

Why Nations Fail: Managerial Decisions and Performance in Indian Cotton Textiles, 1890–1938

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Between 1890 and 1938 Japan experienced rapid economic growth. India stagnated. This national divergence was reflected in the performance of both countries' leading modern industry, cotton textiles. The parallels between national and industry performance suggest the problems of the Indian textile industry may have been those of India as a whole. Weak management is widely blamed for poor performance in textiles. An analysis of managerial decisions in Bombay shows, however, that on all measurable dimensions Indian managers performed as well as they could. The problem instead was one factor they could not change—the effort levels of Indian workers.

In 1890 Indian and Japanese cotton spinning mills had roughly equal capital and labor productivity. Thereafter, however, the cotton industries of the two countries diverged dramatically. Table 1 shows estimates of output per worker hour and per spindle hour in spinning in both countries from 1890 to 1938 by five year averages. Between 1890 and 1938 Japanese firms nearly quintupled output per worker hour, while output per worker hour rose little in India. Japan also achieved higher outputs per spindle hour, though here the gains over India were much more modest. The table indicates that the Japanese labor productivity advantage was 300 percent, while the Japanese advantage in terms of capital was only 50 percent. And because labor costs in India in the 1920s were at least double the costs of fixed capital, the low labor productivity of the Indian industry was a much more important problem than the lower output per spindle.

The central problem of the Indian textile industry in the years 1890 to 1938 was thus the failure to improve labor productivity. In this article, concentrating in particular on the firms of Bombay, India's largest textile center, we make the following arguments about India's failures. The divergence in textile labor productivity between Japan and India was not due to differences in machinery. The equipment used in the two countries was basically similar

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TABLE 1
CAPITAL AND LABOR PRODUCTIVITY IN SPINNING 20S YARN: INDIA AND JAPAN,
1890-1938

Period	Pounds of Yarn per Worker-hour		Pounds of Yarn per Spindle-hour	
	India	Japan	India	Japan
1890-1894	0.75	0.80	0.027	0.026
1895-1899	0.79	0.89	0.028	0.036
1900-1904	0.80	1.35	0.026	0.039
1905-1909	0.78	1.42	0.029	0.040
1910-1914	0.75	1.63	0.027	0.044
1915-1919	0.73	1.91	0.026	0.042
1920-1924	0.92	1.88	0.027	0.042
1925-1929	1.13	2.56	0.034	0.042
1930-1934	—	3.54	—	0.048
1935-1938	0.90	3.99	0.030	0.045

Notes: The figures for India for the years 1925-1929 are from a sample of some Bombay mills in 1929 only. We show later that in Bombay there was little increase in output per worker between 1907 and 1938. The figures for India from 1935-1938 are for 1949, because figures for the intervening years are not available. As can be seen there is no growth in labor productivity in India between 1920 and 1949.

Source: Clark, "Textile History."

and did not change significantly in either country over the period 1890 to 1930. Nor was there a lack of entrepreneurial initiative in India. It appears that investment responded to relatively modest positive profit rates, and had Bombay mills brought their labor requirements down to those of English and later Japanese mills, their profits would have risen enough to justify a great expansion. Why did managers fail to improve labor productivity? There is no evidence for the conventional view that the problem of the Indian industry was managerial.¹ Some Bombay managers did take steps to "rationalize" labor usage and achieved staffing levels similar to Japanese averages. The majority of Indian managers did not follow their lead because firms which rationalized did not improve profits. A contemporary manager who noted "that in many sections of the industry, operatives were not doing from more than three to four hours actual work" was correct.² A preference for low labor inputs by workers was at the heart of the Indian cotton industry's problems. The sources of this preference cannot be completely resolved here. The low efforts of the Indian workers could reflect worker solidarity and a failure of bargaining between workers and managers to translate these unused efforts into useful

¹ Supporters of the conventional view include Bagchi, *Private Investment*; Chandavarkar, *Origins*; Kiyokawa, "Technical Adaptations"; Mass and Lazonick, "British Cotton Industry"; Otsuka, Gustav, and Saxonhouse, *Comparative Technology*; and Morris, *Emergence*. Morris argues that while the overstaffing may not have been a problem in the early history of the industry, efforts to eliminate it in the interwar period were unsuccessful due to management's lack of direct control over labor. Morris, *Emergence*, pp. 129-53. Clark, "Would Better Management," discusses the importance of management in mill success in India and China in the 1920s.

² India. Royal Commission on Labor in India. [hereafter IRC]. *Evidence*, vol. 1, part 1, p. 486.

work, a result of the peculiar institutions of the Indian labor market. Or, the low efforts could reflect the leisure preferences of Indian workers.

THE BOMBAY INDUSTRY AND ITS PROBLEMS, 1890–1938

At the most basic level the problem of the Indian industry was a huge excess of workers assigned to each machine. Based on the technical specifications of the machines and the practices of countries such as England and the United States, Indian mills, even in the relatively productive center of Bombay, employed as many as five times the number of workers as were needed. Morris Morris argues that India's low wages and high capital costs explain the additional labor. The apparent excess manning was actually optimal, he argues, because it allowed managers to run the machines faster with fewer stoppages.³

Yet even under particular Indian conditions, such as high breakage rates, most of the mill labor force was redundant. Consider, for example, time study estimates of the minutes required per task in spinning. These predict well the number of workers required per spinning frame at different yarn counts in U.S. mills in 1949. Workers had five tasks to perform in ring spinning: to replace exhausted input packages (creel), to repair thread breaks (piece), to clean lint from the machine, to patrol to check for breaks, and to remove the filled output bobbins (doff). The second column of Table 2 shows the frequency of each task per hour on a spinning frame of 326 spindles under Indian conditions. There is some uncertainty about the breakage rate, which would affect piecing. We assume 25 breaks per 100 spindle hours, which would be 2.5 to 7 times the British and American breakage rates in this period. This is at the upper end of the various estimates we have.⁴ The third column of Table 2 shows the minutes required per task. The fourth column shows the total minutes required per hour per frame in India. Each spinning frame should have required less than one worker. A conservative estimate of the actual number of workers tending each frame, however, is somewhere between 3 and 3.8.⁵ Thus between

³ Morris, *Emergence*, p. 6.

⁴ One expert cited the records of a Bombay firm in 1938 as indicating 27 breaks per 100 spindle hours. He claimed he had seen rates higher than this: as many as 35 breaks per hour. Maharashtra State Archives [hereafter MSA]. Textile Labour Inquiry Commission, Oral Evidence, vol. 21, pp. 4983 and 4977, File 7-B. On the other hand, Pearse watched two frames for three minutes in a Bombay mill in 1929 without seeing a single break. If the breakage rate was as high as 25 breaks per 100 spindle hours, he would expect to see 8.5 breaks in this time, and the chances of seeing zero would be 2 in 10,000. Pearse, *Cotton Industry*, p. 129. Even using the highest rate quoted, 35, would still only add 9.4 minutes of work per hour per frame, which would not materially change the implications of Table 2.

⁵ Thus, for example, it was reckoned that in an average Indian spinning room in 1929 spinning 20s yarn the labor required would be in total 5.1 workers per frame, including however, ancillary workers such as bobbin carriers and sweepers, and supervisors. Cotton Yarn Association, "Statistics," p. 12. Modern mills in Bombay were said to employ 3 operatives per frame—2 spinners and a doffer—but even these mills would employ extra workers to assist the regulars. Pearse, *Cotton Industry*. An alternative estimate of the total numbers of workers per spindle comes from the wages census of 1921, which

TABLE 2
LABOR REQUIREMENTS IN SPINNING 20S YARN IN INDIA, 1890-1929

Task	Tasks per Hour for 326 Warp Spindles	Time Required per Task (Seconds)	Total Time Required (Minutes)
Creeling	18.7	17.5	5.5
Piecing	73.4	16.6	20.3
Cleaning	—	301	5.2
Patrolling	6	23	2.3
Doffing	132	3.9	8.6
Minutes required			41.9
Minutes available			180 to 230
Percent labor efficiency			18 to 23

Notes: Calculations assume that the net weight of yarn on the input (creel) bobbin is 0.63 pounds, that output per spindle per hour is 0.036 pounds, and that the net weight of the yarn on the output bobbin is 0.089 pounds. These assumptions are taken from the average specifications of machines purchased by Indian firms from Platt's in the years 1890 to 1929, assuming 90 percent spindle efficiency in operation. *Sources:* The times required for each operation are an average of those given in Doraiswamy, "Scope"; Cotton Spinning Productivity Team, *Cotton Spinning*; Grosse, "Technological Structure"; Gunther and Gross, "Spinner's Task"; Subramanian and Garde, *End Breaks*; and Textile Council, *Cotton*. The estimate of actual workers per frame is discussed in the text.

three-quarters and four-fifths of the workers in Indian mills were super-numerary. Doffers, for instance, would be required to work only 9.6 minutes of each hour. This exercise indicates that Indian spinning mills were over-staffed by at least 300 percent. In marked contrast, similar calculations for Japan indicate that by the late 1930s Japanese mills were close to the level of staffing we would expect from time studies estimates.⁶

While Indian labor productivity was low, output per spindle hour in Indian mills compared well with English and U.S. performance. Thus in 1924 output per spindle hour spinning 20s ring yarn was estimated as follows: United States, 0.031 pounds per hour; England, 0.029 pounds per hour; India, 0.028 pounds per hour; Japan, 0.042 pounds per hour.⁷ Spindle productivity thus looks good compared to both the United States and England, and while it lags Japan the differences are minor compared to labor productivity.

An examination of the details of the ring spinning machines purchased by both countries from Platt Brothers in Lancashire, the world's major supplier of textile machinery, makes it clear that the rise in labor productivity in Japan in relation to India had little to do with the differences in machinery

implies 3.8 workers per frame in Bombay. The census reveals that the 2,381,876 ring spindles in Bombay in 1921 were tended by 15,183 spinners and 7,385 doffers, as well as 5,485 "gaiters" and "tarwallers and followers." This would imply one spinner per 157 spindles, as well as one doffer per 323 spindles, and a further helper per 434 spindles. Shirras, *Report of an Enquiry into the Wages*, pp. 4, 25, 35, 37. The labor officer of the Bombay Millowners Association gave *best practice* in 1957 at 8.75 workers per 1000 spindles on 20s count, or 2.85 workers for a frame of 326 spindles.

⁶ Clark, "Textile History."

⁷ *Ibid.*

TABLE 3
TECHNICAL SPECIFICATIONS OF NEW RING SPINNING MACHINERY: INDIA AND
JAPAN, 1890–1934

Period	Number of Observations		Average Draft		Average Ring Bobbin Size*		Average Roving Bobbin Size*	
	India	Japan	India	Japan	India	Japan	India	Japan
1890–1899	28	13	5.9	6.2	100	100	100	95
1900–1909	17	7	5.7	6.8	103	97	93	104
1910–1919	28	48	6.3	6.3	101	100	110	109
1920–1929	65	106	6.7	8.8	112	105	121	138
1930–1934	60	9	12.2	13.8	115	113	160	245

*These sizes have been set equal to 100 for Indian machines over the years 1890–1899.

Notes: All measures are standardized for a machine spinning 20s count yarn using information for 1,596 orders of ring machinery for all countries between 1890 and 1934.

Source: Lancashire Record Office, Platt Ring Order Books, Platt MSS, DDPSL 1/42/7-42.

choices. Labor requirements per pound of yarn were influenced by such factors as the size of the yarn packages that workers had to transfer between machines and how many preparation steps were required before raw cotton reached the ring frame. Larger packages and fewer processes lowered labor requirements. Table 3 shows the major characteristics of machines purchased by India and Japan in each decade from 1890 to 1934 which affected labor requirements. The average draft of a spinning frame is the weight per yard of the cotton input, called roving, divided by the weight per yard of the yarn produced. The greater this number, and hence the coarser the roving, the smaller the number of preparatory frames the roving has to pass through. Drafts were similar between the two countries until the mid-1920s, when average draft increased in Japan. Drafts also increased in India shortly thereafter. These increases reflect the introduction of new techniques called “high drafting,” which allowed the spinning machine to use coarser roving, delivered in bigger input packages which reduced creeling labor. The last two columns of Table 3 show an index of the package size, normalized to be 100 for India in the 1890s. Input packages got significantly bigger in Japan in the late 1920s and India in the 1930s. High draft spinning did not have much impact on the size of the output package, the ring bobbin; nor is there much change in ring bobbin size between 1890 and 1934 in either country.

Overall, we see that until the mid-1920s India and Japan bought machines which were almost identical in their labor requirements per pound of yarn spun. After 1925 Japan moved more quickly toward high draft spinning. But because this saved labor only on new machines starting in the later 1920s, and because Japan’s lead in adopting this technique was short lived, this explains little of the differences in labor productivity trends in each country over the longer period, 1907 to 1938.

Despite the manifest problem of too many workers, the Indian industry showed little sign of any improvement in manning levels before 1938.

TABLE 4
CHARACTERISTICS OF THE BOMBAY COTTON INDUSTRY, 1907-1938

Year	Gross Profit Rate on Fixed Capital	Industry Size (millions of spindle equivalents)	Labor Efficiency Index	Mule-to- Spindle Ratio	Value Share of Spindles
1907	0.11	2.93	0.96	0.39	0.84
1908	0.08	3.11	0.97	0.37	0.83
1909	—	3.23	—	0.34	0.82
1910	—	3.30	—	0.33	0.81
1911	0.02	3.38	0.95	0.32	0.81
1912	0.09	3.39	0.95	0.30	0.81
1913	0.07	3.46	0.94	0.29	0.81
1914	0.03	3.60	0.91	0.27	0.80
1915	—	3.64	—	0.25	0.79
1916	0.07	3.66	0.97	0.24	0.79
1917	0.10	3.69	0.95	0.22	0.77
1918	0.05	3.66	0.98	0.22	0.76
1919	—	3.73	—	0.22	0.76
1920	0.16	3.75	1.02	0.21	0.76
1921	0.13	3.84	1.06	0.21	0.76
1922	0.08	3.99	1.03	0.19	0.76
1923	0.02	4.28	1.01	0.16	0.76
1924	0.00	4.40	1.00	0.14	0.76
1925	-0.01	4.45	0.97	0.13	0.76
1926	0.00	4.49	1.02	0.12	0.76
1927	0.03	4.50	1.00	0.12	0.76
1928	-0.02	4.50	1.34	0.11	0.75
1929	0.00	4.52	0.95	0.11	0.75
1930	-0.01	4.51	0.93	0.10	0.75
1931	0.01	4.51	0.92	0.10	0.75
1932	0.00	4.52	0.93	0.10	0.75
1933	-0.01	4.33	0.95	0.10	0.75
1934	0.01	4.15	0.90	0.09	0.75
1935	0.01	3.96	0.93	0.08	0.75
1936	0.01	3.96	0.91	0.08	0.75
1937	0.02	3.84	0.91	0.07	0.74
1938	0.03	3.87	0.90	0.06	0.74

Notes: The labor efficiency index is the average of L_1/L_0 , the ratio of actual labor inputs to predicted labor inputs. Value share of spindles is value of spindles / (value of spindles + value of looms). See the text for the derivation of these figures. Profits and L_1/L_0 are constructed only for the mills listed in the *Investor's India Yearbook*. For the construction of profit rates see the Appendix.

Sources: Profit data are from the *Investor's India Yearbook*, and are calculated as described in the Appendix. All other data are from the Bombay Millowners' Association annual reports.

Table 4 gives a summary picture of the Bombay cotton industry in the years 1907 to 1938. The third column shows the size of the industry measured in millions of ring spindle equivalents, where mule spindles and looms were converted to equivalent ring spindles based on their relative associated fixed capital. The industry grew from 1907 to 1924 at an average of 3 percent per year, but thereafter stagnated and eventually began to decline in size. Because output per machine was relatively standard, a simple measure of labor

productivity is the number of machines manned by each worker.⁸ To obtain an industry-wide measure of machines per worker, we needed to control for the varying composition of the equipment in different mills. We constructed the index of labor per machine complement in the following way. Because firms had different types of machinery—rings, mules, and looms—which embodied different capital-to-labor ratios, to measure labor inputs per mill we estimate a regression

$$LABOR_i = a_1 RINGS_i + a_2 MULES_i + a_3 LOOMS_i + e_i$$

over the years 1907 to 1938. This gives the average amount of labor used as a function of the number of machines of each type each firm was utilizing that year.⁹ The estimated coefficients are

$$LABOR_i = 0.032 RINGS_i + 0.028 MULES_i + 0.928 LOOM_i$$

(0.001) (0.001) (0.029)

$R^2 = 0.10, N = 1,707$

with standard errors in parentheses. These estimates are similar to the average manning levels Pearse obtained from a survey of Indian mills in 1930, where he found 0.021 workers per ring spindle and 0.91 workers per loom.¹⁰ Further, the labor per mule is less than the labor per ring, as we would expect because a mule's output per spindle was less, and therefore there would be less cotton input per spindle and less preparatory work.

We use these estimates to calculate for each firm L_0 , the amount of labor its equipment would be predicted to require on average. The ratio of actual labor inputs to predicted inputs is L_i / L_0 . The average of this measure from 1907 to 1938 will be unity. Firms for which the measure is greater than one use more labor than predicted by their equipment. As reported in Table 4, this measure shows that there was very little change in the capital-to-labor ratio over time. The ratio of actual to average labor inputs starts at 0.96 in 1907, and ends at 0.90 in 1938.¹¹ Clearly, the Bombay mills in aggregate were not shedding much labor over this period, despite a vigorous debate about rationalization. Contrast the stagnation of this ratio in Bombay to the 55 percent increase in the capital-to-labor ratio we observe in Japan between the periods 1920 to 1923 and 1935 to 1938.¹²

⁸ Clark, "Why."

⁹ In the estimated regression, we transformed all variables by dividing by the size of the working capital stock. This normalization avoids heteroskedasticity from larger mills having larger error terms.

¹⁰ Pearse, *Cotton Industry*, pp. 288–306.

¹¹ Labor used per machine increases slightly on this index in the 1920s. This increase is probably a result of changes in the composition of the sample. The records of 19 firms are given in the 1911 edition, but 44 in the 1919 edition. *Investor's India Yearbook*, years indicated.

¹² See Wolcott, "Perils," table 1.

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While the Indian industry as a whole experienced stagnant labor productivity, some mills did reduce their manning levels. The firm of E. D. Sassoon was the pioneer.¹³ After a "careful survey of the international textile situation made in 1923," Fred Stones, the manager of all of the Sassoon mills, concluded that the Japanese and Chinese were able to undersell Bombay due to lower labor costs and product standardization. He noted that past attempts to lower Bombay wages had resulted in strikes, and determined that it would be preferable to decrease labor costs through "Fordizing" the industry. This strategy later came to be known as "rationalization" in India. An examination of his mills convinced him that in many sections of the industry, operatives were not doing more than three to four hours actual work, and the actual amount of work that could be done in these particular departments could easily be doubled without unduly taxing the worker.¹⁴

Stones thus altered his labor practices to increase the number of machines per worker. Despite worker resistance, by 1935 the four most rationalized Sassoon mills employed only 0.58 workers per standard unit of labor required in Bombay. The other Sassoon mills on average used 74 percent of the average labor input of Bombay mills. Though several other firms claimed to have rationalized parts of their mills, the Bombay Labour Officer stated that only two other firms had done so successfully.¹⁵ Toyo Podar, the only Japanese owned and managed Indian mill, used only 69 percent of the predicted labor. Bombay Dyeing and Manufacturing, managed by Ness Wadia, a Parsi trained in England, used only 68 percent of the predicted labor. The Bombay average in 1935 excluding these "rationalizers" was 0.93 workers per predicted worker, a substantial difference.

Estimated average annual profit rates for Bombay mills, calculated as explained in the Appendix, are shown in the first column of Table 4. Because throughout this period the interest cost of capital to mills seems to have been about 6 percent, and the depreciation cost of buildings and machinery would be at least 2 percent, we would expect new investment only if the gross profit rate on fixed capital was above 8 percent. Profit rates surpassed 8 percent only in the years 1907/08, 1912/13, 1916 to 1918, and 1920 to 1922. The decline of the industry in the late 1920s and the 1930s is clearly explained by the inability of firms to make enough profit to justify new investment. The connection between profits and investment is evident

¹³ In 1923, at the start of their rationalization efforts, the firm owned six mill companies (and a total of 11 mills), and employed 21,078 workers, 14 percent of the Bombay workforce. By the end of the interwar period the firm had also acquired two "upcountry" mills, but one of their Bombay mills was largely shut down.

¹⁴ IRC, *Evidence*, vol. 1, part 1, p. 486.

¹⁵ The four rationalized mills were the Edward, Meyer, Manchester and Apollo Mills, which had moved to six looms per weaver, as had the Japanese. All of the other Sassoon mills had rationalized spinning, and parts of their weaving operations. Textile Labour Enquiry Committee, *Extracts*, vol. 2, pp. 2 and 20, File 81(3).

statistically. If we estimate the percentage change in capital in year t on the profit rates from two years before we find the following relationship.

$$GROWTHRATE_t = 0.010 + 0.363(PROFIT RATE_{t-1} + PROFIT RATE_{t-2}) / 2$$

(0.007) (0.091)

$R^2 = 37, N = 25$

Standard errors are in parentheses. There is a strong connection between profit rates and subsequent growth rates.¹⁶

The excess labor of Indian mills was enough on its own to make a dramatic difference to the profitability of the industry. The amount by which profits should increase as the manning levels are reduced depends on the share of capital, labor, and other inputs in the costs of production. In general, in an industry with free entry we will find that for the average firm,

$$pQ = \pi_0 K + wL + p_c X$$

where pQ is revenue, π_0 is the gross return on capital, including depreciation, and K is the value of the capital stock, wL are wage payments, and $p_c X$ are payments for other inputs (here mainly cotton, fuel, and lubrication). Suppose the average labor requirement is L_0 . Then if the labor requirement of a given firm is L_i , the profits of the firm will be,

$$\begin{aligned} \pi &= (pQ - wL_i - p_c X) / K \\ &= (pQ - wL_0 - p_c X) / K + (wL_0 - wL_i) / K \\ &= \pi_0 + \left(\frac{wL_0}{K} \right) \left(1 - \frac{L_i}{L_0} \right) \end{aligned} \tag{1}$$

For Indian mills in this period the annual wage bill would be about 10 percent of the value of the capital of the mill (measured as the replacement cost).¹⁷ An Indian mill which reduced its labor usage to the amounts suggested by the time studies of Table 2 should have increased its gross return on capital by 8 percent. Because the average firm even in the good years of 1907 to 1922 was making a gross return on capital of only 8.25 percent, this would represent a very large increase in terms of the average net return on capital. Indeed the implied profit rates with no overmanning in Bombay

¹⁶ These estimates imply growth at average profit rates as low as 3 percent. But the relation between growth and profits should be nonlinear, with growth at profit rates above 8 percent, no growth from zero to 8 percent, and contraction at rates below zero percent. The linear relationship we fit to this data would have an expected intercept of between zero and 8 percent. The actual estimate is thus within the expected range.

¹⁷ Rutnagur, *Bombay Industries*, gives wage costs for all Bombay firms in 1924. We used this data to compute the average.

would be sufficient to cause the industry to grow even in the years 1924 to 1938 when gross profits in practice were close to zero.

Though little was changing in manning levels over the years 1900 to 1938, the Bombay industry was restructuring in other ways. The fifth and sixth columns of Table 4 show the ratio of mule spindles to all spindles, and the ratio of the value of spindles to all fixed capital. From 1907 to 1938 the fraction of spindles which were mules declined steadily from 39 percent to 6 percent. Until 1924 this reflected both large purchases of rings and large absolute declines in the stock of mules. After 1924 both scrapping of mules and installations of rings continued, but at a much slower pace, suggesting that the ring was viewed as more profitable throughout. But because mules were only being scrapped gradually, the remaining mule spindles still should have yielded positive profits if managers were rational. From 1907 to 1938 the ratio of spindles to all equipment moved from 84 to 74 percent. This is a much less dramatic decline than for mule spindles, and it was a decline that was largely complete by 1918. We would thus expect that in the earliest period looms would have been more profitable than rings, but thereafter there should have been no difference in profit rates between looms and rings.

THE CAUSE OF OVERMANNING IN BOMBAY

While the symptom of the Bombay industry's failure is easy to diagnose—too many workers—discovering the cause of these problems is difficult.

The proponents of managerial failure would argue that the excess labor in the mills was due to ineffective management.¹⁸ Though doffers, for example, may have been idle most of the time, their idleness could represent a failure by managers to supervise them effectively or to realize that there was much untapped labor potential. Subsequently we use the calculated profit rates of individual firms in Bombay in the years 1907 to 1938 to argue that there is no evidence that managerial failings had any responsibility for surplus labor in Bombay mills. We do this in three ways. First, we show that firms which reduced their labor usage per machine did not increase profit rates. Second, we show that where strategies did seem to be associated with greater profits, firms pursued those options: when firms earned profits they invested in expanding capacity; when profits disappeared after 1924, firms bought no new plant, even when they had reserves of cash; when looms appeared to earn more profits in the 1910s, firms acquired looms; because ring spindles were associated with higher earnings per unit of capital than looms, firms generally only invested in rings. Third, we show that where firms varied in their choices, such as in whether to employ local or foreign managers, or what size to make mills, these variations were not associated with any systematic differences in profits. In

¹⁸ See note 1 for a list of scholars who hold this view.

short, where profit opportunities appeared, managers in India exploited them. Where different choices were not clearly associated with differences in profits, then we observe a variety of decisions.

The profit rates for mills were constructed from several sources. The Appendix explains in detail how this was done. As the profit rates are important to our claim that the overmanning in Bombay was not a managerial problem, we need to be confident that the profit rates are reasonably reliable. The underlying balance sheet data are drawn from the published annual reports of incorporated firms, which were attested to by independent accountancy firms and filed with the registrar of firms. The calculated profit rates correlate well in aggregate and for individual mills with other indicators of success or failure. As noted earlier, the aggregate statistical relationship between growth and profits is quite strong. The pattern fits with what we would expect from anecdotal accounts. The Bombay Millowners Association first applied for tariff protection from the Indian government in 1925, the first year in which average profits became negative. The extended general strikes of 1928 and 1929 show up as a second bout of negative profit rates. The negative profit rate in 1933 (actually, for most firms, April 1933 to March 1934), corresponds to the general strike which ended in April 1934, and estimated profit rates improve in the later 1930s as significant protection is granted to the industry. The aggregate data also correspond well to the state of the market in Bombay. We regressed the aggregate profit rate on the ratio of cotton mill wages to cloth value added. The estimated coefficient is negative, as expected, and statistically significant at better than the 1 percent level.

Perhaps the strongest evidence of the reliability of individual profit rates is that these correlate also at the individual level with individual mill growth and with measures of the capacity utilization of the individual firms. A regression of individual mill growth on the average of the previous two years profit rates yields the following relationship

$$GROWTH_{i,t} = 0.01 + 0.217(PROFITRATE_{i,t} - 1 + PROFITRATE_{i,t} - 2) / 2$$

(0.004) (0.049)

adjusted $R^2 = 0.02$, $N = 778$

with standard errors in parenthesis.¹⁹ Given that growth should be a function of expected future profits, for which past profit is a weak proxy, the clear

¹⁹ The intercept is larger and the slope coefficient smaller than in the aggregate regression. This is as expected. The growth variable in the aggregate regression considered the industry as a whole, including mills for which we do not have profit data. The assumption is that the observed profit data series is a reasonable proxy for the profit rate pattern of the industry as a whole. The growth variable in the individual regression included only mills for which we have profit data. Most of the growth and subsequent decline of the industry as a whole came from mills entering and exiting. By construction, if a mill remained in our sample, it did not exit the industry. Thus the average growth of our sample is greater than the average growth of the industry as a whole. The tendency of the industry to expand primarily through entry also explains why the aggregate growth response to profits is greater than the individual mill response.

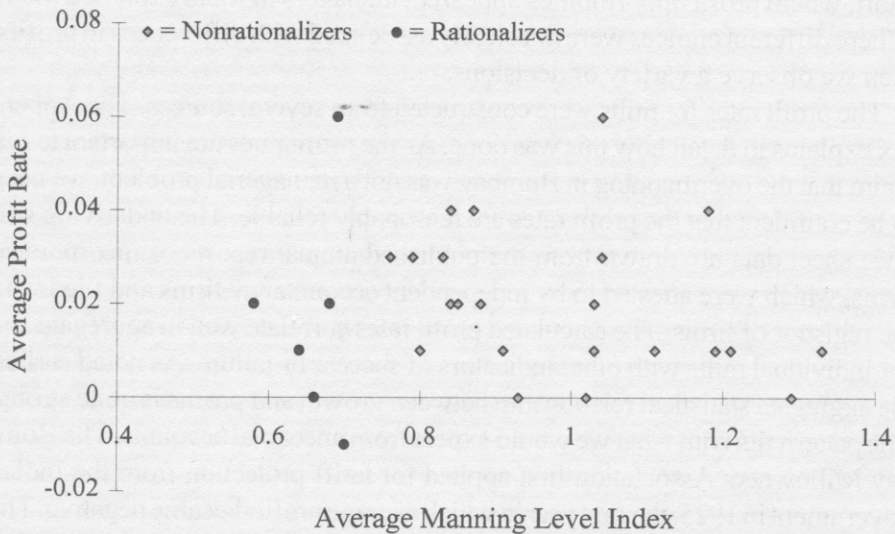


FIGURE 1
AVERAGE PROFIT RATES AND MANNING LEVEL INDICES, 1935-1938

Notes: These are the average profit rates and manning level indices, L_i / L_0 , of the 27 firms for which we have profit data in the period from 1935 to 1938. The rationalizing firms are those identified by the Bombay Labour Officer as having successfully "rationalized" their production (File 81(3) Textile Labour Enquiry Committee, Extracts on Rationalization, vol. 3, p. 2). Toyo Podar is the only rationalized firm not included here as there are no published profit data.

Source: See the text.

association is a strong sign that the individual profit rates convey good information about the success of firms. Capacity utilization is also correlated with the pattern of individual mills' profits over time. For the 30 firms for which we have at least 15 annual data points, capacity utilization has a positive and statistically significant effect on the mill's profit rate in 21 cases. The effect is positive in all 47 cases for which we have any data. Thus the aggregate and cross-section patterns of the profit rate series seem to correspond well with measures that we know *a priori* should be correlated with profits. Though our estimates may be less than perfect, they are sufficient to detect the large increases in profits that an elimination of overmanning in Bombay should have created.

Yet these estimated profit rates in fact show little association between the shedding of labor and the making of profits. Figure 1 shows the profit rates of 28 Bombay mills for the years 1935 to 1938 compared to their average labor efficiency L_i / L_0 (actual workers divided by expected workers). The rationalizing mills, represented by black circles, are clustered at the left end of the graph with low labor usage. Clearly, the rationalizers on average made no more profit than the nonrationalizers. The average profit rate of the ratio-

nalizers was 1.7 percent, while that of the nonrationalizers was 2.0 percent. Shedding surplus labor did not lead to higher profits in Bombay.

Bombay Dyeing and Manufacturing, which generated a 6 percent return, was the most profitable of the rationalizers. But even this mill was not a success in the eyes of its managers. The minutes of the board of directors meetings show that the profit rate was only sufficient to induce some replacement of worn out equipment.²⁰ Between 1930 and 1938 the board authorized average annual expenditures on equipment of 374,469 rupees, 1.3 percent of the value of their fixed capital stock. On net, however, the numbers of their spindles and looms declined. During these years the board also authorized large investment of surplus cash on government bonds. By 1938 the market value of the company's holdings of government bonds was 8,026,989 rupees, sufficient to extend their mills by 25 percent had they wished.

To test more systematically for the effect of labor utilization on profits we estimated the following regression for each of four subperiods: 1907 to 1914, 1915 to 1918, 1922 to 1924, and 1935 to 1938.²¹

$$\pi_{it} = b_0 + b_1 RING_{it} / K_{it} + b_2 LOOM_{it} / K_{it} + b_3 L_{it} / L_0 + b_4 FORDUM_{it} \\ + b_5 K_{it} + b_6 AGE_{it} + b_7 (1 - UTIL_{it}) + e_{it}$$

where $RING_{it}$ is the fraction of the capital stock which is rings and $LOOM_{it}$ is the fraction of the capital stock which is looms. The coefficients b_1 and b_2 measure the differences in profit rates between rings and mules, and looms and mules, respectively. $FORDUM_{it}$ is a dummy variable which is one when the mill is foreign owned, and K_{it} is the size of the capital stock in the mill. The variable AGE_{it} is an indicator of the average age of the machinery of the mill.²² The evidence of the Platt data on machine purchases suggests that the coefficient on this variable should be negative but small. $UTIL_{it}$ is the fraction of the mill equipment in operation in the period in question. Some mills did not operate to full capacity for all the years for which we have profit rates: they were closed by strikes; equipment was installed, but only began operating part way through the year; or they closed down for part of the year because of lack of demand. Table 5 shows the result of estimating this regression using the average values for each mill in each period.

²⁰ Bombay Dyeing and Manufacturing Co., Minutes of the Board of Directors Meetings, 1930–1938.

²¹ The early subperiods are dictated by data availability. We limited the last period to the later 1930s to give rationalization the best chance of being effective. Anecdotally, resistance to rationalization ended after the 1934 General Strike.

²² For machinery where we know the purchase date the age is taken as the years since purchase. For any machinery where we do not know the purchase date the age is taken as the years since the mill was founded. Suppose, for example, a mill started in 1907, but we begin to have data on profits and machine purchases only in 1920, and it doubles its machinery stock in 1924 with no subsequent additions. The variable AGE would be $(YEAR - 1907)$ from 1920 to 1923. From 1924 to 1938, the variable age would be $(YEAR - (0.5 \times 1907) - (0.5 \times 1924))$.

TABLE 5
RESULTS OF REGRESSIONS OF PROFIT RATES ON FIRM CHARACTERISTICS,
1907-1938

	Simple Labor Efficiency Index				Modified
	1907-1914	1916-1918	1923-1924	1935-1938	1935-1938
Mean profit rate (percentage)	5.0	6.9	1.0	2.0	2.0
Intercept	8.22 (9.03)	-1.03 (5.97)	4.67 (5.83)	-1.33 (3.28)	0.67 (3.02)
<i>RING / K</i>	4.63 (5.49)	1.14 (4.46)	2.52 (4.84)	3.29 (3.35)	1.80 (2.96)
<i>LOOM / K</i>	3.14 (8.39)	20.85*** (5.67)	0.75 (6.87)	5.03 (5.01)	3.68 (4.70)
L_t / L_0	-4.87 (8.57)	3.51 (4.71)	-2.03 (3.35)	0.76 (1.60)	0.59 (1.93)
<i>FORDUM</i>	-2.28 (1.98)	-0.87 (1.51)	-1.46 (1.59)	1.69** (0.69)	2.21*** (0.79)
$K / 10^{-6}$	-0.13 (0.34)	0.16 (0.25)	-0.03 (0.15)	0.04 (0.07)	0.05 (0.06)
<i>AGE</i>	-0.01 (0.07)	-0.02 (0.04)	-0.04 (0.05)	-0.02 (0.03)	-0.03 (0.03)
<i>1-UTIL</i>	-14.49 (16.28)	-19.45* (11.40)	-18.09*** (6.51)	-8.01** (3.82)	-9.19*** (3.29)
R^2	0.12	0.36	0.20	0.43	0.36
<i>N</i>	30	40	50	27	27

* = Significant at the 10 percent level.

** = Significant at the 5 percent level.

*** = Significant at the 1 percent level.

Notes: Standard errors are in parentheses. Modified results for 1935-1938 use the labor efficiency index corrected for the quality of cotton. For an explanation of the index and this correction, see the text.

Source: See the text.

Given the apparent labor surplus in Bombay mills shown in Table 2 we would expect the coefficient on L_{it} / L_0 to be -10 based on equation 1.²³ In general our estimates are imprecise because profits varied greatly across firms, as can be seen in Figure 1, and because we have small numbers of firms with the requisite data. But the standard errors of the estimates are low enough that in all but the first period we can reject the idea that profit gains from reducing the numbers of workers were as great as would be predicted if firms had excess labor, as Table 6 shows. Indeed though some firms used only half as much labor per machine as others there is no sign that this resulted in *any* gain in profits. In the thirties when rationalization increased the dispersion of manning levels we get more precise estimates of the possible effect of manning levels on profit rates, and these estimates confirm that eliminating labor had very little effect. At best the effect was one-quarter of what would be predicted from the apparent labor surplus. Across all four periods the weighted average estimate is that the value of the coefficient on

²³ The coefficient should be -10 because profits are measured in percentages in the regression equations.

TABLE 6
ESTIMATED EFFECT OF MANNING LEVELS ON PROFIT RATES

Period	Estimated Value	Expected Value	95 Percent Confidence Limit
1907-1914	-4.9	-10	-22.0
1915-1919	+3.5	-10	-5.9
1923-1924	-2.0	-10	-8.1
1930-1938	+0.8	-10	-2.4
Weighted average	-0.7	-10	-3.1

Notes: The weights used to construct the weighted average for the whole period are the squared inverses of the standard errors of each coefficient estimate.

Source: Table 5.

L_i / L_0 is -0.7 as opposed to the value of -10 which we would expect given the labor surplus in the mills.

The estimated coefficients on the fractions of the capital stock invested in mules and looms are as we would expect given trends in the industry towards scrapping mules and slightly increasing the relative numbers of looms. In all cases mules are estimated to earn less profit than rings, though in none of the samples individually is the result statistically significant. In both the periods 1916 to 1918 and 1935 to 1938 the estimated gross profit on mules is predicted to be negative, implying firms should scrap mules, though the effect again is not statistically significant. Looms are generally estimated to earn more profits than spindles, though again the effects are not statistically significant except in the war years 1916 to 1918 when looms appear highly profitable.

Foreign-owned firms do not do any better in general than Indian-owned firms. In the different periods foreign-owned firms were estimated to earn anywhere between 2.3 percent less to 1.7 more as their return on capital. Taking a weighted average across all four periods the best estimate is that foreign firms earned a 0.1 percent lower return on capital. The standard errors are small enough that we can say with 95 percent confidence that firms under foreign ownership earned within 1.3 percent of the return on capital of domestic firms. Again the market looks to have been very competitive, with local entrepreneurs doing as well as their foreign competitors. There is no sign that foreign entrepreneurs were more efficient but somehow were blocked from taking over a larger share of the market.

It is noteworthy that the one statistically significant positive coefficient on foreign ownership is for the 1930s. It was a period of especially strong nationalist political fervor in which we might have expected foreign managed firms to have done poorly relative to domestic firms. But the higher returns to foreign management are very stable over the years 1931 to 1938. Only in 1930 do the foreign-owned firms earn less. The poor performance of foreign firms in 1930 is perhaps due to the boycott of foreign-owned firms Gandhi organized that year, but it could also be due to the fall in world trade, if it is true,

as Morris asserts, that foreign firms were more likely to rely on exporting.²⁴ The only observable way in which the foreign-managed firms differ on average from domestic firms is that their average wages were slightly higher.

There are no consistent size effects on profits. In some periods it is positive and in others negative. In none is it statistically significant. Consistent with the generally competitive nature of the industry in all countries, there were no measurable economies of scale in cotton textiles in Bombay at the firm level. There was considerable variation in the size of firms in the Bombay market, but again there is no sign that this involved mistakes or constraints on managers in the smaller firms. Even though we have valued the capital stock of firms using a replacement cost for equipment of each type, and have thus made no allowance for the technological inferiority of older machines, the effect of the average age of mill equipment on profit rates is always estimated to be small, and is never statistically significant. For each ten years the average age increased, measured profit rates are estimated to have been only 0.2 percent less. This is a very modest effect, and suggests that there was little technological improvement in the equipment of the industry in the years 1907 to 1925 when new investment largely ceased.²⁵

The analysis thus far suggests that the Bombay cotton textile industry operated in a competitive and reasonably well functioning market. Investment responded to relatively modest profit opportunities. There are no obvious managerial choices about machinery or labor utilization which we found to be associated with greatly improved profits. Different managers made different choices, but the regressions suggests they made no obviously bad choices.

It might be argued, however, that we failed to measure differences in labor utilization accurately. The most important factor affecting a mill's labor requirements other than the quantity of machinery used was the fineness of yarn being spun. When the cotton spun was coarser the amount of labor required per spindle and per loom rose because input packages were depleted more quickly and output packages filled up more quickly. The average cotton consumed per spindle, which indexes the yarn fineness, is thus another important predictor of labor requirements per spindle or loom.²⁶ The Bombay Millowners' Association annual reports give the total raw cotton consumed annually per mill. Because this includes cotton consumed on both the day and night shifts, to get a measure of cotton consumed per spindle hour we need measures of the amount of night shift work that was done. For the years 1921 to 1927 there was only one shift worked by Bombay mills. By the 1930s multiple shifts were common, but the unpublished files of the

²⁴ Morris, "South Asian Entrepreneurship," pp. 350-53

²⁵ Saxonhouse finds a similar result for the 1920s Japanese spinning industry. Saxonhouse, "Productivity Change," p. 214.

²⁶ Output per machine hour is lower with finer yarn, implying less labor in preparing cotton per spindle, and less doffing per spindle hour.

Textile Labour Inquiry Committee Report give information on the amount of shift working by each mill in 1935 and 1936. This allows us to estimate cotton consumed per spindle for the years 1932 to 1938.

To calculate the predicted labor per mill we regress labor usage per shift on raw cotton used (in 784 pound “candies”), along with mules working, rings working, and looms working. This regression included data only from the years 1921 to 1927 and 1932 to 1938. For the latter set of years, we estimated the cotton used per firm by multiplying the cotton consumed per spindle in the day shift in 1935 and 1936, multiplied by the number of spindles operating in the day shift. The resulting estimated regression is as follows

$$\begin{aligned}
 LABOR_i = & 0.020RINGS_i + 0.010MULES_i + 0.873LOOMS_i + 0.080COTTON_i \\
 & (0.001) \qquad (0.001) \qquad (0.029) \qquad (0.007) \\
 & \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad R^2 = 0.18, N = 607
 \end{aligned}$$

with standard errors in parenthesis. The coefficient on raw cotton has the correct positive sign and is statistically significant, and incorporating this variable improves the fit of the regression in a statistically significant way. But this revised average labor usage regression has only a limited effect on the measure of the mills’ relative labor efficiencies. The main effect is to attenuate extremely low values. Thus, the original index of actual usage relative to expected usage (L_i / L_0) varied across mills from 0.58 to 1.33 in the period 1935 to 1938. When one incorporates cotton quality as well as machinery usage to determine expected labor usage, the index varies from 0.63 to 1.39 across mills in this same period. The “rationalizers” have the lowest measured manning levels with the new coefficients.

The improved manning level index has virtually no effect on the profit rate equations. The last column of Table 5 reports the results of regressions which use the corrected labor efficiency index. They are qualitatively similar to those using the original coefficients. Thus it appears that the estimated labor efficiency index is uncorrelated with profits because labor efficiency is uncorrelated with profits, and not because the estimate is a poor measure of actual labor efficiency.

RATIONALIZATION AND WAGE RATES

Shedding labor did not raise profits in part because the mills which shed labor paid higher wages to those workers retained. Thus in the years 1935 to 1937 the average daily wage per worker on the rationalized mills was. 1.26 rupees compared to 1.11 rupees for nonrationalized mills. Similarly if we compare the changes in average wages in mills in the years 1923 to 1924 and

TABLE 7
ESTIMATED ELASTICITY OF DAILY WAGE RATE WITH RESPECT TO LABOR USAGE INDEX

Period	Dependent Variable	Independent Variable	Parameter Estimated	Coefficient	Implied Wage Elasticity	N
1923-1924	log of wage rate	log of labor usage	b	-0.27*** (0.11)	-0.27	60
	log of labor usage	log of wage rate	1/b	-0.34*** (0.13)	-2.94	60
1935-1938	log of wage rate	log of labor usage	b	-0.20** (0.09)	-0.20	48
	log of labor usage	log of wage rate	1/b	-0.42** (0.20)	-2.38	48
Change 1923-1924	percentage change wage rate	percentage change labor usage	b	-0.42*** (0.11)	-0.42	43
Change 1935-1938	percentage change labor usage	percentage change wage rate	1/b	-0.57*** (0.16)	-1.75	43

** = Significant at the 5 percent level.

*** = Significant at the 1 percent level.

Note: We use the manning level index corrected for cotton consumption in these regressions. The coefficients are slightly larger with the basic index.

Sources: Wage data for 68 mills in 1924 are given by Rutnagur, *Bombay Industries*. The Bombay Millowners' Association, Annual Report, 1924, gives the number of workers in 1924. Information on wages and employment in 44 mills in 1935-1937 is given in File 39 of MSA. Textile Labour Inquiry Commission, Written Replies.

1935 to 1937 with the change in labor utilization we find that while nominal wages fell 6 percent in the rationalized mills, wages fell 21 percent in the nonrationalized mills. More generally, subjecting two cross sections of wages from Bombay constructed for the years 1923 to 1924 and 1935 to 1937 to statistical analysis, we find a positive association between the average wage and the number of machines tended per worker.²⁷ Thus if we regress

$$\ln W_i = a + b \ln (L_i / L_0) + e_i$$

for both these samples the estimated values of b are -0.2 and -0.27 , as is shown in Table 7. We also take a sample of firms for which we have data in both periods and compare their percentage wage change from the years 1923 to 1924 and 1935 to 1937 with the change in machines per worker. Here we get an estimated coefficient of -0.42 . This suggests that at least one quarter of any gains from lower manning levels were eaten up in higher wages. The true figure would actually be even higher, because the variable L_i / L_0 measures actual versus required labor only with an error created by variations in how fine the yarn being produced was, the vintage of the equipment, and the

²⁷ Though this is a very simple specification, note that the index contains information on the mixture of each mill's machinery—ring, mule, and loom—as well as a rough indicator of the quality of the cotton spun.

inaccuracy of the stated mill labor forces. The existence of this downward bias in our estimate of b is revealed when we regress

$$\ln(L_i / L_0) = (a / b) + (1 / b) \ln W_i + e_i$$

The estimated values of b from this regression are between -1.75 and -2.94 . The measurement error in wages here leads to a downward biased estimate of $1/b$, and so an upward biased estimate of b . Thus, all we can say is that the true increase in wages associated with a 1 percent reduction in labor requirements was between 20 and 294 percent. If the errors in both variables relative to their variances were the same, the best estimate is the geometric mean of these estimates, which would be 70 to 101 percent.²⁸ Bombay managers clearly had to pay at least some amount for greater labor efficiency, and higher wages may have absorbed all the gains from labor savings.

Other costs that seemingly made rationalization unprofitable were that rationalizing firms often changed other elements in the production process in the course of rationalization. Preparations were undertaken to minimize the effort requirements per machine, despite the apparently minimal tasks of the workers before rationalization. Machine maintenance was improved and better cotton quality used, both being designed to reduce the breakage rate.

LABOR SOLIDARITY OR LABOR PREFERENCES?

The most plausible reason for the lethargic pace of rationalization in Bombay from 1890 to 1938 was that firms which eliminated some of the "surplus" labor made no gains over firms that did nothing. It is also clear that at least some of the labor cost savings from rationalization were lost through increased wages paid to the remaining workers. But the rise of wages with rationalization has two very different possible explanations. Suppose workers in Bombay were hired in a competitive labor market, but they preferred a combination of low wages and easy conditions at work. Then firms that demanded more effort would find they could not retain workers unless they paid more in compensation. In this case firms in Bombay were simply responding to worker preferences when they seemingly employed many "surplus" workers per machine. The lowest cost wage-effort combination involved low wages and many workers. Consequently, true labor costs in India were actually much higher than the day wages would indicate, and the decline of the Bombay industry in the late 1920s can be attributed to the preferences of Bombay workers, which made it a relatively high labor cost location.

²⁸ Kennedy, *Guide*, pp. 137-39.

Alternatively, workers may not have had preferences any different from those in Britain, Japan, or the United States concerning the choices between wages and effort. Suppose workers before rationalization received a wage that was above the free market rate, so that their jobs had some value to them. Suppose also they were able to impede rationalization, and management had to buy out their resistance by raising the wages of workers that were retained. Then the cause of the failure of rationalization to raise profits could have been the solidarity and resistance of Bombay workers. There was no formal bargaining over rationalization in Bombay, but in Ahmedabad the labor union organized by Mahatma Gandhi bargained for a rule in spinning that wages would increase 75 percent for doubling the work completed. The Delhi Agreement of 1934 compromised on a gain of 45 percent.²⁹ By this account the Bombay industry declined because of the tenacious solidarity of the Bombay workers.

The extent of worker bargaining power in Bombay is hard to gauge because workers were generally not formally organized. There are some indications, though, that the mill labor market was not as competitive as might be expected in these circumstances. The ratio of textile wages to value added per yard of cloth increased dramatically following World War I.³⁰ It had been fairly stable between 1900 and 1913, but had dropped during the war as wages failed to keep up with the increase in cloth prices. Wages finally caught up in 1920, but almost immediately the price of cloth began to fall due to the world recession of 1920 to 1921. Cloth prices continued to fall gradually for the remainder of the period. By 1938 the price of cotton and cloth was only 3 percent greater than in 1910. Wages never experienced a corresponding drop. The real wage increase had, in fact, been one of the prime motivating factors behind the rationalization movement. The initial increase following the war was perhaps due to real labor shortages, but even though money wages continued to rise until 1926, whatever shortages may have existed in the war period had disappeared by the general strike of 1925, which followed management's unsuccessful attempt to lower nominal wages. The interwar period saw the decline of the Bombay industry from 80 to 60 mills, and a fall in employment of 15 percent. It was unanimously described as a period of "easy" labor market conditions. Yet the labor force was able to hold on to and build upon the nominal wage gains they had made until the failure of the final general strike of the interwar period in 1934. Real wages rose steadily from 1913 to 1933. Moreover, textile wages rose relative to the workers' opportunity wages as field labor in the Deccan. From 1911 to 1914 the

²⁹ MSR. Textile Labour Inquiry Commission, Extracts on Rationalisation, vol. 2, pp. 36, 57, File 81(3).

³⁰ Value added was computed by deducting the price of a pound of cotton from a pound of cloth. The aggregate Bombay wage series is from Mukerji, "Trend," table 6. Cloth prices are from Bombay Millowners' Association, Annual Report, 1939, table 10. The cotton price data are from India. Department of Statistics. *Prices*, before 1920, and for later years, India. Department of Statistics. *Agricultural Statistics*.

ratio of the daily wage of a Bombay textile worker to that of a Deccan field laborer averaged 2.06. The ratio's average from 1920 to 1937 was 2.64. In the period of greatest decline in the industry, 1932 to 1937, when labor demand should have been lowest, the ratio averaged 2.99.³¹ This increase was not due to either increased hours or productivity. Average daily hours fell from 12 to 10 subsequent to the Factory Act of 1922.³² And as Table 5 indicates, labor productivity was stagnant. Because rationalized wages were even higher, the increase of these workers' wages relative to their opportunity costs was 48 percent. It is hard to explain these wage increases except by allowing that Bombay mill hands had some degree of market power.³³

Even if workers were able to display considerable solidarity in Bombay and resist rationalization, this solidarity cannot readily explain the stagnant labor productivity of the entire subcontinent. If labor resistance based on outdated work norms in the declining center of Bombay was the problem, rationalizing managers would have had enormous incentive to move to new locations where labor norms had not yet been established and where workers were new to the industry. In fact, there was rapid growth in such places as Ahmedabad, Cawnpur, Nagpur, Madras, Delhi, and Coimbatore where the day wages of workers were generally lower in the interwar period. But while machinery and employment expanded, labor productivity at these other newer textile centers tended to be even lower than in Bombay.³⁴

LABOR SURPLUS AND MACHINE PURCHASES

One possible way of discerning between the two possible sources of the excess labor—worker preferences, or worker resistance—is to examine the

³¹ Mazumdar, "Labour Supply," appendix. One would prefer to compare the ratio of urban and rural real wages, but there are no measures of rural costs of living in this period. It seems unlikely that changes in the relative cost of living accounted for the increased wage gap. The costs of tradable commodities—food, clothing, and fuel—presumably diverged little between the city and the country. Housing, at 9 percent of urban expenditures, is the only service which is significant in the working-class budget. Even if we assume that the postwar housing price rise of 165 percent was strictly confined to the city that would require only a 0.058 increase in the ratio of the nominal industrial wage to the nominal agricultural wage to maintain a constant ratio of real wages. Shirras, *Report*, pp. 15 and 40–41.

³² Ram, *State*, pp. 106–07.

³³ Mazumdar, "Labour Supply," first noted the high ratio of wages relative to the opportunity cost of labor, focusing on the period 1900 to 1937. He argued that the high ratio was necessary to secure "committed" married labor as opposed to "transient" single men. There are some difficulties with Mazumdar's analysis. See Newman, "Social Factors," pp. 286–87. But for the purpose of our argument, it is irrelevant whether Mazumdar's explanation for the generally high ratio of the industrial to the agricultural wage is true or false. We are concerned here with the increase of this ratio in the 1920s and 1930s and what that implies about the labor market. Newman argues that the high urban relative wage, and its movement over time, is due to the market power of the millhand. Wright found similar signs of labor power among an equivalent unorganized labor force, the village-based male textile workers of the American South. Wright, "Cheap Labor."

³⁴ Wolcott, "Perils," table 2.

TABLE 8
MACHINE CHARACTERISTICS CIRCA 1910
(20s warp yarn)

Country	Wage to Capital Cost Ratio	Spindles per Frame	Spindle Speed (revolutions per minute)	Ring Bobbin Volume (cubic Inches)	Roving Bobbin Volume (cubic inches)
Canada	1.4	363	8,161	16.2	101
England	1.0	368	8,040	13.7	83
Brazil	0.7	351	8,012	12.0	84
France	0.6	416	8,255	14.0	99
Germany	0.6	378	8,560	12.9	90
Italy	0.4	393	8,364	11.6	84
Spain	0.4	438	8,186	12.4	87
Mexico	0.3	348	7,989	13.4	88
Poland	0.3	365	8,271	12.0	87
Russia	0.3	367	8,211	13.2	90
India	0.1	326	8,194	11.7	76
China	0.1	375	8,858	9.8	70
Japan	0.1	374	9,112	10.9	75

Source: See Table 3 for machine characteristics. The wage rental ratio is from Clark, "Why."

machine choices of Indian mill managers, using the Platt records. If managers were stuck with extra workers who had nothing to do because of the workers' solidarity in resisting reductions in manning levels, then when purchasing machinery they should have regarded their labor cost as effectively zero, and bought machinery that used the maximum amount of labor where this allowed savings on capital and cotton costs.

One theory of labor resistance might be that Indian workers had particular complements of machinery to which they were accustomed. It was sometimes said, for example, that workers in spinning insisted on operating only one side of a spinning frame.³⁵ In this case, because frames would vary in length and in the number of spindles they contained, we would imagine that managers in India would have had an incentive to order longer frames with more spindles, or pack more spindles onto frames of given length (if the mill buildings constrained the length of the frames). Yet when we compare Indian machine purchases around 1910 with those of other countries, as in Table 8, we see that Indian ring frames were in fact somewhat smaller than those of other countries.³⁶ There is no sign in these purchases of the alleged labor resistance to taking more than one side.

When we look at machine speeds we again see no sign that labor was regarded as being in surplus in Indian mills. Machine speeds in India on a

³⁵ Clark cites several references to such conservatism. Clark, "Why," p. 168.

³⁶ We control for the yarn count in doing this comparison because that affected frame length. But even before these controls Indian ring frames had fewer spindles.

given count were the same as in countries where the wage level was 6 to 14 times that of Indian mills. Indian mills did not push up speeds to the maximum that was technically feasible and then use extra labor to fix the increased number of thread breaks that would result. Countries such as Japan and China whose wages were about the same as those of India in 1910, were running their machines much faster.

The only case in which India did appear to act as if labor was in any sense cheap was with regard to package sizes. The volume of India ring and roving bobbins was a little lower than those of the higher wage countries, so that the machines would have required more doffing and more labor. On the other hand, the Indian bobbins were bigger than those of the other low wage countries such as Japan and China.

Thus there is no evidence from comparisons with other countries' machinery choices that Indian managers regarded themselves as operating with surplus labor that they could use at zero cost. The second form of evidence that Indian managers did not regard labor as being essentially costless is that they were changing the machines ordered in the period 1890 to 1929 toward ones that used less labor. Thus the average size of the output bobbins spinning 20s yarn went up from 13.8 cubic inches circa 1890 to 15.72 cubic inches circa 1929. Similarly the average size of the input bobbins on 20s yarn moved up from 80.22 cubic inches circa 1890 to 115.1 cubic inches circa 1929.³⁷ Indian managers were choosing machines that occupied more floor space but saved on labor. Why would they do this if they were constrained to have surplus labor? Though by the standards of Table 1 Indian managers were operating with a surplus of labor on their machines throughout the period, certainly in 1910 they were choosing machines that implied they thought that labor had a cost to them.

CONCLUSION

Why did Indian mills fail to capitalize on their low-cost labor in the early twentieth century and spearhead the industrialization of India? This article shows that, contrary to most previous writing, there is no evidence that this was a failure of management. The Indian industry had a higher proportion of mule spindles than Japan, but we show that while mules were most likely less profitable than rings, the profit rate was not so low that it justified scrapping the existing equipment until the 1920s, when the equipment was indeed scrapped. The Indian industry was slow to enter the weaving sector, but again there were no great profit opportunities evident there. Indigenous management did as well as foreign managers, and there is no sign that mills were too small. The spinning machines purchased by Indian mills were very

³⁷ The second change was statistically significant at the 1 percent level, the first at the 10 percent level.

similar to those purchased by other countries. Further, while Indian mills employed astonishingly large amounts of labor, mills which reduced manning levels did not thereby make more money. The poor performance of the Indian mills instead was a problem of the low labor input per mill worker.

While we can conclude this much, we cannot with the information available discriminate between two competing explanations of the source of the labor problem. The first is that Indian workers were simply incompetent or had low taste for effort on the job. The second is that there was surplus labor in the mills, but workers exercised power in the labor market to block manning reductions for fear of unemployment. We can show that mills that tried to reduce labor inputs had to both increase wages and, in at least some cases, reduce work loads per machine. These observations are compatible either with the need to pay workers in a free market more money to induce higher efforts, and with workers having to be paid to overcome their antipathy to manning reductions, where that antipathy had other causes.

Appendix: The Calculation of Profit Rates by Mill

To calculate profit rates of the Indian textile mills studied in this article we need to estimate both the earnings of mills, and the value of the capital stock. Mill earnings are derived from the *Investor's India Yearbook* and S. N. Rutnagur, *Bombay Industries: The Cotton Mills*. The *Investor's India Yearbook* annually printed summary balance sheets and other relevant information for publicly traded Indian firms. Published in Calcutta, it lists information for all of the firms carried on the Calcutta stock market as well as a limited number of others. Consequently, it only reports the profits of about half of the Bombay Mills. This financial data is available for every year that we have data on the mills from the Bombay Millowners' Association. Rutnagur gives information on the finances of a more comprehensive set of 66 mills in Bombay for the years 1923 to 1924. Profits are reported in the *Investor's India Yearbook* as total revenues minus total expenses (including wages, supplies costs, debt service, and commission to managing agencies). The relation between these profits and operating profits is

$$\begin{aligned} & \text{PROFITS IN MILL OPERATIONS} \\ & = \text{REPORTED PROFITS} + \text{NET DEBT SERVICE} - \text{DEPRECIATION} \end{aligned}$$

We use reports in the *Investor's India Yearbook* on the long-term debt of all firms, and the interest rates on these debts for some firms. We infer the interest rates for others as the average for that year of the reported interest rates. Some short-term debts and loans of firms are not reported and so will constitute noise in the measurement of profits. There is evidence from the 1920s, where we have access to the detailed accounts of some of the firms that cotton and yarn stocks at the mills were at least partly financed by short-term borrowing of "call" money by mills.³⁸

³⁸ For those mills which were borrowing to cover part of their working capital, our estimates will understate their profit rates because the denominator of our calculated profit rate includes both working and fixed capital, and the numerator excludes payments of interest for short term loans. We calculated an alternative profit rates series in which we used only the estimated fixed capital in the denominator.

Data on the fixed capital by mill were extracted from the annual reports of the Bombay Millowners' Association. This gives the number of mule and ring spindles and looms installed in each mill, and the average annual number of spindles, looms, and workers employed in the day shift. We have collected this data for all operating mills in Bombay for the years 1907 to 1908, 1911 to 1914, 1916 to 1918, and 1920 to 1938.³⁹

Estimating the value of the capital stocks of the firms is more difficult. The *Investor's India Yearbook* gives the nominal value of share capital, but this is not a true representation of capital, as most of the mill expansions had been financed through retained earnings.⁴⁰ We do have information on the insured value of mills for 1912, which should be a good indication of the value not just of the buildings and machinery, but of the associated stocks of cotton and work in process. To get from these insurance valuations to a value for each mill in each year we use the following procedure. First we regressed the 1912 insured value of the fixed capital and stock and inventories of 19 mills in rupees on their spindle and loom inventories.⁴¹ The estimated regression was

$$\begin{aligned} \text{INSUREDVALUE}_{1912} = & 74.1(\text{RINGS}_{1912} + 0.85\text{MULES}_{1912}) + 1092.1\text{LOOMS}_{1912} \\ & (8.3) \qquad\qquad\qquad (342.3) \\ & R^2 = 0.78, N = 19 \end{aligned}$$

with standard errors in parenthesis. We estimated the capital stock of all mills in all years using these coefficients and a price index. This technique has the advantage of allowing us to use the data from all years where the Bombay Millowners' reports are available. Because these values include both fixed capital, which was approximately 76 percent of capital, and stocks of cotton, yarn, and cloth, the price index used was a similarly weighted average of Bagchi's Indian textile equipment index and a cotton and cloth price index.⁴²

This procedure estimates the replacement value of the capital stock of all mills, not the depreciated value. Over this period there was little improvement in the performance of textile machinery, as was illustrated in Table 4 for labor requirements. Similarly the speeds of the machinery improved little. On 20s yarn average machine speeds, in revolutions per minute, for ring spinning machines were 8,351 for 1890 to 1899, 8,463 for 1900 to 1909, 8,752 for 1910 to 1919, 8,443 for 1920 to 1929, and 9,634 for 1930 to 1934. Thus, again, it is only in the 1930s that we see any sign of increases in output per machine, and even then the gain was only 15 percent compared to the 1890s. Consequently machinery was used by the firms for very long periods. Fifty-year-old machinery was not unusual. Our method of estimation, while it will overstate the value of capital for mills with older machinery, should not distort the estimate of capital by too much. In the regression estimates, we include as a control variable the age of machinery.

The gross profit rate of the firms measured in terms of the replacement cost of fixed capital, will thus be

For a few years, the difference is relatively large. The maximum difference is 6 percent in 1920. But overall, the difference between the two series is minor, with the average being 1.3 percent.

³⁹ The missing years were created by the unavailability to us of copies of the Bombay Millowners' Association Annual Report for these years. Few copies of these early reports survive.

⁴⁰ Bagchi, *Private Investment*, p. 68.

⁴¹ These data are given in the 1913 edition of the *Investor's India Yearbook*. The relative amount of capital embodied in ring and mule spindles was calculated from Clark, *Cotton Fabrics*, pp. 23–4; Benjamin, *Practical*, p. 611; and Winterbottom, *Cotton Spinning*, pp. 264–73.

⁴² The estimate of the relative proportion of fixed capital and stocks is derived from the insured value of the Finlay Mill and the Bombay Dyeing and Manufacturing Spring Mill. Both of these mills were built around 1912 for a known amount of rupees. Thus the difference between the value of their fixed and working capital is obvious.

$$\pi = (\text{REPORTED PROFITS} + \text{LONGTERM DEBTSERVICE}) / \text{FIXED CAPITAL}$$

These are the profits reported in Table 4 as an annual average for the Bombay mills. This average will exceed the net profit rate on fixed capital by the depreciation rate on capital. As noted, the depreciation rate was low in the textile industry because machines physically lasted a long time, and from 1890 to 1930 there was little technical improvement to new machines that would create economic obsolescence of older machines.

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