The Myth of the Corporate Economy: Factor Costs, Industrial Structure, and Technological Choice in the Lancashire and New England Cotton Industries, 1900-1913

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My dissertation uses new and substantially more reliable data to better answer some of the classic questions about the Lancashire cotton spinning industry in a comparative setting. In so doing it generates some surprising results about its New England rival.

New Data

For Britain, the principal "new" source of data is the *1906 Enquiry in Earnings and Hours*, which gives employment levels and wages for 10,000 mule spinners, 17,000 piecers, almost 4,000 ring spinners, and 70,000 weavers [*1906 Enquiry*, pp. xiii, 29-31]. It is the most reliable source for wages and employment in this period. Further, the information is disaggregated in two useful ways. First, data for mule wages and employment are divided according to whether the spinner was spinning coarse (sub-40), medium (40-80) or fine (supra-80) yarns. As rings were overwhelmingly used – both in Britain and the US – to spin sub-40 yarns, dividing mule spinners by count allows ready and fair comparisons between the two technologies. Second, the data is disaggregated by district, dividing Lancashire into 12 towns and their hinterlands. This allows us to look at variations in unit labor costs across Lancashire; further, it means that we know the districts in which cotton was

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being spun into yarn and woven into cloth. In addition, Cotton's unpublished thesis gives the location of individual spinning and weaving mills in Blackburn, a typical Lancashire cotton town, allowing us to assess exactly where cotton could be spun and woven in a representative district.

For New England, the new sources of data are more extensive, and much "newer." The *1905 Census of Manufactures* gives capital to labor ratios, that is, the number of spindles per operative. These figures can be compared with new archival sources: for mule spinners, the figure is within 1% of the average given in 3 firm records; for ring spinners, the *Census* figure is 12% lower than the average derived from the records of 6 mills.[2]

Data on weekly wages are taken from a newly discovered survey carried out in 1904 by Pidgen, head of the Massachusetts Bureau of Statistics. His figure for mule wages is 8% higher than the average wage paid by the two firms whose records survive. For ring spinning his figure is identical to the average of seven observations that were taken from firm records.

Output per spindle comes from the production records of three key firms – the Amoskeag, Lyman, and Naumkeag mills. Each recorded the weight of yarn produced by each spindle, at the various counts produced. For each method of spinning, the firm's data are merged and then estimated to give two continuous, count specific series for productivity. The procedure works well for both ring and mule spinning, with R^2 values of 0.941 and 0.994 respectively. As we would expect, the count of yarn spun is an excellent predictor of productivity, with t-statistics of 17.37 and 69.97 respectively.

Hypotheses[3]

Ring spinning is a more modern technology, and allowed the mill owner to economize on labor costs by using unskilled female labor in place of more expensive skilled male labor. A number of hypotheses have been advanced to explain why Lancashire continued to install mules. The first hypothesis (uniformly rejected by modern authors) suggested that although mule spinning was more expensive, spinners were simply irrational in their attachment to a well-known technology. Conversely, it has been argued that spinners were rational in installing mules simply because mule spinning was a cheaper method of production in Britain, where skilled labor was abundant, and so relatively cheap [Sandberg, 1969, 1974]. Two alternative hypotheses have been advanced [see Mass and Lazonick, 1990]. Both accept that mule spinning was associated with lower unit costs in Lancashire, but argue that ring unit costs would have been reduced if the industry structure had been different. In particular, had Lancashire ceased to consist of small, vertically specialised firms, almost all of which either spun yarn or wove cloth (but not both), the benefits of ring

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[2] The full details of "new" archival sources are available from the author.

[3] The reader should be aware that my brief summaries of the secondary literature are necessarily crude. My apologies to them and to those whose works have been so rendered.

spinning would have been better realised, for two reasons. First, there are well known technical (and so cost) complementarities between ring spindles and automatic looms, a new method of weaving invented in this period. An integrated spinning-weaving firm could introduce both technologies in a coordinated manner (as happened in New England), a vertically specialised industry could not (as did not happen in Lancashire). Second, ring spinning produces yarn attached to a heavy wooden bobbin, which, for weft yarn at least, had to travel to the weaving shed with the yarn. This does not matter if the firm is vertically integrated, because the weaving shed will be close by, if not in the same building. But in a vertically specialised industry, especially one in which individual regions specialise in either spinning or weaving, the transport costs associated with shipping bobbins from spinner to weaver and back again will slow the adoption of ring spinning.

Results

The Myth of the Corporate Economy addresses all of these questions, and, in addition, uses the new sources of data to compile new estimates of relative labor productivity in the two cotton spinning industries.

New series for ring and mule unit labor costs are constructed for both Lancashire and New England. For Lancashire, new estimates of mule unit labor costs are constructed using the new wage data taken from the *1906 Enquiry*, combined with standard data on spindles per operative [Jewkes and Grey, 1935, p. 205] and output per spindle [Winterbottom, 1907, p. 204; Taggart, 1923, pp. 155-7]. For ring spinning, the employer-union *Universal Wage List* of 1912, which gives wages per 100 spindles per week [Jewkes and Grey, 1935, p. 121], is combined with the Winterbottom/Taggart series for output per spindle [Winterbottom, 1907, p. 213; Taggart, 1923, pp. 202-3]. These figures demonstrate that previous authors, using estimates provided by contemporary writers, have substantially overestimated the unit labor costs of producing yarn on both ring and mule spindles and the cost advantage that a spinner could gain from adopting ring spindles [Sandberg, 1974, p. 45; Lazonick, 1981a, p. 101]

New England unit labor costs are constructed from the weekly wages for mule and ring spinners given in Pidgen's *Survey*, the capital to labor ratios given in the *1905 Census* and output per spindle derived from firm's production records [1905 Census, p. 60]. Again these show that the potential labor cost savings have been overestimated in the literature [Sandberg, 1974, p. 45].

Although these figures show that previous authors have overstated the advantage available to those adopting ring spindles, they confirm the substance of the original hypothesis: the gain from adopting rings was in general considerably greater in New England than in Lancashire, and the rate of adoption there was correspondingly more rapid.

These new figures show that New England's universal preference for rings was rational, but they are not sufficient to show that Lancashire's precise rate of ring adoption was an optimal response to costs. We can, however, test Lancashire spinners' ability to optimize by looking at whether the variations in costs across Lancashire are sufficient to explain the differing rates of ring takeup. The *1906 Enquiry* is used to calculate the proportion of yarn spun on rings in each district as well as ring and mule unit labor costs in each area. A weighted least squares logistic regression model is used to assess whether the differences in the rate of ring adoption can be explained by these variations in costs. Transport costs (see below) are also included as a separate independent variable. Both labor savings and transport costs are significant, and the model has an R^2 of 0.768. When variations in factor cost savings of just 2% of the final selling price cause the rate of ring takeup to vary from 12% to 61%, we feel safe in concluding that cotton spinners in Lancashire responded closely and accurately to the costs that they faced.

The "institutional" critique of the Lancashire industry receives less support. That there were technical complementarities between ring spindles and automatic looms is not in doubt: the use of rings with plain looms meant that the weft yarn had to be rewound prior to weaving, a stage not necessary if using automatic looms. The question is whether this extra stage was sufficient to deter spinners from installing rings for weft without automatic looms. We can test this explicitly by looking at the behaviour of spinners in the years between the invention of the ring and that of the automatic loom. If spinners installed rings for weft in this period, we can say for sure that weft rings and plain looms represented an efficient combination and that integrated firms, able to install both technologies in a coordinated manner, were not necessary to ensure the adoption of rings. For the United States, we use data from Copeland to show that, by 1890, just prior to the invention of the automatic loom, at least 45% of weft spindles were rings [Copeland, 1912, p. 70]. For Lancashire we limit ourselves to looking only at vertically integrated mills, that is, those mills for whom we know that transport costs cannot have reduced the rate of ring adoption. Combining data from the Sandberg, Lazonick, and Farnie gives a result very similar to that of the U.S.: 55% of weft spindles installed between the introduction of the ring and the automatic loom were rings [Sandberg, 1969, p. 29; Lazonick, 1984, p. 394; Farnie, 1979, pp. 313-7]

Lazonick has further argued that the additional transport costs of using rings in Lancashire's vertically specialized industrial system represent "the primary constraint on the introduction of ring spinning in Lancashire" [Lazonick, 1983, p. 205]. The employment data for spinners and weavers in the *1906 Enquiry* can be used to establish the amount of spinning output and weaving capacity in each of the 12 districts of Lancashire. The data show that the majority of coarse yarn could be woven into cloth in the district in which it was spun, that is, within a couple of miles of where it was spun. Cotton allows us to assess the distance between mills within each district: his data show that, on average, Blackburn's spinning mills had seven weaving sheds less than 300 yards away, and 28 within half a mile [Cotton, 1970, map 1.5]. It is clear that transport costs would not have constrained the technological choices of such firms. Of the twelve districts of Lancashire, only spinners in Oldham, and, to a lesser extent Ashton and Stockport, were constrained in their choice of technology by the need to transport their yarn to be woven into cloth. In all other areas, vertically specialized firms should have been as ready to adopt rings as their integrated rivals. This proposition can be tested directly. We find that 79% of spindles installed in vertically integrated spinning-weaving firms between the ring's invention and 1906/7 were rings; for all firms located outside of Oldham, Ashton and Stockport the figure is 87%. This suggests strongly that the take-up of ring spinning was not a function of vertical integration, but of the proximity of spinners and weavers.

The new data assembled in this thesis allows us to better assess labor productivity in the Lancashire and New England cotton spinning industries. We construct four new, count specific, labor productivity series: for Lancashire mules, Lancashire rings, New England mules, and New England rings. Each gives the weight of each count of yarn that could be produced by one operative in one day. These allow us to compare relative labor productivity for any type of yarn on either machine; equally they allow us to compare Lancashire mules with New England rings.

Each labor productivity series is constructed by multiplying data for output per spindle by data on the number of spindles tended per worker. In all cases the data applies to all installed machinery, rather than just to new machines. Our sources are generally the same as those we used when trying to assess unit labor costs. Output per spindle for Lancashire comes from Winterbottom and Taggart [Winterbottom, 1907, pp. 204, 213; Taggart, 1923, pp. 155-7, 202-3], whereas output per spindle for New England comes from the series that were estimated from the actual production records of the Amoskeag, Lyman, and Naumkeag mills. The number of spindles tended by each Lancashire mule spinner is calculated from data in Jewkes and Grey, whereas the number of spindles tended by each ring spinner is calculated by dividing weekly wages by the (count-specific) wage per 100 spindles [*1906 Enquiry*, p. 30; Jewkes and Grey, 1935, p. 205]. For New England we take the number of spindles per ring and mule spinner from the *1905 Census* [*1905 Census*, p. 60]. The data show that labor productivity was higher in Lancashire than in New England: on average by 64% in mule spinning, and 49% in ring spinning; further, Lancashire's mule spinners were 10% more productive than New England's ring spinners.

All previous work has suggested that the U.S., rather than Lancashire, had higher levels of productivity. The contrast is marked, but explicable. Lazonick's uses Cramer's machinery catalogues as his source for New England mule productivity [Lazonick, 1981b, p. 510]. But Cramer sold at most 3 pairs of mules per year, almost certainly imported, so his knowledge of mule productivity was almost certainly slight [*1905 Census*, pp. 51, 60; *U.S. Tariff Board Report*, p. 473]. Clark gives the number of machines per operative, but not figures for labor productivity itself [Clark, 1987]. Broadberry's figures, based on production censuses, look only at the total weight of yarn produced, without taking into account that U.S. yarn was on average considerably coarser than British yarn; the relevant adjustment is sufficient to reconcile Broadberry's figures to those offered here [Broadberry, 1994, p. 541; *1905 Census*, p. 48; Saxonhouse and Wright, 1984, p. 511].

Lancashire's labor productivity advantage appears to have been based on three factors. The first, Lancashire's natural humidity, was estimated by contemporaries to raise productivity by 16% [Farnie, 1979, p. 49]. Second, New England had a larger tail of under-performing firms [U.S. Tariff Board Report, 1912, pp. 416-20]. Third, it appears certain that, in an industry in which experience was the primary determinant of productivity [Lazonick and Brush, 1985, p. 76-82], Lancashire operatives were, on average, considerably more experienced than their New England rivals. Evidence for this comes from three sources: a comparison between New England firm records and the *1906 Enquiry* suggests that New England operatives were younger [*1906 Enquiry*, p. 29]; comparing Nelson and Rose shows that New England labor turnover in cotton was over four times as high as in Britain [Nelson, 1995, p. 85; Rose, 1977, p. 115]; in addition we know that spinning suffered particularly high rates of labor turnover in New England [Hareven, 1982, p. 253].

Our productivity figures have implications for our understanding of comparative advantage. They show that Lancashire's export success was not built only on low wages, but also on high levels of labor productivity. Equally, although we know from trade statistics that the New England cotton industry was never a successful exporter, these figures show that this lack of success was caused not just by high wages, but also by low levels of productivity.

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