also see information in the Public Records Office (BT 6-112; 140; 180) and in the Liverpool Papers in the British Library (Add Mss. 38223 (2); 38391 (26; 35; 56)).

> immense quantities of goods into consumption. This Manufacture is checked as it were in a moment by a great and sudden reduction of the prices of East India goods of some species which have recently sold 20 percent. on average, under the lowest prices at which British Manufacturers can afford to sell without loss. The consequence of which has been that *an universal stagnation* has taken place; the stock of hand daily accumulate – the poor Spinners who work upon hand-mills are in greatest distress and a great and valuable system is in danger of being broken down in a moment, if some remedy cannot be applied; for unless the British Market can be opened for the home Manufacturer, it is impossible to go on – Men and women trained to the business, at great expense, will be set a drift and numerous children sent back to the hospitals and parishes from whence they came.[5]

Improved technology no longer created profits, but rather provided consumers with textiles at low prices. Thereafter the industry grew as a result of continued technological progress and expansion in demand. The end of super profits is confirmed by archival evidence that shows profits fluctuated sharply thereafter but not, on average, exceed a competitive rate of return commensurate with the risks involved.

[5] British Library, Add Mss 38223, F, 5, p.2.

II. Cotton textile prices, 1760s to 1830

The general downward movement of cotton goods prices caused by new technology, first in spinning and then from the second quarter of the nineteenth century in power weaving, have been well-known generally but not in detail. Detailed archival research in company accounts books has traced the price movements with greater precision (Harley, 1998). Initially, innovation was confined to spinning and had a much greater impact on fine yarns and warps than on coarse wefts. Nonetheless all yarn prices declined dramatically from at least the mid-1780s (see Table 1 and Figure 1), eroding initial profits. The real price of even the coarsest weft yarns fell to only a third of their early 1780s level by 1815, while the prices of other yarns fell by much more.

Table 1: Yarn Prices, Nominal Deflated 1769-1827[6]

(pence per lb.)

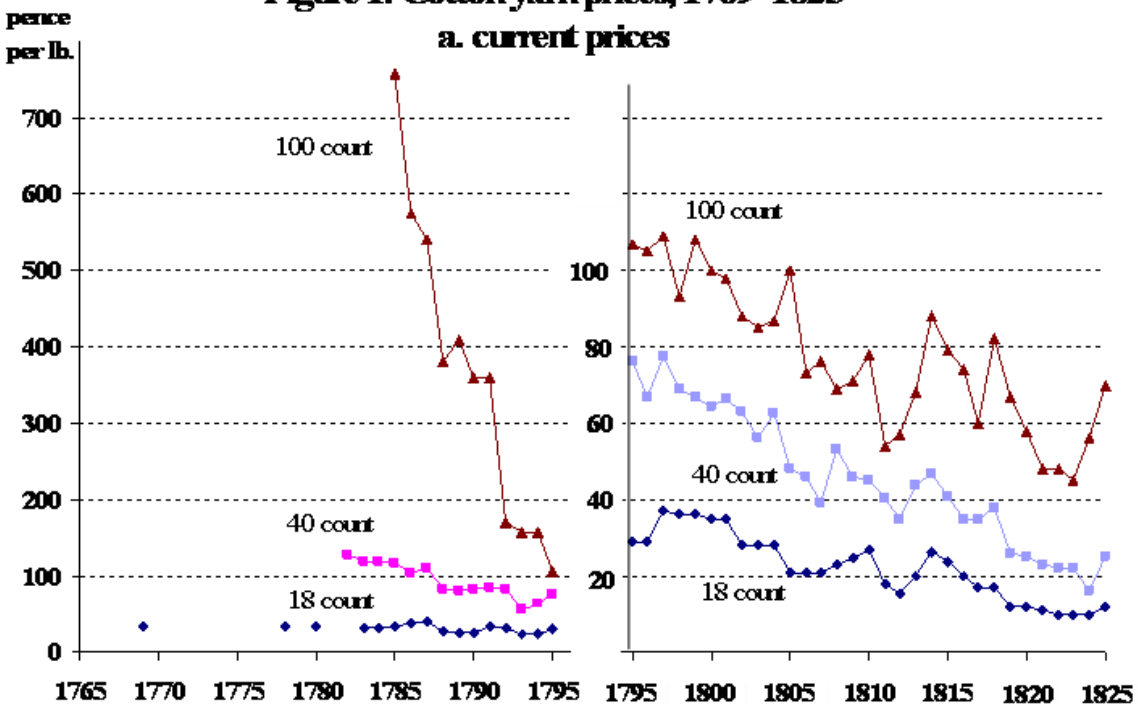
Period	Current Prices			Deflated Prices		
	18 weft	40	100	18	40	100
1769	33					
1778	34					
1780/4	33	122		47	168	
1785/9	33	99	532	47	142	761
1790/4	27	74	240	36	97	318
1795/9	33	71	104	36	77	112
1800/4	31	62	92	27	55	80
1805/9	22	46	78	19	39	66
1810/4	21	42	69	15	30	50
1815/9	18	35	72	15	30	62
1820/4	11	22	51	11	22	51
1825/7	10	21	53	10	20	52

Cotton cloth prices fell much more slowly than yarn prices in the first generation of the Industrial Revolution. The slower price decline occurred, however, not because of a delayed diffusion of new technology but because technological advance had not occurred

[6] Source: Harley, 1998. Deflation uses Feinstein (1995) cost of living index.

in weaving. Even so, as Figure 2 shows, cloth prices fell impressively in real terms before the end of the Napoleonic Wars because the price of yarn had fallen so much. Cloth prices continued to fall thereafter as technology improved in weaving and finishing.

Figure 1: Cotton yarn prices, 1769 -1825



Source: Harley (1998).

Among the various cotton textiles, the particular nature of technological advance changed relative prices as a relatively rapid process of competitive entry would predict. The varied effects of innovations even among yarns of different types have already been noted. As the industry had low vertical integration, market prices of semi-finished goods at various stages of production are available. Weaving firms bought yarn and sold grey cloth. Table 2 and Figure 3 show the movement of prices of various components of a standard printing calico between the early 1780s and the 1830s.[7]

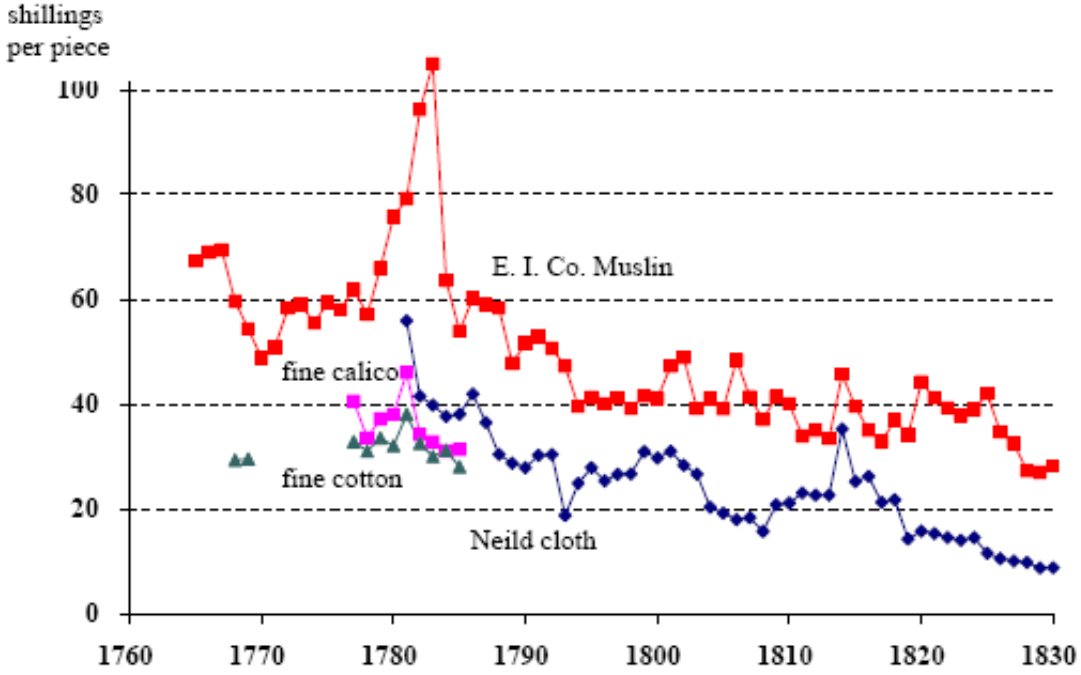
It is useful to trace the 'margin' between cloth prices and the price of yarn used to construct that cloth[8] (Table 2 and Figure 4). There was no technological improvement in weaving until the 1820s so the weaving margin provides an indication of the shorter term fortunes of the industry. The 'normal' weaving margin appears to have been between 6 and 7 shillings per cloth both in the 1780s and in the early 1820s. Levels above that rate reflected prosperity and expansion; levels below reflected distress.

[7] The cloth is that discussed by Neild (1861).

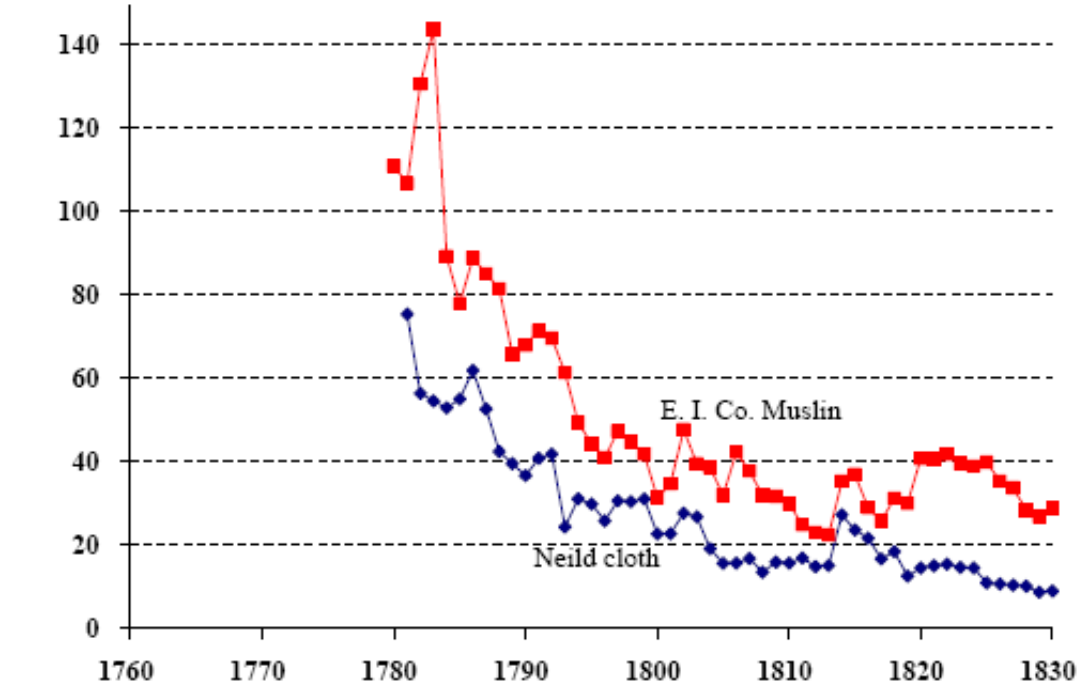
[8] See Appendix 1 for a detailed discussion of the components of the cost of a standard cotton cloth.

Figure 2: Cotton cloth prices, 1765-1830

a. current prices



b. deflated prices



Source: Harley (1998).

Table 2

Cost components (deflated), printing cloth

(shillings per cloth)

	Cloth	yarn	cotton	Cloth-yarn	Yarn-cotton
1782/85	49.0	42.9	11.4	6.1	31.5
1786/90	40.4	33.6	10.3	6.8	23.3
1791/95	34.6	25.7	10.6	9.0	15.1
1796/1800	30.9	20.0	11.8	10.9	8.2
1801/05	23.6	15.0	7.8	8.6	7.1
1806/10	15.8	10.8	7.3	5.0	3.5
1811/15	19.5	9.4	6.7	10.1	2.7
1816/20	16.7	8.8	5.9	7.9	2.9
1821/25	14.1	7.3	3.9	6.8	3.4
1826/30	9.8	5.2	2.8	4.5	2.5

From the 1780s to the end of the century, yarn prices fell, but the value added in weaving yarn into grey cloth did not. Indeed, the weaving margin increased by about fifty percent as the industry expanded enormously in response to cheap yarn. During these years, workers and entrepreneurs shared exceptional gains. Weaving wages rose dramatically. Almost all commentators since Baines (1835, 337) have included the following quotation from William Radcliffe's 1828 memoirs (1828, 59; 66):

> In the year 1770,...the father of a family would earn from eight shillings to half a guinea at his loom, and his sons, if he had one, or two, or three along side of him, six or eight shillings each per week....From the year 1770 to 1788 a complete change had gradually been effected in the spinning of yarns....[O]ur family and some others in the neighbourhood during the latter half of the time, earned from three to four fold wages [in weaving] to what the same family had heretofore done....The next fifteen years, viz. form 1788 to 1803, which fifteen years I will call the golden age of this great trade, which has been ever since in a gradual decline....the price of labour only rose to five times the amount ever before experienced in this sub division, every family bringing home weekly 40, 60, 80, 100 or even 120 shillings per week!!!

Figure 3
Components of Cloth Price, deflated 1781-1830
shillings per piece

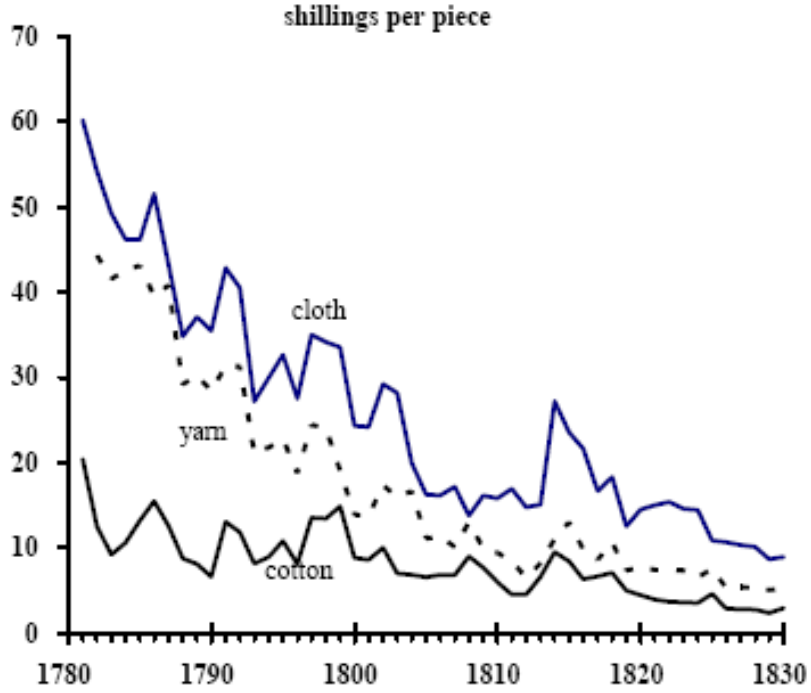
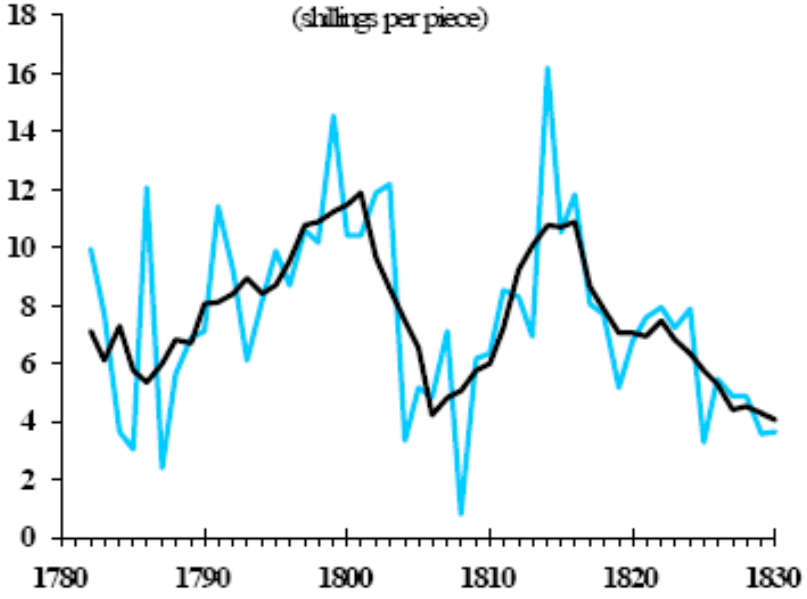


Figure 4
Weaving Margin (deflated), 1782-1830
annual and 5 yr moving ave.
(shillings per piece)



Source: Appendix 1.

Weaving margins and weavers' real wages began to decline after the turn of the century as an abundant pool of labour within traditional sectors of the economy moved into weaving. in response to the (temporarily) higher wages. Added to the effect of the fall in weavers' wages on the margins were real difficulties in the industry arising from the Napoleonic Wars. The combination of Napoleon's Continental System and the British Orders in Council sharply cut the volume of export trade and, in what was a highly competitive industry with excess capacity, also led to sharp falls in prices.[9] The margin calculations show that the second half of the first decade of the century was very difficult for the industry (as the profit calculation below confirm). Napoleon's defeat reversed the situation by opening up Continental markets. The industry enjoyed exceptional prosperity as Continental markets reopened after Napoleon's Russian campaign failed in 1812, and the boom continued until after Waterloo. The boom was short-lived however, as the passing of exceptional conditions and the years of deflation resulting from the return to gold created further difficulties. By the mid 1820s, technological change in weaving began to have an important impact. The pressure from power weaving started to reduce the margin between yarn costs and cloth prices. In this environment the real earnings of hand-loom weavers continued to deteriorate even in normal years for the industry.

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[9] The authoritative source remains Crouzet (1958). This work draws heavily on the letter books of the Manchester fine spinning firm of McConnel & Kennedy (in the Rylands Library in Manchester). His description of the industry's fortunes between 1803 to 1812 contain the following summary statements:

> Aussi, à la crise de 1803 succéda, en 1804, une sorte de marasme prolongé, que provoqua de plaints de la part des milieux cottoniers. En 1805, la situation fut meilleurs (c'est ainsi que les salaries de tesserands augmentèra légèrement). Mais la correspondence de Mac Connel et Kennedy révèle que les filatueurs conurent certaines difficultés (p. 192).
>
> Au total, it apparâit que l'industrie du coton connut pendant l'année 1806 des fluctuations assez fortes; cependant, l'été fut une période d'activité intense, et la production totale fut certainement supérieure à celle des années précédentes. Mais on peut penser que les profits des entreprises de filature ne furent pas très considérables (p. 195).
>
> Au total, l'année 1812 fut assez mauvaise pour l'industie du coton. Certes, elle ne connut pas un marasme aussi complet et persistant qu'en 1811, mais la depression regna pendant la plus grande partie de l'année, et la situation ne s'améliora nettement qu'à l'extrême fin de celle-ci (p. 728).

Also see Edwards (1967, Ch. 4).

III. Profits Rates[10]

Profit data are much more difficult to obtain than price data since private partnerships generally have no interest in publicizing profits. Furthermore, while a competitive market generally equalises product prices among firms (with due allowance for quality differences), profit levels will vary with management ability and luck. The general histories of the cotton industry offer conflicting evidence. Certainly Arkwright became very rich off his invention. Jedediah Strutt, an already wealthy partner and financier of Arkwright, benefited greatly from his early involvement (Fitton and Wadsworth, 1958). We also know, however, that Samuel Oldknow who invested in spinning in the 1780s, in close connection with the Arkwrights, was kept afloat in his lifetime only by the help of the younger Richard Arkwright who assumed his assets on his death (Fitton, 1989). It is also well known that Samuel Crompton never reaped financial fortune from the mule that he invented. In the cotton finishing business, the Peels became very rich (in part from their early association with Arkwright) but their late eighteenth century rivals, Hargreaves and Liversey, succumbed to spectacular bankruptcy in 1788.

The qualitative evidence suggests that there was a broad range of profit experience but provides no precise indication of the size of profits relative to capital employed. Unfortunately, it also suggests that a small sample of carefully examined firm-level profit data may fail to reveal the average industry trend. Nonetheless, it is useful to examine the profit performance from surviving company records in detail. Sufficiently detailed records survive to provide reliable profit indications for protracted periods around the turn of the nineteenth century for three companies – Richard Cardwell and his partners, Samuel Greg and his partners; William Grey and his partners. The first firm – through most of the period a partnership between Richard Caldwell and Richard Birley, although the records cover several partnerships with some variation – was an extensive putting-out weaving firm. Profits can be calculated from the late 1770s to the late 1810s. The second firm, the Quarry Bank Mill, whose principal owner was Samuel Greg[11], was a rural water frame spinner. The accounts that I consider span from the years 1796 to 1811. The third firm, William Gray and Sons, was a Bolton mule spinning firm. The profits can be estimated – rather less comprehensively than for the two firms above – from accounts that run from 1801 to 1810. All three firms were highly successful. Greg and Richard Hornby, who joined the Cardwell partnership in 1797, and their descendants, were major figures in the industry in the first half of the nineteenth century. Grey's firm continued to prosper until at least the 1850s. Since we know many firms failed during this period, the data from these firms probably exaggerate the overall industry profit rate, but on this we have no direct evidence.

[10] Details of the profit calculations are presented in Appendix 2.

[11] For a history of this firm see Rose (1986).

Assessment of profit rates requires care in identifying both the firm's capital stock and the returns that are appropriately allocated to capital. Accounts from these cotton firms of the late eighteenth and early nineteenth centuries contain information to construct capital stock values and returns, but to do so requires careful attention to accounting practices. The firms estimated profits by comparing balance sheet totals of work in progress, finished goods and the financial assets and liabilities of the firms in sequential periods. However, considerable payments to capital are not included in these profit calculations. In particular, firms usually paid interest on partners' initial capital and on any residual earnings in the firm before constructing profit estimates. These payments usually appear in the Private Ledgers of the partners. These charges to capital need to be included in measures of returns to firm capital. In addition, calculation of the firm's capital stock requires the consultation of various Private Ledgers in addition to the main profit and loss accounts.

Finally, attention should be drawn to two additional problems for calculating reliable profit figures. First, the partnership accounts make it possible to identify payments to the partners but do not distinguish payments to capital from payments to management. Second, general price level changes distorted profits during the inflationary era of the Revolutionary and Napoleonic Wars and the deflationary post-war period. With the accounting practices used by these firms, a rising price level will lead to a higher valuation of the inventories and accounts receivable that constituted the bulk of the firm's assets than would have been the case if prices had remained stable. Consider a firm that ended the year with exactly the same assets, in terms of physical inventory and accounts receivable relative to sales, that it started the year with. In real terms, its assets had not increased in value but the balance sheet would reveal an increase. This increase would be reported as profits, thus exaggerating the rate of return of capital. This problem is particularly important in the early years of the war when prices rose rapidly. Of course, a similar but exactly opposite distortion occurred during the post-war deflation where real profits would have been understated.

Caldwell and Birley

Caldwell and Birley's weaving business primarily involved circulating capital in the form of goods in process of production and sale, and only small amounts of fixed capital. As a consequence, its return to capital is relatively easy to calculate. The firm's accounting centred on annual inventories of stock, debts and credits, and a private ledger[12] that recorded the partners' interests in the firm. The annual inventories contain information about the stocks of inputs, initially raw cotton and linen warps and then increasingly cotton yarn, held in the firm's warehouses and the large amount of warps and cotton in the hands of weavers, who numbered some 250 in the late 1770 and

[12] Rylands Library English MS 1199/1.

increased to the end of the century when the firm had well over a thousand warps in the hands of weavers. The inventories also recorded debts owed by and owed to the firm. A considerable amount of the debt was trade credit, but a not insubstantial amount was clearly capital provided by long-term lenders who received interest at 5%. My possibly incomplete calculation of this investment in the firm in 1778 amounted to more than £5,000 (Rylands Eng MS 1199/1 p.55). The lenders seem to have had personal connections with the partners in the firm. Over £861 came from Hugh Hornby & Wm Clayton and £228 from Elizabeth Cardwell. The largest deposit was £1747 by the Executors of the late Mr Holme. Most intriguing were three deposits by the "Trustees of the Charity School" amounting to £408.

The firm calculated its profits from changes in the annual inventory of goods and financial assets and liabilities. That calculation is a misleading indication of the return to capital however because, prior to calculating the firm's worth, book transfers were made to the partners. These transfers consisted of two parts. First, 6 percent of the partnerships original capital (£12,000) was moved to the private ledgers (£720 per year).[13] In fact relatively little of the money credited to the partners in the private ledgers was actually removed from the firm. The remaining balance was counted as a loan by the partners to the firm. These "loans" were quite large. For example, during the partnership of Richard Cardwell and Richard Birley, initiated in 1772 with an initial capital (and stock in trade) injection of £12,000, the partners' "loans" peaked at £4,957 in 1783. These loans received interest at 5% before the inventory balance was calculated.

During the initial (1772) partnership between Cardwell and Briley, increases (and decreases) in the value of the firm as revealed in the annual inventory remained as 'surplus' in the firm's income accounts. The accumulated surpluses in the first partnership amounted to £21,166 by the time the partnership was revised in 1785. By that time the retained earnings in the firm's accounts and in the partners' private ledgers was more than twice the partnership's initial capital.

The partnership was reconstituted in 1785 with Richard Cardwell, Jr replacing his father and John Hornby added as a partner. The partnership's capital was £50,000. This was mostly made up with the valuation of the prior partnership (£33,166), along with additional transfers from the partners' private ledger accounts. There is some additional partners' capital, most of it financed by borrowing. Hereafter, the partnership's surplus, which had previously been carried on the firm's account, was credited to the partners. Most of this remained in the partnership as 'partners' loans' receiving 5 percent interest before the annual profit and loss balance was struck.

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[13] The following notation (from the end of the inventory for 31 Dec. 1782 (Rylands Eng MS 1199/1 p. 108)) appears regularly:

"Having first deducted 6pCt on £12000 agreed to be taken out yearly by C&B being their original Stock in Trade & entered to their Credit in each of their private accounts in the Ledger amounting together to £720."

The partners established a new partnership at the start of 1792 with a capital of £55,000 (Hornby increasing his capital from £10,000 to £15,000)[14]. In 1797 the partnership was again renewed. This time the capital amounted to £100,000. Birley became the largest partner with a capital of £40,000, made up of his £20,000 investment in the old firm plus £20,000 from his accumulated retained earnings. In addition, he left a further £6,795 as monies on interest in the partnership at the end of the year. Cardwell put up £30,000, consisting of £20,000 in the old firm plus £10,000 of his accumulated retained earnings. He had an additional £17,432 in monies on interest in the firm. Hornby made up his £30,000 with his £15,000 in the old partnership, money from his retained earnings and by becoming a debtor to the partnership to the extent that he had a debt to the firm of £6,903 at the end of the year.[15]

The partnership terminated in 1798 and was followed by two successor firms – Birley & Hornby and Richard Cardwell & Sons. The final years of the surviving accounts are those of Birley & Hornby. The firm's capital consisted of £40,000. As had previously been the case, the partners' retained earnings in the partnership were transferred to private ledgers, largely left in the firm and accounted as loans. Interest was paid on both the capital and the loan.

The financial history of the firm followed the pattern that we have come to expect of early modern partnerships. Most of the initial capital came from existing activity in industry. The records contain inventories of preceding firms taken in 1768. At that time the partnership of Richard Cardwell, the Heirs of the late Mr. John Shepherd and Richard Birley had a gross stock of £18,636 and debts of £4,163. Of this two-fifths was Richard Cardwell's and one-fifth Richard Birley's.[16] At the same time John Thorton had a "neat stock" of £1,042.[17] The new firm of Richard Cardwell, Richard Birley and John Thorton, created on 1 January 1768 had a capital of £15,000. Cardwell's £6,000 share was made up almost entirely by the £5,789 in stock in trade he brought from the preceding firm. Birley's share was also £6,000 but his credit from the previous firm was only half of Cardwell's so he had to find somewhat more than half his share. He appears to have been able to do this from funds he had available. Thorton's share of £3,000 exceed the stock in trade he contributed by £1,959 which he borrowed. This he did with a "cash upon bond from Mr. Wood of £500" and smaller borrowings from 10 more people, four of which involved transfers of debts formerly owed by Cardwell, Shepherd and Birley.[18] The inventory of the predecessor firm at the end of its first year of existence showed considerable borrowing by the firm in addition to Thorton's personal debts. The principal debts of the partnership were:

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[14] Rylands Eng MS 1199/1 p. 226.

[15] Rylands Eng MS 1199/2 p. 53.

[16] Rylands Eng MS 1199/1, p. 10.

[17] Rylands Eng MS 1199/1, p. 18.

[18] Rylands Eng MS 1199/1, p. 19, p. 8.

Mrs Jennet Squires	£ 1646
Mrs Liversey	£103
Mr Henry Williamson	£175
Mr John Holme	£722
Trustees of the Charity School	£201

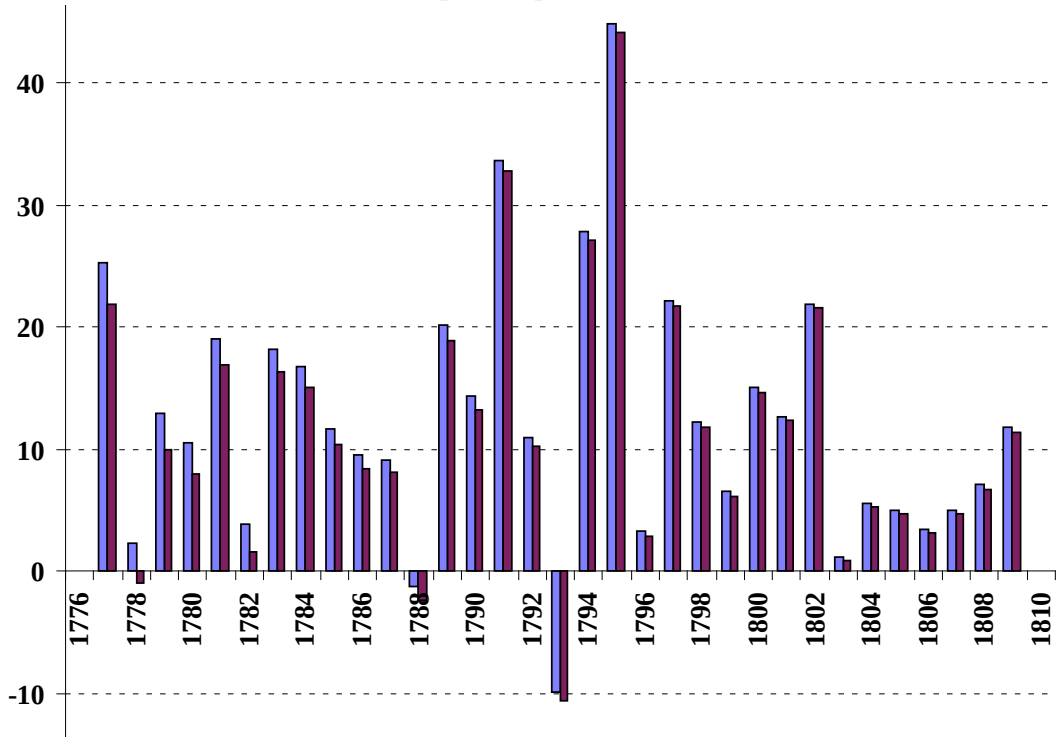
Together these debts amounted to £2,672. This is a relatively small portion of the total capital but combined with Thorton's personal borrowing amounts to a little over a quarter of the partnership's capital. The records provide little indication of the relationships involved in this credit, but presumably it rested on personal acquaintances (as the later inclusion of persons with the same surnames as partners, already noted, indicates). The records also indicate active involvement in mercantile credit in the early stages. On 1 January 1769, the firm showed accounts receivable of £14,779, presumably on sales carried out with deferred payments. The firm also owed £1,700 in trade credit.[19]

The growth of the firm's capital from about £12,000 (since Thornton drops out of the firm in 1776) in 1768 to nearly £140,000 in 1798 was financed almost entirely by retained earnings. Birley and Hornby's business over the next 11 years, in contrast, maintained a more or less constant capital stock. The rapid growth of the firm between 1768 and 1798 was certainly impressive. Its capital grew at a rate of just over 8 per cent per year for 30 years. Was this an indication of the industry's dependency on super profits to grow, or simply an abstention from consumption and plowing back of 'normal profits'? In considering this question, it is useful to calculate the firm's profit rate from year to year. This involves reworking the firms accounts to accurately calculate the payment to capital, and to relate those payments to the capital invested in the firm.

Payments to capital include not only the surplus calculated in the profit and loss accounts but also the interest payments on partners' capital and retained earning. The capital to relate to these payments is the partners' capital invested (capital plus retained earnings) which involves combining information from the private ledgers as well as the profit and loss inventories. Annual profit rates calculated in this manner are plotted as the dark bars on Figure 5. Over the entire range from 1777 to 1809 profits average 12.5 percent and range from a high of 45 percent in 1795 to 10 percent loss in 1793.

[19] Rylands Eng MS 1199/1, p. 28-30.

Figure 5
Cardwell and Birley rate of return on capital, 1777-1809
(percent per year)



Source: Appendix 2

The profits calculated above, however, represent not only payment to the firm's employed capital but also to management. The account of the late 1790 indicated that Richard Cardwell's son (also called Richard), who had been entered the firm as an apprentice in the early 1790 and became a partner with his father when the partnership between Cardwell and Birley ended in 1799, was being paid £200 per year. If that amount is deducted (presumably conservatively) for each partner before calculating profits, the profit rates are indicated by the clear bars on Figure 5. The average rate of return over from 1777 to 1809 was 11.4 per cent. If we double this amount the return is reduced by about another half a percent. Given the risk involved in the firm this return hardly seems to be an indication of super profits in the cotton textile industry during the industrial revolution.

Quarry Bank[20]

The profits of a rural water-powered Arkwright spinning mill in the last years of the eighteenth and first years of the nineteenth century may be traced with the surviving records from Samuel Greg's Quarry Bank Mill. The structure of the firm, both in its actual operation and in its accounts, was more complex than was that of Cardwell and Birley because the spinning firm, unlike the putting-out weaving firm, had substantial fixed capital. The structure of the accounts, however, is quite similar. The firm calculated its profits semi-annually as the change in the value of its stock in trade and financial holdings.[21] As in the case of the weaving firm, amounts were transferred to the private accounts of the partners to cover interest before profit or loss was calculated;a payment for the cost of physical capital was also transferred to the relevant private account.

The accounts begin with the establishment of a partnership between Samuel Greg and Peter Ewart on 1 Sept. 1796.[22] Ewart brought no capital to the initial partnership but was given a quarter share in the partnership. Greg, on the other hand, brought considerable capital into the partnership. He owned the mill and its machinery which was valued at £12,000 – calculated on the basis of 95 shillings per spindle 'including tools and implements of every kind'. The partnership paid Greg rent of 10% annually on the value of the mill (and subsequent additions) into the F/O account before calculating profit and loss for distribution. Greg also brought into the partnership stock in hand worth £5,002 plus £8,973 in cash that was to receive annual interest at 5% before calculation of partnership profits and loss.[23] As the partnership made profits, these were transferred to the private accounts of the partners. Much of this was retained in the business, and partners received 5% interest on this amount prior to profit calculations.[24] Some of Greg's account financed additions and improvements to the mill and equipment. These were recorded separately, added to the mill valuation in the F/O accounts and received the same 10% rent as the rest of the mill and equipment.[25]

One feature of the Quarry Bank accounts was a striking accumulation of cash balances. This was certainly not a financially constrained firm whose expansion was limited by profits being ploughed back into fixed capital. In the first valuation, at the end

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[20] The history of the Greg and Quarry Bank from the industrial revolution to the First World War has been covered at length in Rose (1986). Chapters 1 and 2 deal with the period discussed here but Rose does not explore the account books.

[21] Manchester Central Library, Ms C5/1/2/2 F/N(Factory/New) accounts.

[22] For the early years of the Quarry Bank Mill and the initial sources of Greg's capital see Rose (1986, Ch. 2).

[23] Manchester Central Library, Ms C5/1/2/2 F/O (Factory/Old) accounts.

[24] Manchester Central Library, Ms C5/1/2/2 SG (Samuel Greg) and PE (Peter Ewart) accounts.

[25] Manchester Central Library, Ms C5/1/2/2 SG his a/c with Stock.

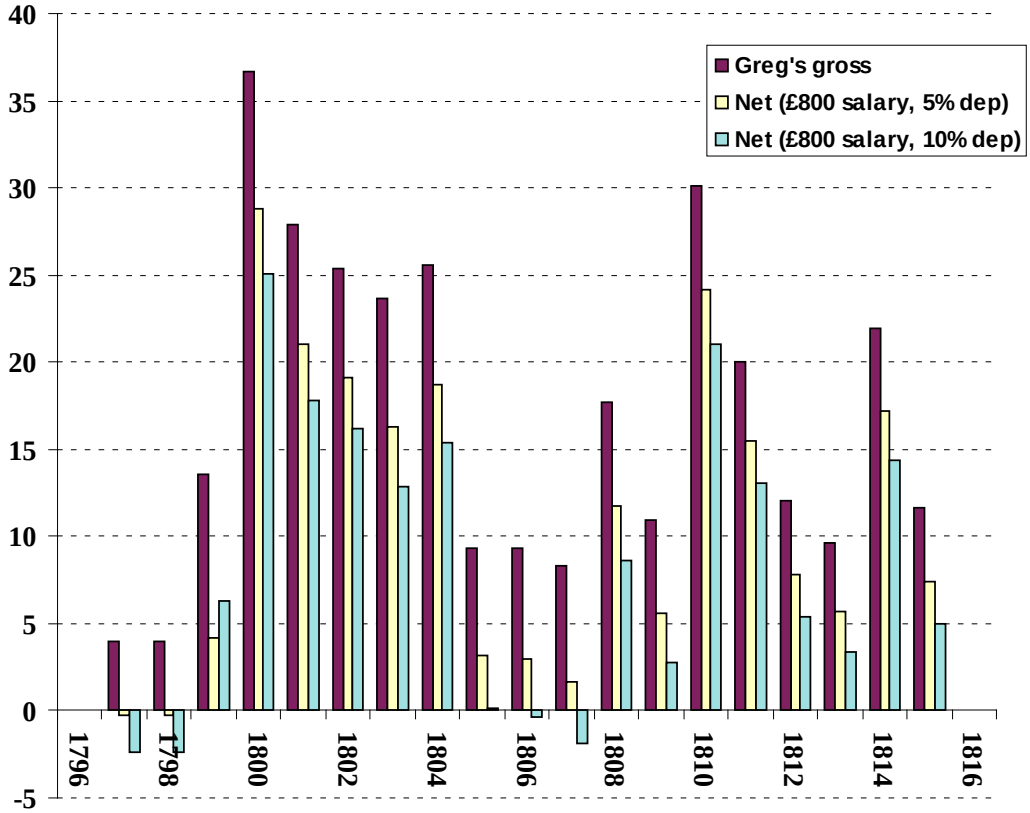
of 1798, the firm had a debt balance of £3,822 in its bank accounts. This quickly became a positive balance. By the end of March 1801, it had been transformed into a credit balance of £16,342. The balance grew fairly steadily to £69,047 in September 1810. At this point these balances constituted sixty-six percent of the firm's total assets of £104,354. At that time, the partners withdrew £43,650 from the cash account and from their private ledgers with the partnership. The cash account remained large, growing to £44,127 in September 1814 before declining slightly.

Calculating economically meaningful profit rates from these accounts in order to represent the returns of capital in cotton spinning requires several adjustments. First, the payments to the F/O account for rent of fixed capital and to partners' private ledgers for interest on retained earnings need to be added back to the profits calculated for partnership distribution. Second, depreciation of the fixed capital needs to be considered. It is clear from the decline of about 5% in most years in the valuation of the fixed capital enumerated in the F/O accounts that the partnership was calculating depreciation. The reported depreciated value of capital should appropriately be included in the denominator of the profitability calculation. In addition, depreciation should be deducted from profits as a cost rather than being considered a part of the return to capital. I have calculated two profit rates, one with a 5 percent depreciation rate and a second with a 10 percent depreciation rate (even though Greg seems to have used a rather less systematic procedure). Third, the firm's large bankers' balances are problematic. These balances did not make up a part of the economically relevant capital stock of the cotton spinning firm. In addition they presumably received interest from the bankers that entered the accounts and appeared in the firm's calculated profits. I have assumed that the bankers' balances received 5% interest and removed that amount from the calculated profits, and also removed the balances from the capital stock. It is worth noting that this raises the calculated profit rate since the rate I calculate considerably exceeds 5%. In calculating profit rates, I have focused on the Greg's capital and his returns since Ewart initially brought no capital to the firm. Just as in the case of Cardwell and Birley, there remains the question of what part of Greg's income should be considered as managerial remuneration. Ewart's share of the profits amounted to approximately £800 per year and I have deducted this from Greg's income to calculate a pure return to capital that is presented in Figure 6.

Greg's average rate of return gross of management salary and depreciation from 1797 to 1815 amounted to 18.8 percent. If management salary and depreciation is deducted, the rate of return falls to 12.9 or 9.9 percent depending on the rate of depreciation. Again these are hardly spectacular rates of profit. As was the case with Cardwell and Birley, returns fluctuated quite widely between a maximum (deducting ten percent depreciation and management cost) of 29 percent in 1800 and a small loss in 1798.

The Greg accounts also make it clear that the firm's expansion was not constrained by limitations of finance and dependent on profits. After all, for most of the period the firm had very substantial cash balances that often exceeded the value of its fixed and working capital.

Figure 6
Samuel Greg's rate of return on capital, 1797-1815
(percent per year)



Source: Appendix 2.

William Gray and Sons

The third set of accounts from which I have been able to calculate profits over a substantial period are those of a firm that became William Gray and Sons.26 This was a mule spinning partnership in Bolton that subsequently expanded into a major business in the region during the early nineteenth century. The detailed surviving accounts run from

[26] Bolton Archive and Local Study Service MS ZGR.

1801 to 1810 and relate to a partnership of three brothers, John, Henry and William Gray. The firm survived and eventually prospered, but the period covered by these accounts was difficult. When the surviving accounts begin in 1801, it appears that the sons had recently taken over the firm from their father who had provided most of the capital employed.

The liability side of the 31 December 1801 balance sheet[27] was as follows:

To:	Sundry Persons	£968
	My Father on Bond	£3300
	Ballance (sic)	£3953

The firm's assets were divided among trade credit due, plant and equipment and work in progress in the following manner.

Due from Sundry Persons	£2242
Inventories of raw material and work in progress	£3863
Machinery	£3066
Factory, Weir etc.	£5500
Total	**£13721**

When the trade liabilities (£968) are netted out, the firm's capital amounted to £12,753. The mill was described at the end of 1809 as:

[27] ZGR 6 f. 16.

Premises in Darcey Lane	
One Mill 4 stories high 304^{ft} long & twenty foot wide, and do 3 stories high & twenty foot wide, two Water Wheel with upright & laying Shaft wear Fender & Shirs	£4000.0.0
A Warehouse adjoining, 17 Cottages at Damside & 6 cottages by the Canal.	£1500.0.0
	£5500.0.0

The £5500 valuation of the factory building, wear etc. does not appear in the balance sheets until the end of 1805. It is not clear whether the father retained ownership or whether it was simply left out of the balance sheet because its value did not change over time.[28] It is not clear whether the father retained ownership or whether it was simply left out of the balance sheets because its value did not change over time.

Much of the capital – the majority if the mill had remained in the old man's hands – was in the hands of the father. I have not been able to ascertain the payments credited to the younger Grays and their father prior to the striking of the annual balance. Given contemporary practice, however, it is almost certain that interest was paid on the bond listed above. It is likely that some rent was also paid on the mill and that any balance left in the firm also received interest. Lacking details about these payments makes calculating the profit rates problematic. The Grays periodically, but not systematically, reduced the reported value of the machinery for depreciation in calculating balances. The 1809 account, for example, contains the following:[29]

The Machinery is the same as last year	£1700.6.0
from which deduct one sixth	£283.7.8

Thus, although depreciation accounting was not systematic, calculated profit and loss were net of depreciation.

Since our concern is primarily to investigate whether cotton textile firms generally earned super profits during the first generation of expansion, these problems need not trouble us excessively since the few years that began in 1805 were nearly fatal for the Gray firm. The partners clearly knew that they were in financial trouble as the accounts contained quarterly calculations of the (declining) balance of equity in the firm rather than the customary annual calculation. As conditions deteriorated, partial inventories in

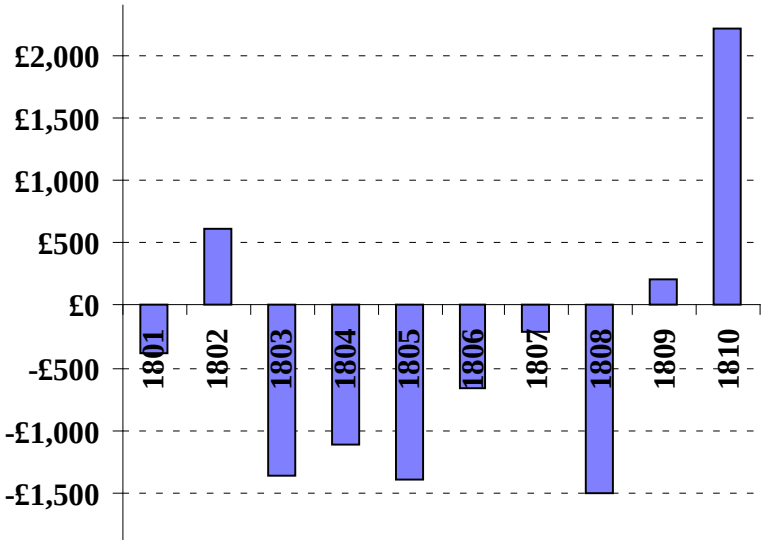
[28] f. 134

[29] ZGR 6 f. 169.

1806 through to 1808 did not contain complete balances. When a balance was struck at the end of 1808, it showed a negative net worth for the firm.[30]

The 'profits' calculated from the balances from 1801- to 1810 are shown in figure 7. Over these years the balance averaged a loss of £261 per year. Not a large percentage loss on a capital over £10,000 but certainly not super profits. It is fairly certain that some capital charges were either paid or transferred to other accounts prior to the striking of

Figure 7
Gray Surplus and losses, 1801-1810



Source: Appendix 2.

balances. Those payments should be included in the return to capital, so the firm's cash flow and actual return to capital were almost certainly not negative. Interest was almost certainly paid, at least in reasonably good years, on the debts to John Gray, Sr. The interest rate on these debts, however, was low. An "account John Gray, esq" indicates "To my Bond for the Balancing with Int at 3 per C ..£350" in 1796. An entry for 1797 reads; "To my Bond fro Ballancing with Intst at 4 perC from the 6th March 1797…£500" and "To my Note with Interest at 5 perCt from 6th March 1797..£150."[31] With these varying interest rates, it is impossible to present an accurate estimate of the return to capital. It was, however, clearly below the opportunity cost of capital and well below any reasonable risk-adjusted competitive return. This, of course, would be even more clearly so if management income for the partners were accounted for in the calculations.

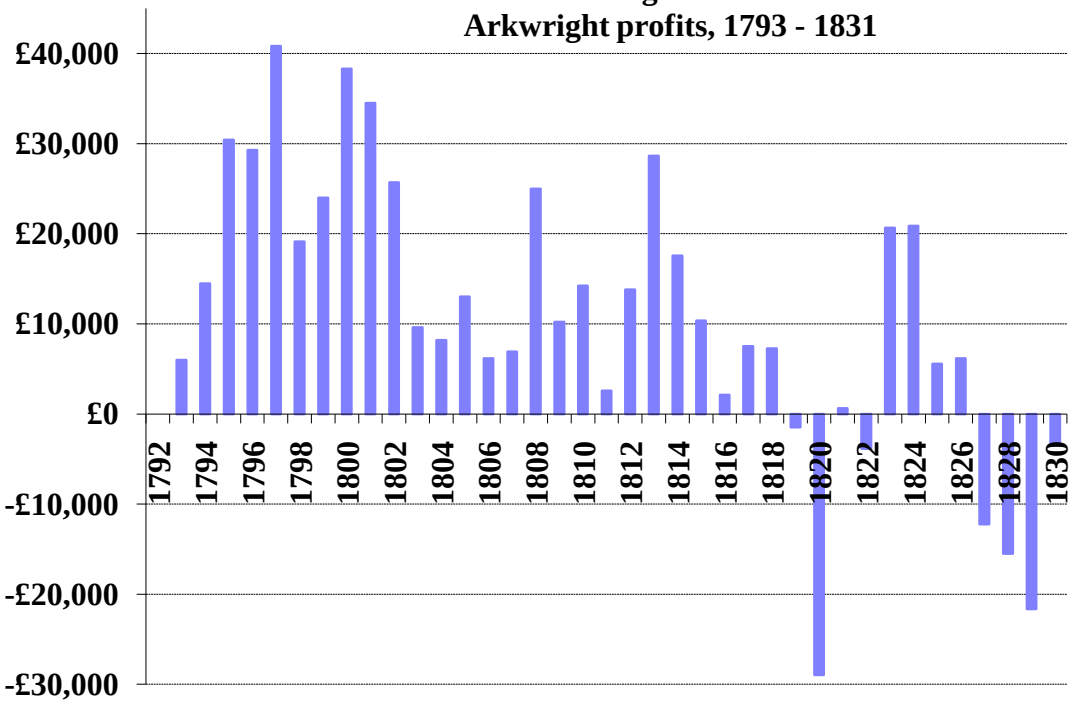
[30] f. 165.

[31] ZGR 2 p. 34-5.

Arkwright

The spinners we have considered were not earning excess profits by 1800 or so. The impression that super profits had disappeared by the late years of the eighteenth century is reinforced by the experience of the pioneering firm in the industry. Richard Arkwright Jr.'s annual profits are summarised in Figure 8 (Fitton, 1989, pp. 225-8). R. S. Fitton reports annual profits in money terms. Unfortunately, there is no information about how these profits were calculated or the capital base to which they relate. Nonetheless they confirm both that profits fluctuated and their declining trend. The difficult war years after 1802 that show up in the other three firms are evident here as is the boom that accompanied the reopening of trade with the Continent in 1812. In addition, the unprofitable state of the industry after the return to peace stands out (although here the price deflation led to accounting profits falling below real profits).

Figure 8
Arkwright profits, 1793 - 1831



Source: Fitton (1989), pp. 225-8).

IV. Implications of price and profit data for views of the industrial revolution

Among the persistent debates in economic history, the question of how great a role the mechanical inventions, and the associated development of the factory system in British cotton textiles at the end of the eighteenth century played in the emergence of modern economic growth in Britain and the subsequent 'great divergence' continues to occupy a prominent place. From the late nineteenth century onwards, most economic histories emphasized the changes in economic organization, social relationships and technology in the cotton factories as the key transformation. Some dissenters, most notably Sir John Clapham, pointed out that despite its growth, cotton constituted a small part of the economy and emphasized continuity rather than decisive change (i.e. Industrial Revolution) within the industry. The pioneering quantitative estimates of British economic growth by Hoffmann (1955) and Deane and Cole (1962) indicated clear acceleration of growth during the Industrial Revolution, and tended to reinforce the view of the decisiveness of the cotton innovations. The revisions of national income estimates in the 1980s (Crafts, 1985; Harley, 1999; Crafts and Harley, 1993) showed a much more gradual acceleration of aggregate growth and suggested a more gradualist view. This in turn supported views that changes in the cotton industry were less central to the emergence of modern economic growth.

A perception of slower aggregate change, however, does not necessarily contradict a central position for the innovations of the late eighteenth century. Joel Mokyr, one of the leading scholars of the Industrial Revolution, has argued for what he calls a 'growing-up model' (Mokyr, 1976; 1999, 82-89; 98-103). This is a Schumpeterian view in which technology creates profit opportunities, and where technology is only slowly diffused. The essence of the model is captured in the following quotation from Mokyr (1999, 83):

> The growing-up model…is a disequilibrium model. Its dynamics depend on the coexistence and interaction of the "old" and "new" technologies….The traditional sector, which produces the same good (or a close substitute) as the factories, can continue its existence for a long time after the process has started, because the modern sector is still too small to supplant it altogether. As long as the two sectors coexist, the modern sector earns a "quasi-rent," a disequilibrium payment that will eventually disappear when the manual industries have disappeared. Through continual reinvestment, this rent in its turn provides the fuel for further growth of the modern sector.

Mokyr envisages a long disequilibrium phase; his discussion of wage trends (Mokyr 1991, 190) suggests that he considers it to have persisted until 1840 or 1850. Imperfect capital markets underlie the long disequilibrium. The rents are not dissipated by new entry, and investment by firms in the new industry depends on retained earnings. and its growth is consequently limited (Mokyr, 1999, 99).

In contrast to Mokyr's perception of a long disequilibrium and diffusion of new industrial revolution technology, Crafts and Harley have attempted to analyse the industrial revolution using comparative static general equilibrium analysis (Crafts and Harley (2004), Harley and Crafts (2000)). This analysis rests on assumptions of product and factor markets finding equilibrium fairly rapidly. Profit opportunities created by technological change attract competition and output expansion that eliminates profits by driving product prices down to reflect the cost reduction of the new technology. The benefits of technological change are cheaper textiles for consumers not higher profits for firms.

Schumpeterian and gradualist neo-classical views of the Industrial Revolution predict different price and profit developments following the famous cotton innovations of the 1760s and 1770s. Prices movements are the most easily observable implication. A Schumpeterian view such as Mokyr's predicts, and in fact depends on, a delay in the fall of the price of manufactured goods after the technological breakthrough and a protracted period of exceptionally high profits. The neo-classical view emphasizes the diversity of manufactured products and the product specific, and thus limitted, nature of technological change and its rapid exploitation of technological change. The expectation of this view is for the prices of cotton textiles – the specific goods in which technological breakthroughs occurred – to fall relative to the prices of other goods, both manufactured and agricultural, as cotton output expands. The price data presented in Section I show a rapid fall in cotton textile prices, and a pattern of price changes between yarn and cloth that reflects the timing of technological change.

The relationship between expanding industries and the capital market provide another contrast. In the "growing-up" model, capital market failure is central to delayed diffusion. Profits do not attract outside capital and consequently super-profits quasi-rents persist. Expansion of the new technology is, in turn, financed out of these profits. In the neo-classical view, profit opportunities are rapidly exploited, attracting capital from elsewhere in the economy if necessary. Product prices fall and eliminate super-profits. A sample of three firms is, of course, too small to draw definitive conclusions, but the experience of these firms, while they were subject to wide fluctuations, does not appear to have been one of profits being above the opportunity cost of capital in the economy when risk and management responsibilities are considered.

The financing of investment is another feature of Mokyr's "growing-up model." Limitations to investment in modern machinery that embodies new technology delay the traverse to a modern economy. During the transition, capital in modern equipment earns super-profits but outside capital fails to enter the market in order to expand modern industrial output, presumably because technological knowledge is guarded by innovators who prevent it from diffusing to outside firms. Furthermore, capital markets do not finance modern firms so growth of the modern sector depends on the profitability of innovating firms and entrepreneurial willingness to reinvest profits.

The diffusion model receives support from the widespread observation that reinvested profits financed most of the expansion of the Industrial Revolution's firms, as the

accounts reviewed here would indicate. Such observations, however, are weak indications of capital market failure. Certainly reinvested profits were a major source of investment funds but this remains true for firms today. Most studies of the late eighteenth-century textile industry, however, reject the view that firms were isolated from the capital market. Histories of the industry, while confirming the importance of retained earnings for firm expansion, suggest several reasons for doubting the existence of a serious capital constraint. Fixed capital played a relatively modest role in the cost structure of new firms. The new technology attracted capital from pre-existing putting-out and mercantile sources. New firms using the new technology were able to fit into the sophisticated "web of credit" that existed in Britain by the late eighteenth century (Crouzet, 1962, 1972; Pollard, 1964; Chapman, 1967, 1970; Cotterell, 1980; Hudson, 1986, 1989). The credit system involved book credit among customers, bills of exchange and the emerging country banking system. Crouzet ((1972, 45) citing Pollard (1964)) concludes:

> that 'this web of credit should be placed near the centre of the exposition of the accumulation of capital.' Merchant firms, which supplied industry with a large part of the circulating capital, thus played a dominant and decisive part in the industrial revolution, and the financing of stocks by mercantile capital was much more important than industry's self-finance, at least up to 1815.

Crouzet ends his discussion of the financing of firms (p. 53) concluding that:

> the emphasis which recent writing has placed upon trade credit, a closer relationship between banks and industry, and the early capital market, has tended to show that in eighteenth century and early nineteenth century Britain, with its sophisticated and innovating financial system, capital supply was not a serious problem.

Certainly eighteenth century businesses drew heavily on internal funds, and external funds came from individuals with personal or business contacts with the firm's owners. This , however, should not be a source of surprise. Investment always involves the surrender of command over current resources for expectations of future returns. Future returns depend in large measure on the ability, diligence and honesty of those running the firm using the investment. When outsiders lend, they must be compensated for the risks they bear in depending on the performance of others in managing the firm. This risk of uncertain agent behaviour does not arise when partners in the firm invest their own funds. Consequently, internally generated funds are cheapest to the firm and will be used in preference to other funds if they are available. The next cheapest funds come from those who are able independently to judge the character of the firm's partners. Only when the economies of scale in the technology are so great as to necessitate very large firms for efficient production does it become appropriate to invest in managerial

and accounting techniques that can provide investors who do not personally know the managers of the firm the reassurance they need to be willing to part with their funds.[32]

The predominance of internally generated funds in the expansion of firms cannot, by itself, tell us whether the capital market operated efficiently during the Industrial Revolution. Perhaps firms needed no additional funds to exploit the opportunities the technology presented, as was clearly the case at Quarry Bank where the partnership carried large cash balances through the period investigated. The rate of return that capital earned in the industry, relative to its earnings in other uses with comparable risk, provides a proper test of the availability of capital. The calculated rates of return do not suggest that opportunities to invest were missed.

Conclusions

Examining the details about cotton textile prices and the profits earned by a small sample of firms in the early years of the Industrial Revolution indicates that technological changes that lowered production costs quickly attracted capital. Output expanded and prices fell. Limited data on profits are far from conclusive, but they indicate that sufficient capital was attracted to the industry to expand output and drive profits down to something that resembles the equilibrium of the economists' model of a perfectly competitive market. The data examined here do not support the contention that the process originated by improved cotton technology is usefully analysed by a disequilibrium "growing-up" model that emphasizes the difficulty that outsiders had in gaining knowledge of the technology and the imperfections in the capital market. It suggests, instead, that an approach which recognizes the limitations of the impact of technological change in a single industry, and which focuses on the distinctions between industries and on changing relative prices, probably has more to offer in understanding the beginnings of modern economic growth in Britain. This in turn suggests that although the history of the cotton textile industry deserves the attention it receives, it is far from providing the key to understanding the modern growth process.

[32] See Neal (1994, pp. 151-7) for a discussion of this issue. Mokyr (1999, 99-102) makes these same points.

Appendix 1: Cost components of cotton cloth

The calculations of the time trend in cloth prices presented in Table 2 and Figure 3 are based on the grey printing cloth whose prices Alderman William Neild, a leading cotton Manchester printer, presented in an 1861 paper to the Statistical Society, provides the basis for comparison. Neild's cloth is described in detail in John Lyons' 1977 doctoral dissertation:

> A printing calico with the following characteristics: 29 yards finished length, 28 inches finished width, with 84 picks of weft yarn per inch, and 77 threads of warp yarn per inch. (note 5: In the finished cloth, warp threads are of a density of 77 to the inch, which results from the shrinkage due to tension from 30 inches in the reed at 72 threads per inch, to 28 inches in the woven state.) Each piece contained an average of 87696 picks of weft of 36 hanks to the pound and 2160 threads of warp yarn of 36 hanks to the pound. The weight of yarn per piece is 2.215 pounds of warp, and 2.415 pounds of weft. The remainder of the 5 pounds 2 ounces of finished weight is flour used in dressing the warp preparatory to weaving.[33]

Neild's series of cloth prices has been projected back into the late nineteenth century (Harley, 1998). The same source provides information regarding prices of warp and weft of various counts, including the 36 count used in the Neild cloth. Several similar, albeit un identical, series of raw cotton prices are available. The cotton prices used in the calculations are described in detail below. In calculating raw cotton cost I have followed early nineteenth century convention of adding ten percent for waste.

The use of this cloth for the late eighteenth century is somewhat anachronistic. The cloth uses rather higher count cotton than was common until the beginning of the nineteenth century. It seems, nonetheless, appropriate to follow a single cloth through the period considered. In addition, there is some evidence that cotton waste may have been a few percentage points higher in the late eighteenth century.

Raw cotton

The literature offers several sources of series of raw cotton price during the Industrial Revolution (notably Tooke, 1838; Burn, 1847; Ellison, 1858; Ellison, 1886; Gayer, Rostow and Schwartz, 1953). The series begin at different dates. Tooke's West Indian cotton series begins in 1782 and his Bowed Georgia series in 1793; Gayer, Rostow

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33. 'Lancashire Cotton Industry', p. 195. In fact Neild's price quotations for 1812 to 1817 were for a slightly finer cloth, an 80 reed rather than a 72 reed cloth. Neild stated that it would have sold for a 10.7 percent higher price than the 72 reed cloth in the rest of his series.

and Schwartz's series for West Indian cotton begins in 1790; Ellison presented a series of upland cotton in his 1858 volume that began in 1800 and in his better know 1886 volume, a slightly different series that began in 1811 and presents slightly lower prices for 1811-15. I have also been able to construct a series from the Caldwell and Birley accounts from 1780 to 1798. Where the series overlap they are generally very similar but not identical. This is hardly strange since cotton is not a homogeneous commodity and was not systematically classed until the middle decades of the nineteenth century. In particular, West Indian cotton was almost always more expensive than upland American cotton because of its longer staple length.

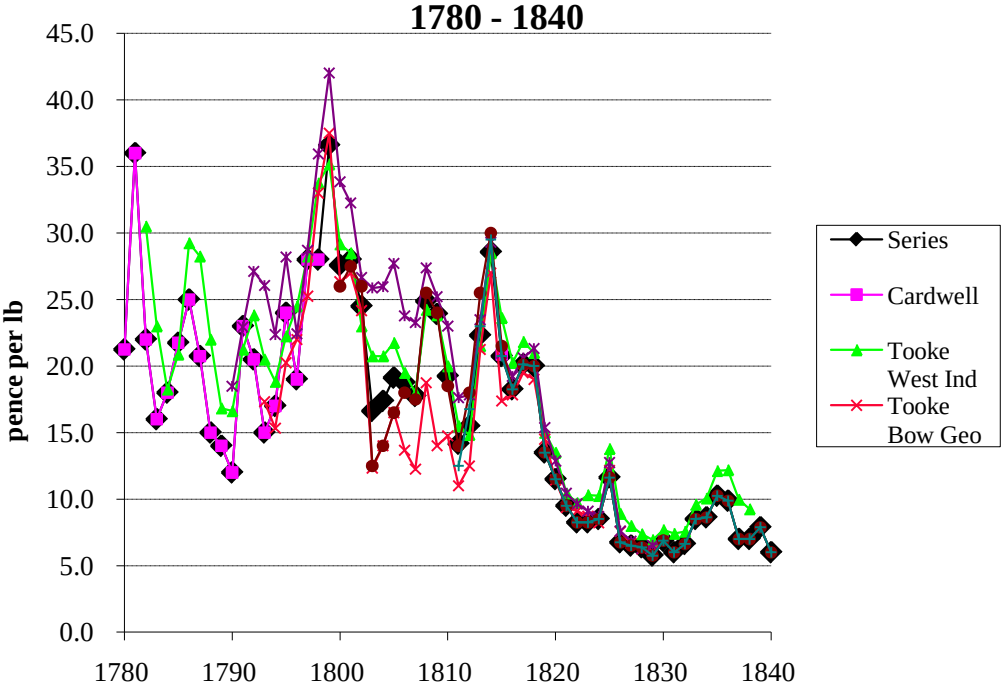
In my calculations, I have chosen to use the Caldwell and Birley inventory price until 1798. From 1815, I have adopted Ellison's 1886 numbers for upland American cotton. For 1800 to 1810 I have used an average of Tooke's two series, Gayer, Rostow and Schwartz series and Ellison's 1858 series. Since Ellison's series does not begin until 1800 but is one of the low series (Tooke's Georgia cotton was also cheaper than West Indian quotes), for 1799 I used the average of the other three series but adjusted it downwards by four percent to reflect the ratio of the average of the three series to average the four in the three years 1800-02. For 1811 to 1815 I continued to use the average of the series since the war of 1812 disrupted American supply and it seemed appropriate to keep West Indian prices in the estimate, but I replaced Ellison's 1858 numbers with his 1886 numbers. The values that have been used in the calculations in Table 2 and Figures 3 and 4 are presented in Appendix Table 1:1 below. The various underlying series are presented in Appendix Figure 1:1 where the series used in the calculations are indicated by the larger black diamonds. Differences among the various series are apparent but they are in general conformity.

Appendix Table 1:1:Raw cotton prices, annually 1780 – 1839[34]

Year	Pence per lb	Year	Pence per lb	Year	Pence per lb
1780	21.3	1800	27.6	1820	11.5
1781	36.0	1801	28.0	1821	9.5
1782	22.0	1802	24.5	1822	8.3
1783	16.0	1803	16.6	1823	8.3
1784	18.0	1804	17.4	1824	8.5
1785	21.8	1805	19.1	1825	11.6
1786	25.0	1806	18.8	1826	6.8
1787	20.8	1807	17.8	1827	6.5
1788	15.0	1808	24.9	1828	6.4
1789	14.0	1809	23.9	1829	5.8
1790	12.0	1810	19.3	1830	6.9
1791	23.0	1811	14.2	1831	6.0
1792	20.5	1812	15.5	1832	6.6
1793	15.0	1813	22.3	1833	8.5
1794	17.0	1814	28.6	1834	8.6
1795	24.0	1815	20.8	1835	10.3
1796	19.0	1816	18.3	1836	9.9
1797	28.0	1817	20.1	1837	7.0
1798	28.0	1818	20.0	1838	7.0
1799	36.6	1819	13.5	1839	7.9

[34] Source: See text.

Appendix Figure 1.1: Raw Cotton Prices, various series 1780 - 1840



Source: See text.

Appendix 2: Details of profit calculations

1. Caldwell and Birley Accounts

Appendix table 2:1 provides details of the Cardwell and Birley profit calculations summarized in Figure 5.

Appendix Table 2.1:Financial Results Caldwell and Birley (and successors)

Partnership of Richard Cardwell and Richard Birley initiated in 1772 (surviving full accounts begin 1777):

	Capital invested	Surplus retained	Partners' loans	Profit, inventory	Return to captal[1]	Return on capital %[2]
1777	12000	3747	2433	3747	4589	25.2
1778	12000	3325	2357	-422	416	2.4
1779	12000	5016	2481	1691	2535	13.0
1780	12000	6489	4330	1473	2410	10.6
1781	12000	10778	4789	4289	5248	19.0
1782	12000	10867	4824	89	1050	3.8
1783	12000	15881	4957	5014	5982	18.2
1784	12000	21166	3818	5285	6196	16.8

[1]Calculated profits plus 6% paid on capital and 5% paid on partners' loans.

[2]Return to capital divided by capital, surplus and loans.

Partnerships of Richard Birley, Richard Cardwell, Jr. and John Hornby:

	Capital invested	Partners' loans	Profit, inventory	Return to captal[1]	Return on capital %[2]
1785	50000	320	3327	5843	11.6
1786	50000	3265	2410	5073	9.5
1787	50000	3891	2243	4938	9.2
1788	50000	4470	-3411	-688	-1.3
1789	50000	512	7638	10164	20.1
1790	50000	8011	5390	8291	14.3
1791	50000	14120	18391	21597	33.7
1792	55000	26892	4878	8973	11.0
1793	55000	33190	-13179	-8770	-9.9
1794	55000	20581	17308	21087	27.9
1795	55000	32477	34858	39232	44.8
1796	55000	64419	-2030	3941	3.3
1797	100000	37770	23715	30604	22.2
1798	100000	39531	10161	17138	12.3

[1]Calculated profits plus 5% paid on capital and partners' loans.

[2]Return to capital divided by capital, surplus and loans.

Partnership of Birley & Hornby: J. Birley's share

	Capital invested	Partners' loans	Profit, inventory	Return to captal[1]	Return on capital %[2]
1799	40000	13595	827	3507	6.5
1800	40000	18248	5842	8754	15.0
1801	40000	19980	4630	7629	12.7
1802	40000	26934	11299	14646	21.9
1803	40000	32106	-2760	845	1.2
1804	40000	42564	402	4530	5.5
1805	40000	18163			

Yr end June 31:

	Capital invested	Partners' loans	Profit, inventory	Return to captal[1]	Return on capital %[2]
1806	40000	18008	-892	2008	3.5
1807	40000	16554		2828	5.0
1808	40000	12419	1088	3709	7.1
1809	40000	10753	3452	5990	11.8
1810	40000	11525		2576	6.5

[1]Calculated profits plus 5% paid on capital and partners' loans.

[2]Return to capital divided by capital, surplus and loans.

2. The Quarry Bank Accounts

Appendix Table 2.2 provides details of the Quarry Bank Mill accounts and the rate of return on capital calculations that lie behind Figure 6. Since Samuel Greg provided the capital for the enterprise except so far as Peter Ewart retained earning in the firm, the results plotted in Figure 6 represent Samuel Greg's returns. The three bars in the graph represent respectively, the ratio of Greg's return to the value of his capital; the ratio of Greg's return less £800 as management salary and 5 percent depreciation on the machinery account and the result with a 10 percent depreciation rate. The three rates of return average over the period of the accounts 18.8 percent; 12.9 percent and 9.9 percent respectively.

Appendix Table 2.2:Financial for Quarry Bank Mill

	Fixed capital	Stock Accounts:			Bank balance	Profit	Capital return[1]	Greg's return[2]
		F/O	S.G	P.E.				
Sep1798[3]	15,380	17,663	-164		-3,822	-3,042	2,166	2,927
Sep1799	14,750	20,051	-2,850	-799	473	2,614	4,885	4,272
Mar1801	14,120	23,734	-2,525	-263	16,342	10,628	11,860	10,454
Sep1801	13,500	25,002	5,196	2,435	18,796	1,898	3,344	2,384
Mar1802	12,860	26,466	6,058	2,995	18,927	1,571	3,144	2,161
Sep1802	12,880	27,771	7,330	3,472	26,712	4,048	4,743	3,890
Mar1803	14,760	29,075	10,485	3,599	33,202	1,068	2,595	1,698
Sep1803	15,304	30,415	10,838	3,962	36,237	3,081	4,092	3,201
Mar1804	13,404	31,750	13,381	4,844	35,376	1,627	3,048	2,134
Sep1804	15,040	33,125	14,575	5,374	40,408	3,670	4,621	3,687
Mar1805	15,534	34,534	17,250	6,438	41,784	1,408	3,109	2,083
Sep1805	15,728	35,979	17,526	6,951	42,761	-959	1,391	336
Mar1806	15,728	37,460	16,109	6,866	43,493	-307	1,846	808
Sep1806	16,119	38,977	15,800	6,949	45,341	744	2,642	1,600
Mar1807	17,831	40,533	15,298	7,305	49,526	1,032	2,872	1,823
Sep1807	17,831	42,128	16,557	7,336	49,413	-1,099	1,422	299
Mar1808	18,220	43,762	16,009	6,702	51,555	1,847	3,618	2,502
Sep1808	18,220	45,437	18,120	6,992	50,833	1,802	3,810	2,581
Mar1809	18,220	47,155	20,249	7,153	52,792	599	3,002	1,726
Sep1809	18,220	48,915	21,506	7,138	57,611	731	3,011	1,780
Mar1810	18,220	50,719	22,897	6,797	61,599	3,172	4,802	3,590
Sep1810	18,220	52,568	26,199	7,367	69,047	5,349	6,320	5,166
Mar1811	18,600	10,105	31,310	98	19,785	3,570	5,619	4,148
Sep1811	18,600	10,957	34,759	972	25,148	3,119	5,228	3,783
Mar1812	20,553	11,831	37,050	834	24,560	2,902	5,448	3,812
Sep1812	20,787	12,727	40,279	914	32,016	-197	2,980	1,416
Mar1813	20,787	13,645	37,497	79	26,761	2,097	4,871	3,222
Sep1813	20,979	14,586	39,821		27,771	-614	2,969	1,254
Mar1814	20,979	15,551	39,702		37,036	6,205	7,663	6,158
Sep1814	21,995	16,540	45,466		44,127	1,305	4,072	2,525
Mar1815	22,107	17,553	47,586		41,451	1,279	4,354	2,657

[1]Profits plus 10% on fixed capital plus 5% on stock accounts less 5% on bank balance.

[2]As above except ¼ of profits and 5% on P.E. stock account omitted.

[3]Accounting period began Sept. 1776

William Gray and Sons

The Gray accounts do not include private ledgers so it is not possible to construct the return to capital. It is, however, possible to follow the inventory 'profits.' The material summarized in Figure 7 is presented in Appendix Table 2.3 below.

Appendix Table 2.3:
Financial results of William Gray and Sons, 1801 – 1810

Dec. 31	Balance forward	Balance year end	Gain or Loss	Father's bond	Debts of the firm
1801	4,336	3,953	-383	3,300	234
1802	3,953	4,563	610	3,300	1,146
1803	4,563	3,207	-1,356	3,800	685
1804	3,207	2,092	-1,115	3,800	641
1805	2,092	697	-1,395	3,800	1,155
1806	697	27	-670	3,800	1,342
1807					
1808		-342	-342		
1809	-342	-137	205	5,100	3,179
1810	-137	2,075	2,212		6,798

References

Primary Sources:

The records of Cardwell, Birley and Hornby (after 1798, Birley and Hornby). The John Rylands Library, Manchester. English Ms. 1199.

Colquhoun Ms: Baker Library, Harvard Business School in bound volume entitled Manuscript Memorandum of Cotton Manufacture in Great Britain HB 44LT E. MSS: 442 1771-1789 C722.

Liverpool Papers, British Library Add Mss. 38223 (2); 38391 (26; 35; 56)

The records of W Gregg and Partners. The Manchester Reference Library, Local History Unit. Quarry Bank Mss. Ms C5/.

The records of William Grey and Sons. The Bolton Archive and Local History Service. Ms. B259.

Public Records Office (BT 6-112; 140; 180).

Published Material

Antras, P. and H. J. Voth (2003) "Factor prices and productivity growth during the British industrial revolution." *Explorations in Economic History* 51, 734-62.

Baines, Edward (1835), *History of the cotton manufacture in Great Britain.* London: H. Fisher, R. Fisher, and P. Jackson.

Burn, R. (1847) *Statistics of the Cotton Trade.* London.

Clapham, Sir John H. (1926). *An Economic History of Modern Britain: The Early Railway Age, 1820-1850.* Cambridge: Cambridge University Press

Crafts, N.F.R.C. (1985). *British Economic Growth during the Industrial Revolution.* Oxford: Clarendon Press.

_____ and C. K. Harley (1993). “Output growth and the British industrial revolution: a restatement of the Crafts-Harley view.” *The Economic History Review*, 45, 703-30.

_____(2004) “Precocious British industrialization: a general equilibrium perspective” in Leandro Prados de la Escocura (ed), *British Exceptionalism: A Unique Path to the Industrial Revolution* (Cambridge University Press, 2004)

Crouzet, François (1958) *L’économie britannique et le blocus continental (1806 -1813)* Paris: Press Universitaires de France.

_____ (1962). “Capital Formation in Great Britain during the Industrial Revolution.” In *Second International Conference of Economic History. Aix-en-Provence, 1962*, II. Reprinted in Crouzet, ed. (1972), *Capital Formation in the Industrial Revolution.* London: Methuen.

_____, (1972), “Editor’s Introduction.” In Crouzet, ed. (1972), *Capital Formation in the Industrial Revolution.* London: Methuen, 1-69.

Deane, Phyllis and W. A. Cole (1962) *British Economic Growth, 1688 - 1959.* Cambridge: Cambridge University Press.

Edwards, M.M. (1967). *The Growth of the British Cotton Trade, 1790 – 1834.* Manchester: Manchester University Press.

Ellison, Thomas (1858) *Handbook of the cotton trade.* London:.

_____(1886) *The Cotton Trade of Great Britain.* London.

Feinstein, C. H. (1995). “Changes in nominal wages, the cost of living and real wages in the United Kingdom over two centuries, 1780-1990.” In P. Scholliers and V. Zamagni, eds. *Labour’s Reward: real wages and economic change in nineteenth- and twentieth-century Europe.* Aldershot:

Fitton, R. S. (1989). *The Arkwrights: spinners of fortune.* Manchester: Manchester University Press.

_____ and A.P. Wadswoth (1958). *The Strutts and the Arkwrights: 1758 – 1830.* Manchester: Manchester University Press.

Gayer, Arthur D., W.W. Rostow, Anna Jacobson Schwartz (1953) *The growth and fluctuation of the British economy, 1790-1850.* Oxford: Claredon.

Harley, C. Knick (1998). "Cotton textile prices and the industrial revolution." *The Economic History Review*, 51, 49-83.

_____ (1999). "Reassessing the Industrial Revolution: A Macro View." In Mokyr, ed., *The British Industrial Revolution: An Economic Perspective 2nd edition.* Boulder: Westview Press, 160-205.

_____ and N.F.R. Crafts (2000) "Simulating Two Views of the British Industrial Revolution" *Journal of Economic History* 60, 819-41.

Hobsbawm, E.J. (1968) *Industry and empire : an economic history of Britain since 1750*. London : Weidenfeld & Nicolson.

Hoffmann, Walther G, (1955) *British Industry, 1700 – 1950.* Oxford: Blackwell.

Hudson, P. (1986). *The Genesis of Industrial Capital: A Study of the West Riding Wool Textile Indsutry, c. 1750 – 1850.* Cambridge: Cambridge University Press.

_____ , ed. (1989). *Regions and Industries.* Cambridge: Cambridge University Press.

Lyons, John S. (1977). 'The Lancashire cotton industry and the introduction of the powerloom, 1815 -1850' (unpub. Ph.D. diss., University of California, Berkeley).

Mantoux, Paul (1928) *The Industrial Revolution in the eighteenth century: and outline of the beginning of the modern factory system in England.* London: Jonathan Cape.

Mokyr, Joel (1976). "Growing-Up and the Industrial Revolution in Europe." *Explorations in Economic History* 13, 371-396.

_____. (1991). "Dear Labor, Cheap Labor, and the Industrial Revolution." In P. Higonnet, D. Landes, and H. Rosovsky, eds., *Favorites of Fortune: Technology, Growth, and Economic Development Since the Industrial Revolution.* Cambridge: Harvard University Press.

_____. (1999). “Editor’s Introduction: The New Economic History and the Industrial Revolution.” In Mokyr, ed., *The British Industrial Revolution: An Economic Perspective 2nd edition.* Boulder: Westview Press, 1-127.

Neal, Larry (1994). “The finance of business during the industrial revolution.” In R. Floud and D. McCloskey, eds., *The Economic History of Britain since 1700: Vol. 1: 1700 – 1860.* 2nd Ed., Cambridge: Cambridge University Press.

Neild, [W.] (1861), ‘An account of the prices of printing cloth and upland cotton from 1812 to 1860, &c.’ *Journal of the Statistical Society London,* XXIV, 491-7.

Pollard, Sidney (1964), “Fixed Capital in the Industrial Revolution in Britain.” *Journal of Economic History,* 24, 299-314. Reprinted in Crouzet, ed. (1972), *Capital Formation in the Industrial Revolution.* London: Methuen

Radcliffe, William (1828) *Origin of the new system of manufacture commonly called power-loom weaving.* Stockport: J. Lomax.

Rose, Mary B. (1986) *The Gregs of Quarry Bank Mill: the rise and decline of a family firm, 1750-1914.* Cambridge: Cambridge University Press.

Tooke, Thomas (1838) *A history of prices, and of the state of circulation, from 1793 to 1837.* London: Longman, Orme, Brown, Green and Longmans.

Wadsworth, A.P. and Mann, J. De L. (1931). *The Cotton Trade and Industrial Manchester*. Manchester: Manchester University Press.

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