The Spinning Jenny: A Fresh Look

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In "The Industrial Revolution in Miniature," I calculated that the spinning jenny was profitable to install in England in the 1780s but not in France.[1] My calculations assumed that a spinner using a wheel in a domestic setting worked a total of 100 days per year and spun 100 pounds of course cotton (one pound per day). The jenny raised labor productivity to three pounds per day in the "most likely" scenario. I showed that it would have been cheaper to spin 100 pounds per year with a jenny than with a wheel in England, while the reverse would have been true in France. Hence, the jenny was installed in England rather than France. Ugo Gragnolati, Daniele Moschella, and Emanuele Pugliese have pointed out that this argument assumes that output was kept at 100 pounds per year, and the effect of the jenny was to reduce the spinner's work year to only 33–1/3 days per year.[2] They suggest that it was more likely that the spinner would have continued to work 100 days per year and produce 300 pounds of yarn instead. In that case, they argue, it would have been profitable to install the jenny in France as well as England. Profitability would have increased in both countries under these assumptions because capital costs would have been cut by a third if three times as much output was produced from the same capital (although profitability was still much higher in England). Hence, they conclude that economic considerations do not explain the diffusion of the jenny.

However, the matter is not as simple as Gragnolati, Moschella, and Pugliese suggest. Here I discuss three issues that were not included in my 2009 article, but which increase the differential between England and France. One issue relates to the objective of spinners and their response to income changes, the second is the difference between a capitalist employer and a woman who bought a jenny and operated it on her own account, and the third is the implication for profitability of learning to operate the jenny effectively.

First, it is not so clear that we should follow Gragnolati, Moschella, and Pugliese and assume that the spinner would continue to work 100 days per year once she had mastered the jenny. The reverse is more likely. Gragnolati, Moschella, and Pugliese justify their claim by invoking Jan De Vries' "industrious revolution" and contending that no one reduced their work year in the late eighteenth century.[3] To understand the effect of the jenny, however, we must ask: why not? Jacob Weisdorf and I explore the hypothesis that farm laborers in southern England between 1300 and 1830 had a target level of consumption and adjusted their work year to achieve it.[4] When the daily wage rose, they cut their work effort, and conversely, when wages fell, they increased it. We show that this hypothesis explains the various estimates of days worked per year by laborers from the late middle ages through the early nineteenth century.

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I thank Jean-Laurent Rosenthal for his advice. Remaining errors are my own.

[1] Allen, "Industrial Revolution."

[2] Gragnolati, Moschella, and Pugliese, "Spinning Jenny."

[3] De Vries, "Industrial Revolution."

[4] Allen and Weisdorf, "Was There an 'Industrious Revolution?'' The target level was the "respectability budget" defined in Allen, "Great Divergence."

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The work year was increasing among laborers in the late eighteenth century due to the slow decline in their real wage. Conversely, the implication of this model is that an increase in income results in a fall in time worked per year. Since spinners were from the same social stratum as laborers (indeed, they were often married to each other), the labor supply decisions of spinners were governed by the same considerations as their husbands'. Hence, the rise in productivity due to the spinning jenny would have resulted in a decline in time spent working, as my original calculations assumed.

Second, another reason why Gragnolati, Moschella, and Pugliese's calculations overstate the profitability of jennies in both England and France is because they present too simple an analysis of the profitability of a spinner's buying and operating a jenny in her cottage. It is important to distinguish that decision from the decision of an entrepreneur who was buying a jenny and operating it with hired labor in a situation where labor was available in unlimited supply at the market wage. The latter is the situation analyzed by Gragnolati, Moschella, and Pugliese. In my article, I did not clearly distinguish between the two problems; however, my book on the Industrial Revolution focuses the discussion on the entrepreneur's decision, which is the only one modeled by my original profitability calculation as well as by Gragnolati, Moschella, and Pugliese's.[5] However, it is not the relevant calculation when the spinner buys a jenny and operates it by herself.

When the spinner bought a jenny, she contracted with a putting out merchant who supplied her with raw cotton and purchased her yarn. The price she received for her yarn was the price of the value added, i.e., the price of yarn less the price of raw cotton multiplied by the pounds of raw cotton required for a pound of yarn—about 1.125 pounds. [6] This "price of value added" covered the cost of all of the steps involved in converting raw cotton to yarn. These steps included cleaning, carding, making rovings, spinning, and reeling the finished yarn. I have estimated that these amounted to 2.067 days per pound. One day of labor per pound was required for spinning, and the other 1.067 days were cleaning, carding, and reeling.[7] Where did all the other labor come from? In a small farming village where most women were spinning, there was not a pool of labor from which spinners could hire their carders and reelers—which is what Gragnolati, Moschella, and Pugliese implicitly assume. The spinners had to supply the labor themselves.

We can analyze the decision of a spinner who purchased a jenny and who did all of the clean, carding, and reeling—as well as the spinning—herself. In this case, she spun for only 48 days per year, spent the other 52 days carding, reeling, etc., and produced 48 pounds of yarn. If she bought a jenny, her productivity in spinning (but not the other tasks) would have increased. If we assume that her productivity with the jenny was three pounds per day, she could produce 71.43 pounds per year by working 100 days in total. Using the jenny would increase her production by 23 pounds per year, and this would have been worth 24.77 shillings in England and 21.43 livre tournois in

[5] Allen, *British Industrial Revolution*, p. 194.

[6] The price of yarn received by the spinner was the market price of yarn, for instance, as summarized by Harley, "Cotton Textile Prices," p. 74, less the putting out merchants margin equal to about one fifth of the price of the yarn (Baines, *History*, pp. 131–32). In the case of the hand spinner whose capital costs were negligible, this also equalled the wage cost of spinning one pound of yarn.

[7] These are the labor requirements implicit in the costs of "hand method, 1760" in Table 8.1 in Allen, *British Industrial Revolution*, p. 185. Since productivity in hand spinning was assumed to be one pound per day, dividing the costs per pound of "preparatory, carding, spinning, and reeling" by the daily wage rate of 7 d. gives days labor per pound.

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France. With the base case assumptions made previously, the rate of return to the woman's buying a jenny works out at 33.4 percent in England and 8.6 percent in France. The former exceeds the opportunity cost of capital (15 percent), while the latter falls short.

Third, my 2009 article took no account of learning, and that is another factor that favored early adoption in England. I inferred the increase in efficiency due to the jenny using English earnings estimates from the 1780s. These machine spinners produced three pounds per day, but it is very unlikely that they spun as much in the late 1760s when jenny spinning began. The reason for thinking this is the record of productivity in the earliest attempts to set up jenny spinning in Barcelona. James Thomson has analyzed the records of the Royal Spinning Company in the late 1780s when the first trials were made to spin with machines.[8] The Royal Spinning Company was using 30 spindle jennies in a workshop setting. These were slightly larger than the 24 spindle jennies commonly used in English cottages. In the first months of operation in 1786, the spinners only managed 5 ounces per jenny per day. By 1787 this had increased to 10 ounces. These were derisory output levels and less than those achievable with wheels. The factory ran at a large loss. In early 1788 productivity rose to 1–1/3 pounds per day, and by December of that year, new management regulations pushed it to 1–1/2 pounds per day.[9] At this point, the spinning jennies were covering their costs, and this was also the point when production per day with the jenny exceeded that of the wheel.

The development of machine spinning was a path-dependent process in which productivity increased over time as skills developed and machinery was improved. The question is the profitability of jenny spinning in France and Britain at the early stages of this progression. When productivity was less than one pound per day, the jenny was unprofitable everywhere, i.e., its "R&D" phase was still underway. Commercial production, when the jenny paid for itself, probably commenced in England when productivity rose to about 1.5 pounds per day, as in Catalonia. If we use Gragnolati, Moschella, and Pugliese's equation 4 (with labor fixed at 100 days per year) to calculate profitability in England and France with output per jenny set to 1.5 pounds per day, we find that the rate of return to installing the jenny was 24 percent in England and –0.1 percent in France. At this stage of the learning process, the jenny was profitable in England but not in France, and that is why the English adopted the jenny first.

[8] Thomson, "Transferring the Spinning Jenny."

[9] Gragnolati, Moschella, and Pugliese, "Spinning Jenny," think it "totally unlikely" that the productivity of the jenny could have been as low as two pounds per day since Landes, *Unbound Prometheus*, p. 85, thought the jenny was six to twenty-four times more productive than the wheel. Landes, however, offered no evidence for this, and it looks like he was simply counting threads. The reason that productivity was not proportional to the number of threads in the machines is that the yarn frequently broke in the jenny because it malfunctioned. I asked a spinner who was demonstrating a jenny at the Quarry Bank Mill in Cheshire how well the machine performed. She described the jenny as "cantankerous": it was difficult to get the machine to operate well on an ongoing basis.

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