Economic Change and Sex Discrimination in the Early English Cotton Factories

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8 March 1994
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Abstract

This paper considers sex discrimination in the early English cotton factories. Intrinsic differences between men and women offer a less compelling explanation for sex discrimination than much of the literature suggests. A labor sorting model offers an alternative explanation of how discrimination could be transmitted from established labor markets to the new factory labor market. While the relevance of this model to the early factory workforce has not been recognized in the literature, the historical evidence indicates that it might provide an economic rationale for discrimination between men and women in the early English cotton factories.

JEL Classification: N330, J160, O150

* I am grateful for comments and suggestions from Claudia Goldin, David Landes, Emma Rothschild, and Peter Temin.

In 1833, upon reviewing the wages of male and female factory workers, James Mitchell, a British Factory Commissioner, declared,

> Some persons feel much regret at seeing the wages of females so low. . . but perhaps such persons are wrong; and nature effects her own purposes more wisely and more effectually than could be done by the wisest of men. The low price of female labour makes it the most profitable as well as most agreeable occupation for a female to superintend her own domestic establishment, and her low wages do not tempt her to abandon the care of her own children. Nature therefore provides that her designs shall not be disappointed.[1]

With its emphasis on microeconomic incentives and its invocation of an impersonal force setting wages "optimally," this argument represents an interestingly twisted piece of economic analysis. Note that while Mitchell recognizes intrinsic differences between men and women, he does not attribute women's low wages to these intrinsic differences. Like other contemporaries, Mitchell feared that the new labor market opportunities that emerged with the Industrial Revolution might subvert gender unless these opportunities themselves were gendered appropriately. He argued that, fortunately, nature had set women's wages low so that women would act to fulfill "her designs."[2]

Mitchell's assumptions, and fears, about possibilities in the labor market contrast sharply with economic theories of gender based on intrinsic differences between men and women. Simpler theories of this sort assert that intrinsic differences between men and women in physical strength and psychological characteristics directly account for women's inferior position in the labor market. A more sophisticated theory (Becker, 1991) notes that women have a comparative advantage in work associated with child-bearing and child-rearing within the home. Efficient specialization in response to this intrinsic difference then explains gender distinctions and relative wages in the labor market.

While jettisoning Mitchell's ideas about wage-setting, this paper will take seriously his assumption that intrinsic differences between men and women did not assure the perpetuation of gender in the Industrial Revolution. I argue that intrinsic differences on the job and in the home were not determinative. Rather, the historical structure of asymmetric opportunities in older segments of the labor market, via a process of differential labor sorting, promoted sex discrimination within the new factory labor market. Moreover, the result -- low wages for women in factory jobs -- helps explain why women continued to be more likely than men to work within the home.

I. Differences in Ability between Men and Women

The literature considering the implications in the early English factories of differences between men's and women's physical and supervisory abilities focuses on why women were excluded from mule spinning, a high-wage job in the factories (Lazonick, 1978, 1979; Freifield, 1986; Cohen, 1990). The debate has centered on why, after self-acting mules eliminated the most physically taxing aspects of mule spinning, mule spinners remained predominantly male. This section will move a step backward to examine some shared assumptions in that debate. It will show that the significance of differences in men's and women's physical and supervisory abilities -- the accepted explanation for why men dominated mule-spinning *before* the advent of the self-acting mule -- have themselves not been convincingly documented.

Prior to the second half of the eighteenth century, women dominated the job of spinning thread. The etymology of the word distaff reflects the distinctively female character of early spinning. As early as the fifteenth century, distaff was used to refer not just to the stick used in spinning but also to the female sex. [3] Moreover, while "spinster" was originally used as a general term for a woman, or the rare man, who spun, in the seventeenth century spinster became a legal term for a woman who remained unmarried. Thus the English language itself illustrates the depth of the connection between women and the occupation of spinning.

With the development of factories, the sexual division of labor in spinning took two different forms tied to two different spinning technologies: the throstle and the mule. Women and older children, as well as some men, handled throstles, often with the assistance of younger children known as piecers. Mule spinners were predominantly men, and they typically supervised a larger team of piecers than was used on most throstles. Mule spinning could produce finer threads than throstle spinning, and it became the dominant spinning technology in England.

The physical demands of spinning coarse threads on a mule were described in an often-cited document.[4] According to this document, a carriage carrying 336 spindles weighed 14 cwt (1568 pounds). The spinner used his hand and knee to return the carriage to the closed position. This action was described as requiring "the same mechanical exertion which would raise 160 lbs. the distance of six feet in the same time." The spinner took three seconds to do this operation, and, working 12 hours and handling two machines, the spinner performed the operation 5000 times. The total power necessary for the 5000 operations was described as:

> The same power of 160 lbs., as before, or about three-fourths of the ordinary power of a horse, continued during the whole time of action, viz. 5,000 times three seconds, or four hours ten minutes.

This description suggests that coarse spinners had an average power output of 320 ft lb/sec (.58 hp) for 3 second intervals in the approximately 9 second cycles that made up the (12 hour) work day.

One way to think about this power requirement is to consider the calorie intake necessary to support the spinner's work. According to the above data, a coarse spinner did more than 1555 kcals of work per day. Assuming a muscular efficiency of 25%, the spinner would have to consume 6220 kcals daily just to supply the energy necessary to move the carriage.[5] This figure is unreasonably large, hence the above account must represent a significant exaggeration.[6] Nonetheless, key works in the debate about the sexual division of

labor in the early cotton mills have used this account as a basis for considering whether women lacked the physical strength necessary to operate hand mules.[7]

While men on average have greater muscular strength than women,[8] the historical context and the significance of physical strength as a constraint on the organization of work need to be assessed. Working class women in early nineteenth century England did physically demanding work. Women were employed in agriculture as day laborers and worked at digging, hoeing, trenching, planting, and gathering.[9] Women, sometimes with help from men, did laundry, a strength-intensive job in early nineteenth century England.[10] Some women also worked in the coal mines pulling coal to the surface on sledges.[11] In early nineteenth century England, it would not have been unusual for a woman to have a job that was highly taxing physically.

Moreover, there is some evidence that mule spinning technology could have evolved more quickly to better accommodate women's physical capabilities. As one of the foremost authorities on the history of spinning technology pointed out:

> It seems very likely that elementary forms of putting-up motion were employed within weeks of the first realization that mules had reached such a size that the spinner needed help at this point in the cycle. The first putting-up motion was probably no more than a crude arrangement to prevent the main driving belt going fully on the loose pulley on completion of the draw.[12]

This evaluation contrasts sharply with the actual development of the self-acting mule: the first patent for a self-acting mule was issued in 1792, the first commercially successful self-actor was developed about 1825, and self-acting mules achieved widespread use only by the early 1840's.[13] If women's physical abilities were constraining their employment as spinners, one might have expected the incentive to expand the pool of potential spinners to have produced a faster evolution of the self-acting mule.

Some scholars have argued that women were less capable of supervising piecers than men and that this comparative disadvantage explains why only a relatively small number of

women worked as mule spinners.[14] One scholar declared, "In short, that the supervisory responsibilities of the trade barred women from the mule is hardly astonishing."[15] Another scholar presented the same position but with a Marxist flair: "...in fact the "skill" which women lacked was their inability to order around other people in a manner consistent with the requirements imposed by capitalist production..."[16]

The most prominent piece of evidence used to document women's relative disadvantage as supervisors is a poignant anecdote.[17] The anecdote is part of a fifteen year-old male piecer's testimony in a British parliamentary investigation in 1833. The piecer, who had worked for eight male spinners and two female spinners, said that he preferred to work with female spinners because the male spinners disciplined him with beatings while the female spinners,

> They used to ask them if they'd mind their work, and then they'd give 'em half penny or penny, and then the piecers was pleased, and worked; and if the piecers had no meat, they used to give 'em meat, and marbles, and tops; and at any pastime here gives 'em money; 6d. or 1s.

A more detailed analysis of this anecdote indicates that it has little value as evidence of the economic significance of sex-based differences in mule-spinners' supervisory abilities. When asked whether the women spinners swore, the piecer declared, "The two mistresses I worked for never did swear, as I heard." When asked whether the piecers swore, the piecer responded, "No, sir; they [the women spinners] wont have a piecer that swears, nor would they let the piecers talk bad." On the other hand, when asked, "Do the men let you talk bad, and behave indecent?" the piecer responded, "Yes, sir; and some will encourage us up." One of the women spinners under whom the piecer worked had been a teacher. Perhaps she taught him this peculiar moral outlook, an outlook that foreshadows Victorian feminine ideals. In any case, the characterization of vulgar men and pristine women contrasts sharply with other descriptions throughout the factory reports.[18]

Moreover, the same spinner hints at an alternative disciplinary mechanism. Speaking of women spinners, he declared, "They never beat; they turned away." The context clearly indicates that being "turned away" means being fired.[19] While the impact of this sanction would depend on labor market conditions and signaling effects, it is not unreasonable to suppose that being fired imposed significant costs on piecers.[20]

There is direct evidence about women's abilities as mule spinners.[21] The former manager of one of James Kennedy's mills testified in 1818 that Kennedy employed principally women spinners in the factory he had formerly managed.[22] The women spun threads with 110 to 230 hanks per pound using frames holding 336 spindles.[23] The number of spindles per frame indicates that the spinning machines were of a size normal for male spinners, while the fineness of the threads (hanks per pound) ranged from relatively coarse fine threads to threads as fine as were regularly spun in any mill. The women spinners, who were in their late teens to early twenties, earned from 18s to 26s. In Manchester in 1818, male fine spinners, who were probably on average closer to 30 years old, earned about 30-32s, while male coarse spinners earned about 20s.[24]

The women spinners had piecing teams that included teen-age males and that were similar in size to those that male spinners supervised. By closely examining the roster for Kennedy's mill, thirty-one women spinners and their piecer teams can be identified.[25] Table 1 shows that women spinners supervised both male and female piecers, including male piecers ranging up to age 20 and female piecers ranging up to age 22.[26] While the older piecers probably functioned as more general assistants, the work of the women spinners does not seem to have been closely supervised by men.[27] Among the women spinners, 23 managed teams of 3 piecers and 4 managed teams of 4 piecers; the other 4 worked jointly.[28] The average size of male spinners' piecer teams in a sample from Manchester in 1818 was 3.8 piecers per spinner, while the average team size in a sample of fine-spinning mills in 1832 was 3.9.[29] Thus male and female spinners had similar size piecing teams.

Factories that employed women mule spinners continued to do so for many years. Kennedy's mill continued to operate with women spinners for at least a decade and a half.[30] A mill in Salford hired women mule spinners in 1807 and continued to use women spinners through 1833.[31] The persistence of the strategy of employing women spinners indicates that it was possible to operate profitably a cotton mill with women mule spinners.

Yet, over-all, women mule spinners in England were a rarity. By the 1830s most adult jobs in the mills were rigidly gendered. Men generally worked as overlookers, carders, mule spinners and dressers, while women generally worked as pickers, tenters, reelers, and throstle spinners. Only in power weaving did a significant number of men and women do the same work. On average there may have been differences in the intrinsic productivity of men and women. Claudia Goldin (1990, p. 104) found that in America in 1895, for the same work, the same piece rate, and in the same factory, women earned 80% of what men earned. Yet the almost complete occupational segregation by sex in the English factories, and the fact that women's average earnings were only 45% of men's, seem to be sex discrimination that is too significant to explain with the evidence on physical and supervisory differences.[32]

II. The importance of marriage, pregnancy, and child-rearing

Theories that explain sex discrimination based on the significance of marriage, child-bearing and child-rearing to women's work patterns are on particularly weak ground with respect to the early English factory workforce. For many working class women in early nineteenth century England, poverty or the threat of falling into poverty meant that work in the labor market was a crucially important opportunity. Many female factory workers started working at a very young age -- about 40% began working in cotton mills at age ten or younger.[33] Many continued to work after marriage, and some continued to work through pregnancies and while raising young children. Marriage, child-bearing, and child-rearing had a much less significant effect on women's factory work in early nineteenth century England than the existing literature suggests.[34]

In a superb early study of women workers, Pinchbeck (1930) downplayed the significance of married women workers in the factories. She argued that married women worked in other occupations and that women's agricultural work did more damage to "home life" than did women's factory work.[35] As to the number of married women in the factories, she declared, "[s]tatistical evidence is inadequate for any precise statements on this question." Nonetheless, she cited an 1844 survey indicating that, in nine Lancashire cotton mills, 27.5% of women of "marriageable age" were married.[36]

More comprehensive evidence that Pinchbeck neglected suggest a significantly higher figure. In a sample of 412 cotton mills employing 116,281 workers in 1844, 40% of the females 21 years of age or older were married.[37] Evidence from a cotton factory employing 1220 workers near Ashton-under-Lyne in 1844 shows that 43.5% of the female workers over 21 were married.[38] In a factory survey in 1848 of operatives in factories throughout Lancashire, 50.2% of the female cotton workers ages 20 and older were married.[39]

Several decades later Hewitt (1958) presented some additional evidence but in a different way. She focused on the fraction of female operatives who were married. Using a sample of household surveys from the Census of 1851, Hewitt (1958, p. 15) found that in the

main cotton districts of Lancashire about 26.9% of the female labor force was married. She also stated that 57.4% of the female operatives were over 20 years of age. Given that most women married later than twenty years of age, Hewitt's figures imply that about 47% of the female operatives over 20 years of age were married.[40]

In thinking about the extent to which marriage caused women to leave the mills, this latter figure is the more relevant statistic. Looking at the share of married women among all females employed ignores the structure of demand for females of different ages. That many girls were employed says little about how marriage affected a woman's likelihood of holding a factory job.

In fact, age-specific marriage incidence rates among women workers in cotton factories were only slightly lower than marriage incidence rates for women in the population as a whole. Table 2 shows marriage incidence rates by age for female cotton workers in Lancashire and for all females in England and Wales.[41] The marriage incidence rate for female factory workers ages 25-29 was 67% as compared to 58% for the population as a whole. At other ages the marriage incidence rate for female factory workers was only about ten percentage points lower than for the female population of England and Wales.[42] This evidence suggests that marriage and family did not strongly constrain factory women's work patterns in mid-nineteenth century England.

One might think that pregnancy significantly hindered women's work capacity. While pregnancy must have been a handicap, working class women in early nineteenth century England did not lose many work days due to pregnancy. A Manchester midwife, when asked whether factory women worked up to the time of their confinement, declared:

> Many of them up to the very day; some up to the very hour, as I may say. Some have gone to work before breakfast, and I have had them in bed at two o'clock the same day. A girl has gone to work after her breakfast, and I have delivered her, and all over, by twelve o'clock the same forenoon.[43]

According to the midwife, many of the factory women returned to work a fortnight after confinement, and "three weeks they think a great bit." Another Manchester midwife stated that some factory women went back to work after nine or ten days, while some stayed at home "even three weeks or a month." [44] Such behavior was not limited to factory workers. A female coal miner told an investigator that she worked in the pits while pregnant. She gave birth to her baby in the pit and carried the new-born up the pit-shaft in her skirt.[45]

The growth of a family did have different implications for male and female factory workers. Table 3 shows the number of children in the families of the married workers included in a factory survey. The data suggest that, as the number of children increased, a married woman was more likely to withdraw from the factory than was a married man. This isn't surprising. Since women's wages in the mills were on average about half men's wages, wives had a greater incentive to shift to work in the home than husbands did.

While some women withdrew from the factories as they had children, others stayed. Table 3 indicates that 71% of married women working in the factories had children, and 41% had 2 or more children. Some married women hired others to help with cleaning the house, washing, cooking, and sewing.[46] A sample of Lancashire households from the Census of 1851 indicated that about 21% of the married women cotton operatives had children under one year of age.[47] Working women with infants could hire nurses -- young girls or old women -- to look after their infants.[48] Wet nurses were not used. Instead, working mothers breast-fed infants at breakfast, noon, and in the evenings, and weaned them as quickly as possible.[49]

Especially toward the middle and later years of the nineteenth century, working women's practice of mothering become the focus of condemnation and reform efforts (Dyehouse, 1978). The issue was the effect of these mothering practices on infants' welfare. The significance of these mothering practices for womene as workers was ignored. Yet in modern theories of wage determination, experience and job tenure are key variables. These mothering practices meant that women workers often lost weeks of work, rather than months or

years, as a result of having children. These practices also imply that, in well-paid jobs, women might have been expected to have relatively long and continuous careers in the factories.

III. A Model of the Effect of Historical Sex Discrimination

The argument to this point is that intrinsic differences between men and women cannot adequately explain the segregation of women into lower paying jobs in the factories in early nineteenth century England. This section presents an alternative explanation. It describes a simple formal model of how unequal opportunities in older segments of the labor market could have perpetuated unequal opportunities in the new factory labor market.

The basic idea is as follows. Males and females started working in the factories at a young age. As they accumulated experience in the factories, they learned about the demands of that work environment and about their ability and desire to deal with it. Males who found that they were not able to cope effectively or did not want to could leave, since they had a range of labor market opportunities outside the mills. Females had much more restricted opportunities in the labor market outside the factories. Thus, given a pressing need for income, females were more likely to stay in the mills, independent of their suitability for the work.

A result of these different incentives was that the males who remained in the mills were, on average, better quality workers than the women who could work only there. Given that firms could not perfectly observe worker quality, firms would rationally choose to assign males to high skill jobs rather than females. By providing different opportunities for on-the-job training, such economically rational differences in job opportunities would magnify the wage effects of the difference in average quality of male and female workers .

The formal model is as follows. Assume that young males and females are endowed in period 0 with a factory ability parameter q_i that can assume either a high (i=H) or low (i=L) value. The probability that $q_i=q_L$ is π_0, irrespective of the sex of the worker. Workers initially do not know the value of their factory ability parameter, and in period 1 ("childhood") they enter

the factories in unskilled jobs that pay a wage $\underline{w}_1$ and generate a return $\underline{r}_1$ for factory managers. Wages in unskilled jobs are not differentiated by sex.

There are also skilled factory jobs, which require an expenditure of $\underline{c}$ per period for capital and managerial overhead. In the skilled job workers with ability parameter q_i earn $\underline{k}q_i$ while the factory owner gets a net return $(1-\underline{k})q_i-\underline{c}$. Define

(1) $\underline{Q}=q_L\underline{\pi}_0+ q_H(1-\underline{\pi}_0)$

Assume that

(2) $(1-\underline{k})\underline{Q} - \underline{c} < \underline{r}_1$

(3) $(1-\underline{k})q_H - \underline{c} > \underline{r}_1$

Thus a firm would want to create a skilled job for a high quality adult but would not want to do so for an average quality adult.

The incentives of firms and workers may conflict. Suppose that by the end of period 1 each worker has gained enough factory experience to learn what his or her own abilities are, but factory managers do not know each worker's ability. Assume that

(4) $\underline{w}_1 < \underline{k}q_L$

Given equation (4), low productivity workers have an incentive to claim to be high ability workers. Given factory managers' informational constraint and equation (2), the factory manager rationally places all workers in low skill jobs.

Alternative opportunities outside the factory can resolve the above incentive problem. Suppose that in period 2 males ("young adults") have the opportunity to take up non-factory jobs that pay $\underline{w}^n$. Assume that

(5) $\underline{k}q_L < \underline{w}^n < \underline{k}q_H$

Given (5), in period 2 low ability males will leave the factory to seek non-factory work. The mill manager, who knows workers' generic labor market strategies, will then create skilled jobs and place experienced male workers in them. Females workers who do not have this self-selection opportunity will remain confined to low-skill jobs.

The above model implies that the over-all return to males from entering the factory is greater than that for females. Suppose that factory and non-factory wages for children are not differentiated by sex and are equal to $\underline{w}_1$.[50] Assume that factory and non-factory wages for adult (period 2) females are also equal to $\underline{w}_1$. In contrast, non-factory wages for adult (period 2) men are $\underline{w}^n$, and by the labor sorting process described above, factory wages for adult males are $\underline{k}q_H$. Thus, given a second period discount factor of δ, a male child's expected value from entering the factory is $\delta(1-\underline{\pi}_0)\underline{k}q_H$ greater than the expected value for a female child.

The above model assumes that wage rates for skilled adults are not differentiated by sex. This could reflect, for example, codified piece rates not differentiated by sex. However, even if $\underline{k}$ could depend on the sex of the worker, the above model could still produce occupational segregation by sex. If $\underline{Q} - \underline{c} < \underline{r}_1$, then reducing women's wages to zero in the skilled job would not be sufficient to overcome the differential sorting effect. Of course if women faced no liquidity constraints (not a particularly realistic assumption for working class women in early nineteenth century England), one could always assess a (temporary) fee on women in high skilled jobs sufficient to make their employment in such jobs profitable.

The implications of this model of differential labor sorting differ sharply from a similar model of Rosen and Lazear (1990). Their model assumes that males and females have identical productivity in the labor market, but females have higher non-market productivity. They argue that this advantageous outside opportunity leads to women's lower wages or occupational segregation by sex. In their model, firms choose to invest in workers before workers learn their non-market productivity. Thus a firm worries about investing in workers who will later learn that they have high non-market productivity and leave the firm. In contrast, the model in this section assumes that workers' decisions to leave the factories for opportunities elsewhere occur before firms invest in workers.

IV. Evidence on Differential Labor Sorting

The historical evidence indicates that the labor sorting model described above may have played an important role in limiting women's opportunities to get high-paying jobs in the early English cotton factories. In the early English factories, male and female life cycle patterns of work differed significantly. Most of the workers began work in the factories at a very young age (see Table 5). Yet there is a significant difference between male and female workers: 71% of the male workers began work in the factory at 10 years old or younger while 39% of the female workers fell in that category. Moreover, 24% of female factory entrants entered the factories at ages 14-19 while only 6% of male entrants entered at those ages.

This pattern is consistent with the theory outlined in the previous section. While the wages for male and female children were not differentiated by sex,[51] male children had a greater incentive to enter the factory because they had the possibility of getting a high-paying adult factory job, giving the labor sorting effect among young male factory workers. On the other hand, a factory manager could not use this sorting effect as the basis for presuming that an older male entrant was a high ability worker. Such an entrant's factory opportunities would be more similar to females'. Given males better non-factory opportunities, it is not surprising that a smaller share of males entered the factories above age 13 than did females.

The exit patterns of males and females are also consistent with the theory outlined above. Figure 1 shows the age distribution of Manchester cotton workers in 1818.[52] It suggests that a large number of males left the mills between ages 14 and 19, while a much smaller share of females left during these ages. For subsequent ages, the female age profile is more downward sloping than the male one, suggesting that females were more likely to depart than males after 20 years of age.

More detailed calculations confirm that gross exit probabilities differed sharply between males and females. Table 5 shows annual gross exit probabilities estimated from the starting age distribution and the current age distribution.[53] Males ages 14-19 had 2.6 times as high an exit

probability as females did. On the other hand, males ages 20-29 and ages 30-39 had exit probabilities 40% and 60% lower than females in those respective age groups.

Using an age distribution to estimate exit probabilities assumes that the age distribution is stable over time. Table 6 compares the age distribution in Manchester mills in 1818 and 1833.[54] The upward shift in the age distribution for males is similar to what Saxonhouse and Wright (1984) found for the American South, and suggests that the departure probabilities in Table 5 decreased over time, or that the age distribution in Figure 1 did not represent a steady state.[55] Note, though, that in 1818 there were three times as many males ages 12-13 as ages 18-19, while in 1833 there were about twice as many. Given an industry growth rate of about 5% per year, these distributions imply that about half of males ages 14-19 left factory work. For females, the distribution of workers ages 14-19 was flat in 1818 and 1833.

Why were males ages 14-19 much more likely to leave the mill than females of those ages? The occupational census for Manchester in 1841 provides an important clue.[56] While about the same share of males and females under age 20 had an occupation (24% of males, 21% of females), many more young males worked in trades than did females. Among young males, 34% worked in factories, 3% worked as domestic servants, and the remaining 63% were distributed across a wide variety of trades. Among young females, 55% worked in factories, 26% worked as domestic servants, and only 19% had other occupations. The young males worked with shoemakers, clerks, bakers, blacksmiths, painters, in the army, in warehouses, and as errand boys. Young females' opportunities in these established trades were much more limited than boys'.[57] Moreover, there is evidence that girls who worked in the factories from a young age would not have been desirable as domestic servants, the most important occupation for girls outside the factory.[58]

The labor sorting effect put forward in this paper is less likely the more positively correlated is workers' productivity inside and outside the factory. Factory work in early nineteenth century England involved a radical change in the organization of work, the structure of time, and the nature of workers' skills.[59] Factory managers preferred to employ workers

who had begun work in the factory at a young age because the requirements of the factory were so different from the requirements of other jobs at that time. Adult workers who had not worked in the factories as children generally could not find jobs in the factories, even if they were willing to work at low wages.[60] Thus a worker's potential productivity inside the factory probably was unlikely to be highly positively correlated with the worker's productivity outside the factory.

Male workers who had the ability to perform high-skill jobs in the factories had an incentive to pursue these jobs. Table 7 compares men's earnings in the cotton mills in Manchester to men's earnings in other occupations in Manchester. The average earnings for men in the mills were about equal to those of skilled workers in the building trades, while mule spinners were particularly well off. One might argue that there was a compensating differential for the harsh working conditions in the factories; on the other hand, the factories offered the considerable advantage of relatively continuous work. Men who remained in weaving or piecing jobs in the cotton mills earned relatively low wages. Why didn't they leave? One answer might be that they were anticipating being promoted to higher paying mill jobs in the future.

An important facet of the model of differential labor sorting presented here is that the worker had more information than the factory manager about the worker's potential ability as an adult factory worker. A worker, after acquiring considerable experience in the factories, would have better information than a factory manager about the extent of his skills and about how hard he would be willing to work as an adult. As both Lazonick (1979) and Huberman (1986, 1987, 1991) have argued, workers retained discretion to adjust their effort. Huberman (1991) also presents evidence that variations in the quality of workers were significant, and that firms entered into long-term relationships with their spinners in order to mitigate screening and recruiting costs.[61]

The harsh work conditions in the early English factories need to be considered in interpreting the nature of factory "ability" and the extent of public knowledge about that ability.

A worker's health matters greatly for his or her future work performance. Workers in the early English factories reported relatively few health problems to official inquirers sponsored by the mill owners.[62] On the other hand, other evidence suggested that the factories had grave consequences for workers' health.[63] A worker in need of income, and without any other good choice than a factory job, would have an incentive to cover-up bad health for as long as possible. On the other hand, a worker whose health was suffering from the factory, and who had a good outside opportunity, would leave to take up that opportunity. Thus differences in exit opportunities may have caused male workers on average to have greater ability than female workers, in the sense that the remaining male workers were better able to endure the harsh work conditions.

V. Conclusion

In considering explanations of the differences between males and females in the early factory labor market, one confronts a fundamental problem of identification. Married women in the early English factories were more likely than married men to withdraw from the factory to work in the home. Given that women's wages were on average much lower than men's, economic incentives supported this pattern of behavior. What factors created this underlying pattern of economic incentives?

A key question is as follows. If women's economic opportunities in the mills had been the same as men's, would women still have withdrawn from the factory to work in the home? Apparently Mitchell did not think so, nor did others at the time. These contemporaries stressed the need to preserve established patterns of gender in the face of the new economic opportunities emerging with the Industrial Revolution. This paper suggests that in a sense Mitchell and his contemporaries were right: differences between men and women in physical and supervisory abilities and the requirements of marriage, pregnancy, and child-rearing were not sufficient to determine the observed sex-based differences in the new factory labor market.[64]

Other factors, such as male unions, men's interests in restraining women's labor market opportunities, and patriarchal ideology on the part of employers, were undoubtedly important.[65] Nonetheless, the Industrial Revolution was a time when patriarchy was potentially open to challenge.[66] This paper shows that market processes could have contributed to the segregation of women into relatively low-paying jobs in the new factory labor market.

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TABLE 1
PIECERS WORKING UNDER WOMEN SPINNERS

ages	males	females
10&under	1	3
11 to 13	14	20
14 to 16	12	16
17&over	7	14
total #	34	53

Source: See text.

TABLE 2
MARRIAGE INCIDENCE
(% of age group married)

ages	female factory workers in Lancashire, 1848	females in England and Wales, 1851
15-19	4.6	2.8
20-24	21.4	32.5
25-29	66.7	58.8
30-34	62.8	70.2
35-39	65.1	74.9
40 & over	69.1	61.3
# of obs	350	691,840

Source: See text.

TABLE 3
FAMILY SIZE AMONG MARRIED FACTORY WORKERS
(Lancashire, 1848)

# children	% of men	% of women
0	8.2	28.6
1	18.8	30.5
2	14.7	21.0
3	15.1	12.4
4	16.7	3.8
5 & over	26.5	3.8
# of obs	245	105

Source: B.P.P. 1849 XII, *Horner's Survey*.

TABLE 4
STARTING AGE OF WORK IN COTTON MILLS
(Manchester cotton workers starting work 1816-18)

ages	males (%)	females (%)
10 & under	70.8	39.3
11-13	17.8	17.3
14-19	5.8	24.2
20-29	3.6	14.7
30 & over	2.0	4.5
# of obs	445	491

Source: Lords Report (1818, 1819, appendices). The over-all sample, drawn from a collection of complete mill rosters, includes 2817 males, 3062 females, and 362 persons whose sex could not be determined because only a first initial was listed. Mills in which the sex of more than 25% of the workers could not be determined were excluded from the sample since the method of recording names may not have been uncorrelated with sex. Starting ages are calculated by subtracting years of experience from current age. The tabulated starting ages are thus for workers who had two years or less of experience.

TABLE 5
ANNUAL EXIT PROBABILITIES

ages	males	females
14-19	.220	.085
20-29	.062	.105
30-39	.085	.217

Source: See text.

TABLE 6
EMPLOYMENT SHARES
(Manchester Cotton Mills)

	Males		Females	
Ages	1818	1833	1818	1833
9&under	4.2	6.0	1.7	3.2
10-11	13.7	9.9	7.9	6.0
12-13	15.8	12.3	10.1	8.5
14-15	16.0	10.3	12.5	11.9
16-17	7.9	8.5	9.4	11.9
18-19	5.5	6.0	10.9	11.8
20&over	36.8	47.4	45.8	49.6

Source: Lords Report (1818, 1819, app.) and B.P.P. 1835 XLIX.1 No. 329.

TABLE 7
COMPARATIVE WAGES IN MANCHESTER, 1833

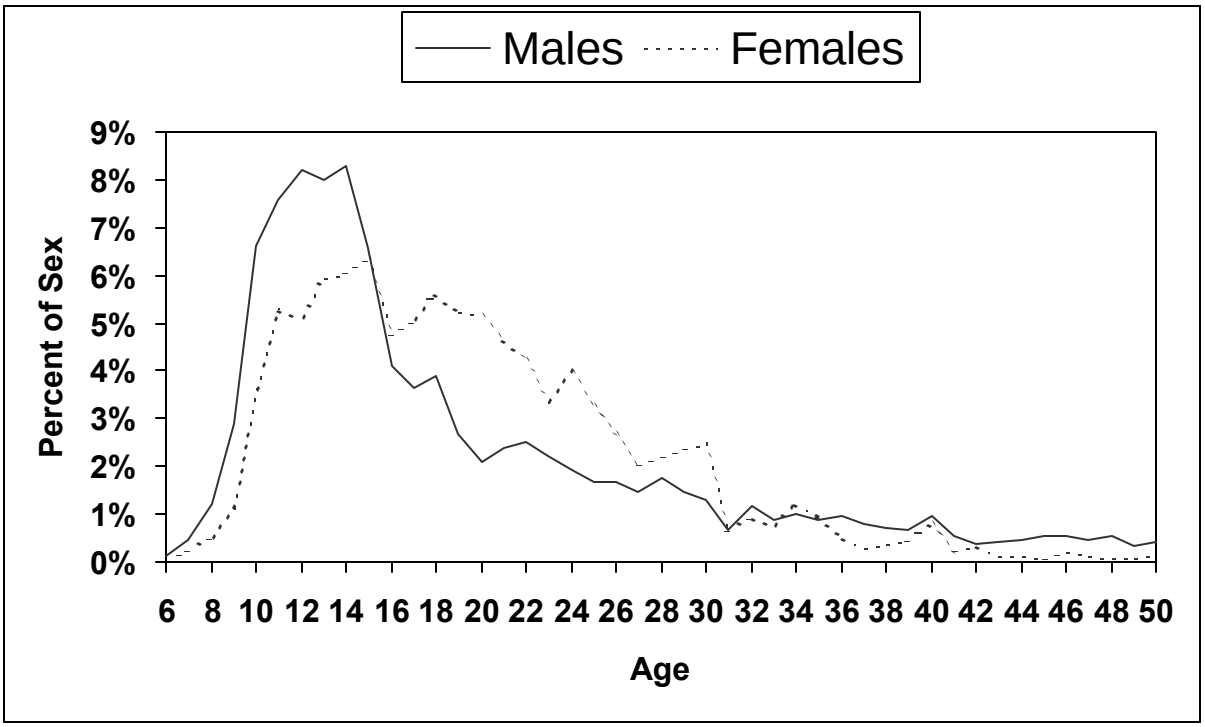
Non-Factory Jobs			Cotton Mill Jobs		
Job	Wage	%Emp.	Job	Wage	% Emp.
iron-founder	29	0.6	spinning overlooker	33	1.5
sawyers	26	0.6	mule spinner	29	33.6
carpenters	24	3.6	dresser	27	4.9
stonemason	20	1.0	carder	26	3.7
packer	20	0.9	thistle, weaving overlooker	24	4.9
plasterer	20	0.4	engineer, fireman, mechanic	22	11.3
bricklayer	19	0.9	card room	16	14.0
tailor	18	3.0	weaver	15	13.8
shoemaker	16	4.2	piecer	10	5.9
porter	15	2.3	males 21&over	22.5	48.7
laborer	12	6.1	males under 21	6.2	51.3
hand weaver	11	2.6	females 21&over	9.5	44.5
others		60.1	females under 21	6.8	55.5

Sources: The wages for jobs in cotton mills were calculated from the Manchester mills in the Cowell-Stanway survey of 1833. B.P.P. 1834 XIX D.1. The averages for men and women are from a survey of mills in Manchester in 1833. See B.P.P. 1835 XLIX.1 No. 329. The estimates for wages in occupations outside the factories are Manchester wages from B.P.P. 1835 XLIX.1 No. 325, 327. The rate for laborers is that given for bricklayers' laborers in *ibid*, No. 327. Hunt (1986) gives 12s. 5d. as the wages for agricultural labors in Lancashire, 1833-1845. Job shares for non-factory occupations are from B.P.P. 1844 XXVII, *Census of 1841*.

FIGURE 1

AGE DISTRIBUTION OF COTTON WORKERS

(Manchester, 1818)



Source: Mill rosters from Lords Report (1818, 1819, appendices).

[1] B.P.P. 1834 (XIX), p. 39.

[2] Mitchell's theory of wage-setting presents nature as a kind of invisible hand in the labor market. Adam Smith himself was suspicious of "invisible hands." See Rothschild (1994).

[3] Simpson and Weiner (1989).

[4] B.P.P. 1837-8(VIII) pp. 306-7. Mule spinning was the most physically demanding type of spinning. The source for the description is identified only by the initials W.S.B.W. But there is textual evidence that the source is sympathetic to the exertions of the spinners. Parts of the description are joined by the comment "...this is by no means the extent of the spinner's labour," and elsewhere the source notes that a certain action is "a matter...of no slight difficulty." The calculation below provides additional and perhaps more compelling evidence of exaggeration.

[5] The figure for muscular efficiency is from Benedict and Villars (1973, p. 5-73). The worker would also have to consume additional calories to cover basal metabolism (1350-2000 kcal), eating and digesting food, and hygienic and other activities. Workers themselves recognized a connection between the amount of work they did and the amount of food they consumed. When some factories reduced their hours from 12 to 10 in 1847, a number of male operatives noted that with the reduced hours they could get by with one less meal per day. See B.P.P. 1849 XXII *Horner's Survey*, p.27, No. 10; p. 32, No. 169; p. 36, No. 240.

[6] Shammas (1990) has estimated calorie consumption per adult male equivalent in rural England in 1790 as 2500-2700 kcal.

[7] See Lazonick (1979, p. 235) and Cohen (1990, p. 65). Burnette (1996, p. 323) also refers to this evidence.

[8] Burnette (1996, pp. 324-5) reviews the evidence on strength differences. Men can lift about twice as much as women, and this difference is large relative to the standard deviation of women's lifting ability.

[9] Pinchbeck (1930, p. 61).

[10] Burnette (1996, p. 328).

[11] John (1980)

[12] Catling (1970, p. 42).

[13] Lazonick (1979, pp. 236-7).

[14] Pinchbeck (1930, p. 186), Lazonick (1978, p. 9; 1979, p. 236) and Cohen (1990, p. 64).

[15] Ibid.

[16] Lazonick (1978, p. 9). For a further sense of the interpretive stretch in the literature, consider this statement which followed the anecdote analyzed subsequently in the text above: "There is no doubt that the women possessed the more humane incentive system but it could hardly be expected to be an effective or financially viable method in the context of the capitalist enterprise, and especially when applied to a 13 1/2 hour day and 74 1/2 hour week." Ibid.

[17] The scholars cited above all refer to this anecdote.

[18] Consider, for example, this story: "....a witness before Sadler's Committee described how when he was a child, he was beaten by a slubber. 'One of the young men who served the carder went out and found my mother': 'She came in...and asked me what instrument it was I was beaten with, but I durst not do it; some of the bystanders pointed out the instrument...and she seized it...and beat it about the fellow's head, and gave him one or two 'black eyes'." Quoted in Thompson (1964, p. 339) . This story suggests that mothers supervised the behavior of adult male workers in the mills and applied physical sanctions when men behaved inappropriately.

[19] In the previous sentence the examiner asked the piecer if he knew of any (male) spinners who had been "turned away" for beating piecers.

[20] The literature also suggests another disciplinary scheme: an overlooker could beat a piecer at the women spinner's request. See B.P.P. 1833 (450) XX D.1. p. 55.

[21] Huberman (1991) finds that M'Connel and Kennedy, a large Manchester fine-spinning firm, began using women spinners in 1810. He also found that cotton waste doubled between 1810 and 1817. He argues that waste increased because of women's relative poor abilities as supervisors. While that's an interesting hypothesis, he provides no direct evidence linking women spinners' supervisory ability to the amount of waste. In fact, there is no data about the number of women spinners employed or any comparative evidence regarding waste trends.

[22] Lords Report (1818, pp. 185-94). The details of the mill's operating characteristics in the subsequent text are from this testimony. The number of employees in the mill indicates that it was Kennedy's mill on Great Ancoats St. in Manchester. Kennedy had another mill on Pickford St., also in Manchester. Another witness indicated that one of Kennedy's mills employed wholly female spinners. Lords Report (1819, p. 342).

[23] The fineness of the threads spun indicates that the mill's spinning machines were mules.

[24] The average age of male fine spinners in Manchester in 1832 was 32 years of age. See Shuttleworth (1842,p. 269). The wage data is from Tables of the Revenue &c of the United Kingdom, Part III, 1834, p. 402, and Lord Report (1819, pp. 84, 117, 137-8).

[25] Lords Report (1818, App. 8, pp. 26-31). The key observation is that the workers were listed on the mill roster in a way that reflected their organization on the factory floor, and one can recognize the age and experience pattern of a spinning team. Scavengers, who were young children who advanced gradually to piecing, are subsumed under the category piecers in the analysis below.

[26] Piecers supervised by joint male-female spinning teams are not included in Table 1. See below.

[27] Their overlookers were probably three men, two age 40 and one age 47, all of whom had 24 years or more of experience.

[28] Adam and Sarah Furnival, both age 22, jointly supervised three piecers ages 11, 12, and 13. Ann Blinkhorn and Thomas Bradbury, age 21 and 25 respectively, supervised two piecers: a seventeen year old girl and a ten year old boy. Helen Plunket and Charlotte Davis, both age 20, also worked together supervising a boy and a girl age 14 and 11 respectively.

[29] The first figure is from the spinner/piecer teams identified in Lords Report (1818,1819, appendices); the second is from Shuttleworth (1842).

[30] The roster for Kennedy's Great Ancoats Street mill, recorded in 1818, indicates that the firm employed women spinners (see text above). Total employment in Kennedy's mills in 1818 was 518 persons. In 1833 James Kennedy employed 599 persons spinning threads with an average count of 90 and some threads of count 170. This means that Kennedy's mills were doing a significant amount of fine-spinning. Nonetheless, a survey of (male) fine-spinners reported only 11 spinners working for Kennedy in 1832 (Shuttleworth, 1842).

Moreover, the average weekly wage reported for Kennedy in 1833 is 15-25% lower than wages for other mills spinning comparable thread (B.P.P. 1834 XIX D.1.119p). This evidence indicates that Kennedy employed a significant number of women spinners in 1833.

[31] Kirby and Musson (1975, p. 13).

[32] Freifeld (1986) presents an interesting angle on the supervision issue. She argues that the problem was a breakdown in the intergenerational transmission of skills. She assumes that young females learned about spinning only from women spinners; Cohen (1990, p. 66) also asserts that only a small number of females served as assistants to (male) mule spinners. The evidence in the Lords' Report (1818, 1819) suggests otherwise; among identified piecers over 14 years of age who were working for males spinners, 54% were female. For a different critique of Freifeld's argument, see Cohen (1990, pp. 188-9, n. 12).

[33] As discussed subsequently. See Table 5.

[34] See the classic references below. More recently, Bolin-Hort (1989, p. 109) asserted that women generally left the factory at marriage or at first confinement. Hartmann (1976, p. 153) asserted that the number of married women working has been greatly exaggerated.

[35] Pinchbeck (1930, p. 199). Her defensive tone needs to be understood in the context of contemporary denunciations of married women's work.

[36] Ibid., p. 198.

[37] Morning Chronicle, 9 May 1844.

[38] Ibid.

[39] B.P.P. 1849 XXII, *Horner's Survey* pp. 13-86. The sample includes 350 women, 9 of which were widows. Of this sample 54% did not report age, and among those not reporting age 83% were married. Women who did not report age were distributed according to the age distribution of women with corresponding marital status.

[40] In B.P.P. 1849 XXII, *Horner's Survey*, pp. 13-86, only 1% of the married women were under 20.

[41] Data for female cotton workers in Lancashire is from ibid. The distribution was calculated as described in the footnote above. The data for all females is from B.P.P. 1852-3 LXXXVIII, *Summary Tables, Census of 1851*.

[42] The marriage incidence rate for female factory workers ages 40 and over was greater than for the population. But in this age category the population as a whole is significantly older than the sample of factory workers and hence includes a much larger share of widows.

[43] B.P.P. 1833 XXI D.3.13.

[44] Ibid., D.3.12.

[45] B.P.P. 1842 XV p. 27.

[46] See B.P.P. 1849 XXII *Horner's Survey*, Horner's evidence, operatives No. 38, 47, 100, and 160. One married woman noted, "We get old folks to do the work at home, and for my part I would as soon work in the mill." Ibid., evidence of Sub-Inspector B, No. 99.

[47] Hewitt (1958, p. 102).

[48] One women earned 7s a week but paid 3s a week for child care. See B.P.P. 1849 XXII *Horner's Survey*, Horner's evidence, No. 165. Elderly relatives also provided child care. Ibid., evidence of Sub-Inspector B, No. 51.

[49] B.P.P. 1833 XX D.3.11.

[50] As discussed subsequently, this reflects the historical facts of the situation being analyzed.

[51] See B.P.P. 1834 XIX "Dr. Mitchell's Report," p. 21, and B.P.P. 1835 XLIX "Tables of Revenue," Part II, p. 102.

[52] The sample is the same as the over-all sample described under Table 4.

[53] I scaled the starting age distribution by two-thirds the number of workers aged 10 and under, and then calculated the year-by-year gross exit probabilities as $(c(i)-c(i+1)+s(i+1))/c(i)$, where $c(i)$ is the number of workers of age i in the (current) age distribution and $s(i)$ is the scaled number of workers starting factory work at age i. I then fitted a constant probability of exit model for the years in each age category.

[54] Age distributions after 1833 are potential affected by significant legislative restrictions on child labor.

[55] The sample of mills differs somewhat between 1818 and 1833. Evidence from M'Connel and Kennedy's mills in 1818 and about 1835 supports the picture presented here. See Lee (1972, appendix).

[56] B.P.P. 1844 XXVII, "Census of 1841, Occupational Enumeration," p. 70-98.

[57] For an early discussion of these issues, see Clark (1919) and Hutchins (1915). Hareven (1982, p. 245) noted that in a large cotton manufacturing company in New Hampshire from 1912-36, women "...tolerate more difficult working conditions and lesser opportunities for advancement to cling to the mill jobs until they have to leave because of family obligations or layoffs, whereas men were more likely to leave in search of better working conditions and opportunities for advancement." Quoted in Carter and Savoca (1991, p. 326).

[58] The middle class tended to think that factory work injured girls morals and character. Thus they were less likely to employ former factory girls within their homes, where domestic servants primarily worked in Manchester. See Neff (1929, p. 54).

[59] See Galbi (1994) for some new evidence and citations to the literature.

[60] Ibid.

[61] For a critique of Huberman's position, see Rose, Taylor, and Winstanley (1989).

[62] Lords Report (1818, 1819, appendices).

[63] Thompson (1964, pp. 326-349).

[64] Using a sample of workers in light manufacturing in San Francisco in 1892, Carter and Savoca (1991) show that expected job tenure for young women was actually longer than that for young men. They argue that differences in incentives to invest in training because of differences in expected job tenure, as well as occupational tenure, cannot explain gender differences in earnings. Their evidence is consistent with the thrust of this paper. However, this paper stress how earnings differences affect labor market tenure, and links training more tightly to job assignments.

[65] Hartman (1976) and Valverde (1988) stress these factors.

[66] For an elaboration of this view, see Honeyman and Goodman (1991, pp. 614-621).