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Were Spinners Part of the High Wage  
Economy?**

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# Wages at the Wheel: Were Spinners Part of the High Wage Economy?<sup>†</sup>

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## Abstract

In our earlier paper we used archival and printed primary sources to construct the first long-run series of wages for hand spinning in early modern Britain. Our evidence challenged Robert Allen's claim that spinners were part of the 'High Wage Economy', which he sees as motivating invention, innovation, and mechanisation in the spinning section of the textile industry. Here we respond to Allen's criticism of our argument, sources and methods, and his presentation of alternative evidence. Allen contends that we have understated both the earnings and associated productivity of hand spinners by focussing on part-time and low-quality workers. His rejoinder is found to rest on an ahistorical account of spinners' work and similarly weak evidence on wages as did his initial claims. We also present an expanded version of the spinners' wages dataset, which confirms our original findings: spinners' wages were low even compared with other women workers and did not follow a trajectory which could explain the invention and spread of the spinning jenny.

JEL Codes: J24, J31, J42, J46, N13, N33, N63, O14, O31

Keywords: hand spinning, women's wages, Industrial Revolution, textiles, Great Divergence, induced innovation, High Wage Economy

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In our earlier paper we used archival and printed primary sources to construct the first long-run series of wages and empirical estimates of productivity for hand spinning in early modern Britain. The evidence from these sources challenged Robert Allen's claim that spinners were part of the 'High Wage Economy' and that their high wages motivated invention, innovation, and mechanisation in the textile industry, specifically the development and diffusion of the spinning jenny. Here we respond to Allen's criticism of our argument, sources and methods, and his alternative evidence. Allen reiterates his own position and then supports it by adjusting his wage series without explanation and adding two observations of the same fragmentary and hearsay kind that he cited initially. We have continued to investigate spinners' wages and productivity, adding more than 1500 new observations to our dataset. This evidence reinforces our view of spinning as a low-productivity, low-earning occupation. Professor Allen, not us, is spinning his wheels.

Section I exposes problems with Allen's depiction of spinners' wages and work organisation. It notes slippage between earlier and current claims about remuneration and questions the strange assumption that, although impoverished, spinners chose to forgo earning opportunities in favour of leisure. Section II responds to the claim that spinners and manufacturers met on a level playing field when bargaining over wages, while Section III counters his criticisms of our productivity estimates. Section IV examines his claims about our wage data in detail, and further scrutinizes his sources for spinners' earnings. Section V provides a more robust decadal wage series with a combination of new evidence and hedonic wage regressions for daily earnings and piece rates. The results underline our previous conclusion: *contra* Allen, the wages of spinners do not show a trend that would have induced innovation and mechanization.

## I

Robert Allen includes estimates of hand spinners' daily wages on his valuable and much-used website, which draws together comparative data on wages and living costs over time and space. He used these estimates and assumptions about spinners' working time to parametrize his model of the returns to a hand spinner's investment in a jenny in the 1780s.<sup>1</sup>

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<sup>1</sup> Robert C. Allen, "The Industrial Revolution in Miniature: The Spinning Jenny in Britain, France, and India," *The Journal of Economic History* 69, no. 4 (2009).

More boldly, he graphed the spinners' day wage series to show that its peak coincided with the cluster of inventions that revolutionised spinning.<sup>2</sup> In 'Spinning their wheels', Allen asserts that 'a sturdy hardworking young spinner' could spin about a lb of coarse yarn per day, a level of production that would supposedly have earned his stylized spinner 8d (implying a piece rate of 8d per lb). In his 2015 paper, he went much further, claiming that daily earnings rose to 12d in 1770–1774, a dramatic pinnacle strategically coincident with the spinning inventions. This high point has been summarily dropped without explanation in the more recent reply, significantly changing the earnings trajectory in his Figure 1.<sup>3</sup>

There are several problems with Allen's stylized spinner. First, we have no information on what share of the population could qualify as 'sturdy' or 'hardworking'. It is unclear why scholars should be more interested in the earnings of such constructs than in those of the *actual* spinners whose earnings we have collected here and in our previous paper, and which would have been the motivation for any induced innovation. Second, as we discuss later, the empirical evidence does not show spinners producing a lb of yarn per day except in unusual circumstances. Allen contends that this was because they did not work full time; indeed, he begins his critique of our work by claiming that he never assumed that spinners produced a lb a day or earned the day wages reported on his website. These, he says, are full-time equivalents. He states that most spinners spun part-time, assumed at 40 per cent of 250 total working days, that is 100 days per year. This supposition is built into his estimates of the returns to spinning machinery and spinners' contributions to family incomes.<sup>4</sup> Thus, he claims

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<sup>2</sup> "The High Wage Economy and the Industrial Revolution: A Restatement," *The Economic History Review* 68, no. 1 (2015).

<sup>3</sup> Allen notes, without explanation: 'The figure of 12 pence per day for 1760–4 has been excluded from the calculations', notes to Figure 1, "Spinning Their Wheels: A Reply to Jane Humphries and Benjamin Schneider," *Oxford Economic and Social History Working Papers* No. 166 (2018): 10. In fact, Allen's website records this level of wage for 1770–4.

<sup>4</sup> Allen admits that the pattern and percentage are assumptions. He points to Eden's claim that married women could only spin 2.5 lbs per week compared to 6 lbs for unmarried women, but our research using archival sources that provide output for both married and widowed women shows a difference of no more than 10% in their productivity (see Bodleian Library MS North d 51). Allen also directs readers to A. S. Bhalla, "Investment Allocation and Technological Choice—a Case of Cotton Spinning Techniques," *The Economic Journal* 74, no. 295 (1964). Bhalla, in turn, cites a statistical bulletin that states spinners in mid-20<sup>th</sup> century India worked for 'no more than' four to six hours per day. It is not clear why Allen considers it appropriate to use work patterns from 20<sup>th</sup> century India to support his assumptions about working time in 17<sup>th</sup> and 18<sup>th</sup> century Britain. Robert C. Allen, *The British Industrial Revolution in Global Perspective* (Cambridge: Cambridge University Press, 2009), 214. See also

to use 'full-time data' adjusted for part-time work to derive actual earnings (and productivity), and accuses us of being vague about working time.<sup>5</sup> The implication is that our estimates are low because they are not for full days of work. We agree that some hand spinners probably did work part-time, but certainly not all, and not for the reasons that Allen implies, or in the way that he supposes.

Allen contends that spinners worked part-time consistently, choosing daily to put aside their spinning wheels and forgo opportunities to earn.<sup>6</sup> His stylized spinner displayed a preference for leisure or was able to satisfy her modest consumption aspirations through limited work, as he makes clear in his defence of the assumption of fixed levels of output in his original computation of the return to investment in a jenny.<sup>7</sup> Backward bending supply curves are inconsistent with the voluminous contemporary evidence suggesting that spinning was a valued source of employment and income seized upon by impoverished and otherwise underemployed women and children.<sup>8</sup> Many spinners worked as near to full-time as possible,

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John Styles, "Robert Allen's Spinning Jenny Is Still Broken," <http://spinning-wheel.org/2019/05/robert-allens-spinning-jenny-is-still-broken/>.

<sup>5</sup> Allen's attention to the length of the working year in spinning is at odds with the lack of evidence about working time in his international comparisons of builders' wages, another occupation where seasonality was important, see Kathryn Gary, "The Distinct Seasonality of Early Modern Casual Labor and the Short Durations of Individual Working Years: Sweden 1500–1800," *Lund Papers in Economic History* No. 189 (2019). Judy Z. Stephenson, "Looking for Work? Or Looking for Workers? Days and Hours of Work in London Construction in the Eighteenth Century," *University of Oxford Discussion Papers in Economic and Social History* No.162 (2018). Mario García-Zúñiga et al., "Seasonality and Working Patterns in the 18th Century Construction Industry: A European Comparison," in *Economic History Society Annual Meeting* (Queen's University Belfast, 2019).

<sup>6</sup> Not only do spinners only work 40 per cent of the time but they also only work 250 days in the year between spinning and other unspecified occupations, see Allen, "Spinning Their Wheels: A Reply to Jane Humphries and Benjamin Schneider," 5.

<sup>7</sup> Gragnolati, Moschella and Pugliese criticised Allen's assumption that after purchasing a jenny and so increasing her productivity, a spinner would produce the same amount and so work less time, see Ugo Gragnolati, Daniele Moschella, and Emanuele Pugliese, "The Spinning Jenny and the Industrial Revolution: A Reappraisal," *The Journal of Economic History* 71, no. 2 (2011). In his reply Allen argued that it was inappropriate to assume that after mastering the jenny a spinner would continue to work the same number of days in the year as spinners likely had '...a target level of consumption and adjusted their work year to achieve it', Robert C. Allen, "The Spinning Jenny: A Fresh Look," *ibid.*: 461. See also Allen's original computation of the profitability of a spinner's purchase of a jenny "The Industrial Revolution in Miniature: The Spinning Jenny in Britain, France, and India."

<sup>8</sup> Comments from the late 16<sup>th</sup> century attesting to the poverty of spinners include Letter from John Saunders to the Privy Council, Cecil Papers, CP 197/86. The lack of employment for the rural poor produced by mechanization is discussed in C. Vancouver, *General View of the Agriculture of Devon* (1808), 464, T. Rudge, *General View of the Agriculture of Gloucester* (1813), 346–347, and the Report of the Poor Law Commissioners (1834). Corroborating evidence for Lancashire flax spinners at the end of the 17<sup>th</sup> century can be found in Alfred Powell Wadsworth and Julia de Lacy Mann, *The Cotton Trade*

particularly those in urban areas or regions where protoindustry was well established. Even so, spinners were at the mercy of putters out for work and the yarn factors themselves were constrained by both the availability of fibre and cyclical and seasonal changes in the demand for final products.<sup>9</sup> Instead of working regularly but part of the time, many spinners appear to have spun full time for periods or seasons when fibre was available and other work scarce. Spinning was patched into an economy of makeshifts that together provided an income.<sup>10</sup> This pattern of work means that, *contra* Allen, many of the recorded wages and outputs on which we draw do relate to full days or weeks of work.<sup>11</sup>

Moreover, if the cost of hand spinning was the motive to invent and mechanize, the time allocation of spinners is of second order importance. It would affect the range of putting out operations and so transport costs and the timeliness of turnaround, but since masters paid piece rates, they would not care whether spinners took 1 or 2 days to produce each lb of yarn since they paid the same price for the work.<sup>12</sup> The most salient cost for induced innovation would have been the piece rate, trends in which we analyse in Section V. On the other hand, our view is that piece rates would have incentivized hand spinners to greater diligence when

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*and Industrial Lancashire, 1600–1780* (Manchester: Manchester University Press, 1931), 90. Adam Smith also notes that spinners were poor in the mid-18<sup>th</sup> century, Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (New York: Random House, 1974), Book IV, Chapter 8, 608. Allen seems to agree that spinners were generally poor, Allen, "Spinning Their Wheels: A Reply to Jane Humphries and Benjamin Schneider," 1.

<sup>9</sup> Jane Humphries and Benjamin Schneider, "Spinning the Industrial Revolution," *The Economic History Review* 72, no. 1 (2019): 152. Benjamin Schneider, "Creative Destruction in the British Industrial Revolution: Hand Spinning to Mechanisation, C. 1700–1860" (M.Sc. Thesis, University of Oxford, 2015). The blanket manufacturers of Witney, cited by Allen as a well-functioning putting out system, valued their export markets particularly because as ships sailed in the spring these markets complimented the summer work geared to domestic demand and smoothed out the seasonal production cycle, see Simon Townley, *The Victoria History of the County of Oxford, Volume Xiv: Witney and Its Townships* (London: Oxford University Press, 2004), 79–80.

<sup>10</sup> Olwen H. Hufton, *The Poor of Eighteenth-Century France 1750–1789* (Oxford: Clarendon Press, 1978). Jane Humphries, *Childhood and Child Labour in the British Industrial Revolution* (Cambridge: Cambridge University Press, 2010), 102–18.

<sup>11</sup> To use these to infer annual income requires assumptions about the length of the spinners' working year which need support from further research.

<sup>12</sup> Here the assumption is that masters are the incipient inventors and mechanisers. In his computation of the returns to investment in the Jenny Allen assumes it is the spinner herself who invests, hence the increased profit is measured by the value of the time she saves producing the same output, as in Allen, "The Industrial Revolution in Miniature" or the value of the increased output when she works the same time on the more productive machine, as in Allen, "The Spinning Jenny".

work was available.<sup>13</sup> Further, it is unclear how Allen can be certain that the wage figures he provides are for full-time work. As we discuss below, he has now rejected the original sources for his 2015 paper, and his 'new' sources are opaque about the origin of their information and do not provide clarity about working hours. The only information he has is that the wages presented in these questionable sources are higher than are most of ours.

In short, the assumption of a backward-bending supply curve seems at odds with the pressures on clothiers to source yarn, the absence of alternative work in rural areas, the neediness of many spinners, and the incentive effects of piece rates. Our view of the ways in which spinners worked, based on evidence from contemporary descriptive sources, supports our interpretation of many recorded wages as day rates.

## II

In contrast with Allen's paradoxical proposition of high and rising unit labour costs but low actual earnings,<sup>14</sup> we offered several explanations of how spinning employment could expand without pressure on wages. Monopsony was one possibility: yarn masters had market power.<sup>15</sup> In support of this possibility, and contrary to Allen's claim that we offer 'no evidence',<sup>16</sup> we cited Jane Fiske's conclusion based on the business papers of the Oakes family, prominent Suffolk clothiers, whose spinning network covered 60 miles. Fiske shows that piece rates for spinners went down when trade was slack but rarely up after a recovery, and that masters decided rates of pay at an annual meeting at the local wool hall 'so that the manufacturers' claim that free competition kept wages up was less than the truth'.<sup>17</sup>

Allen also counters the monopsony argument with an account of market structure based on the demand for wool yarn and employment around Witney, concluding from this example that competitive markets ruled.<sup>18</sup> Allen references his own work when describing the Witney case study, but the original source appears to be Robert Plot, whose account has been

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<sup>13</sup> As Allen argues for construction workers, see Allen, "Spinning Their Wheels: A Reply to Jane Humphries and Benjamin Schneider," 10.

<sup>14</sup> *Ibid.*, 1.

<sup>15</sup> Humphries and Schneider, 150–52.

<sup>16</sup> Allen, "Spinning Their Wheels: A Reply to Jane Humphries and Benjamin Schneider," 5.

<sup>17</sup> Jane Fiske, ed., "The Oakes Diaries: Business, Politics and the Family in Bury St. Edmunds," *Suffolk Record Society XXXII* (1990).

<sup>18</sup> His reference is to Robert C. Allen, *The Industrial Revolution : A Very Short Introduction* (Oxford: Oxford University Press, 2017), 15–18.

reproduced and repeated and underpins the description in the Victoria County History volume for Witney and its townships on which Allen draws.<sup>19</sup> While this secondary source describes a putting-out system providing widespread local employment, the author is at pains to emphasize that numbers were often exaggerated and that the industry experienced busts as well as booms.<sup>20</sup> Allen claims that in the eighteenth century about 7000 packs of wool were processed a year in Witney which, assuming as he does that each woman spun 100 lbs a year (.4 lbs per day for 250 days), would have provided employment for 16,000 spinners. We have been unable to track down the source of the estimate of fibre supply, but Townley, Allen's main reference, disputes this figure. He says that while some 10,000 people, including carders and spinners in surrounding villages, were claimed dependent on the industry this figure was inflated. The actual number was closer to 5000 and this was 'allowing for part-time and seasonal work'. Even more important in this context was the establishment by Royal Charter in 1711 of the Witney Blanket Weavers Company to regulate and control the numerous small independent manufacturers operating within a 20-mile radius of the town. The Company regulated quality standards, the taking of apprentices, and the employment of journeymen. It brought masters together to oppose wage increases for journeymen and would have provided the basis for a collective position on spinning piece rates.<sup>21</sup>

Allen's certainty on the equal bargaining power of spinners and yarn factors is at odds with the limited evidence provided by the sources. As we suggested in our original paper, growth of employment on the extensive margin (discussed further below) and imports of yarn

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<sup>19</sup> Alfred Plummer traces Plot's influence. Plot's original description appeared in his *Natural History of Oxfordshire*, in 1677; Cox in his book on Oxfordshire (published in 1700) mentioned the making of rugs and blankets at Witney and repeated Plot's account almost word for word; in the later editions of Defoe's *Tour through England and Wales*, a paragraph which is Plot slightly abridged was inserted; Postlethwayt in his *Dictionary* says that 'Witney has a trade in spinning for the neighbouring clothiers, but its greatest manufacture is rugs and blankets'. He then follows Cox in repeating Plot's description and gives precisely the same figures of looms, persons employed, etc. for 1774 that Plot gave in 1677! See Alfred Plummer, *The Witney Blanket Industry : The Records of the Witney Blanket Weavers* (London: George Routledge and Sons, 1934).

<sup>20</sup> Townley, 80.

<sup>21</sup> Ibid. For further detail on the Company and the religious, sociability and family ties linking the blanket makers of Witney see Stanley C. Jenkins, *The Blanket Mills of Witney* (2001). Alfred Plummer and Richard E. Early, *The Blanket Makers, 1669–1969 : A History of Charles Early & Marriott (Witney) Ltd* (New York: Augustus M. Kelley, 1969). Jane Cavell, *A History of the Blanket Hall, Witney, 1721–2011* (Witney: Early's Archive Trust, 2016).

could have provided additional supply without the need for wage increases. Both these points remain unchallenged.

### III

Allen contests our productivity estimates for hand spinners. He claims that the workers for whom we have evidence were unrepresentative and that the inclusion of workhouse spinning and philanthropic enterprises produces a downward bias. We disagree: such workers were part of the spinning work force, indeed probably an increasing share with the geographical expansion of spinning networks. As Allen believes there was no change in the industriousness of spinners over the period, all growth must have been on the extensive margin. There are many references throughout the early modern period to spinning as a source of employment for the poor and recent work, including our earlier paper, has shown that philanthropy and the poor law overlapped with commerce in its organisation. We can add to the illustrations already provided using Allen's own case of Witney, where eighteenth-century masters supplemented yarn supplies by contracts with local poor houses. Arrangements were made with parish officers in Oxford, Stanlake, Bicester, and Burford, and spinning houses in Milton, Woolton, Combe, and Brampton, where Witney blanket masters had wool in 1744 and 1778, may similarly have been poor houses or workhouses. In common with many prisons, the Witney bridewell had spinning wheels and cards in 1766.<sup>22</sup>

In anticipation of the suggestion that our sample was subject to the kinds of biases suggested, we described the hours of work and supervisory and incentive systems in place in spinning schools, philanthropic schemes and workhouse manufacturing. These were not suggestive of relaxed regimes or short hours, and some provided incentives for greater production over and above payment by piece rates.<sup>23</sup> Nor, in fact, were the personnel so very different from ordinary spinners. Further, our estimates of productivity are backed up by

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<sup>22</sup> Oxford Journal Synopsis, 27 March 1777, 1 December 1781, 1 June 1782, 26<sup>th</sup> February 1785; ORO Ms Wills Oxon 304/4/26, *ibid* DAI/8; Bridewell Rec. Witney 3 (April 1778) 15–17; Cited in Townley, 84.

<sup>23</sup> E.g. Barnsley Archives EM/985. Children in this spinning school were ranked and given prizes for producing more than their peers. Prizes and premiums for output were common in spinning schools, see Irene F. M. Dean, *Scottish Spinning Schools* (London: University of London Press, 1930), 89–90, 101. The Articles of agreement between the Church Wardens and Overseers of the Poor of Mortlake and Henry Wilkins who was to manage spinning by the poor specified 12 hour days in summer and 10 hour days in winter, Surrey History Centre, 2397/6/32.

other (independent) scholars working on different sources (e.g. Dolan and Ottoway), corroboration ignored in Allen's reply.<sup>24</sup>

In contrast, Allen seizes upon the relatively high productivity that we reported for what he identifies as 'the single commercial enterprise': the Newbury-Kendrick spinning shop. Actually, this enterprise too had its origins at least in philanthropy, and our claim that Newbury-Kendrick spinning was of inferior quality wool was not special pleading, as Allen charges, but based on the judgement of Christine Jackson, the editor of the business records. Moreover, that the enterprise concentrated on producing inferior material is confirmed by the miserable piece rates that Jackson cites: 1¾–2d per lb!<sup>25</sup>

Allen also argues that our estimates of earnings and productivity may be biased by the fact that we count each spinner returning yarn as one worker, even though she may have been returning the work of several women.<sup>26</sup> This is correct and unavoidable given the available sources, but making this assumption biases our productivity and earnings figures *upwards*, towards his claims.

In criticizing our archive-based estimates of productivity, Allen presents three 'new' pieces of evidence. The first is from the well-known work by Richard Guest on the cotton industry.<sup>27</sup> This is useful because it relates to cotton spinning by hand which is notoriously difficult to document. However, Guest's main aim was not to identify the relative costs of different methods of production but to refute Richard Arkwright's claim to have invented the jenny. The estimates that Allen cites occur in a footnote reflecting back on conditions in the

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<sup>24</sup> Alice Dolan, "The Fabric of Life: Time and Textiles in an Eighteenth-Century Plebeian Home," *Home cultures* 11, no. 3 (2014). Susannah Ottoway, "Workload and Labour Discipline in the Eighteenth-Century Workhouse," in *Economic History Society Annual Meeting* (Royal Holloway, University of London, 2017).

<sup>25</sup> See Christine A. Jackson, ed., ed. *Newbury Kendrick Workhouse Records, 1627–1641* (Reading: Berkshire Record Society, 2004).

<sup>26</sup> Allen, "Spinning Their Wheels: A Reply to Jane Humphries and Benjamin Schneider," 12.

<sup>27</sup> Richard Guest, *A Compendious History of the Cotton-Manufacture: With a Disproof of the Claim of Sir R. Arkwright to the Invention of Its Ingenious Machinery* (Manchester: Joseph Pratt, Chapel Walks, 1823), 10–11. Allen also makes a passing reference to a 'pound-per-day' productivity figure in a French journal article, but again here the source of the claim is not clear. We noted in our earlier work that any attempted rehabilitation of Allen's comparative case would require observation of actual payments to spinners in France (as opposed to social commentators' claims).

1760s (the book was published in 1823). The source for Guest's figures is unknown, and there is no elaboration or background.<sup>28</sup>

In Guest's example spinning costs 9d per lb and the preparatory processes of picking, carding, and roving 9d per lb.<sup>29</sup> Allen says that Guest does not tell us how long it took to perform these tasks and therefore uses the relationship between day wages outside spinning and piece rates to compute productivity, inferring that it took 1.09 days to spin 1 lb of cotton: a daily productivity of almost 1 lb, Allen's benchmark. However, Guest *is* explicit that 'the weaving of a piece containing 12 pounds of eighteen-penny weft occupied a weaver about 14 days'.<sup>30</sup> The spinning to match cost 9s, the basis for Allen's 9d a lb. Guest's costing appears to be for balanced cycle times since he states that the weaver required 'three grown persons' to supply him with weft. Assuming half of these ancillary workers was employed in the preparatory processes, 1.5 or even 2 spinners were needed to supply the 12lbs of yarn over the 14-day production cycle. This suggests a productivity level of .57-.43 lbs per day (12lbs/14 (1.5-2)). Thus, while probably for full-time workers, Guest's assumed productivity was more like half than a full lb per day.

Allen's second 'new' source is the 1899 report on the comparative productivity of hand and machine methods of production, compiled by the US Commissioner of Labor, Carroll Wright. This source is introduced to provide point estimates in line with Guest's figure and bolster Allen's original numbers. In order to measure productivity and costs in hand production, the first strategy of Wright's agents was to search for relics of such methods in isolated rural areas. Allen emphasizes Wright's assurance that the identification of hand

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<sup>28</sup> Guest's account of the industry and the pressures to mechanise are disputed by more recent research. His main theme resembles the now discredited challenge and response story with the flying shuttle unbalancing the spinning and weaving sectors of the industry and forcing changes on the spinning side. For evidence on the slow progress made by the flying shuttle see Akos Paulinyi, "John Kay's Flying Shuttle: Some Considerations on His Technical Capacity and Economic Impact," *Textile History* 17, no. 2 (1986). For a broader critique of challenge and response see Patrick O'Brien, "The Precocious Mechanization of a Global Industry: English Cotton Textile Production from the Flying Shuttle (1733) to the Self-Acting Mule (1825): A Bibliographical Survey and Critique," *LSE Economic History Working Papers* No. 295 (2019). Guest's evidence is very similar to the social commentators' writings that Allen dismisses in that it provides no contextual information. Also, unlike the writings of Eden, Young, and others, it was produced decades after the work (and pay rates) it describes.

<sup>29</sup> The preparatory processes in cotton spinning were more labour intensive than in wool which was usually already combed when provided to spinners, see John Styles, "The Rise and Fall of the Spinning Jenny: Domestic Mechanisation in Eighteenth-Century Cotton Spinning," in *Explaining the British Industrial Revolution: textiles, technology and work* (California Institute of Technology, 2018).

<sup>30</sup> Guest, 10.

techniques was done with great care and the findings on productivity checked by appropriate experts. However, concerned about commercial sensitivity, the Commission did not provide information on the actual sources for either hand or machine methods, so we have no idea where the examples of cotton spinning by hand were found. It is difficult to imagine that by 1899 there were many—or any—hand spinners of raw cotton left in the United States. In fact, the authors of the report admitted that '[m]any of these [hand production] processes are not now in use at all', and acknowledged the difficulty of finding any sort of evidence about productivity.<sup>31</sup> It is likely then that Wright had to fall back on his second information-gathering strategy: 'the testimony of employers or workmen long since retired'.<sup>32</sup> But by 1899 were there any even 'long since retired' hand spinners able to recollect their working hours, productivity, and wages? This may well have led the report's authors back to secondary sources already used by Allen, perhaps even including Guest. Even if Wright's agents found a hand spinner in late 19<sup>th</sup> century America, she may have been spinning on a wheel with an 'accelerating' head, which was significantly more productive than the wheels used by British spinners in the 17<sup>th</sup> and 18<sup>th</sup> centuries.<sup>33</sup> The reliability of this source as an *independent account of 18<sup>th</sup> century spinners' productivity* is highly questionable.

One final point: in his discussion of the Commissioner of Labor's study, Allen notes that no children were working as hand spinners, an exclusion that he also finds in Guest's account. Children may have been absent in the US study (peculiar as it is) and Guest may not have mentioned children in his footnote, but to deny their presence flies in the face of a huge amount of historical evidence. The employment figures for spinning in Witney for example refer to a workforce 'from eight years old to decrepit old age'.<sup>34</sup> Children's spinning earnings also appear frequently in the printed sources that Muldrew relied upon. Such workers were cheap, cheaper even than adult women, but there again with traditional methods they could

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<sup>31</sup> 13<sup>th</sup> Report of the Commissioner of Labor, Vol. I, 6, 12–13.

<sup>32</sup> 13<sup>th</sup> Report of the Commissioner of Labor, Vol. I, 12.

<sup>33</sup> One 19<sup>th</sup> century account suggested that this technique was between 33% and 50% more productive than traditional spinning; James Leander Bishop, *A History of American Manufactures from 1608 to 1860* (Philadelphia 1861), Volume II, 167. James L. Garvin, "Report on the Piece Shops, Spofford Village, Chesterfield, New Hampshire," (Concord, NH: New Hampshire Division of Historical Resources, 2005).

<sup>34</sup> Plot, cited in Townley, 80.

not approach the latter's productivity.<sup>35</sup> Even when vigorously incentivised as at the Lindsey spinning school, girls could not reach, let alone sustain, the levels of productivity that Allen promulgates as his benchmark. However, their employment was economic because they were paid by output, meaning the unit costs were no higher than for adults.<sup>36</sup> To ignore children's work and wages not only leads to an overestimation of productivity and daily remuneration but also hides an important motive to mechanize: the desire to narrow the productivity gap between children and adults through new machines and work practices, and so release the potential of child labour.<sup>37</sup>

Allen also cites Thomas Jefferson's *Farm Book* (1953) as 'superficially' appearing to contain similar information on productivity in the hand spinning of wool, linen and cotton. Ironically, he rejects this as a serious source because 'the values are not measurements of actual work but claims of equipment manufacturers or his [Jefferson's] own planning projections....', that is because it is *hearsay*.<sup>38</sup> While we have reservations about the comparability of slave and free labour and recognise the problems with interpreting the data so as to yield time rates, it is worth retaining this source since it provides detail on cotton in comparison with other fibres. Jefferson set his experienced female slaves to spin different fibres in order to establish 'what may be spun daily'. We can assume that the women were obliged to spin diligently during the hours of daylight, not just because they were enslaved but also because Jefferson wanted to establish productivity benchmarks. The records enable computation of output per day across the year. For linen the average output was 19 oz per day, for short staple wool 15 oz but for cotton 8 oz (and this is assuming the women spun all daylight hours, so 12–14 hours from spring to early autumn).<sup>39</sup> The slaves were spinning

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<sup>35</sup> Arthur Young gives some information on children's wages in spinning in his *Northern Tour*: near Howden in East Yorkshire for spinning flax while a woman could earn 4d a day a girl of ten could only manage 3d; at Slensingford in North Yorkshire for spinning worsted a woman could earn 5d while a girl of twelve only 4d; again at Aysgarth in the same county, for knitting and spinning a woman could get about 6d, girls only 2d or 3d; and, finally in Manchester spinning cotton a woman could manage 2s to 5s a week but girls from six to twelve 1s to 1s 6d Young, *Six Months Tour*, Vol. II, 335, 425; Vol. III, 192.

<sup>36</sup> Barnsley Archives, EM/985. We thank Jo Innes for sharing her preliminary analysis of this source.

<sup>37</sup> For the employment implications of narrowing the productivity gap between children and adults, see Kaushik Basu and Pham Hoang Van, "The Economics of Child Labor," *The American Economic Review* 88, no. 3 (1998). Jane Humphries, "Childhood and Child Labour in the British Industrial Revolution," *The Economic History Review* 66, no. 2 (2013).

<sup>38</sup> Allen, "Spinning Their Wheels: A Reply to Jane Humphries and Benjamin Schneider," note 9.

<sup>39</sup> Long-staple worsted yarn was not included in these 'time trials'.

coarse yarns for slave clothing and bedding, and doing so under duress, yet it was only for the linen yarn, spun from hemp fibre, (the easiest to process), that output reached 1 lb per day.

While we cannot be sure exactly how these experiments were conducted, some important conclusions can be drawn. First, Jefferson provides a useful contemporary estimate of maximum daily and even hourly hand spinning productivity under closely supervised conditions and involving skilled workers. Since the duration of the experiments is unknown, and hourly productivity remains suspiciously constant regardless of the length of the working day, it seems likely that Jefferson had the women spinning for a stretch, observed productivity per hour and then multiplied it by the number of hours of daylight to estimate what could be produced in each season.<sup>40</sup> But in this case the resulting numbers represent *maximum* productivity which would have been hard to maintain over several days or weeks. At any rate, given Jefferson's systematic practice in his scientific and economic investigations, the productivity estimates deserve to be taken at least as seriously as numbers produced by contemporary social commentators who often had little background but several axes to grind. Second, hand spinning of cotton emerges as very slow in comparison with the other fibres, which chimes with the opinion of experienced modern hand spinners.<sup>41</sup> Perhaps Allen is disinclined to give credence to these figures not because of doubts about their source (they certainly seem more credible than Wright's estimates) but because they bolster our position on productivity.

#### IV

The key point of our debate is, of course, daily wages. Allen largely—but not entirely, as we note below—stands by the numbers he has presented before. He describes these as 'my estimates' and 'my series'. In fact, they are claims made about spinners' time rates (sometimes constructed from underlying ideas about productivity and piece rates) found in secondary

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<sup>40</sup> This might well have been the case since although the table is not dated the context seems to have been his deliberations whether or not to acquire a spinning jenny. We thank John Styles for discussion of this source.

<sup>41</sup> Personal communication from Anne McCants. Some of the reasons are rehearsed in A. F. Barker, *Textiles*, Rev. ed. (London: Constable, 1922), 110–11. For further detail see Styles, "The Rise and Fall of the Spinning Jenny: Domestic Mechanisation in Eighteenth-Century Cotton Spinning."

sources and reported in a seminal article by Muldrew as is made clear on Allen's website.<sup>42</sup> They show no variance, unlike our archival data, because only one estimate is provided for each time period. For the years 1588–1750, Allen relays only 6 estimates of spinners' earnings, fewer than 4 per century! Allen is alarmed by our data's variability. However, variation is to be expected when collecting a large amount of actual historical data and some at least is accounted for by sub-dividing by source, fibre and type of labour as summarised in our Table 6.<sup>43</sup> Our range of observations of actual payments contrasts with Allen's point estimates. With only one 'observation' (per quarter-century) of course the variance is zero.<sup>44</sup>

In the 'Restatement' the series is described as extended through the Industrial Revolution using Charles Feinstein's data for hand spinners.<sup>45</sup> Since Allen's webpage data for 1770 and after is identical (and unavailable in Muldrew) it is to be assumed that it too is taken from Feinstein, who cites as his sources the now well-worn set of social commentators.<sup>46</sup> In our earlier paper, we argued that such sources are not to be trusted (a view supported by simple regression analysis) and we contrasted data that relates to actual payments to spinners with claims made by economic commentators.

Against our evidence from actual business records, Allen now sets Defoe's much-cited whinge about farmers' inability to recruit female servants because hand spinners could earn so much (more hearsay evidence). This comment accompanied an estimate of potential earnings so high (7–8s a week) that, if correct, would have persuaded not only male farm labourers (earning perhaps 5s a week) but some skilled artisans to sit at the wheel!<sup>47</sup> Moreover,

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<sup>42</sup> Craig Muldrew, "'Th'ancient Distaff' and 'Whirling Spindle': Measuring the Contribution of Spinning to Household Earnings and the National Economy in England, 1550–1770," *The Economic History Review* 65, no. 2 (2012).

<sup>43</sup> Jane Humphries and Benjamin Schneider, "Spinning the Industrial Revolution," *ibid.* 72, no. 1 (2019): 146.

<sup>44</sup> Here again there is a contradiction between Allen's stated wage levels and the sources he asserts bolster his claims. While he claims that the variability of our data undermines its credibility, he points to Mann's table of spinning rates in his Reply as supporting his case, but these figures show substantial variation over time and a wide dispersion in rates paid for several dates (most notably 1677, 1760, and 1789). Julia de Lacy Mann, *The Cloth Industry in the West of England from 1640 to 1880* (Oxford: Clarendon Press, 1971), 322–25.

<sup>45</sup> Allen, "The High Wage Economy and the Industrial Revolution: A Restatement," 15.

<sup>46</sup> Charles Feinstein, "Wage-Earnings in Great Britain During the Industrial Revolution," in *Applied Economics and Public Policy*, ed. Iain Begg and S. G. B. Henry (Cambridge: Cambridge University Press, 1998), 189.

<sup>47</sup> Defoe, *Behaviour of Servants in England*, quoted in Ivy Pinchbeck, *Women Workers and the Industrial Revolution, 1750–1850* (London: George Routledge & Sons, Ltd, 1930), 140. Sharpe notes that this

Allen claims inadmissible the wage observations that we categorize as indirect claims (which include Defoe, Arthur Young, Frederick Eden, and other social commentators), because they ‘are hard to assess without a case-by-case examination to ascertain whether the wage reported is that of a full-time or a part-time worker [...] [i]n many cases, it is impossible to say’—but it is *exactly these sources* that are the underlying primary sources for *his* claims about spinners’ remuneration.<sup>48</sup> Having found that the evidence he relied upon does not, on closer examination, support his case, he now dismisses this same evidence. Allen’s newfound skepticism about social commentators as a source for evidence on spinners’ earnings leaves readers entirely in the dark about the primary sources that justify his claims about spinners’ remuneration. Having dismissed our archival and printed sources (which included the basis for his 2015 article), it is unclear what evidence he proposes as an alternative, robust source of spinners’ earnings over the 17<sup>th</sup> and 18<sup>th</sup> centuries.

Moreover, as noted above, a crucial aspect of the earlier data presented by Allen has disappeared: the claim to earnings of 12d per day in spinning in 1770. This observation provided the peak of spinners’ earnings presented as conclusive evidence for coincidence of the increase in spinners’ earnings and mechanization,<sup>49</sup> but Allen has now dropped it *without explanation*.<sup>50</sup> Absent the 12d figure, the series that Allen has spliced together from secondary sources shows stable nominal wages from 1750–1779—why would the three spinning inventions have clustered in the decade after 1764? His claim to explain both British industrialization *and its timing* cannot be sustained, even using the evidence from secondary sources that he presents.<sup>51</sup>

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figure relates to high rates prevailing in trade upswings and that ‘the normal weekly rate... was only a third’ of the Defoe estimate, Pamela Sharpe, *Adapting to Capitalism : Working Women in the English Economy, 1700–1850* (Basingstoke: Macmillan, 1996), 31.

<sup>48</sup> The social commentators’ evidence and pamphlets, which we categorize as indirect claims about spinners’ earnings, were the main source for Muldrew’s observations of hand spinners’ earnings that made up the entirety of the wage series presented by Allen before the late 18<sup>th</sup> century.

<sup>49</sup> Allen, "The High Wage Economy and the Industrial Revolution: A Restatement," 15.

<sup>50</sup> The observation was based on the paper by Charles Feinstein, cited above, n. 46, and itself based on secondary sources and accompanied by advice on cautious usage, see Feinstein, 189. This observation is most likely drawn from a single observation by Arthur Young in 1771 as this is the only primary source where we have found a claim to daily earnings of this level that is roughly contemporaneous with Allen’s timing. We neglected to note in our earlier paper that Allen uses Feinstein’s series of *cotton* spinning earnings as representative of all spinners’ earnings, and treats the two as interchangeable throughout his discussion of spinning earnings.

<sup>51</sup> Allen, "The High Wage Economy and the Industrial Revolution: A Restatement," 14. Moreover, the underlying evidence contained in other parts of the secondary sources that Allen uses, such as Arthur

We have continued to look for more sources of spinners' earnings and have added 1726 new observations from 16 sources to our database, most of which relate to actual payments and piece rates received by hand spinners. Again, we drew on contemporary observers, the 'indirect claims' relied on by earlier investigators including Allen, but about which we have reservations. We supplemented this standard—but we think dubious—source with claims by commentators from within the textile industry, our 'direct claims', and additional 'wage assessments,' which are available particularly for the earlier period. However, the source which we consider most reliable are surviving 'accounts' which provide concrete evidence on wages and rates paid. Where possible we continued to record the fibre spun and the age and gender of the worker.<sup>52</sup> As before, where we have data on the piece rate and productivity, we have constructed daily earnings, included such cases in the sample, and noted their provenance so that we are able to control for the construction in later analysis.<sup>53</sup>

Figure 1 replicates the scatter plot by type of observation included in the original paper.<sup>54</sup> It illustrates the same findings. Even the indirect claims are more pessimistic than suggested in the high wage economy thesis and the pessimism again mounts when we admit estimates based on more trustworthy sources such as account books. The same outliers remain; as noted, these were probably the work of more than one spinner or come from interested sources such as Defoe. Aside from these, while our data broadly match that of Muldrew for the early seventeenth century, there was no sustained and general increase in earnings by the mid-eighteenth century. Six pence per day may have been possible for some

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Young's tours, show more variability of earnings than he suggests and lower observed levels of earnings. In his reply, Allen also references figures from Julia de Lacy Mann's study of textile production in the West Country and says that they support his view of earnings rising up to the period of the three inventions. In fact, the figures Mann presents show variation without a clear trend in rates paid for spinning from the 1710s to the 1760s.

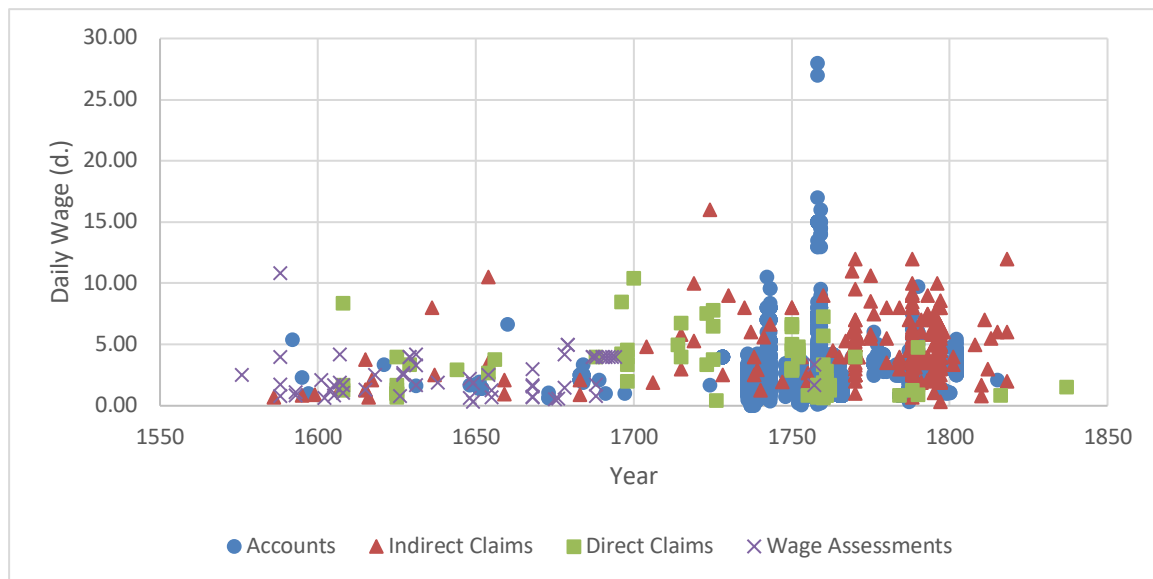
<sup>52</sup> We assume a six-day working week and wages based on longer periods have been converted into day rates.

<sup>53</sup> 51 per cent of the sample observations are constructed in this way. For more detail on our method, see Humphries and Schneider, 141–43.

<sup>54</sup> Our dataset for the original paper used Defoe's implausibly optimistic figures twice, as they appeared on separate pages. We have removed the lower observation as we considered this to be duplicative. We also removed one further duplicative observation from Dorset in 1608.

spinners in 1700, but the vast majority of observations were below 8d around 1750 and the now excised 12d in 1770 was clearly fanciful.

*Figure 1: Daily wages by source type, nominal d.*



Sources: see the online appendix to Humphries & Schneider (2019), the archival and printed sources sections of the bibliography, and the text.

Table 1 shows the results of replicating the regression analysis of the logarithm of daily wages on the date of the observation while controlling for source, fibre, and age and gender of the spinner used in the original paper to explore the determinants of wages.

*Table 1: Spinners' Wages by Source, Fibre, and Type of Labour*

<b>Constant</b>	-2.435** (.706)	-2.629** (.707)
<b>Year</b>	.002** (.000)	.002** (.000)
<b>Source:</b>		
Accounts	-.457** (.036)	-.440** (.036)
Direct Claims	-.502** (.070)	-.438** (.072)
Wage Assessments	-.548** (.094)	-.489** (.095)
<b>Fibre:</b>		
Cotton	-.223** (.085)	-.213** (.085)
Flax	.079 (.046)	.043 (.047)
Hemp	-.121 (.084)	-.126 (.084)
Tow	-.635* (.268)	-.590* (.268)

Wool	-0.113** (.041)	-0.132** (.041)
<b>Labour:</b>		
Boys	-0.458** (.048)	-0.494** (.049)
Children	-0.485** (.021)	-0.422** (.027)
Girls	-0.662** (.032)	-0.697** (.033)
Men	.033 (.052)	.002 (.052)
Women	-.027 (.030)	-.052 (.031)
<b>Wage Construction</b>		
Productivity x Piece rate		-.104** (.026)
<b>R<sup>2</sup> (adj)</b>	.282	.284
<b>SEE</b>	.528	.527
<b>F</b>	121.136**	114.466**
<b>N</b>	4283	4283

Notes: The dependent variable is the natural logarithm of the nominal daily wage. Coefficients are reported with standard errors in parentheses. \*\* and \* indicate significance at the 1% and 5% levels. Bootstrapping made only small differences to the standard errors and no differences to the variables judged significant.

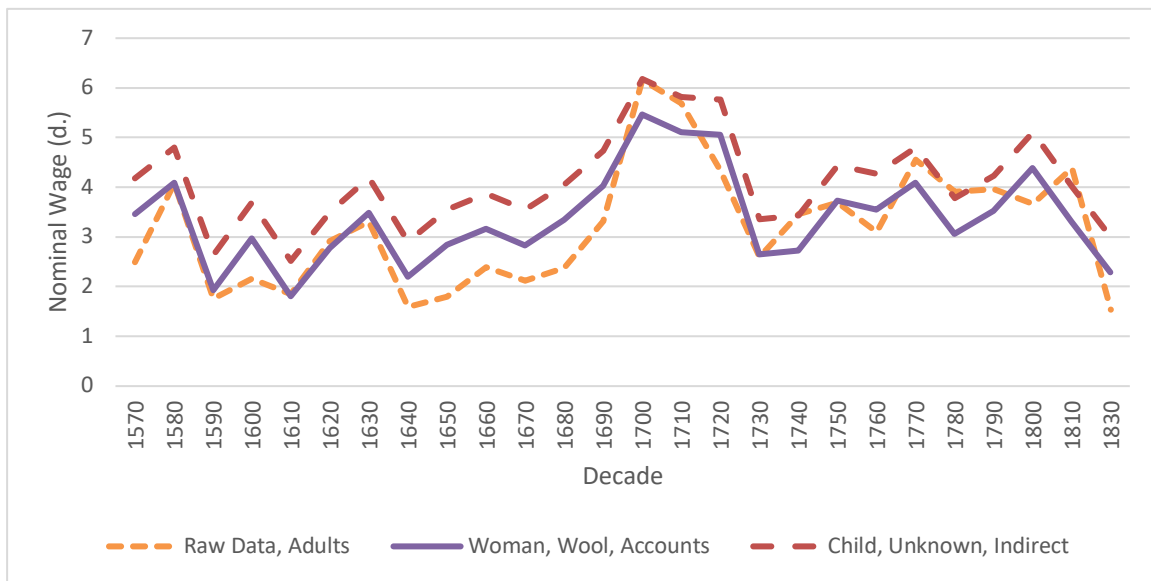
To track the decade-by-decade development of earning levels with controls for variation in our sample by worker type and fibre, we have constructed wage profiles for various stylised spinners using the coefficients from a regression of nominal wages on all our controls but replacing year by decade dummies.<sup>55</sup> This procedure allows us to control for the inevitable heterogeneity in the primary data.<sup>56</sup> Our constructed wage trends can be compared with developments in the raw data as in Figure 2 below which compares the mean daily wages for all adults in the sample, whatever the source of data or fibre being worked, with two profiles that control for heterogeneity in the underlying data. The first represents the wage earned by an adult woman spinning wool with her earnings recorded in accounts. The second shows the wage earned by a representative child as claimed by contemporary social commentators. As is obvious from the reported regression results, wages reported for children by social commentators were above those actually earned by adult women as recorded in

<sup>55</sup> We regress nominal wages in pence per day on categorical variables for type of source, type of fibre, and type of worker and a series of decade dummies benchmarked against 1770, over half of which are statistically significant. The resulting coefficients can then be used to control for type of source, worker and fibre while tracing out evolution by decade.

<sup>56</sup> The regression is described in the appendix below.

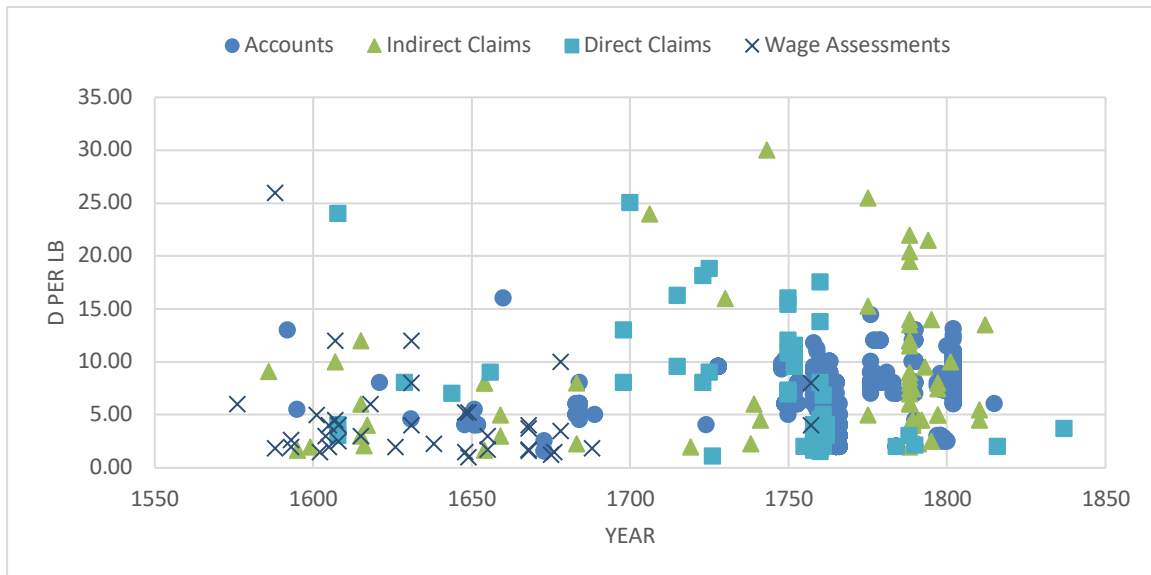
surviving account books, demonstrating the implausible optimism of the social commentators' claims.

Figure 2: Wage profiles of certain stylised hand spinners



Sources: see the online appendix to Humphries & Schneider (2019), the archival and printed sources sections of the bibliography, the appendix to this paper, and the text.

Figure 3: Piece rates by source type, nominal d.

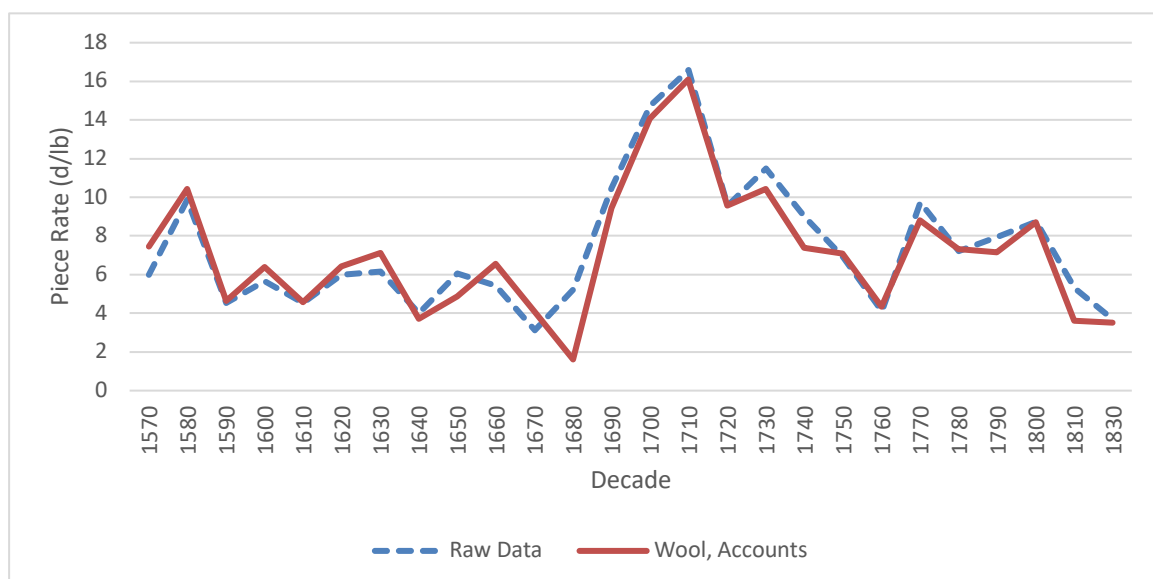


Sources: see the online appendix to Humphries & Schneider (2019), the archival and printed sources sections of the bibliography, and the text.

The evolution of spinners' wages remains subject to short term movements in the early eighteenth century in part because of the scarcity of data and some extreme observations. While we still see an apparent boom *circa* 1710, this is swiftly followed by a return to more traditional levels. It is hard to see this record as participation in a high wage economy.

Finally, as well as using our 2187 observations of piece rates to construct estimates of daily wages, we also investigated trends over time in the piece rates themselves. While Allen and our initial paper have focused on daily earnings, the primary incentive to innovate would have been the unit cost of spinning: the piece rate. Shortages of yarn would have shown up in market prices so we would expect inflated rates to herald the invention of the jenny. Descriptive evidence of rising cloth quality as well as a small rise in prices over the century preceding the spinning innovations might be expected to increase piece rates. Analysis shows that first, controlling for source, worker and fibre, there is no statistically significant time trend in the data. While there is substantial short-term variation in rates, averaged by decade, neither the raw data nor indices constructed to control for heterogeneity in the underlying sample show a boom *circa* 1760. If there was a boom, as might be inferred from the wage evidence above, it occurred much earlier, while the decades preceding the invention of the jenny saw a return to more customary levels. As with the daily wage observations, there are few observations of piece rates that compose the possible peak at the beginning of the 18<sup>th</sup> century. Figure 4 below compares the all-sample decade average piece rates with the rates for spinning wool captured in business and household accounts constructed, as above, from the coefficients of a regression analysis of piece rates on our standard controls.

*Figure 4: Nominal piece rates, raw data and constructed from regression analysis*



Sources: see the online appendix to Humphries & Schneider (2019), the archival and printed sources sections of the bibliography, the appendix to this paper, and the text.

## VI

The challenges Allen makes to our archival data, like his earlier contentions regarding spinners' work and earnings, rest on very limited contemporary evidence, often of an incidental kind and frequently involving recycled guesstimates. We agree that spinners likely worked part-time but according to rhythms very different from those Allen assumes. We contend that when work was available spinners often worked long hours and that as a result most of our observations are analogous to Allen's 'full-time equivalents'. We reject Allen's implausible claim that although they were poor, spinners limited their working time per day and days per year, sacrificing opportunities to earn.

We defend our expanded series, which remains based on a large body of direct historical evidence relating to *actual* payments to often *named* spinners for *specific amounts and types* of work. Our figures for daily earnings are reinforced by an analysis of observed piece rates, which do *not* show a rising national trend that would have induced mechanization.<sup>57</sup> Spinners were sometimes—but certainly not always—unskilled and young, they were usually poor, and their work was on occasion mediated by the poor law and even penal authorities. Some may have worked discontinuously. But this was the reality of the spinning work force in preindustrial England. Making such workers more productive and their output more consistent was what motivated the early textile inventors and innovators. The jenny, Allen's archetype response to his mythically high wages, was intended to be worked by adolescents or young people. Experimentation with prototype machines at the North-Western Museum of Science in the 1970s demonstrated that they were ill-adapted to adult operators: '...the bent posture, the reach of the right hand to the wheel, the difficult co-ordination of the two hands and foot, all make this a most uncomfortable machine to work. Adult jenny spinners must have been bent double and soon have developed back ache'.<sup>58</sup> Ogden gave a full account: 'The awkward posture required to spin on [hand jennies] was discouraging to grown up people, while they saw, with a degree of surprize, children from nine to twelve years of age, manage

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<sup>57</sup> This is not to dispute problems with the supply of certain kinds of yarn, particularly difficult-to-spin cotton, in certain regions at particular times, see Styles, "The Rise and Fall of the Spinning Jenny: Domestic Mechanisation in Eighteenth-Century Cotton Spinning." See also "Robert Allen's Spinning Jenny Is Still Broken".

<sup>58</sup> R. L. Hills, "Hargreaves, Arkwright and Crompton. Why Three Inventors?," *Textile History* 10, no. 1 (1979): 119.

them with dexterity'.<sup>59</sup> Berg concludes that 'the original jenny was best suited to being worked by children'.<sup>60</sup> Rather than saving time for adult women, as Allen's model implies, it made children more productive.

Although it did probably bridge the productivity gap between women and children and so cheapen the supply of yarn, the jenny did not go far enough in this endeavour, nor did it solve the technical problems the industry increasingly faced, particularly in its attempts to produce the finer all-cotton cloths that were hitherto supplied from India.<sup>61</sup> Some of these problems were partially addressed by the transition to larger jennies housed in workshops, for the domestic phase of jenny production was very short lived. More extensive and lasting solutions required different technical and organizational arrangements: the water frame, mule spinning, and above all the factory system.

Many factors fed into the emergence of mechanized spinning in the north-west of England. While it left in its wake thousands of stranded and impoverished spinsters elsewhere in the country, mechanization was never propelled by a widespread ability for women to earn 8d or 12d a day. Contemporary sources, whether the printed accounts of social commentators or observations of actual payments to spinners, show that the large majority of spinners earned far less than this. In his insistence on high wages in all corners of the eighteenth-century British economy, Robert Allen has lost the thread of empirical evidence that connects economic historians to the subjects of their study.

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<sup>59</sup> Cited in C. Aspin, *James Hargreaves and the Spinning Jenny* (Preston: Helmshore Local History Society, 1964), 48.

<sup>60</sup> Maxine Berg, *The Age of Manufactures : Industry, Innovation and Work in Britain, 1700–1820* (New York: Oxford University Press, 1986), 254.

<sup>61</sup> Styles, "The Rise and Fall of the Spinning Jenny: Domestic Mechanisation in Eighteenth-Century Cotton Spinning."

## Appendix

### Hedonic Regression for Nominal Wages

Source	SS	df	MS
<b>Model</b>	4994.77243	39	128.071088
<b>Residual</b>	11523.6705	4,243	2.71592517
<b>Total</b>	16518.4429	4,282	3.85764664

Number of obs =	4,283
F (39, 4243) =	47.16
Prob > F =	0.0000
R-squared =	0.3024
Adj R-squared =	0.2960
Root MSE =	1.648

	Coefficient	Std. Error	t	P >  t	95% Confidence Interval	
<b>Source Type</b>						
Accounts	-1.56391	.137253	-11.39	0.000	-1.832997	-1.294822
Direct Claims	-1.51029	.2506558	-6.03	0.000	-2.001707	-1.018874
Wage Assessments	-1.728883	.3431561	-5.04	0.000	-2.401649	-1.056118
<b>Fibre</b>						
Cotton	-.4622495	.3314529	-1.39	0.163	-1.112071	.1875716
Flax	.5736457	.1821075	3.15	0.002	.2166197	.9306717
Hemp	-.3094961	.2862338	-1.08	0.280	-.8706641	.2516718
Tow	-1.42677	.862404	-1.65	0.098	-3.117533	.2639934
Wool	-.029613	.1444968	-0.20	0.838	-.3129024	.2536765
<b>Labour Type</b>						
Boys	-1.198439	.1948457	-6.15	0.000	-1.580438	-.8164392
Children	-1.052322	.2175932	-4.84	0.000	-1.478919	-.625726
Girls	-1.537185	.1498105	-10.26	0.000	-1.830892	-1.243478
Men	-.2173912	.2060186	-1.06	0.291	-.6212955	.186513
Women	-.1718576	.1329088	-1.29	0.196	-.4324283	.0887132
<b>Constructions</b>						
Productivity	-.9727061	.1075156	-9.05	0.000	-1.183493	-.7619193
<b>Decades</b>						
1570–1579	-.6253631	1.693602	-0.37	0.712	-3.945709	2.694983
1580–1589	-.0047538	.8073264	-0.01	0.995	-1.587536	1.578028
1590–1599	-2.161942	.659005	-3.28	0.001	-3.453937	-.8699475
1600–1609	-1.118105	.5583126	-2.00	0.045	-2.21269	-.0235203
1610–1619	-2.284721	.6789166	-3.37	0.001	-3.615752	-.9536888
1620–1629	-1.309276	.5214257	-2.51	0.012	-2.331544	-.287009
1630–1639	-.6067649	.6817006	-0.89	0.373	-1.943255	.729725
1640–1649	-1.897647	.7377099	-2.57	0.010	-3.343945	-.45135
1650–1659	-1.255235	.4223458	-2.97	0.003	-2.083253	-.4272161

1660–1669	-.9305974	.7518285	-1.24	0.216	-2.404575	.5433799
1670–1679	-1.256248	.6250339	-2.01	0.045	-2.481642	-.030855
1680–1689	-.7486879	.4179677	-1.79	0.073	-1.568123	.0707475
1690–1699	-.0656334	.5395512	-0.12	0.903	-1.123436	.9921693
1700–1709	1.374185	.9769523	1.41	0.160	-.541153	3.289523
1710–1719	1.018039	.6594541	1.54	0.123	-.2748357	2.310914
1720–1729	.9649023	.3648749	2.64	0.008	.2495566	1.680248
1730–1739	-1.444671	.2429422	-5.95	0.000	-1.920965	-.9683771
1740–1749	-1.368325	.2519622	-5.43	0.000	-1.862303	-.8743474
1750–1759	-.3638357	.2289436	-1.59	0.112	-.812685	.0850135
1760–1769	-.5348177	.29584	-1.81	0.071	-1.114819	.0451835
1780–1789	-1.026393	.2241857	-4.58	0.000	-1.465914	-.5868714
1790–1799	-.567082	.2178547	-2.60	0.009	-.9941912	-.1399728
1800–1809	.3004599	.2831387	1.06	0.289	-.2546402	.8555599
1810–1819	-.7913286	.535087	-1.48	0.139	-1.840379	.2577218
1830–1839	-1.805226	1.674046	-1.08	0.281	-5.087232	1.47678
<b>Constant</b>	5.856565	.2277192	25.72	0.000	5.410117	6.303014

Notes: The dependent variable is the nominal daily wage in pence. The reference categories are indirect claims, unknown fibre (which was likely wool), unknown worker (likely women), and 1770–1779. The Hand Spinners’ Wages Dataset contains no observations for the decade 1820–1829.

### Hedonic Regression for Piece Rates

Source	SS	df	MS
<b>Model</b>	7996.39415	38	210.431425
<b>Residual</b>	8886.01285	2,148	4.13687749
<b>Total</b>	16882.407	2,186	7.72296752

Number of obs = 2,187  
F (38, 2148) = 50.87  
Prob > F = 0.0000  
R-squared = 0.4737  
Adj R-squared = 0.4643  
Root MSE = 2.0339

	Coefficient	Std. Error	t	P >  t	95% Confidence Interval	
<b>Source Type</b>						
Accounts	-1.071051	.3633256	-2.95	0.003	-1.783558	-.3585449
Direct Claims	-.8759002	.4757775	-1.84	0.066	-1.808933	.0571323
Wage Assessments	-2.521775	.5831852	-4.32	0.000	-3.665441	-1.378108
<b>Fibre</b>						
Cotton	3.846078	1.111753	3.46	0.001	1.665854	6.026301
Flax	2.270925	.3502194	6.48	0.000	1.58412	2.957729
Hemp	-.5843719	.6622072	-0.88	0.378	-1.883006	.7142621
Tow	-1.847704	1.280316	-1.44	0.149	-4.358492	.6630832

Wool	-.1212277	.3111442	-0.39	0.697	-.7314031	.4889476
<b>Labour Type</b>						
Boys	-4.132481	2.066258	-2.00	0.046	-8.184555	-.080407
Children	-.2630298	.581193	-0.45	0.651	-1.402789	.8767298
Girls	10.66196	1.616432	6.60	0.000	7.492026	13.8319
Men	.9069702	2.04413	0.44	0.657	-3.10171	4.915651
Women	-.8013674	.3805092	-2.11	0.035	-1.547572	-.0551625
<b>Decades</b>						
1570–1579	-1.369377	2.13203	-0.64	0.521	-5.550436	2.811681
1580–1589	1.609622	1.273281	1.26	0.206	-.8873709	4.106615
1590–1599	-4.195619	.9146037	-4.59	0.000	-5.98922	-2.402018
1600–1609	-2.429237	.7728216	-3.14	0.002	-3.944793	-.9136803
1610–1619	-4.266667	.9121791	-4.68	0.000	-6.055513	-2.477821
1620–1629	-2.401577	1.251342	-1.92	0.055	-4.855545	.0523916
1630–1639	-1.71505	1.075743	-1.59	0.111	-3.824656	.3945565
1640–1649	-5.101758	.9617783	-5.30	0.000	-6.987871	-3.215644
1650–1659	-3.945266	.6983438	-5.65	0.000	-5.314766	-2.575765
1660–1669	-2.263767	1.057736	-2.14	0.032	-4.338061	-.1894739
1670–1679	-4.753778	.9132301	-5.21	0.000	-6.544685	-2.96287
1680–1689	-7.215202	1.099415	-6.56	0.000	-9.371231	-5.059172
1690–1699	.6287419	1.527529	0.41	0.681	-2.366847	3.624331
1700–1709	5.236184	1.489496	3.52	0.000	2.31518	8.157189
1710–1719	7.276115	1.251733	5.81	0.000	4.821379	9.73085
1720–1729	.7396988	.5503821	1.34	0.179	-.3396384	1.819036
1730–1739	1.608848	1.261792	1.28	0.202	-.8656126	4.083309
1740–1749	-1.452382	.6035871	-2.41	0.016	-2.636058	-.2687058
1750–1759	-1.727071	.4249265	-4.06	0.000	-2.560381	-.8937607
1760–1769	-4.470239	.6758382	-6.61	0.000	-5.795604	-3.144874
1780–1789	-1.508671	.457459	-3.30	0.001	-2.40578	-.6115624
1790–1799	-1.667893	.3878691	-4.30	0.000	-2.428531	-.9072552
1800–1809	-1.1280253	.4596184	-0.28	0.781	-1.029369	.7733181
1810–1819	-5.207114	.9820422	-5.30	0.000	-7.132966	-3.281261
1830–1839	-5.325252	2.094652	-2.54	0.011	-9.43301	-1.217494
<b>Constant</b>	10.01238	.4639304	21.58	0.000	9.10258	10.92218

Notes: The dependent variable is the nominal piece rate in pence per lb of yarn. The reference categories are indirect claims, unknown fibre (which was likely wool), unknown worker (likely women), and 1770–1779. The Hand Spinners' Wages Dataset contains no observations for the decade 1820–1829.

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<sup>†</sup> These are the sources we have used to expand the Hand Spinners' Wages Dataset or referenced in this paper. The original dataset sources are listed in the appendix to Humphries & Schneider (2019).

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