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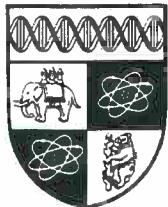
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THE INDUSTRIAL REVOLUTION

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This paper is circulated for discussion purposes only and its  
contents should be considered preliminary.

# **Cotton Textiles and Industrial Output Growth During the Industrial Revolution**

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**February 1994**

In a recent paper Cuenca Esteban re-examined the growth of industrial output in Britain during the Industrial Revolution. His analysis was based on a revisionist assessment of the size of the cotton industry. The central finding was that cottons in the 1770s were much larger relative to industrial activity as a whole than anyone has hitherto believed with the implication that estimates of industrial output growth should be raised appreciably for the period 1770-1831, back roughly to the growth rates proposed by Deane and Cole.<sup>1</sup>

In particular, Cuenca Esteban suggested that the share of cotton textiles in industrial value added was 8.6% in 1770 and 25.6% in 1801 and that nominal prices of cotton goods in 1770 were 10.7 times the 1841 level and 2.73 times the 1815 level.<sup>2</sup> Thus he argued:

- i) 'shares of cottons in total industrial value-added are far greater than those proposed by Crafts and Harley...'<sup>3</sup>
- ii) 'Harley and Crafts's rates of British industrial growth ultimately stem from hasty conjectures on prices of cottons and from selective choice and manipulation of a handful of highly questionable estimates of value added. Such calculations are not acceptable...'<sup>4</sup>
- iii) 'cottons output was already significant in value added terms as early as the 1770s, so that the influence of its phenomenal growth on total industrial production was correspondingly stronger than Harley and Crafts contend....A return to Deane and Cole's less pessimistic views would lend support to McCloskey's contention that 'ingenuity' was very broadly based during the industrial revolution...'<sup>5</sup>

In returning to the question of cotton's weighting, Cuenca Esteban has addressed the central issue.<sup>6</sup> Unfortunately, despite the elan with which they are presented, his results are completely unreliable and his interpretation of his findings quite misleading, as we show

here. We conclude that our earlier findings remain the best guess estimates of industrial output growth.<sup>7</sup>

## I

In this section we briefly review the evidence on changes in the price of cotton textiles. A fuller account can be found in a forthcoming paper.<sup>8</sup> Table 1 presents a compilation of directly available data for comparison with Cuenca Esteban's estimates which were inferred indirectly from trade values and proxies based on very limited information on costs. In considering this price data, it is important to remember that prices of finer cloths and yarns fell by much more than those of coarse materials but that the latter comprised by far the main part of the industry. For example, in 1788 the average count of yarns was 27.<sup>9</sup>

**Table 1 : Prices of Cotton Cloth and Yarn, 1768-1827**

a) Cloth Prices. (d)

	East India Calicos (/piece)	Fustian, Lord Chamberlain (/ell)	Birley, Cardwell and Hornby Fine (/28yds)	Superfine (/21yds)	Neild Printing (/piece)	Cuenca Esteban (/14yds)
1768	406	12.0	351	469		
1769	394	12.0	351	469	512	
1770	381	12.0				659
1771	410	12.0				706
1772	407	12.0				649
1773	370	12.0				573
1774	407	12.0				666
1775	458	12.0				672
1776	444	12.0				684
1777	485	12.0	393	471		760
1778	428	12.0				712
1779	329	12.0				829
1780	487	12.0				675
1781	474	14.0	488	538		632
1782	520	12.0	408	480		565
1783	488	13.0	393		439	590
1784	459	13.0	372			559
1785	435	13.0	375	384		663
1786	505	13.0	414	420		516
1787	399	13.0	360	360		537
1788	377	13.0	300	300		502
1789	377	13.0	318	324		577
1790	389	13.0	302	324		579
1791	394	13.0	369	382		543
1792	536	13.0	330	354		455

	East India Calicos (/piece)	Fustian, Lord Chamberlain (/ell)	Birley, Cardwell and Hornby Fine (/28yds)	Birley, Cardwell and Hornby Superfine (/21yds)	Neild Printing (/piece)	Cuenca Esteban (/14yds)
1793	404	13.0	240	252		391
1794	380	13.0	276	288		454
1795	388	13.0	342	366		456
1796	409	13.0	306	324	355	499
1797	416	15.0	372	366		513
1798	470	15.0	360	360		512
1799	480	15.0				494
1800	459	15.0				435
1801	475	15.0				461
1802	432	15.0				402
1803	403	15.0				379
1804	306	15.0				377
1805	287	15.0				433
1806	267	15.0				346
1807	271	15.0				333
1808	231	15.0				299
1809	304	15.0				316
1810	307	15.0				327
1811	333	15.0				266
1812	338	15.0			271	246
1813	391	15.0			271	269
1814	458	15.0			423	292
1815	371	15.0			303	242
1816	314	15.0			314	219
1817	288	15.0			255	191
1818	277	15.0			261	206
1819	262	15.0			171	192
1820	254	15.0			189	175
1821	238	15.0			183	164
1822	248	15.0			174	149
1823	236	15.0			168	141
1824	229	15.0			174	138
1825	229	15.0			138	
1826	148	15.0			126	119
1827	133	15.0			120	116

b) Yarn Prices. (d/lb))

Year	18 Weft	Greg 25 Twist	25 Warp	30 Warp	100 Twist
1769		33			
1770					
1771					
1772					
1773					
1774					
1775					
1776					
1777					
1778		34			
1779					

Year	18 Weft	Greg 25 Twist	25 Warp	30 Warp	100 Twist
1780	35				
1781				103	
1782			73		
1783			64	75	
1784	32		55	68	
1785	34		54	66	
1786	39			73	456
1787			63	60	456
1788	20		50	50	420
1789				60	408
1790	25			57	360
1791	33			63	359
1792	31			55	169
1793				41	157
1794	24			43	157
1795	29			54	107
1796	29			50	105
1797	37			60	109
1798	36		56	54	93
1799			61		108
1800					100
1801					98
1802					88
1803		39			85
1804		39			87
1805		39			100
1806		36			73
1807		36			76
1808		38			69
1809		40			71
1810		42			78
1811		33			54
1812		31			57
1813	20	35		28	68
1814	22	46			88
1815	24	39		37	79
1816	20	34			74
1817	17	34		29	60
1818		33		34	82
1819	12	27		24	67
1820	12	21			58
1821	11	19		20	48
1822	10	19		19	48
1823	10	19		17	45
1824	10	20			56
1825	12	15		22	70
1826	9	14		13	44
1827	9	14			44

Source Notes Table 1(a) Cloth:

1. East India Calicos: Cuenca Esteban, 'British Textile Prices', pp.72-3.
2. Fustian, Lord Chamberlain: Beveridge, *Prices and Wages*, pp.450, 458.

3/4. Cardwell, Birley Fine and Super-fine Calicos: Inventory Books of Messrs Cardwell, Birley and Hornby, of Blackburn (John Ryland Library, English Manuscripts 1199/1-2). The fine cloth was manufactured with an 18 count weft. The superfine cloth with a 28 count weft. Corrections have been made for the slight change in the characteristics of the superfine cloth in 1782.

4. Neild Cloth: 1812-27: Neild, 'An Account of the Price'. The prices for 1812 to 1817 have been reduced by 9.7 percent as Neild suggested (p.491) to correct for a changed character of the cloth he purchased.

1796: Calculated cost of cloth with Neild's specifications from the Cardwell, Birley and Hornby inventory (Eng. Ms. 1199/2, pp.44-7).

1783: Calculated cost of cloth with Neild's specifications from Oldknow accounts (Ryland Library, Eng. Ms. 751-804. The data for the calculation comes from Eng. Ms. 744, 755, 758, 774-7, 796(1)).

1769: Interpolated from the 1796 calculation on the basis of the Cardwell, Birley and Hornby series for superfine cloth.

6. Cuenca Esteban Series: Cuenca Esteban, British Textile Prices, pp.72-3.

Source Notes Table 1(b) Yarn:

1/4. 18 weft and 30 warp: Cardwell, Birley and Hornby inventory data; 18 weft supplemented for 1778, 1780 and 1784 using data in von Tunzelmann, *Steam Power*, p.181.

2. Greg Twist: This is a series for the price of about 25 count "furnished by Samuel Greg & Co., not from their own mills, but they can vouch for its being accurate" presented to the Factory Commissioners in 1833, *Report of the Factory Commissioners*, P.O. 1834, XIX, p.185. The count of the yarn in the original data varies somewhat so price has been adjusted to 25 count on the basis of contemporary quotations.

3. 25 warp: von Tunzelmann, *Steam Power*, p.181; there are also quotations for 1810 and 1816 but as is well-known these are not comparable with the earlier figures.

5. 100 Twist: 1787-94: Baines, *History*, p.357.

1795-1827: Lee, *A Cotton Enterprise*, p.176.

Table 1 reports new evidence on cloth prices from accounts in the Ryland Library along with previously published series. The records of the Blackburn firm of Cardwell, Birley and Hornby contain prices for several identifiable types of cloth during the last thirty years of the eighteenth century. In addition, data in the Cardwell, Birley and Hornby records and in the Oldknow accounts permit detailed calculation of the price of a cloth that is

identical to the well-known printers cloth whose price from 1812 to 1860 was reported by Alderman William Neild of Manchester in the Journal of the Statistical Society. The evidence on cloth prices shows clearly that Cuenca Esteban's constructed series is way out of line with the others. His series shows prices in 1770 at 2.67 times its 1815 level, but fustian and East India calicos were 0.80 and 1.04 times their 1815 level.<sup>10</sup> The Cardwell, Birley and Hornby data, splicing to the Neild cloth in 1796 was 1.48 times its 1815 level if superfine cloth is used or 1.17 if the fine cloth, which better represents the average cloth of the late eighteenth century, is used.<sup>11</sup>

For yarn prices we see that in 1815 18s weft was around 2/- having been 2/9d per lb in 1769 while 30s warp fell from around 8/- in 1780 to around 3/- per lb in 1815. Lyons's recent research concluded that weaving costs were roughly double the 1770 level in 1815 reflecting higher wages in a sector still reliant on handlooms.<sup>12</sup>

Taking these points together makes it clear that Cuenca Esteban's price series is highly implausible and that his complicated method of constructing prices is unsatisfactory. In particular, it seems most unlikely that average nominal cloth prices fell between the late 1760s and the late 1790s where Cuenca Esteban believes they fell some 25%. Cuenca Esteban seems to have been led astray by failing to take proper account of the most obviously relevant primary sources and of the literature on weaving while placing undue reliance on the prices of 100 count yarns to infer cost changes.

We remain of the view originally expressed by Harley that average nominal prices for cotton cloth were probably not much different in 1770 and 1815.<sup>13</sup> This should not be too surprising for two reasons. First, given that other prices had risen, this implies a real price fall of perhaps 50%. Second, while technological change in spinning had progressed rapidly the transformation of weaving was still in the future.

## II

The share of cotton in industrial value added is a crucial piece of information for estimating industrial output growth during the Industrial Revolution. Given information on this statistic for the 1830s and 1840s and data on the relative price of cotton textiles back to 1770, an estimate can be made for the relative size of cotton in 1801 and 1770. This procedure was followed by Harley in his original article.<sup>14</sup> An alternative is to use the contemporary sources on the size of the industry compiled by Deane and Cole.<sup>15</sup> Crafts adopted this approach but made some errors later corrected in Crafts and Harley.<sup>16</sup>

Cuenca Esteban seeks to revise Harley's calculation in the light of his new estimates for cotton goods prices. As a cross check, he compares the outcome with a reworking of Deane and Cole's data (labelled 'new independent estimates') building on suggestions by Chapman and making greater allowances for value added in bleaching, finishing and printing.<sup>17</sup> Cuenca Esteban concludes that the two methods give similar results. If we are right to reject his new price series, we must also justify a rejection of his new independent estimates of value added.

Table 2 reports these various estimates for cotton's relative size in 1770 and 1801, together with Hoffmann's figures for comparison. Evidently, Cuenca Esteban's estimates are by far the largest. His calculations for 1801 imply that gross output was worth about 5.6 times the cost of cotton compared with the Deane and Cole/Crafts figure of 3.3. For 1770 Cuenca Esteban has gross output worth about 12.4 times the cost of cotton compared with a Deane and Cole/Crafts figure of 4.5.

Table 2 : Cotton's Share in Industrial Value-Added (%)

	1740	1770	1783	1801	1812
Crafts/Deane & Cole	2.6		13.5		
Harley		1.0		6.0	
Hoffmann	2.8		6.7		12.2
Cuenca Esteban					
Price estimates	8.4		28.2		
Independent estimates	8.6		25.6		

Sources: Deane and Cole, British economic growth, pp. 185, 187; Harley, 'British industrialization', p. 269; Hoffmann, British industry, p.18; Cuenca Esteban, 'British textile prices', p.86.

Fortunately the late eighteenth century Manchester accounts contain direct evidence with which to confront Cuenca Esteban's highly speculative calculations. The Birley, Cardwell and Hornby accounts for 1797 show the value of a very fine grey cloth with Neild's specifications was about 3.5 times and a superfine calico of 27 count yarn about 2.0 times the value of raw cotton. Bleaching costs were modest and added a shilling to grey cloth valued between 25/- and 30/-. Much cloth was sold either grey or white. Dying the entire cloth would have increased its value by up to a quarter.<sup>18</sup>

Printing was a more expensive form of finishing. Chapman and Chassagne suggest that most printing in Lancashire would have added a third to a half to the price of grey cloth.<sup>19</sup> Only a small proportion was printed - about 5% of the cotton imported was printed for the home trade around 1818 while about twice as many printed goods were exported as consumed at home.<sup>20</sup>

The preceding considerations indicate that a value of output including all finishing and all purchased inputs of about 3 to 4 times the value of the cotton is most unlikely to underestimate the value of cotton output. Precision is impossible but plainly Cuenca Esteban's estimates are gross exaggerations. Their implausibility does nothing to reinforce his claims

about textile prices; on the contrary, the evidence suggests that the hitherto unanimous view that the cotton industry was still small in 1770 remains acceptable and confirms that Cuenca Esteban's price series is unreliable. It may be that Harley slightly underestimated cotton's size in 1770 but the very most the other price data in Table 1 suggest would be an increase to around 2% of industrial value added.

### III

Cuenca Esteban claims that his estimates, if accepted, would restore Deane and Cole's view of economic growth and McCloskey's vision of broadly based 'ingenuity'. This argument is also incorrect for several reasons.

First, it is quite clear that Deane and Cole themselves stressed that cotton was still an industry of negligible importance in 1770.<sup>21</sup> As we have pointed out previously, had Deane and Cole constructed a quantity index to estimate industrial output growth rather than relying on indirect methods, they would undoubtedly have arrived at an estimate very similar to those of Crafts and Harley.<sup>22</sup> Similarly, as Table 2 reminds us, Hoffmann also explicitly thought cotton was small in 1770; the high weight he implicitly allowed cotton to have was an inadvertent error.<sup>23</sup> Cuenca Esteban's picture of rapid industrial growth driven from the 1770s by a large cotton industry is radical revisionism not a return to old beliefs.

Second, Cuenca Esteban's estimates would not restore Deane and Cole's view of either industrial output or GDP growth in 1801-31, where their methods made very heavy use of unacceptable price index numbers to deflate current prices estimates of sectoral incomes originating.<sup>24</sup> In fact, his implied view of growth in this period is very similar to that of Crafts and Harley, as Table 3 shows. The main implication of Cuenca Esteban's calculations would be to reduce still further any apparent acceleration in Britain's growth rate in the early nineteenth century.

**Table 3 : Comparisons of Growth Estimates (% per year)**

	1760-1801		1801-31	
	Industrial Output	GDP	Industrial Output	GDP
Deane and Cole	1.96	1.36	4.44	3.06
Crafts (1985)	1.81	1.01	3.00	1.97
Crafts (1992)	1.63	1.01	2.78	1.90
Cuenca Esteban				
(1)	2.30	1.34	3.18	2.03
(2)	2.30	1.43		

Sources: derived from Deane and Cole, *British economic growth*, pp. 78, 166; Crafts, *British economic growth*, pp. 32, 45; Crafts and Harley, 'Output growth', p. 715; Cuenca Esteban, 'British textile prices', p. 88. In deriving the implications of Cuenca Esteban's estimates for GDP growth, estimate (1) assumes all other sectoral growth rates are unchanged while estimate (2) allows for an implied change to agricultural output growth using the demand formula described in Crafts, *British economic growth*, pp. 39-41.

**Table 4 : Sectoral Contributions to Productivity Growth, 1780-1860 (% per year)**

	McCloskey	Harley	Cuenca Esteban
Famous sectors	0.52	0.34	0.45
Agriculture	0.12	0.19	0.19
All others	0.55	0.02	0.02
Total	1.19	0.55	0.66

Sources: McCloskey, 'Industrial revolution', p. 114; Harley, 'Reassessing', p. 200 and right hand column derived by assuming a doubling of cotton's weight in gross output.

Third, Cuenca Esteban certainly would not resurrect McCloskey's notion of broadly based productivity advance. Rather his estimates would accentuate still further the view, developed in Crafts and reaffirmed by Harley, that productivity change was concentrated in a relatively few famous sectors, as Table 4 demonstrates.<sup>25</sup> Ironically, Cuenca Esteban's revisions, if accepted, would go in exactly the opposite direction to that advocated by our most vociferous critics, Berg and Hudson, who suggest that what we have failed to recognize is productivity advance outside of textiles, iron and transport.<sup>26</sup>

#### IV

In sum, we do not regard the new estimates for industrial output growth presented by Cuenca Esteban as convincing. To the contrary, we consider that the estimates we presented in our previous paper remain acceptable best guesses.<sup>27</sup> In particular, we have argued that primary source materials reject his speculations concerning both prices and value added in finishing. We therefore find both his quite novel claims of a large cotton industry in the 1770s and the implications he derives for industrial output growth completely implausible. We do agree with Cuenca Esteban that more work on the relative size of the cotton industry in the late eighteenth century is desirable.<sup>27</sup>

## Footnotes

- 1/ Cuenca Esteban, 'British Textile Prices', p.88; Deane and Cole, *British Economic Growth*, pp.78, 166.
- 2/ Cuenca Esteban, 'British textile prices', pp.80, 86.
- 3/ Ibid., p.85.
- 4/ Ibid., p.89.
- 5/ Ibid., pp.67-8.
- 6/ Crafts and Harley, 'Output Growth', p.706.
- 7/ Ibid., p.712.
- 8/ Harley, 'Cotton Textile Prices'.
- 9/ Von Tunzelmann, *Steam Power*, p.182.
- 10/ Since the English market was still protected from imports it is dangerous to accept the East Indian calico prices without confirmation as a proxy for English prices but we do know that English goods competed with Indian goods in export markets. We reject Cuenca Esteban's conclusion that 'the milder downward trend in the price of Indian fabrics might serve to reject the hypothesis that British cottons did not cheapen in the late eighteenth century, for many British fabrics are known to have undersold inferior Indian counterparts by one-fourth to one-third at least'. We find this claim deeply unpersuasive since the East India Company actually sold cloth at these prices. Who was buying worse products at 50% premia?
- 11/ All ratios are calculated using the average of the three years centred in 1815 for the 1815 price. Cuenca Esteban's constructed series 1770 price is taken as the average of 1770/3. For the East Indian calico and fustian average price the three years centred on 1770 is used. For the Birley, Cardwell and Hornby series the average of 1768 and 1769 is used.
- 12/ Compare the estimates of weavers wages of six to eight shillings a week in the 1760s in Wadsworth and Mann, *The cotton trade*, pp.333-5, with Lyons' estimate of fourteen shillings in 1815, 'The Lancashire cotton industry', pp.17, 36.
- 13/ Harley, 'British Industrialization', pp.271, 286-9.
- 14/ Ibid., pp.269-72.
- 15/ Deane and Cole, *British Economic Growth*, pp.185, 187, 212.
- 16/ Crafts, *British economic growth*, p.22; Crafts and Harley, 'Output growth', p.709. Our reference to a 13 percent weight for cotton in Harley's calculation includes the 3 percent weight of cotton that Harley placed in clothing. Our lack of clarity on this point seems to have caused some confusion.
- 17/ Chapman, *Cotton Industry*, p.48.

18/ See comparison of the value of bleached and grey cloth and undyed yarns in the Cardwell, Birley, and Hornby and Oldknow accounts. The cost of dyeing varied by colour; blue, green and brown cost about 1s.6d. per pound and red perhaps twice that amount. A thin striped cloth required about a quarter of a pound of dyed yarn while complete dyeing of a cloth amounted to four or five pounds of dyed yarn.

19/ Chapman and Chassagne, *European Textile Printers*, pp.216-7.

20/ Select Committee on the Duties on Printed Goods, PP 1818, III, pp.5-6, 16. The returns on printed goods in Baines, *History*, p.283.

21/ Deane and Cole, *British Economic Growth*, p.163.

22/ Crafts and Harley, 'Output Growth', pp.713-4.

23/ Harley, 'British Industrialization', p.278.

24/ Crafts, *British Economic Growth*, pp.20-36.

25/ Ibid., p. 86; Harley, 'Reassessing', p.200.

26/ Berg and Hudson, 'Rehabilitating', pp.27-8, 31-2.

27/ Crafts and Harley, 'Output growth', pp.712, 715.

28/ 'It cannot be stressed sufficiently that the new estimates of cotton prices proposed here for the period 1770-95, and the new calculations of value added for both cottons and woollens, remain much weaker than is required to establish sectoral weights', Cuenca Esteban, 'British textile prices', p.89. We agree.

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