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Good Jobs and Bad Jobs in History

BENJAMIN SCHNEIDER

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Benjamin Schneider[†]

Abstract

This paper argues that job quality is an important aspect of past wellbeing and constructs a historical index of good work. The paper describes the present-day job quality literature and uses workers' perspectives to derive components of a Historical Occupational Quality Index (HOQI). The index enables systematic analysis of non-wage aspects of jobs for the first time in historical settings. The paper then examines the mechanization of spinning in Britain (c. 1760–1830) using the index. It shows that, for most workers, pay rose but job control fell and work became more dangerous and intense. Job quality also became more unequal on non-wage dimensions during the First Industrial Revolution.

JEL Codes: I31, J28, J81, N33, N63, O33

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[†] Centre for Welfare and Labour Research, Oslo Metropolitan University and Faculty of History, University of Oxford; benjamin.schneider@oslomet.no.

Many metrics are available to analyze historical wellbeing, including income, consumption, outcome indicators such as anthropometrics and vital statistics, and composite indices. However, holistic analysis of work has not been part of research on quality of life in the past, and studies of labor's contribution to living standards have focused overwhelmingly on real wages. Economic historians and labor historians have examined some non-wage aspects such as occupational safety and workers' control, but there have been no attempts to systematically analyze and measure both quantitative and qualitative aspects of historical work.

This paper argues that the quality of occupations is an important aspect of historical quality of life and constructs the first indicator of good work in the past, the Historical Occupational Quality Index (HOQI). The large share of time that employees spend at work substantially shapes their quality of life, including through channels not captured by broader indices. Work contributes significantly to capability, not only through the oft-considered facet of income. Job quality impacts broader wellbeing, and isolating occupational changes allows researchers to identify sources of shifts in general indicators. Further, evaluating work across multiple dimensions produces more complete analysis than a narrow focus on real wages, and provides a firmer basis for studies that compare wages to measure productivity or living standards.

While job quality in the past has not been described or measured systematically or independently, there has been substantial multidimensional research on present-day jobs.[1]

[1] Contemporary approaches include (among many): Iftikhar Ahmed, "Decent Work and Human Development," *International Labour Review* 142, no. 2 (2003). Dharam Ghai, "Decent Work: Concept and Indicators," *International Labour Review* 142, no. 2 (2003); Janine Leschke and Andrew Watt, "Job Quality in Europe," *ETUI-REHS Working Papers* (2008); Francis Green, *Demanding Work: The Paradox of Job Quality in the Affluent Economy* (Princeton: Princeton University Press, 2006). Sandrine Cazes,

Many indices of current occupational quality use surveys to measure qualitative aspects of work and government statistics for pay and working hours. Representative survey data are hardly ever available to historians, and comprehensive official statistics are rare before the mid-20th century. Therefore, present indices cannot be straightforwardly applied to historical work.

However, current indices that derive their components from survey data suggest an alternative path. To determine the components of good work in history, the paper examines evidence of historical workers' preferences in strikes, lobbying, job turnover, insurance purchases, and wage premia. It identifies aspects of jobs that workers valued, that contributed to capability, and that can be assessed with historical sources.[2] The resulting Historical Occupational Quality Index encompasses eight aspects of work that can be measured using a wide range of primary evidence to compare working lives across dimensions. A major contribution of the HOQI is the first systematic criteria for evaluating and scoring important qualitative aspects of historical work such as intensity and job control. These attributes have been discussed by labor historians but have lacked a consistent basis for international or longitudinal comparison, and they have generally been neglected by economic historians. To measure these dimensions, the paper constructs scoring scales derived from the approach used in the European Working Conditions Survey. It also considers whether to aggregate the components into a composite measure of occupational quality. The systematic approach allows researchers to compare the quality of jobs across time and space.

Alexander Hijzen, and Anne Saint-Martin, "Measuring and Assessing Job Quality," *OECD Social, Employment and Migration Working Papers* No. 174 (2015). Sally Wright et al., "Indicators of Job Quality," *CIPD Research Reports* (2018). Earlier literature on this topic is collected in James C. Taylor, *The Quality of Working Life: An Annotated Bibliography* (1973). See also the discussion in Chris Warhurst and Angela Knox, "Manifesto for a New Quality of Working Life," *Human Relations* 75, no. 2 (2020).

[2] Amartya Sen, "The Living Standard," *Oxford Economic Papers* 36 (1984).

Section I explains why labor is an important part of quality of life. While contemporary researchers have argued persuasively that good work is intrinsically important,[3] there is also a growing body of evidence for the broader significance of job quality, and it is a topic of increasing policy relevance. Section II discusses where work appears in historical living standards research. Economic history has analyzed jobs predominantly through wages, despite evidence that many facets of work are important for a good life. Few wage studies compare jobs longitudinally or between locations on non-wage dimensions, which raises concerns that using income levels or changes as an indicator of relative productivity or shifting living standards may be misleading. Section III explains why an index of historical work quality is valuable and outlines the theoretical and practical grounding of the indicator. Section IV provides historical evidence for the aspects of jobs that workers valued and contributed to enhancing their capabilities. Section V describes potential sources of information for the components and how to construct an analytical description of work quality dimensions. Section VI summarizes how the components are quantified, including criteria for converting qualitative evidence into numerical values. It then discusses the advantages and disadvantages of aggregating the components.

The second half of the paper applies the HOQI to a well-known example of job transformation: the mechanization of spinning in Britain during the Industrial Revolution (c. 1760–1830). This case study shows the benefits of a systematic, multidimensional approach to good work for historians. Section VII describes work and job quality in hand spinning, and Section VIII examines work in the early factory system. The analysis of job quality is based on evidence of hand spinners' actual earnings and a new dataset of more than 4000 observations

[3] Francis Green et al., "Job-Related Well-Being through the Great Recession," *Journal of Happiness Studies* 17, no. 1 (2016): 390.

of wages and working time in the early factory system collected from manuscript account books. These sources are complemented by extensive qualitative evidence from archival and printed sources. The HOQI clarifies the tradeoffs forced on workers by the destruction of hand spinning and the rise of factory work. Poorly paid but safe, high-control work in home production was replaced by higher-paid but dangerous, exhausting, and low-control employment in factories. Within the factory there was also a new division of labor in which men claimed the best jobs. When combined with large-scale technological unemployment for women, the analysis suggests that this technological change was male-biased.[4] The case study highlights the importance of non-wage facets of work, and shows that inequality rose on these dimensions. The conclusion (Section IX) recapitulates the evidence presented for measuring job quality in the past, the findings of the case study, and outlines further uses of historical job quality measurement.

I

Work is a key part of wellbeing, and research into present-day jobs has demonstrated its central place in quality of life. Nearly everyone works during their life, and studies have shown that employment affects many areas of objective living standards.[5] Workers spend a large amount of time at work, and low-quality jobs are a source of mental and physical illness.[6]

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[4] Benjamin Schneider, "Technological Unemployment in the British Industrial Revolution: The Destruction of Hand Spinning," *Oxford Economic and Social History Working Papers* No. 207 (2023).
[5] See especially Green, *Demanding Work*; Ahmed, "Decent Work and Human Development." Cazes, Hijzen, and Saint-Martin, "Measuring and Assessing Job Quality."
[6] Rafael Muñoz de Bustillo et al., "E Pluribus Unum? A Critical Survey of Job Quality Indicators," *Socio-Economic Review* 9, no. 3 (2011): 448–50; Elena Cottini and Claudio Lucifora, "Mental Health and Working Conditions in Europe," *ILR Review* 66, no. 4 (2013); M. Bartley, A. Sacker, and P. Clarke, "Employment Status, Employment Conditions, and Limiting Illness: Prospective Evidence from the British Household Panel Survey 1991–2001," *Journal of Epidemiology and Community Health* 58, no. 6 (2004); M. Sverke, J. Hellgren, and K. Näswall, "No Security: A Meta-Analysis and Review of Job

Work is an important part of self-reported wellbeing, which social scientists have increasingly studied since the 1990s.[7] The content and outcomes of work determine whether it is meaningful, which contributes to the development of capabilities and to subjective wellbeing.[8] Job quality also has implications outside of quality of life studies. There is evidence that reported wellbeing-at-work is positively related to productivity, and job satisfaction is a strong indicator of turnover probability.[9]

Job quality has become increasingly salient in policy discussions over recent decades. Since 1999 the International Labour Organization has advocated for access to "decent work" as a policy goal, and it is now part of Sustainable Development Goal 8.[10] SDG 8 combines the aspiration of economic growth with "full and productive employment" and "decent work for all".[11] The European Union has committed to "more and better jobs" in its European Pillar of Social Rights Action Plan, and the G20 countries agreed to the priority of "improving job

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Insecurity and Its Consequences," *Journal of Occupational Health Psychology* 7, no. 3 (2002); Michele Belloni, Ludovico Carrino, and Elena Meschi, "The Impact of Working Conditions on Mental Health: Novel Evidence from the UK," *Labour Economics* 76 (2022). Historically, paid work has occupied humans for an even larger share of their lifetime than in the present: N. F. R. Crafts, "The 15-Hour Week: Keynes's Prediction Revisited," *Economica* 89, no. 356 (2022).

[7] Andrew E. Clark, "Work, Jobs, and Well-Being across the Millennium," in *International Differences in Well-Being*, ed. Ed Diener, Daniel Kahneman, and John Helliwell (Oxford: Oxford University Press, 2010).

[8] Andrea Veltman, *Meaningful Work* (New York: Oxford University Press, 2016); Milena Nikolova and Femke Cnossen, "What Makes Work Meaningful and Why Economists Should Care About It," *Labour Economics* 65 (2020).

[9] John M. Zelenski, Steven A. Murphy, and David A. Jenkins, "The Happy-Productive Worker Thesis Revisited," *Journal of Happiness Studies* 9, no. 4 (2008); Petri Böckerman and Pekka Ilmakunnas, "The Job Satisfaction-Productivity Nexus: A Study Using Matched Survey and Register Data," *ILR Review* 65, no. 2 (2012); Chris Warhurst and Derek Bosworth, "Does Good Work Have a Positive Effect on Productivity? Developing the Evidence Base," in *Can Good Work Solve the Productivity Puzzle?*, ed. Gail Irvine (London: The RSA, 2020). Andrew E. Clark, "What Really Matters in a Job? Hedonic Measurement Using Quit Data," *Labour Economics* 8, no. 2 (2001).

[10] "Report of the Director-General: Decent Work," in *87th International Labour Conference* (Geneva: International Labour Organization, 1999).

[11] United Nations Department of Economic and Social Affairs, "Goal 8," https://sdgs.un.org/goals/goal8.

quality" as part of the 2015 Ankara Declaration.[12] Research showing that work is important for wellbeing is only one motivation for the policy and research attention to job quality. Interest in this area has increased in part because of the declining number of good middle-class jobs in rich countries, described in the literature as job polarization or "hollowing out".[13]

Policymakers' interest in job quality prompted many studies by NGOs and government agencies in the 2000s and 2010s that constructed measures of decent work or occupational quality.[14] Academic research has also explored measures of work quality and emphasized the importance of aspects that can be more difficult to quantify than wages and work hours, such as work stress, as well as heterogeneity across sectors.[15]

This rising policy and scholarly interest has led to the development of more than 15 present-day indices of job quality, which vary widely in their components, criteria for

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[12] European Commission, "European Commission's Priorities," https://ec.europa.eu/info/strategy/priorities-2019-2024_en. Chris Warhurst, "Developing Effective Policy to Improve Job Quality," *Poverty* 156 (2017).

[13] David H. Autor, Lawrence F. Katz, and Melissa S. Kearney, "The Polarization of the U.S. Labor Market," *American Economic Review* 96, no. 2 (2006). Maarten Goos and Alan Manning, "Lousy and Lovely Jobs: The Rising Polarization of Work in Britain," *The Review of Economics and Statistics* 89, no. 1 (2007).

[14] In addition to references above, see David Bescond, Anne Châtaignier, and Farhad Mehran, "Seven Indicators to Measure Decent Work: An International Comparison," *International Labour Review* 142, no. 2 (2003). Florence Bonnet, José B. Figueiredo, and Guy Standing, "A Family of Decent Work Indexes," *International Labour Review* 142, no. 2 (2003); "A Family of Decent Work Indexes." Francis Green and Tarek Mostafa, "Job Quality Indices for Europe," (LLAKES Centre, Institute of Education, London). Janine Leschke, Andrew Watt, and Mairead Finn, "Putting a Number on Job Quality? Constructing a European Job Quality Index," *ETUI-REHS Working Papers* (2008). There is a summary of various indicators developed during the first decade of the 21st century in Rafael Muñoz de Bustillo et al., "Indicators of Job Quality in the European Union," (EU Directorate General for Internal Policies Policy Department A: Economic and Scientific Policy, 2009).

[15] Andrew E. Clark, "Your Money or Your Life: Changing Job Quality in OECD Countries," *British Journal of Industrial Relations* 43, no. 3 (2005); Nádia Simões, Nuno Crespo, and José Castro Pinto, "Determinants of Job Quality — Evidence for European Country Groups," *Acta Oeconomica* 65, no. 2 (2015). Greg Kaplan and Sam Schulhofer-Wohl, "The Changing (Dis-)Utility of Work," *Journal of Economic Perspectives* 32, no. 3 (2018). There is an earlier literature on good jobs from the 1970s, including James O'Toole, *Work and the Quality of Life: Resource Papers for Work in America* (Cambridge: MIT Press, 1973).

including components, unit of analysis, and data sources.[16] Some indices provide a theoretical basis for the components while others use survey data to determine the parts of jobs that workers value. In these indicators, decent work is usually measured at the national level or sectoral level. Variation in the unit of analysis, data sources, and components make international and inter-regional comparisons difficult.[17] Many indices that use survey data combine subjective (e.g. job satisfaction) and objective elements (e.g. income).[18]

II

Despite the importance of work to wellbeing, historical research on living standards and quality of life has not considered good work independently or systematically. Debates about the movement of living standards traditionally examined changes in income, and gradually expanded to include measures of consumption, stature, demographics, and composite indicators.[19] There has been particular interest and development in the latter strand

[16] Many are described in Muñoz de Bustillo et al., "Indicators of Job Quality in the European Union."
[17] Cazes, Hijzen, and Saint-Martin, "Measuring and Assessing Job Quality," 12.
[18] E.g. the UK CIPD's index, "UK Working Lives: Survey Report," *CIPD Research Reports* (2018).
[19] Selected contributions, particularly to the classic British debate, include, on income: Peter H. Lindert and Jeffrey G. Williamson, "English Workers' Living Standards During the Industrial Revolution: A New Look," *The Economic History Review* 36, no. 1 (1983). Jeffrey G. Williamson, *Did British Capitalism Breed Inequality?* (Boston: Allen & Unwin, 1985). Charles Feinstein, "The Rise and Fall of the Williamson Curve," review of Did British Capitalism Breed Inequality?, Jeffrey G. Williamson, *The Journal of Economic History* 48, no. 3 (1988). "Pessimism Perpetuated: Real Wages and the Standard of Living in Britain During and after the Industrial Revolution," *The Journal of Economic History* 58, no. 3 (1998). Consumption: Joel Mokyr, "Is There Still Life in the Pessimist Case? Consumption During the Industrial Revolution, 1790–1850," *The Journal of Economic History* 48, no. 1 (1988). Sara Horrell and Deborah Oxley, "Bringing Home the Bacon? Regional Nutrition, Stature, and Gender in the Industrial Revolution," *The Economic History Review* 65, no. 4 (2012). Ian Gazeley and Sara Horrell, "Nutrition in the English Agricultural Labourer's Household over the Course of the Long Nineteenth Century," *The Economic History Review* 66, no. 3 (2013). Anthropometrics: Roderick Floud, Kenneth W. Wachter, and Annabel Gregory, *Height, Health and History: Nutritional Status in the United Kingdom, 1750–1980* (Cambridge: Cambridge University Press, 1990). John Komlos, "The Secular Trend in the Biological Standard of Living in the United Kingdom, 1730–1860," *The Economic History Review* 46, no. 1 (1993). Stephen Nicholas and Deborah Oxley, "The Living Standards of Women During the Industrial Revolution, 1795–1820," *The Economic History Review* 46, no. 4 (1993). Vital statistics: Thomas McKeown and R. G. Record, "Reasons for the Decline of Mortality in England and Wales During the

of research in recent years. In composite indices, work quality appears as a wage or contribution to per capita income, sometimes as hours of labor, and very indirectly within data on population health.[20] While these composite indices of wellbeing provide compelling and important macronarratives, a high level of aggregation constrains analysis of specific aspects of life and the causal factors that improved or degraded them. Studies of work outright by economic and social historians have usually focused on wages, sometimes working time, and occasionally occupational safety, with a few papers that combine these dimensions.[21]

Nineteenth Century," *Population Studies* 16, no. 2 (1962). Kirsty McNay, Jane Humphries, and Stephan Klasen, "Excess Female Mortality in Nineteenth-Century England and Wales: A Regional Analysis," *Social Science History* 29, no. 4 (2005). Using the Human Development Index: Partha Dasgupta and Martin Weale, "On Measuring the Quality of Life," *World Development* 20, no. 1 (1992). N. F. R. Crafts, "Some Dimensions of the 'Quality of Life' During the British Industrial Revolution," *The Economic History Review* 50, no. 4 (1997); "The Human Development Index and Changes in Standards of Living: Some Historical Comparisons," *European Review of Economic History* 1, no. 3 (1997). Subjective indicators of wellbeing have rarely been used historians but play an increasing role in contemporary discussions. One example is Gross National Happiness, measured in the World Happiness Report produced by the UN Sustainable Development Solutions Network.

[20] Jan Luiten van Zanden et al., *How Was Life? Global Well-Being since 1820* (Paris: OECD Publishing, 2014); Leandro Prados de la Escosura, "World Human Development: 1870–2007," *Review of Income and Wealth* 61, no. 2 (2015); "Augmented Human Development in the Age of Globalization," *The Economic History Review* 74, no. 4 (2021); Daniel Gallardo-Albarrán and Herman de Jong, "Optimism or Pessimism? A Composite View on English Living Standards During the Industrial Revolution," *European Review of Economic History* 25, no. 1 (2021); Leandro Prados de la Escosura, *Human Development and the Path to Freedom: 1870 to the Present* (Cambridge: Cambridge University Press, 2022).

[21] Examples include Mark Aldrich, *Safety First: Technology, Labor, and Business in the Building of American Work Safety, 1870–1939* (Baltimore: Johns Hopkins University Press, 1997); Hans-Joachim Voth, *Time and Work in England 1750–1830* (Oxford: Oxford University Press, 2000); P. W. J. Bartrip, *The Home Office and the Dangerous Trades: Regulating Occupational Disease in Victorian and Edwardian Britain* (Amsterdam: Rodopi, 2002); Wayne Lewchuk, "Industrialization and Occupational Mortality in France Prior to 1914," *Explorations in Economic History* 28, no. 3 (1991). Cliometricians have looked at some aspects of compensating differentials, but many contributions do not separate, for example, work-related illness or injury from causes outside the workplace. Jeffrey G. Williamson, "Urban Disamenities, Dark Satanic Mills, and the British Standard of Living Debate," *The Journal of Economic History* 41, no. 1 (1981); John C. Brown, "The Condition of England and the Standard of Living: Cotton Textiles in the Northwest, 1806-1850," *The Journal of Economic History* 50, no. 3 (1990). While Brown claims to control for working conditions using fines levied by the factory inspectors, occupational safety was hardly regulated in the period he analyzes. A more multifaceted approach is Eric Hopkins, "Working Hours and Conditions During the Industrial Revolution: A Re-Appraisal," *The Economic History Review* 35, no. 1 (1982). However, this article lacks criteria for comparing labor discipline over time, it does not consider effort or safety, and wages are but briefly considered. Perhaps the closest to a job quality analysis is John Rule, *The Experience of Labour in Eighteenth-Century Industry* (London:

Labor historians have described other important aspects of good jobs such as work control, but this literature has lacked a systematic approach to compare jobs across time and space.[22]

Among economic historians real wages remain nearly a sufficient statistic for work, whether they are used to measure living standards or other aspects of the past such as productivity. Dimensions of labor such as work intensity, occupational risk, and job security are hardly considered.[23] In 10 of the most-cited economic history articles that analyze wages, four mention work fatigue, usually in passing, but none consider whether longitudinal or cross-sectional differences in work effort may have been related to wage differences between locations or pay variation over time. Three of the articles make reference to job security, but only one considers this element in its analysis of shifting living standards. None of these articles discuss occupational safety at all.[24] While wellbeing research has recognized the

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Croom Helm, 1981). Rule indeed discusses aspects of labor that are included in present-day job quality metrics, but like Hopkins, does not have a system to make longitudinal comparisons of non-wage dimensions.

[22] E. P. Thompson, "Time, Work-Discipline, and Industrial Capitalism," *Past & Present* 38, no. 1 (1967); David Montgomery, *Workers' Control in America: Studies in the History of Work, Technology, and Labor Struggles* (Cambridge: Cambridge University Press, 1979); James R. Green, *The World of the Worker: Labor in Twentieth-Century America* (New York: Hill and Wang, 1980).

[23] Cf. Green's discussion of the divide between economics and sociology in the assessment of work, Green, *Demanding Work*, 8–13.

[24] Lindert and Williamson, "English Workers' Living Standards."; L. D. Schwarz, "The Standard of Living in the Long Run: London, 1700–1860," *The Economic History Review* 38, no. 1 (1985); E. H. Hunt, "Industrialization and Regional Inequality: Wages in Britain, 1760–1914," *The Journal of Economic History* 46, no. 4 (1986); Robert A. Margo and Georgia C. Villaflor, "The Growth of Wages in Antebellum America: New Evidence," *The Journal of Economic History* 47, no. 4 (1987); Jan Luiten van Zanden, "Wages and the Standard of Living in Europe, 1500–1800," *European Review of Economic History* 3, no. 2 (1999); Stephen Broadberry and Bishnupriya Gupta, "The Early Modern Great Divergence: Wages, Prices and Economic Development in Europe and Asia, 1500–18001," *The Economic History Review* 59, no. 1 (2006); Şevket Pamuk, "The Black Death and the Origins of the 'Great Divergence' across Europe, 1300–1600," *European Review of Economic History* 11, no. 3 (2007); Robert C. Allen et al., "Wages, Prices, and Living Standards in China, 1738–1925: In Comparison with Europe, Japan, and India," *The Economic History Review* 64, no. S1 (2011); Jane Humphries, "The Lure of Aggregates and the Pitfalls of the Patriarchal Perspective: A Critique of the High Wage Economy Interpretation of the British Industrial Revolution," *The Economic History Review* 66, no. 3 (2013); Paolo Malanima, "When Did England Overtake Italy? Medieval and Early Modern Divergence in Prices and Wages," *European Review of Economic History* 17, no. 1 (2013).

limitations of per capita income for decades and extended measurement to other aspects of life, economic historians investigating labor and its outputs have largely remained fixated on wages to the exclusion of other job attributes. Further, wage studies have rarely considered whether the work for which those wages were paid was similar on these broader dimensions between countries and across time.

It is possible that differences in safety or effort were offset by compensating differentials. However, some dangerous jobs were also poorly-paid, particularly when the long-term health risks were not known, and those poorly-understood hazards reduced workers' quality of life.[25] Understanding non-wage facets of work is important not only for wellbeing research, but for any study that uses labor income to understand dynamics of the economic past. Without analyzing and comparing jobs across multiple dimensions, we cannot know whether a high real wage is reflective of high labor productivity, a high standard of living, a compensation for occupational risk, an incentive for high labor effort, or if it offsets insecure employment. Multidimensional analysis allows researchers to analyze the existence and size of compensating differentials, whether they changed over time, and how non-wage aspects of jobs have also compensated—or failed to compensate—for downsides. It also enables more robust research using wages to capture living standards and productivity by ensuring that the work under comparison is consistent or appropriately contextualized between locations and across time.

[25] Bartrip, *The Home Office and the Dangerous Trades*, 6. See also Price V. Fishback and Shawn Everett Kantor, ""Square Deal" or Raw Deal? Market Compensation for Workplace Disamenities, 1884–1903," *The Journal of Economic History* 52, no. 4 (1992). There is evidence that questions the presence of compensating differentials in a more recent context. Muñoz de Bustillo et al., "E Pluribus Unum? A Critical Survey of Job Quality Indicators," 449; Stéphane Bonhomme and Grégory Jolivet, "The Pervasive Absence of Compensating Differentials," *Journal of Applied Econometrics* 24, no. 5 (2009).

III

The variety of present-day metrics for good work may suggest that economic historians could apply a current index into the past. However, the sources to reliably extend these metrics backward do not exist, and the most popular indices contain anachronistic criteria and components. The European Working Conditions Survey is probably the best single source for contemporary researchers, but it was first conducted in 1990 and there are no historical surveys with similar coverage. Even measures such as the dimension of the OECD's Job Quality Framework for "Labour market insecurity" can only be extended to around 1950 in countries with the best available data. More specific difficulties include thresholds for long working hours that are low by historical standards and would present many very different jobs as equal in quality.[26] Historical social science would benefit from an index of decent work, designed for use with evidence available to historians, and informed by the extensive research on measuring contemporary jobs and historical wellbeing studies. This section outlines choices in the development of such an indicator.

The first step in constructing an index is determining how the components should be derived. Sen suggests a typology with three approaches: opulence, utility, and capability.[27] There are contemporary studies that adopt the first two methods to measure the prevalence of good work. Wages have been used as a complete measure of job quality, and there are many articles on job satisfaction.[28] However, utility can rarely be measured in historical contexts

[26] The OECD's Job Quality Framework considers labor in excess of 50 hours per week as "long hours". The threshold is purportedly based on expectations about modern commuting times, but has little empirical grounding. OECD, "Work and Job Quality," in *How's Life? 2020* (Paris: OECD, 2020).
[27] Sen, "The Living Standard."
[28] Goos and Manning, "Lousy and Lovely Jobs: The Rising Polarization of Work in Britain."; Joseph A. Ritter and Richard Anker, "Good Jobs, Bad Jobs: Workers' Evaluations in Five Countries," *International Labour Review* 141, no. 4 (2002).

because of the absence of representative surveys, and opulence would return to a narrow study of real wages. Therefore, capability can provide a more holistic view on quality of work in the past. Further, most economic historians have favored using capability, which is Sen's preferred approach. Sen has provided various definitions of this concept, but the most succinct is "[a person's] ability to achieve various valuable functionings".[29] Positive freedom is an important constituent element of capability, and using this approach links with the ILO's aspiration for workers to labor in "conditions of freedom, equity, security and human dignity".[30]

In historical wellbeing studies, the capability dimensions chosen usually have a theoretical basis or derive their dimensions from the HDI.[31] Present job quality metrics take one of three approaches: indices that measure satisfaction (a utility measure); indicators that derive components from survey data; and indices with theoretically-derived components.[32] Here we adopt a hybrid approach by searching historical sources for aspects of jobs that workers valued and that contributed to enhancing their capability.[33] The resulting components therefore have both a theoretical and an empirical basis.

The second consideration in the construction of an index is the unit of analysis. A labor-market measure gives a broad perspective, but sources at this level are rarely available before the mid-20th century, and countervailing shifts in individual jobs or sectors may cancel

[29] Amartya Sen, "Capability and Well-Being," in *The Quality of Life*, ed. Martha Craven Nussbaum and Amartya Sen (Oxford: Oxford University Press, 1993), 31.
[30] "Freedom of Choice: Concept and Content," *European Economic Review* 32, no. 2 (1988); International Labour Organization, *Reducing the Decent Work Deficit* (ILO, 2001).
[31] Crafts, "Quality of Life."; Prados de la Escosura, *Human Development and the Path to Freedom*. A brief empirical justification of components is provided in Gallardo-Albarrán and de Jong, "English Living Standards," 3–5.
[32] Muñoz de Bustillo et al., "Indicators of Job Quality in the European Union," 12–13. See also the discussion in Wright et al., "Indicators of Job Quality."
[33] Green, *Demanding Work*, 13–14.

out and therefore conceal changes. An occupational-level index can only provide information about work-related wellbeing for individual jobs, and broader measurement would require job quality data from a universe of occupations. However, a micro-level analysis can allow researchers to understand individual jobs in detail and analyze determinants of good work such as working practices, legal changes, or new technology, and job quality.

A third consideration is the types of data required to measure components of the index. While present-day indices use data produced by labor ministries and tailored job quality surveys, there are far fewer pre-existing standardized and quantitative sources available for analyzing historical jobs. For example, occupational safety is a common component of present-day indices, but large-scale data is rarely available before the early 20th century. As a result, an index that requires many specific quantitative inputs will have limited use in the past. To evaluate work dimensions that do not have extensive or representative extant quantitative evidence, it is also possible to use consistent descriptive criteria. The use of coded qualitative information has already been an important feature of long-run indices such as Prados de la Escosura's AHDI, albeit for a smaller share of its components than may be necessary in capturing and comparing occupations.[34]

There are two points of caution: first, scoring qualitative information may collapse differences between jobs that would be distinguishable if quantitative evidence were available. Second, scoring errors resulting from limited evidence or incorrect interpretation of available evidence are an obvious risk. However, a detailed qualitative approach provides a more robust and rounded picture than neglecting dimensions of work that are difficult to

[34] Historical wellbeing studies include scoring of qualitative information, e.g. Crafts, "Quality of Life." There are many more examples in political science, including measures of regime type such as the Polity Index. Prados de la Escosura's AHDI uses the Liberal Democracy Index from V-Dem, Prados de la Escosura, *Human Development and the Path to Freedom*.

quantify. To this end, an index that accepts inputs from descriptive and quantitative evidence enables comparisons of work in many places and times.

IV

Measuring historical job quality requires information about the elements of good work. Work's impacts on capability are multifaceted and there are many dimensions that could be measured. As described above, several contemporary indices derive their components from survey data. [35] Components of work-related wellbeing in the past can be found in the views of historical workers. As historians do not have access to representative surveys, this section begins by considering types of historical evidence that can provide information about workers' views. It then reviews systematic primary sources and an extensive body of secondary literature from labor history and economic history, searching for aspects of jobs that satisfied the following three criteria: (1) the attribute was valued by workers, (2) the attribute contributed to achieving a good life through freedom of choice and function, and (3) evidence about the attribute can plausibly be identified in historical sources.[36]

Strikes were a clear expression of discontent, and their precipitating grievances show workers' preferences. Studies of the causes of strikes have produced extensive evidence about workers' motivations.[37] Industrial action has been mediated by union politics and hierarchies,

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[35] Richard Anker et al., "Measuring Decent Work with Statistical Indicators," *International Labour Review* 142, no. 2 (2003): 150. The CIPD index uses survey data on workers' priorities, "UK Working Lives: Survey Report."

[36] Sen, "The Living Standard." By focusing on *aspects of jobs* in turnover data we do not consider some causes for separation such as looking for an (unspecified) better job, family responsibilities, moving to another location, or workers dismissed by management, as these are not features of the job from which workers departed.

[37] A detailed enumeration of the causes of late 19th century American strikes is *Tenth Annual Report of the Commissioner of Labor: Strikes and Lockouts, Volumes I & II* (Washington, 1896). There is a cautionary note in Isaac Cohen, *American Management and British Labor: A Comparative Study of the Cotton Spinning Industry* (New York: Greenwood, 1990), 154–55. Other compilations include Massachusetts Bureau of

so we will complement it with many other types of evidence. Petitions and lobbying explain workers' preferences in their own words.[38] Wage premia also provide insights: if workers were offered additional compensation, this suggests that they disliked attributes of such jobs. We can also observe workers' preferences in demands for recompense after enduring working conditions that they considered unacceptable. Reports on labor turnover with reasons for employee separation show aspects of occupations that workers found sufficiently unpleasant to cause exits.[39] Finally, some historical studies of workers and job attributes provide the closest parallel to contemporary surveys.[40]

Workers have consistently expressed an interest in their wages and earnings have been the proximate cause of many industrial actions and separations. Income is also a component of nearly all composite indices of wellbeing.[41] Working time has been a recurrent point of contention, and there have been many campaigns and petitions for shorter hours. Reduced hours provided workers with choice over how to dispose of their lives as they wish and the potential to seek fulfillment at their own discretion.[42] Stable and secure employment and

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Statistics, *Thirty-Ninth Annual Report on the Statistics of Labor* (Boston, 1909), F. Peterson, "Strikes in the United States, 1880–1936", *Bureau of Labor Statistics Bulletin* No. 651 (1938). A description of "non-economic" strike causes on American railroads is provided in Shelton Stromquist, *A Generation of Boomers: The Pattern of Railroad Labor Conflict in Nineteenth-Century America* (Urbana: University of Illinois Press, 1987), 31–40.

[38] Thomas Dublin, *Women at Work: The Transformation of Work and Community in Lowell, Massachusetts, 1826–1860* (New York: Columbia University Press, 1979), Chapters 6 & 7.

[39] Sumner H. Slichter, *The Turnover of Factory Labor* (New York: D. Appleton, 1921), Chapters 8, 9, 12, 13. Further specific examples are cited below. A summary of mid-20th century studies that show similar results is Abraham Bluestone, "Major Studies of Workers' Reasons for Job Choice," *Monthly Labor Review* 78, no. 3 (1955).

[40] S. Wyatt, J. N. Langdon, and F. G. L. Stock, "Fatigue and Boredom in Repetitive Work," (London: Industrial Health Research Board, 1929).

[41] In addition to note 37 above, see Ethel L. Best, Gladys McKenna, and I. A. Spring, *Lost Time and Labor Turnover in Cotton Mills: A Study of Cause and Extent*, Bulletin of the Women's Bureau No. 52 (Washington: U.S. Government Printing Office, 1926), 124, 26, 94–97; Boris Emmet, *The Turnover of Labor: November, 1919* (Washington, DC: Federal Board for Vocational Education, 1920), 24.

[42] John R. Commons et al., *History of Labour in the United States* (New York: The Macmillan Company, 1926), Vol. 3, 97–98. Best, McKenna, and Spring, *Lost Time and Labor Turnover in Cotton Mills*, 194–97.

earnings have also been a concern. Workers who were not employed and paid consistently had difficulty securing sufficient income and smoothing their consumption, and these downsides limited their positive freedom. Summary dismissals, short time, and irregular paychecks have been specific causes of unrest. Irregular workers sometimes received higher wages that may have compensated for this inconsistency of income, and campaigns for workers' compensation and workers' private unemployment insurance plans also reflect interest in consistency of income.[43]

Workers have commonly expressed concerns about occupational safety. Toiling in an occupation that had a high risk of injury or death from accidents was undesirable and workers organized for improved safety measures at firms that put employees in danger. When work produced industrial disease such as respiratory illness or cancers stemming from chemical exposure, workers demanded compensation, and in some cases set up self-help organizations to insure themselves against accidents and injuries.[44] Some past studies also found higher

[43] Sara Horrell and Deborah Oxley, "Work and Prudence: Household Responses to Income Variation in Nineteenth-Century Britain," *European Review of Economic History* 4, no. 1 (2000). Michael Quinlan, "The 'Pre-Invention' of Precarious Employment: The Changing World of Work in Context," *The Economic and Labour Relations Review* 23, no. 4 (2012): 12–15; "Precarious Employment, Ill Health, and Lessons from History: The Case of Casual (Temporary) Dockworkers 1880-1945," *International Journal of Health Services* 43, no. 4 (2013); Jane Humphries and Jacob Weisdorf, "Unreal Wages? Real Income and Economic Growth in England, 1260–1850," *The Economic Journal* 129, no. 623 (2019). Commons et al., *History of Labour in the United States*, Vol. 3, 259–62.

[44] P. W. J. Bartrip and Sandra Burman, *The Wounded Soldiers of Industry: Industrial Compensation Policy, 1833–1897* (Oxford: Clarendon Press, 1983). Mark Aldrich, "Running out of Steam: Federal Inspection and Locomotive Safety, 1912–1940," *The Journal of Economic History* 67, no. 4 (2007). Peter Bartrip, "'Petticoat Pestering": The Women's Trade Union League and Lead Poisoning in the Staffordshire Potteries, 1890–1914," *Historical Studies in Industrial Relations*, no. 2 (1996). Barbara Ellen Smith, "Black Lung: The Social Production of Disease," *International Journal of Health Services* 11, no. 3 (1981); Robert Emil Botsch, Organizing the Breathless: Cotton Dust, Southern Politics & the Brown Lung Association, (Lexington, Kentucky: The University Press of Kentucky, 1993); Alan Derickson, *Black Lung: Anatomy of a Public Health Disaster* (Ithaca: Cornell University Press, 2014); Sue Bowden and Geoffrey Tweedale, "Mondays without Dread: The Trade Union Response to Byssinosis in the Lancashire Cotton Industry in the Twentieth Century," *Social History of Medicine* 16, no. 1 (2003); "Poisoned by the Fluff: Compensation and Litigation for Byssinosis in the Lancashire Cotton Industry," *Journal of Law and Society* 29, no. 4 (2002).

turnover in establishments with poor air quality or higher noise levels.[45] Good health is an obvious element of capability and is part of most wellbeing indices.

Control over the work process has been a common point of contention and a cause for labor resistance and industrial action. This aspect encompasses whether workers could determine the location, organization, schedule, and pace of work. Constraints on these dimensions were limitations on positive freedom by definition: they prevented worker choice in the conduct of their occupation. Workers have shown resistance to authoritarian management structures and discipline; some employers have raised wages to ensure that labor accepts reduced control.[46]

Frequent physical exhaustion or work that was mentally taxing could require a wage premium, and workers have resisted increased effort demands or left work that they considered overly strenuous.[47] Intensity may negatively affect capability by impairing

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[45] Best, McKenna, and Spring, *Lost Time and Labor Turnover in Cotton Mills*, 128–31. Turnover studies also note workers' complaints about poor working environments (noise, dust, dirt), Boris Emmet, "Labor Turnover in Cleveland and Detroit," *Monthly Labor Review* 8, no. 1 (1919): 28.

[46] Many examples and a description of the contest between employee control and scientific management are provided in Montgomery, *Workers' Control*. Cf. Green, *The World of the Worker*. Control has also been discussed in the literature on labor process, including Craig R. Littler, *The Development of the Labour Process in Capitalist Societies: A Comparative Study of the Transformation of Work Organization in Britain, Japan, and the USA* (London: Heinemann Educational, 1982). For more examples, see Wayne Lewchuk, *American Technology and the British Vehicle Industry* (Cambridge: Cambridge University Press, 1987), 64–65. Cohen, *American Management and British Labor*. Richard White, *Railroaded: The Transcontinentals and the Making of Modern America* (New York: W.W. Norton & Co., 2011), 236–37, 422. Control and work pacing is discussed in, e.g., S. Wyatt and J. N. Langdon, "The Machine and the Worker: A Study of Machine-Feeding Processes," (London: Industrial Health Research Board, 1938).

[47] Anne Bezanson et al., *A Study in Labor Mobility* (Philadelphia: Reprinted from Vol. CIII of the Annals of the American Academy of Political and Social Science, 1922), 181; Slichter, *The Turnover of Factory Labor*. Best, McKenna, and Spring, *Lost Time and Labor Turnover in Cotton Mills*, 125, 28. Resistance to increased work pace is discussed in e.g. Rick Halpern, *Down on the Killing Floor: Black and White Workers in Chicago's Packinghouses, 1904–54* (Urbana, Ill.: University of Illinois Press, 1997). Dislike of intense or heavy work is also found in turnover studies. Emil Frankel, "Labor Turnover in Cincinnati," *Monthly Labor Review* 8, no. 3 (1919): 45; Emmet, *The Turnover of Labor: November, 1919*, 24.

physical and mental health.[48] High-intensity labor also limited the options of workers to carry out leisure activities and necessary household production outside of their employment hours, and also constrained their physical and psychological capacities on the job. Finally, there is evidence that workers considered highly repetitive labor undesirable. Industrial health studies of repetitive work and wage premia for very routine work indicate that monotony negatively impacted mental health and job quality.[49] Work that was composed of a variety of actions allowed workers greater freedom to use and develop their capabilities, while routine labor constrained choice and improvement.[50]

[48] Intensity was discussed by historical observers of occupational health such as J. T. Arlidge, *The Hygiene, Diseases and Mortality of Occupations* (London: Percival & co., 1892), 13–17. Dissatisfaction with machine pacing was found in Charles R. Walker and Robert H. Guest, *The Man on the Assembly Line* (Cambridge, Mass: Harvard University Press, 1952). Night work contributed to intensity; workers expressed a preference for day work and complained about the exhaustion of night shifts and the difficulty of work in poor light. *Reports of the Society for Bettering the Condition and Increasing the Comforts of the Poor*, vol. IV (London: W. Bulmer and Co., 1805), Appendix 1, 17–18. Night workers exhibited higher turnover than day workers in the same establishments. Frankel, "Labor Turnover in Cincinnati," 40–41.

[49] James Foreman-Peck, Sue Bowden, and Alan McKinlay, *The British Motor Industry* (Manchester: Manchester University Press, 1995), 169–70. Steven Tolliday, "Management and Labour in Britain 1896–1939," in *The Automobile Industry and Its Workers: Between Fordism and Flexibility*, ed. Steven Tolliday and Jonathan Zeitlin (Cambridge: Polity, 1986), 30–31. David A. Zonderman, *Aspirations and Anxieties: New England Workers and the Mechanized Factory System, 1815–1850* (Oxford: Oxford University Press, 1992), 24–25; Walker and Guest, *The Man on the Assembly Line*. Arthur W. Kornhauser and Otto M. Reid, *Mental Health of the Industrial Worker: A Detroit Study* (New York: Wiley, 1965). Wyatt, Langdon, and Stock, "Fatigue and Boredom in Repetitive Work."; S. Wyatt, J. A. Fraser, and F. G. L. Stock, "The Effects of Monotony in Work," (London: Industrial Health Research Board, 1929). Frankel, "Labor Turnover in Cincinnati," 45.

[50] Slichter, *The Turnover of Factory Labor*, 189–91.

Components of the Historical Occupational Quality Index

1. Real Compensation: symbol *w*

- Evidence for inclusion: strikes, petitions, turnover
- Capability: freedom to choose and consume a wide variety of goods and services
- Definition: compensation relative to consumption needs

2. Working Time: *t*

- Evidence: strikes, petitions, turnover
- Capability: freedom to use more non-work time at own discretion
- Definition: time actually worked per week

3. Stability and Quality of Earnings: *s*

- Evidence: strikes, petitions
- Capability: regular usable income enables consistency of choice across time
- Definition: frequency, consistency of payment, full payment, probability of dismissal, and payment in usable instruments

4. Short-Term Health Risks: *a*

- Evidence: compensation demands, lobbying
- Capability: ability to do many activities without pain or encumbrance
- Definiton: probability and severity of workplace accidents

5.Long-Term Health Risks: *d*

- Evidence: compensation demands, lobbying, turnover
- Capability: as above (*a*)
- Definition: probability and severity of long-term health effects from work

6. Control: *c*

- Evidence: strikes, wage premia, worker surveys
- Capability: freedom in the organization, context, and conduct of the job
- Definition: employee choice in work conduct, task organization, manner of completion, location and time of work, association with other persons

7. Work Intensity: *i*

- Evidence: strikes, wage premia, turnover, worker surveys
- Capability: physical and mental capacity to use non-work time
- Definition: physical and psychological exhaustion produced by work

8. Repetitiveness: *r*

- Evidence: wage premia, letters, diaries, worker surveys, turnover
- Capability: opportunity to perform a variety of functions and develop competences
- Definition: range of actions completed by a worker and frequency of repetition

This evidence suggests eight components of historical job quality. Reassuringly, these components are similar to those of several important contemporary indicators.[51] Historical materials will provide quantitative information for some components, but measuring others requires converting descriptive evidence into a numerical value. The next section provides more detail about the sources that can be used to measure each component.

V

The third criterion for including components in the index was the availability of historical sources. Here we elaborate on the variety of sources that can be used to collect evidence for components of the HOQI. The index can be applied to observations from a single firm (with sufficient evidence) or calculated using national-level evidence for an occupation.

Before government agencies collected official statistics, evidence to measure earnings and working time can be found in account books, wage books, payroll sheets, time books, bills, receipts, and vouchers. Some narrative sources provide evidence about standard working hours. Measuring working time is more challenging for piece rate occupations, but descriptive evidence of schedules or standard workdays in similar time-rate occupations can be used to estimate hours of employment. Wages for piece rate workers can be calculated as effective earnings spread over time taken to complete a product or task. Beginning in the 19th century, reports from government labor bureaus or factory inspectors provide evidence about pay and hours, although scheduled hours could vary from hours worked.[52]

[51] Cf. the CIPD Good Work index, Green, *Demanding Work*, the OECD Job Quality Framework, and the ETUI European Job Quality Index. For tractability, one element of contemporary indices that is not included here is long-term career development, described in some indices as "prospects".
[52] For a firm-level examination of this point, see Joyce Burnette, "Missing Work: Absenteeism at Pepperell Manufacturing Co. In 1883," *Cliometrica* (2020).

Stability and quality of earnings will generally require evidence from a mixture of sources. Payment dates in account books indicate the (in)frequency of earnings. Business correspondence and memoranda may describe whether workers were paid in currency or other instruments such as bills or truck. When detailed employee-level records are not available, it is possible to find descriptive evidence of stability from worker-side sources (e.g. diaries and letters), and some firms kept records of dismissals and departures. Regulators' reports and outside observers may provide information about this component. In more recent periods, sectoral or occupation-specific unemployment rates are also a valuable source of evidence about the chance of losing work.

Information about occupational risks can be derived from official statistics, when they exist.[53] While these are frequently unavailable before the advent of labor regulation and widespread insurance for workplace accidents, there are alternative sources. Some firm-level accident books survive from the end of the 19th century, although their coverage is frequently inconsistent. To estimate occupational risks for earlier periods and in places without these sources, researchers may use compilations of injuries or common diseases by managers or doctors, medical journal articles (especially for industrial disease), memoirs or diaries of workers, and court records with causes of deaths.

Control can be determined using qualitative evidence from firms' rules for their employees, discipline records, and workers' diaries and autobiographies. Work intensity can be gauged from similar sources, as well as reports from labor bureaus and factory inspectors. Handbooks of trades and machinery provide detailed descriptions that allow the

[53] The completeness of accident reports compiled by British factory inspectors has been disputed. Bartrip and Burman, *Wounded Soldiers of Industry*, 11–15, 37–38.

reconstruction of job activities necessary to evaluate repetitiveness, and workers' own writings can also be useful.

These sources enable detailed, analytical descriptions of work and labor conditions. To compare developments within and between jobs and locations, six of the components (3–8) are scored based on qualitative evidence, or a mixture of quantitative and qualitative evidence (such as when only limited occupational safety information is available). Values for the scored components should be based upon a comprehensive picture of the occupations under consideration, and particularly information about work activities, tools, organization, and workplaces. Work activities and the implements used by workers shaped occupational safety, job control, intensity, and repetitiveness. The organization of work and hierarchies influenced job control and intensity. Work locations impacted job quality through occupational risk, control, and intensity. Thorough descriptions of working conditions in a case study are provided in Sections VII and VIII. The next section describes how to quantify the components of the HOQI.

VI

Measurement of the first two components (wages and working time) is based on common methods in economic history and wellbeing research. For the components that are based on descriptive evidence (3–8), Appendix II shows detailed scoring rubrics developed from the approach used in the European Working Conditions Survey (EWCS). Respondents to the EWCS are presented with Likert scales of varying granularity, from three points to seven, as well as binary questions about their work.[54] This enables Eurofound to capture

[54] "2015 European Working Conditions Survey ", (Dublin: European Foundation for the Improvement of Living and Working Conditions, 2015).

gradations and shifts in qualitative aspects of labor. A scoring scale with more steps will allow researchers to assign more distinct values, but doing so will also require more detailed evidence to distinguish between scale points. The HOQI uses a middle ground, five-point scale (1–5) for the scored components.

The two quantitative components are *w* and *t*. To calculate *w*, we propose computing the welfare ratio, using earnings and a consumption basket for a week of work.[55] We further propose that the cost of the basket should be scaled based on the estimated consumption needs of the modal type of person (e.g. adult woman, child, etc.) employed in an occupation.[56] Variations in prices and wages between firms or regions can be used to compare the income component of job quality in different locations or establishments. The items in the basket (e.g. types of food, quantity of fuel) may also be adjusted by location.[57] *t* should be measured as hours actually worked per week, and not scheduled hours. If working time is compared between societies with varying week lengths, the comparison could be made by calculating the percentage of hours worked from the total hours in a week.

[55] See Appendix II for details. We recommend using a week as the standard unit of quantifiable work because many historical workers switched jobs on a seasonal basis. Judy Z. Stephenson, "Working Days in a London Construction Team in the Eighteenth Century: Evidence from St Paul's Cathedral," *The Economic History Review* 73, no. 2 (2020). For an earlier period, see John Hatcher, "Unreal Wages: Long-Run Living Standards and the 'Golden Age' of the Fifteenth Century," in *Commercial Activity, Markets and Entrepreneurs in the Middle Ages: Essays in Honour of Richard Britnell*, ed. Ben Dodds and Christian D. Liddy (Boydell & Brewer, 2011). However, the *s* component criteria penalize irregular earnings.

[56] Based on Humphries' revision of Allen, adult men's consumption baskets are set at 100% of the total cost, adult women at 85%, and children at 60%. Humphries, "The Lure of Aggregates and the Pitfalls of the Patriarchal Perspective: A Critique of the High Wage Economy Interpretation of the British Industrial Revolution." Cf. Robert C. Allen, "The High Wage Economy and the Industrial Revolution: A Restatement," *The Economic History Review* 68, no. 1 (2015). See further discussion of this point in Appendix I.

[57] As in e.g. Kathryn E. Gary and Mats Olsson, "Men at Work: Wages and Industriousness in Southern Sweden, 1500–1850," *Scandinavian Economic History Review* 68, no. 2 (2020).

The full criteria for scoring qualitative components are provided in Appendix II; a summary is provided here. Stability and quality of earnings (*s*) is scored from 1 (unpredictable employment with inconsistent payment times or incomplete payment) to 5 (high job security with regular and usable payments). Immediate health risks (*a*) range from a very high probability of serious injury or death at work—an occupation such as logging—to very safe occupations that have low risks of minor injuries. Long-term health impacts (*d*) vary from high risk of industrial disease (e.g. early 20th century coal mining) to low-risk modern office occupations.[58] Psychological trauma with long-term effects should also be considered in *d*.

The scale for control (*c*) runs from, on the low-quality end, total employer choice over the location, manner, and order of task completion, to, on the high-quality end, worker discretion over the location and conduct of their work and freedom of association. The physical and psychological effects of violent supervision are incorporated in the *a* and *d* components. For work intensity (*i*) a job scored as 1 was maximally physically or mentally exhausting—day labor in construction or working as a field hospital nurse are examples, while jobs with minimal exertion receive higher scores. Occupations requiring working hours that disrupt normal patterns of rest, such as night shifts, also score lower on this component. The repetitiveness or monotony of work (*r*) is scored based on the variety of actions involved in an occupation. Jobs that consist of few motions and mental processes should be scored as 1, and occupations that contain a wider variety receive higher scores.[59]

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[58] Separating the two health components allows independent assessment of risks, and enables analysis of varying compensating differentials between immediate and distant risks. For example, there is evidence that the value of life rose in the 20th century. Dora L. Costa and Matthew E. Kahn, "Changes in the Value of Life, 1940–1980," *Journal of Risk and Uncertainty* 29, no. 2 (2004).

[59] The most detailed system for breaking down jobs into sub-units is produced by the US Department of Labor. Their system divides jobs into "tasks" and their sub-units, "elements", with both defined as relative concepts. An element is the "smallest step into which it is practical to subdivide any work activity without analyzing separate motions, movements, and mental processes involved". US

Can, or more pertinently, should these dimensions of work be combined into a composite measure? There are many strong critiques of the rush towards composite indicators.[60] Cautious perspectives include the persuasive arguments that many indices contain the implicit preferences of researchers and that their aggregation obscures more than it reveals.[61] In analysis of work, job quality is rarely aggregated into one composite value. Some job quality indicators provide an intermediate level of aggregation,[62] but most studies do not aggregate across different job quality domains at all.[63] Weighting is a particular issue, and there is no generally-agreed and satisfactory approach to aggregate present job quality components. A historical composite index would either need fixed weights, perhaps based on the premise used in the HDI and AHDI—that all dimensions are equally important for capability—or studies would focus on identifying changes in preferences to determine

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Department of Labor Employment and Training Administration, *The Revised Handbook for Analyzing Jobs* (Washington, DC: US Government Printing Office, 1991), 2–1. Even a single "element" in this system may include many (or few) biomechanical actions or cognitive processes, which provide more (or fewer) opportunities to exercise and enhance capabilities. Therefore, as described in Appendix II, to capture the repetitiveness of labor we require a level below an element, which is referred to here as an "action". This is a physical act or cognitive process that produces a change in the state of the worker's surroundings or a nonphysical output.

[60] Perhaps most stridently Martin Ravallion, "Mashup Indices of Development," *The World Bank Research Observer* 27, no. 1 (2012). However, Ravallion states that composite measurement has value when conducted carefully. More pertinently, there is an excellent discussion of the benefits and drawbacks of aggregating job quality indices in Muñoz de Bustillo et al., "Indicators of Job Quality in the European Union," 16–17.

[61] Nicola Amendola and Giacomo Gabbuti, "Human Development," in *Measuring Wellbeing: A History of Italian Living Standards*, ed. Giovanni Vecchi (New York: Oxford University Press, 2016). Also Nicola Amendola, Giacomo Gabbuti, and Giovanni Vecchi, "On the Use of Composite Indices in Economic History: Lessons from Italy, 1861–2017," *HHB Working Papers Series* No. 11 (2018).

[62] The OECD Job Quality Framework aggregates at an intermediate level with three domains: Earnings Quality, Labor Market Insecurity, and Working Environment Quality.

[63] "UK Working Lives: Survey Report." Janine Berg et al., "Risks to Job Quality from Digital Technologies: Are Industrial Relations in Europe Ready for the Challenge?," *European Journal of Industrial Relations* (2023). Alternatively, these approaches could be explained as containing a lower level of aggregation: there are seven "domains" in the Berg et al approach, which uses EWCS data, and the CIPD considers seven "dimensions", which are different from those used by Berg et al. One rare article that proposes aggregating a series of sub-indices is Bonnet, Figueiredo, and Standing, "A Family of Decent Work Indexes," 233. The authors suggest normalizing the subsidiary index values to between 0 and 1 and combining them with equal weights, but do not present outputs.

appropriate weighting; in turn, this may take precedence to actual changes in occupations. Further, it would be exceptionally difficult to locate appropriate data on historical labor markets that shows when workers shifted between employers or occupations with varying dimensions of quality.

The foregoing derivation of job quality components, the analytical narrative approach for systematically describing working conditions in the past, and the criteria for scoring and comparing occupations contribute to more complete historical social science of labor without aggregation into one composite value. Gathering information about the components is at least as illuminating as the outputs of a composite measure. Moreover, when evidence for one or more components is not available, researchers can systematically analyze and compare changes in the other components. This will provide a more detailed perspective on historical work than has been explored previously.

The main objects of investigation are the ordinal ranking of jobs by component values and changes in these values. The index can show the dimensions of improvement or decline in jobs and variation between different occupations. Job quality measurement opens new opportunities for historical quality of life research and labor history. It also provides a detailed system that can ensure studies of wages make reasonable comparisons of occupations across periods and locations. As will be shown in the second half of this paper, consistent yardsticks for dimensions of work can contribute to historical social science, labor history, and research on the determinants of good lives.

VI

The next two sections illustrate the value of a multidimensional approach to analyze historical job quality through a case study: the mechanization of spinning in Britain during

the 18th and 19th centuries. This case has a large body of surviving qualitative and quantitative evidence to reconstruct job quality. However, as is common for historical occupations, not all aspects of work are easily quantified, which shows the value of an approach that accepts diverse source inputs. It demonstrates how analyzing descriptive evidence in a systematic framework can be used to compare the quality of historical jobs. The multidimensional approach of the HOQI allows researchers to clarify the tradeoffs of factory work to a greater extent than in previous studies. Relatedly, the HOQI shows that this instance of technological change increased the inequality of wellbeing between occupations on non-wage dimensions, which has not been clearly established in previous research. The occupation-level analysis demonstrates the diversity of wellbeing impacts from this instance of technological change, which illustrates how the HOQI can clarify distributional impacts of economic shifts. It also reveals the limitations of narrowly measuring changes in real wages to capture shifts in historical quality of life and of aggregating job quality on a sectoral level.

The case study is an economically important example of technological change and job transformation. Clothing production was the second-largest sector of the preindustrial British economy, employing hundreds of thousands of hand spinners in the mid-18th century.[64] After centuries with only modest technological change, three inventions in the 1760s and 1770s made textiles one of the most dynamic sectors of the First Industrial Revolution. Mechanized factory production shifted workers into new premises and drastically changed the

[64] S. N. Broadberry et al., *British Economic Growth, 1270–1870* (Cambridge: Cambridge University Press, 2015); 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); Schneider, "Technological Unemployment in the Industrial Revolution."

organization of work and working conditions. Factories featured a new division of labor with new jobs and increased inequality of wellbeing.

This section (VII) describes hand spinning work and job quality. The next section (VIII) presents the three machines of the Industrial Revolution and the activities of workers who used them, before moving to an analysis of job quality in the factory, encompassing work premises, conditions, working hours, and pay. Section VIII then summarizes the dimensions of job quality and the differences between hand spinning and factory work.

Hand Spinning: Work Content

For hundreds of years before industrialization spinners produced yarn using spinning wheels or the spindle and distaff.[65] Before spinning, fibers were cleaned and carded or combed (drawn between two parallel wooden surfaces with fine wire hooks). This process formed proto-threads called rovings.[66] The spinner then twisted and drafted (pulled out along its length) the roving into yarn using the rotation of the spindle, and wound it for storage beyond the spindle tip. The spindle was turned by a cord or belt connected to the wheel.[67] Spinners generally sat on a wooden chair or stool next to the wheel, although some wool spinners used larger wheels that required them to stand and walk up to 10 kilometers per day.[68] Most

[65] By the 18th century, the spindle and distaff were mainly used for fine spinning or in peripheral areas. The distaff was a short pole that held unspun fiber; spinners usually propped it under one arm. The spinner held the narrow cylindrical spindle in the opposite hand, drew out fiber from the distaff, and used a weighted 'drop' spindle that rotated to twist the fiber.
[66] Patricia Baines, *Spindle Spinning Cotton: An Introduction to the Technique*, Rev. ed. (Farnham: P. Baines, 1994), 2–3.
[67] Muldrew, "'Th'ancient Distaff'," 501–04. Also Harold Catling, *The Spinning Mule* (Newton Abbot: David & Charles, 1970), 14–16.
[68] Patricia Baines, *Spinning Wheels, Spinners and Spinning* (London: Batsford, 1977), 60–62, 104.

spinners turned the wheel by hand, but foot pedals became increasingly popular during the early modern period.[69]

Hand Spinning: Organization and Qualitative Aspects of Work

The two main systems for organizing hand spinning were household labor and "putting-out". In the former, a family or household unit carded fiber, spun it into yarn, wove fabric, and sold it. The latter system, which was more common, divided production steps across households: a woman received yarn, spun it, and turned it over to a merchant who arranged weaving.[70] This second model took its name from the fact that work was given or "put out" to spinners. In both systems, most hand spinners worked at home, where they had almost total control over the work process. Merchants could only control a spinner's activities by reducing her payment or cutting her off from further employment. When this occurred, it was usually punishment for poor quality yarn, slow delivery, or fiber embezzlement.[71] Some hand spinning occurred in spinning schools and workhouses, with an instructor or overseer monitoring the work.[72]

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[69] Abbott Payson Usher, *A History of Mechanical Inventions* (Cambridge, Mass.: Harvard University Press, 1954), 295.
[70] Pat Hudson, "From Manor to Mill: The West Riding in Transition," in *Manufacture in Town and Country before the Factory*, ed. Maxine Berg, Pat Hudson, and Michael Sonenscher (Cambridge: Cambridge University Press, 1983), 124–25. D. T. Jenkins and Kenneth G. Ponting, *The British Wool Textile Industry: 1770–1914* (London: Heinemann, 1982), 8–11.
[71] T. W. Hanson, "Jonathan Akroyd's Account Books," *Transactions of the Halifax Antiquarian Society* (1939): 142. Sidney Pollard, *The Genesis of Modern Management: A Study of the Industrial Revolution in Great Britain* (London: E. Arnold, 1965), 33–34. John Styles, "Spinners and the Law: Regulating Yarn Standards in the English Worsted Industries, 1550–1800," *Textile History* 44, no. 2 (2013).
[72] Barnsley Archives & Local Studies, EM/985. Almira Vickers Gray, *Papers and Diaries of a York Family 1764–1839* (London: Sheldon Press, 1927), 56.

Spinning was a seasonal and cyclical employment. Spinners frequently stopped for the harvest or worked more during the winter.[73] Irregular work could be reinforced by seasonal changes in remuneration, deadlines for cloth output to reach exporting ships, and cyclical fluctuations in demand.[74] Therefore, earnings in spinning could be inconsistent, both by choice (to take up other work) and because of factors beyond a worker's control. Income also became less regular when the advent of factory spinning reduced employment opportunities for hand spinners. There is no evidence of serious accidents or deaths of hand spinners in court records, although indoor work may have included a small chance of injury from fire.[75] The physical and mental exertion was modest, but producing finer yarns required more focus and skill. All hand spinning was very repetitive, as workers only completed the few biomechanical actions described above. A large majority of spinners were women and girls, though some sources show that boys spun and assisted female spinners.[76]

Hand Spinning: Earnings

Spinners' wages have become part of debates about incentives for industrial innovation. Using figures from Muldrew and Feinstein, Allen claimed that wages rose precipitously to 12d per day in the 1770s, leading to the invention of the spinning jenny and

[73] Examples include Warwickshire County Record Office, DR(B) 100/89; Kent History and Library Centre, P308/12/16.
[74] Jane Humphries and Benjamin Schneider, "Spinning the Industrial Revolution," *The Economic History Review* 72, no. 1 (2019): note 30. Alfred Powell Wadsworth and Julia de Lacy Mann, *The Cotton Trade and Industrial Lancashire, 1600–1780* (Manchester: Manchester University Press, 1931), 404.
[75] There is some evidence that the exertion of spinning on a great wheel (which required workers to stand) may have been injurious to child workers, see London Metropolitan Archives, A/FH/Q/01/011. Thanks to John Styles for sharing this reference.
[76] Francis A. West, *Memoir of Jonathan Saville of Halifax* (New York: G. Lane & C. B. Tippett, 1845), 7–11. "Notes on the Life of Joseph Ricketts, Written by Himself, c. 1858," *Wiltshire Archaeological and Natural History Magazine* 60 (1965): 121–22. Timothy Claxton, *Hints to Mechanics, on Self-Education and Mutual Instruction* (London: Taylor and Walton, 1839), 5.

water frame.[77] Humphries and Schneider found a much lower average level of wages from direct evidence of earnings, and the job quality analysis here and in Table 2 is based on those findings.[78] While there was a range of possible wage levels, with variation primarily driven by yarn quality, average spinning earnings were roughly 4d per day from 1740 to the end of the century, which was lower than wages for other male and female workers.[79]

Hand Spinning: Working Time

There is no direct evidence of hours worked by putting-out spinners. In his criticism of Humphries and Schneider, Allen asserted that they observed low daily earnings because spinners were only working part-time.[80] Contra Allen, Humphries and Schneider claimed that piece rates for impoverished workers incentivized diligence when work was available. Any part-time work was part-time on a yearly basis (spinning consistently and then not spinning for several months) rather than a weekly basis.[81] Evidence from other sectors suggests an 18th century working day of 10–12 hours, and a maximum work week of six days.[82] However, there

[77] Robert C. Allen, "London Prices & Wages Dataset," https://www.nuffield.ox.ac.uk/media/2139/london.xls. Allen omitted the 12d per day observation from "Spinning Their Wheels: A Reply to Jane Humphries and Benjamin Schneider," *The Economic History Review* 73, no. 4 (2020): Figure 1. Muldrew, "'Th'ancient Distaff'." 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).
[78] Humphries and Schneider, "Spinning the Industrial Revolution," esp. Figures 7–9, online appendix S1. Allen has disputed these findings in Allen, "Spinning Their Wheels."
[79] Humphries and Schneider, "Spinning the Industrial Revolution," Figure 9 and online appendix S1.
[80] Allen, "Spinning Their Wheels."
[81] Jane Humphries and Benjamin Schneider, "Losing the Thread: A Response to Robert Allen," *The Economic History Review* 73, no. 4 (2020).
[82] 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): 4–7, 14–15. Cf. Hans-Joachim Voth, "Time and Work in Eighteenth-Century London," *The Journal of Economic History* 58, no. 1 (1998).

was likely some absenteeism or inconsistent work, so we estimate that spinners worked for 48 hours per week.

Hand Spinning: Summary

Hand spinning was largely worker-directed but spinners were dependent on putters-out for employment, so it receives a high control score (4) and a middling stability score (3 until 1790, 2 thereafter to account for the decline of work availability caused by factory competition). There is no evidence of serious accidents or disease for adult workers, therefore it is scored highly on these dimensions (5 for *a* and *d* in Table 2). The physical and mental exertion was modest (scored as 4), although working with a great wheel required a moderate amount of walking, and all hand spinning was very repetitive, which produces a low *r* score of 1. It was poorly-remunerated in comparison with other work, and working time was probably similar to other rural employments (see above and Table 2). It scores highly on several HOQI components (see Table 1 for a qualitative summary and Table 2 for the full component values), but low wages reduced the quality of this occupation.

VII

Beginning in the 1760s and 1770s, three well-known inventions changed job quality in spinning.[83] James Hargreaves' spinning jenny used hand power to turn multiple spindles, and it was mainly operated in homes and workshops. Richard Arkwright's water frame could be monitored by women and children with little training, and inanimate power soon drove many

[83] On the process of innovation, inventors, and motivations, see e.g. C. Aspin, *James Hargreaves and the Spinning Jenny* (Preston: Helmshore Local History Society, 1964). Richard L. Hills, "Hargreaves, Arkwright and Crompton: Why Three Inventors?," *Textile History* 10, no. 1 (1979). J. H. Crabtree, *Richard Arkwright* (London: The Sheldon Press, 1923).

frame spindles. Samuel Crompton's spinning mule combined elements of the jenny and frame to spin finer yarns with human power, and it was eventually adapted to production with an external power source.[84] The frame and mule were predominantly used in factories, where work-related wellbeing was very different from hand spinning or jenny spinning at home. The next three subsections describe the machines and work activities in detail. Following this, several subsections outline the components of factory job quality.

The Spinning Jenny

The jenny used a hand-powered wheel to drive multiple spindles. While turning the wheel to rotate the spindles that twisted the yarn, the operative drafted by pulling a bar that held the ends of the threads and lay parallel to the line of spindles. Like the spinning wheel, the jenny spun intermittently: once a length of yarn was drawn out (drafted) and twisted, the spinner pushed the bar back towards the spindles to wind the yarns below the spindle tip.[85] If threads broke during spinning, the spinner had to "piece" them back together by overlapping the two ends of broken yarn and applying twist over the breakage.[86] Jenny spinning was somewhat more strenuous than hand spinning (moderate intensity, scored 3), though small jennies (10–20 spindles) only needed one operative.[87] Jenny spinners' work was repetitive (an *r* score of 1), but many of them worked at home and retained control of their

[84] Richard L. Hills, *Power in the Industrial Revolution* (Manchester: Manchester University Press, 1970), 134.
[85] Harold Catling, "The Development of the Spinning Mule," *Textile History* 9, no. 1 (1978): 44. Anna P. Benson, *Textile Machines* (Princes Risborough: Shire, 1983), 2.
[86] Maxine Berg, *The Age of Manufactures, 1700–1820: Industry, Innovation, and Work in Britain* (London: Routledge, 1994), 254. "Workers and Machinery in Eighteenth-Century England," in *British Trade Unionism 1750–1850: The Formative Years*, ed. John Rule (London: Longman, 1988), 67.
[87] Aspin, *Spinning Jenny*, 53. Larger machines required assistance from dedicated "piecers" to patch together broken threads. Piecers were also employed in mule spinning, as will be discussed below.

activities and schedule (*c* scored 4).[88] There is no evidence of occupational risks for jenny spinners (*a* and *d* scored 5).

Witnesses before a Parliamentary committee investigating whether spinning machines caused unemployment stated that earnings on 24-spindle jennies had been 8 to 9 shillings a week in 1764 (compared to a dubious 10–15 pence with a spinning wheel), but fell to 4–6 shillings a week by 1780 (and 3–5 pence with a wheel).[89] These witnesses may have exaggerated the earnings of jenny spinners, but the increased productivity of the jenny surely enabled higher earnings before competition from more jennies and factories reduced piece rates. Even on higher wages, jenny operatives were sometimes paid in bills rather than coin and earnings could be inconsistent (*s* score of 3).[90]

The Water Frame

On the jenny, the spinner's fingers were replaced by the draw bar, but the operative still powered the spindles and controlled drafting. Richard Arkwright and John Kay's water frame used pairs of cylindrical rollers to draft the roving before twisting it off a turning spindle and winding it using a rotating flyer in a continuous process.[91] The machine was initially operated by a crank on the side, then adapted for horse power, and finally driven by water wheels when Arkwright established his mills at Cromford, Derbyshire in 1770. Water frame operatives or "tenders" stopped spindles to piece broken threads and cleaned and

[88] *Spinning Jenny*, 42–44, 50–51. Catling, *Spinning Mule*, 27–28.
[89] UK Parliamentary Papers, *Report from the Committee to Whom the Petition of the Cotton Spinners Were Referred*, vol. XXXI Geo. 20 (1780), 4.
[90] George Unwin, *Samuel Oldknow and the Arkwrights: The Industrial Revolution at Stockport and Marple*, 2nd ed. (Manchester: Manchester University Press, 1968), 50.
[91] Benson, *Textile Machines*, 13–15.

lubricated the machine, but did not control the speed of drafting or twisting. Frame tenders were employed directly by the firm and disciplined by overseers.[92]

The Spinning Mule

The mule combined elements of the jenny and the water frame to spin finer yarns intermittently.[93] The operative used a hand crank or wheel to pull roving from bobbins placed at the back of the machine through fixed drafting rollers, and this crank also turned the spindles.[94] The mule's spindles were placed on a wheeled carriage that the operative pulled away from the rollers (the "draw") to impart additional draft while the yarn was twisted by the rotating spindles. [95] After a draw, the operative pushed the carriage toward the rollers while rotating the wheel to wind twisted and drafted yarn below the spindle tip for storage.[96] The first powered mule or "common mule" was introduced in 1790. Water or steam power turned the drafting rollers, rotated the spindles, and drove the outward run of the carriage. The operative still had to push the spindle carriage back towards the rollers and bobbins to wind yarn.[97] The carriage for large early 19th century mules weighted nearly 1400 pounds, and the operative had to push it back ("put up" the mule) every 20–30 seconds.[98]

These larger machines, with more threads, required more hands for continuing operation. There were three workers employed on most mules: the operative, the "big" piecer,

[92] Cohen, *American Management and British Labor*, 58–59, 69–70.
[93] Catling, "Development of the Spinning Mule," 35.
[94] Albert Williams, *36 Stewart Street, Bolton: An Exercise in Nostalgia, 1901–1914* (Manchester: Neil Richardson, 1983), 4.
[95] Catling, *Spinning Mule*, 33–34.
[96] *Spinning Mule*, 33–34.
[97] Williams, *36 Stewart Street, Bolton*, 4.
[98] Cohen, *American Management and British Labor*, 64–65. Catling, *Spinning Mule*, 82–83.

and the "little" piecer. Very long mules could have three piecers and short mules only one.[99] The operative, usually an adult man, controlled the pace of work, adjusted the machine, and ensured that it was in good condition. He also disciplined the piecers, whom he employed and paid.[100] Mule piecers were usually children, with the big piecer usually a teenager and the little piecer a few years his junior. They reconnected broken ends, added fresh roving to the machine, removed spun yarn, lubricated the mule, and cleaned the machinery and the spinning room.[101]

Work in the Factory

Placing common mules and water frames in factories allowed managers to centralize production, apply inanimate power, and control the workforce. The following subsections describe work locations and evaluate the components of job quality in factories.

The Workspace

The physical premises of mills provide the backdrop to occupational experience. The earliest mills were adapted residential buildings, and the first purpose-built factories of the late 18th century, set in rural areas with water power, were of modest size. A common design was 22 x 9 m and five stories, although there was substantial variation. Ceilings were low, generally around 2.75 meters, and sometimes as low as 1.8 meters.[102] The rare interior toilets

[99] John Jewkes and E. M. Gray, *Wages and Labour in the Lancashire Cotton Spinning Industry* (Manchester: Manchester University Press, 1935), 8–9.
[100] Catling, *Spinning Mule*, 161–63.
[101] "Development of the Spinning Mule," 35–36. Andrew Bullen, Terry Wyke, and Alan Fowler, *The Barefoot Aristocrats: A History of the Amalgamated Association of Operative Cotton Spinners* (Littleborough, Lancashire: G. Kelsall, 1987), 3–4.
[102] Edgar Jones, *Industrial Architecture in Britain, 1750–1939* (London: Batsford, 1985), 34–35, 47; Stanley D. Chapman, "The Arkwright Mills—Colquhoun's Census of 1788 and Archaeological Evidence,"

were open chutes that fed into collection points at ground level.[103] Early urban factories were brick structures in a U- or L-shape with an interior yard, and they were larger, 25–50 x 11.5–15 m. Ceiling heights were around 3 meters, with lower ceilings on higher floors that housed spinning machinery. These structures had larger windows with small, hinged panes to allow a little ventilation. Windows were sometimes omitted from the shorter walls and those on upper stories were smaller.[104] The early factories had modest lighting, poor sanitation, limited ventilation, and, as will be discussed further below, substantial fire risk.

Control in the Factory

Moving spinning into these new central locations enabled labor discipline.[105] The control disadvantages of factory work were obvious to contemporaries: workers could not choose their hours or pause for household tasks or childcare when they toiled in mills for 12 or more hours per day.[106] Managers imposed penalties for absenteeism or lateness, restraints on behavior, and corporal punishment.

The early mill owners used fines to ensure that their spinning rooms were fully staffed.[107] Samuel Oldknow warned his employees that "when any Hand is absent from Work

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Industrial Archaeology Review 6, no. 1 (1981). *Sir Richard Arkwright's Masson Mills Matlock Bath, Derbyshire* (Chesterfield: Merton, 2015), 18, 20. Adam Menuge, "The Cotton Mills of the Derbyshire Derwent and Its Tributaries," *Industrial Archaeology Review* 16, no. 1 (1993). Colum Giles and Ian H. Goodall, *Yorkshire Textile Mills: The Buildings of the Yorkshire Textile Industry, 1770–1930* (London: H.M.S.O, 1992), 23. Duncan Gurr, Julian Hunt, and David Collier, *The Cotton Mills of Oldham*, 3rd ed. (Oldham: Oldham Education & Leisure, 1998), 15.

[103] Anthony Calladine and Jean Fricker, *East Cheshire Textile Mills* (London: Royal Commission on the Historical Monuments of England, 1993), 48.

[104] Mike Williams and D. A. Farnie, *Cotton Mills in Greater Manchester* (Preston: Carnegie, 1992), 19, 51–56. Jones, *Industrial Architecture*, 54–55.

[105] Clark has argued that workers accepted coercion to raise output and wages. Gregory Clark, "Factory Discipline," *The Journal of Economic History* 54, no. 1 (1994).

[106] Wadsworth and Mann, *Cotton Trade*, 392.

[107] Arkwright family papers, quoted in R. S. Fitton, *The Arkwrights: Spinners of Fortune* (Manchester: Manchester University Press, 1989), 28. Stanley D. Chapman, *The Early Factory Masters: The Transition*

(unless unavoidably detained by Sickness, or Leave being first obtained), the same shall forfeit as many Hours of Work as have been lost; and if by the Job or Piece, after the Rate of 2s. 6d. per Day".[108] In Jedediah and William Strutt's mills, workers who left without notice forfeited unpaid earnings.[109] Children suffered especially harsh punishment: two girls who ran away from Samuel Greg's mill in Cheshire were punished with a week of solitary confinement and threatened that their hair would be cut off.[110] While punishment varied between mills, taking unauthorized absences generally resulted in a fine or dismissal.

The Strutts also imposed fines for poor quality or slow work, which meant workers had little control over their activities and pace of work. Employer control was not limited to these areas: the Strutts levied fines for "behaving improperly", "bad behaviour", "being saucy", and even "calling through the window to people in the street". Oldknow fined his workers one shilling if "any person, […] is heard to CURSE or SWEAR".[111] Thomas Fernley's Stockport mills prohibited "all shouting, loud talk, whistling, calling foul names, all mean and vulgar language, and every kind of indecency". His fines were much higher at 5 shillings per offense. Benjamin Gott and other Yorkshire woollen millowners prohibited drinking.[112] In hand spinning, workers suffered from slow work by receiving their piece rate earnings less frequently. Factory owners controlled work schedules, in continuous (water frame) mills, they

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to the Factory System in the Midlands Textile Industry (Newton Abbot: David & Charles, 1967), 156–57. See also Columbia University Rare Books and Manuscripts, Samuel Oldknow Papers, MS 0949, letters from John Blundell to Samuel Oldknow and letters from Clerkenwell Parish Overseers to Samuel Oldknow. Pollard, *The Genesis of Modern Management*, 182–83. Michael Huberman, *Escape from the Market: Negotiating Work in Lancashire* (Cambridge: Cambridge University Press, 1996), 21.

[108] Columbia University Rare Books and Manuscripts, Oldknow Papers, MS 0949, Notice to Employees, Mellor, 1 December 1797.

[109] Derbyshire Record Office, W. G. and J. Strutt Papers, D6948/6/75.

[110] Manchester Archives, R. Greg and Co. Ltd of Quarry Bank Mill Records, C5/8/22.

[111] Derbyshire Record Office, W. G. and J. Strutt Papers, D6948/6/75. Columbia University Rare Books and Manuscripts, Oldknow Papers, MS 0949, Notice to Employees, Mellor, 1 December 1797.

[112] Pollard, *The Genesis of Modern Management*, 195.

controlled the pace of work, and they restricted personal conduct. In intermittent (mule) spinning, the operative controlled much of the piecers' work, including the pace of spinning, and he could enforce this control with violence.[113]

Factory Spinning: Working Time

Mills scheduled six days of work per week, with only rare holidays such as Christmas Day. Oldknow's time books suggest a bimodal distribution of actual attendance: a small share of employees—around 10%—worked only one or two days per week, but the majority worked five or six days. Accounts of the Strutts' mills show similar attendance.[114] 12-hour or longer days were standard, some water-powered mills operated for 16-hour shifts, and night work was common.[115] Witnesses to the Sadler Committee stated that mills without pauper apprentices (whose hours were subject to increasing regulation from 1802) continued to work for 11–12 hours in the early 1830s.[116] By this time 6 AM to 7 PM was a common schedule, with

[113] See the section below on short-term health risks.

[114] Columbia University Rare Books and Manuscripts, Oldknow Papers, MS 0949, payroll records. Derbyshire Record Office, W. G. and J. Strutt Papers, D6948/6/1. University of Manchester Special Collections, John Rylands Library, Oldknow Papers, SO/12/7.

[115] Chapman, *Early Factory Masters*, 41, 175. R. S. Fitton and Alfred Powell Wadsworth, *The Strutts and the Arkwrights, 1758–1830: A Study of the Early Factory System* (Manchester: Manchester University Press, 1964), 226. UK Parliamentary Papers, *Report of the Minutes of Evidence Taken before the Select Committee on the State of the Children Employed in the Manufactories of the United Kingdom*, vol. III.235, Paper 397 (1816), 5–9, 18, 39, 240–43, 374–75. McConnel & Kennedy's mills worked from 5 AM to 7 PM in summer and 6 AM to 8 PM in winter, with one hour for dinner and fifteen minutes for breakfast and tea. University of Manchester Special Collections, John Rylands Library, McConnel & Kennedy and McConnel & Co. Papers, MCK/4/5. The Gregs' pauper apprentices worked nearly 13-hour days and only received a dinner hour two days per week. Manchester Archives, R. Greg and Co. Ltd of Quarry Bank Mill Records, C5/8/9/5. A 15-hour workday was "standard" in the Peel mills. Katrina Honeyman, *Child Workers in England, 1780–1820: Parish Apprentices and the Making of the Early Industrial Labour Force* (Aldershot: Ashgate, 2007), 189.

[116] Pauper apprentices were children reliant on their parish for support, and they were frequently contracted out to factories for employment to reduce the parish's costs. Apprentices' hours were limited (patchily) by legislation from 1802. B. L. Hutchins and A. Harrison, *A History of Factory Legislation*, 2nd ed. (London: P.S. King & Son, 1911), 16–18, 23–25, 30–33.

between 30 and 70 minutes of scheduled breaks. In exceptional cases, hours could be 3 AM to 9 PM in summer, although long shifts were usually 15 hours.[117] Factories also worked longer shifts to make up for time lost because of low water or problems with machinery.[118]

While some mills allowed brief meal breaks, other establishments required employees to work through the day and consume sustenance during their shifts.[119] Overseers made workers eat while standing and tending machinery, or demanded they clean for up to 30 minutes during mealtimes.[120] Some supervisors prevented workers from taking meal and toilet breaks entirely, and workers reported soiling themselves as a result.[121] Pauses were rare, brief, and at the discretion of managers.

Factory Spinning: Stability and Quality of Earnings

Factory account books show some absenteeism, but most operatives worked four to six days each week. As discussed above, there was some chance of summary dismissal in factories. Payment in early mills was made weekly, biweekly, or sometimes at even longer intervals.[122] The difficulty of obtaining coinage meant that, like workshop operatives, early factory workers were not always paid in cash on time. On some payment days workers

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[117] UK Parliamentary Papers, *Select Committee on Bill for Regulation of Factories*, vol. XV.1, Paper 706 (1832), 114, 24–25, 48, 57, 67, 99, 230, 349. There are many claims that 13 or more hours per day was a regular schedule, including William Chadwick, *Reminiscences of a Chief Constable* (London: J. Heywood, 1900), 9.

[118] UK Parliamentary Papers, *Select Committee on Factory Regulation*, XV.1, Paper 706, 232, 35, 52, 349. Some workers said factory owners kept false time (an early starting bell and a late closing bell) to lengthen the day. James Myles, *Chapters in the Life of a Dundee Factory Boy: An Autobiography* (Dundee: J. Myles, 1850), 13.

[119] Nathaniel Gould, *Information Concerning the State of Children Employed in Cotton Factories, Printed for the Use of the Members of Both Houses of Parliament* (Manchester: J. Gleave, 1818), 4.

[120] UK Parliamentary Papers, *Select Committee on Factory Regulation*, XV.1, Paper 706, 189, 230, 35, 84. *Select Committee on Factory Regulation*, XV.1, Paper 706, 235. Honeyman, *Child Workers*, 188.

[121] UK Parliamentary Papers, *Select Committee on Factory Regulation*, XV.1, Paper 706, 165.

[122] See the archival sources listed in the bibliography. Some factory owners asserted that factory work was more stable than outworking by the 1810s. Chapman, *Early Factory Masters*, 163.

received 60-day bills of exchange or truck.[123] Early mills also burned down and suffered from demand fluctuations with causes including the Revolutionary and Napoleonic Wars and the American Embargo. These crises bankrupted some firms and caused others to reduce hours. Work improved on this dimension after 1815, although interruptions to demand from tariff changes and foreign economic crises recurred through the 19th century.[124] Factory earnings were more stable than outwork pay, but there was still volatility.

Factory Spinning: Short-Term Health Risks

Entering factories exposed workers to the new danger of industrial accidents. Injuries were not documented systematically, but the preponderance of contemporary evidence suggests that they were common, though not always serious. Accidents usually occurred when workers or their clothing were caught by parts of the machinery. Many workers reported hand and arm injuries from fast-moving straps and interlocked gear teeth, and women and girls' hair could be caught in power transfer mechanisms. Fatigue, inexperience, the design of factory machinery, and carelessness all contributed to accidents that cost digits, limbs, or lives.[125] Belts running at high speed sliced through skin and turning gears easily crushed bones.[126] Most injuries were nonfatal but could be debilitating; they included broken

[123] Michael M. Edwards, *The Growth of the British Cotton Trade, 1780–1815* (Manchester: Manchester University Press, 1967), 230–33. Unwin, *Samuel Oldknow and the Arkwrights*, 176.
[124] Chapman, *Early Factory Masters*, 31, 163–64, 90. Jenkins and Ponting, *The British Wool Textile Industry*, 60–67, 126–28, 53–57, 229–39, 48–51.
[125] Arlidge, *Hygiene of Occupations*, 359–60. Jamie L. Bronstein, *Caught in the Machinery: Workplace Accidents and Injured Workers in Nineteenth-Century Britain* (Stanford: Stanford University Press, 2008), 69. UK Parliamentary Papers, *Royal Commission on Employment of Children in Factories, First Report*, vol. XX.1, Paper 450 (1833), Appendix 1, 1–2. *Select Committee on Children in Manufactories*, III.235, Paper 397, 180, 95, 297.
[126] *Select Committee on Factory Regulation*, XV.1, Paper 706, 142–43, 93, 233, 371, 77, 82.

fingers, arms, or legs, and occasionally the loss of appendages.[127] Long and exhausting hours made accidents more likely.[128] The outward and returning motion of the mule made it somewhat more dangerous than continuous machines: there were more exposed moving parts and some children cleaning between the carriage and creel were crushed by the return run.[129]

Wood interiors, wooden machinery, oil-soaked floors, cotton dust, and candle or lamplight for illumination produced high risks of fire.[130] There are no systematic statistics on mill fires, but anecdotal evidence suggests that they were common and could kill and injure many operatives.[131] In East Cheshire there were five mill-destroying fires between 1819 and 1856 in an area with only 15 mills.[132] To prevent fires, mills with cast iron framing were built as early as the 1790s and they were wrongly regarded as fireproof.[133] Between industrial accidents and fires, spinning factory work involved a far higher rate of accidental injury or death than hand spinning.

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[127] Gould, *The State of Children Employed in Cotton Factories*, 24. While the Factory Acts eventually required firms to compile accident data, the factory inspectors believed reports omitted many injuries. Bartrip and Burman, *Wounded Soldiers of Industry*, 11–15, 37–38. Bartrip and Burman review evidence on injuries in Stockport and Manchester from the 1830s and 1840s and suggest that 1–2.5% of workers suffered an injury that was serious enough to require medical attention each year. For comparison, *death* rates in mining were 5–8 per 1000 workers per year in the 1850s.

[128] UK Parliamentary Papers, *Select Committee on Factory Regulation*, XV.1, Paper 706, 319, 38–39, 82. Myles, *The Life of a Dundee Factory Boy*, 14.

[129] H. S. Richmond, "Safe-Guarding of Machinery," in *Dangerous Trades*, ed. Thomas Oliver (John Murray: London, 1902), 224–25.

[130] Jones, *Industrial Architecture*, 18–20, 35, 43–44. For a comparison with pre-industrial textile workplaces, see Stanley D. Chapman, "The Textile Factory before Arkwright: A Typology of Factory Development," *The Business History Review* 48, no. 4 (1974).

[131] For examples of mill fires see: W. G. Rimmer, *Marshalls of Leeds, Flax-Spinners, 1788–1886* (London: Cambridge University Press, 1960), 45. George Ingle, *Yorkshire Cotton: The Yorkshire Cotton Industry, 1780–1835* (Preston: Carnegie, 1997), 47.

[132] Calladine and Fricker, *East Cheshire Textile Mills*, 51.

[133] D. T. Jenkins, *The West Riding Wool Textile Industry, 1770–1835: A Study of Fixed Capital Formation* (Edington: Pasold Research Fund, 1975), 58–59. Richard L. Hills, *Power from Steam: A History of the Stationary Steam Engine* (Cambridge: Cambridge University Press, 1989), 87.

In addition to the fines for absenteeism and limits on personal conduct described above, factory supervision included violence, primarily aimed at piecers and younger frame or throstle operatives. The first Report of the Factory Inspectors contained lurid details of corporal punishment inflicted upon children in spinning mills.[134] Violence was more frequent towards the end of the day as overseers or mule operatives sought to maintain effort levels.[135] The most common punishment was "strapping": striking workers with a leather strap. Mule operatives and throstle overseers also used sticks, and other instances of punishment included shoving workers against nails in walls, smashing children's heads into spindles, flogging, and kicking.[136] Workers were most frequently beaten for poor piecing, but also for talking, sitting down, damaging machinery or tools, and lateness.[137]

Factory Spinning: Long-Term Health Risks

Early evidence of the factory work environment comes from the Manchester Board of Health in 1796. A Dr. Percival stated that diseases spread quickly in mills and workers suffered "from the debilitating effects of hot or impure air".[138] Spinning factories were kept warm and humid: temperatures from 80–100˚F (26–38˚C) were common in cotton spinning, and mills spinning fine yarn were usually hotter than coarse mills.[139] The doctors consulted

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[134] UK Parliamentary Papers, *Royal Commission on Employment of Children*, XX.1, Paper 450, 18–20.
[135] *Select Committee on Factory Regulation*, XV.1, Paper 706, 116–17, 25, 29, 49–52, 58, 65, 68–69, 74, 93, 232, 451–52. Honeyman, *Child Workers*, 182–85, 240–42.
[136] UK Parliamentary Papers, *Select Committee on Factory Regulation*, XV.1, Paper 706, 39, 99, 129, 45, 99, 237, 377, 89. William Marcroft, *The Marcroft Family* (Manchester: John Heywood, 1886), 33.
[137] UK Parliamentary Papers, *Select Committee on Factory Regulation*, XV.1, Paper 706, 147, 59, 66, 96.
[138] Hutchins and Harrison, *Factory Legislation*, 9–10.
[139] UK Parliamentary Papers, *Select Committee on Factory Regulation*, XV.1, Paper 706, 235, 52, 309, 24, 521. Arlidge, *Hygiene of Occupations*, 355–56, 63. John Tatham, "Dust-Producing Occupations," in *Dangerous Trades*, ed. Thomas Oliver (John Murray: London, 1902), 147. James Wheatley, "Manufacture of Cotton," in *Dangerous Trades*, ed. Thomas Oliver (John Murray: London, 1902). Temperatures in spinning factories may have increased across the 19th century, perhaps to allow for

by the Factory Inspectors offered a variety of views on the health effects of factory work, but many stated that the number of factory workers who attained old age was small.[140]

The primary long-term health risk was respiratory disease.[141] By the late 19th century, researchers determined that work in dusty, poorly-ventilated spinning rooms first produced "mill fever" within a few days or weeks of starting work, including "chills, nausea, and vomiting, quickly followed by headache, thirst, and heat of skin".[142] The longer-term effects of dust were very serious and potentially fatal. Exposure to cotton dust caused difficulty breathing, chest tightness, coughing, and spitting blood.[143] By the middle of the 19th century doctors considered textile fiber dust one of the more dangerous inhaled substances, and in the early 20th century medical professionals applied the term "byssinosis" to lung damage from cotton dust.[144] Also called "brown lung", it begins with the acute symptoms listed above, followed by reduced ventilatory capacity. After extended exposure, the acute symptoms become persistent and it can progress to chronic obstructive pulmonary disease, which

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finer spinning: the Sadler Committee witnesses (1831) reported temperatures in the 80–86˚F range; Wheatley (1902) reported temperatures "commonly above 90˚F, and occasionally above 100˚F".

[140] *PP 1834* "Supplementary Report of Factory Inspectors", Appendix D3, 230–232.

[141] UK Parliamentary Papers, *Royal Commission on Employment of Children in Factories Supplementary Reports, Part I*, vol. XIX, Paper 167 (1834), Appendix D3, 245. Another complaint was that early throstle frames required workers to stop a spindle for piecing by pressing one knee against it. Repetition injured workers' knees until the machinery was changed c. 1830 to allow workers to stop spindles by hand. *Royal Commission on Employment of Children in Factories Supplementary Reports, Part I*, XIX, Paper 167, D2, 200. Also *Select Committee on Factory Regulation*, XV.1, Paper 706, 115–16, 20, 27–28, 46, 53.

[142] Arlidge, *Hygiene of Occupations*, 375–76. Henry S. Purdon, "Flax and Linen," in *Dangerous Trades*, ed. Thomas Oliver (John Murray: London, 1902), 699.

[143] UK Parliamentary Papers, *Select Committee on Factory Regulation*, XV.1, Paper 706, 166. Arlidge, *Hygiene of Occupations*, 360.

[144] Jesse Leach, "Surat Cotton, as It Bodily Affects Operatives in Cotton Mills," *The Lancet* 82, no. 2101 (1863). Thomas Oliver, "Dust as a Cause of Occupation Disease," in *Dangerous Trades*, ed. Thomas Oliver (John Murray: London, 1902), 271–73. Because cardroom workers were most affected, they were the subjects of early systematic studies of respiratory illness, which found very high prevalence (over 70% of strippers and grinders affected). Investigations into spinners found that tuberculosis and bronchitis were common. Jacqueline K. Corn, *Response to Occupational Health Hazards: A Historical Perspective* (New York: Van Nostrand Reinhold, 1992), 155–59.

generally causes disability and death.[145] Work in spinning factories entailed a substantial risk of reduced long-term quality of life from chronic respiratory disease. Another much less serious ailment was skin irritation produced by frequent contact with oils used to lubricate machinery, or applied to fiber to reduce breakages.[146]

Factory Spinning: Intensity

Exhaustion was common among mill workers, especially children. Piecing required dexterity as well as endurance, particularly on longer mules: children reported walking up to 20 miles per day along a mule while piecing and cleaning.[147] Compounding the difficulty of long hours was the common requirement that workers remain standing throughout the day.[148] A child in a Bradford mill reported that he "could not keep [his] eyes open", and one in Huddersfield stated that his colleagues would have fallen asleep if the overseers did not beat them.[149] Sometimes children were so tired by their work that they missed meals.[150] Long hours were even more exhausting during night shifts.[151]

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[145] *Response to Occupational Health Hazards*, 148. Peter Neild, *Byssinosis: The Lancashire Disease* (London: Chartered Insurance Institute, 1982), 17–18.
[146] Arlidge, *Hygiene of Occupations*, 376. Purdon, "Flax and Linen," 699. Mule-spinners' cancer only arose when different oils were introduced for lubrication in the second half of the 19th century.
[147] Thomas Whittaker, *Life's Battles in Temperance Armour* (London: Hodder & Stoughton, 1884), 8. A lower estimate of walking distance was 10 miles per day. UK Parliamentary Papers, *Select Committee on Factory Regulation*, XV.1, Paper 706, 253–54.
[148] *Select Committee on Factory Regulation*, XV.1, Paper 706, 182, 308.
[149] Whittaker, *Life's Battles in Temperance Armour*, 58. UK Parliamentary Papers, *Select Committee on Factory Regulation*, XV.1, Paper 706, 124, 58, 60, 294–95. A more colorful description is Myles, *The Life of a Dundee Factory Boy*, 12–14.
[150] UK Parliamentary Papers, *Royal Commission on Employment of Children*, XX.1, Paper 450, 26–27.
[151] Honeyman, *Child Workers*, 240–42.

Factory Wages

Factory spinning wages were significantly higher than hand spinning earnings across all jobs, although some of the difference is explained by longer hours. At the high end of pay rates in continuous mills, frame spinners in Oldknow's Mellor establishments earned up to 3s. per day in the 1790s, with many earning in excess of 2s. a day, and Feinstein estimated wages for throstle (continuous) spinners at 4s. per week in 1790, rising to 9s. 1d. per week in 1806.[152] Even the lower earners in factories had wages well above the roughly 2s. per week earned by the average late-18th century hand spinner.[153] The wages in Tables 4–8 are based on evidence from more than 4000 observations of factory spinners' wages during the first decades of mechanized spinning. The data are from both continuous (frame) and intermittent (mule) establishments, although there is less evidence for the latter. These direct observations of wages suggest somewhat lower levels in the 1790s for continuous workers (roughly 9 pence per day), but still far higher earnings than available in hand spinning.[154] Moreover, the gains from higher labor productivity were unequally distributed: the best-paid workers were male overlookers, assistant overlookers, and mule operatives. The lowest-paid employees were women monitoring throstle frames and children piecing broken threads and cleaning under mules.

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[152] Columbia University Rare Books and Manuscripts, Oldknow Papers, MS 0949. Feinstein, "Wage-Earnings in Great Britain," 190.

[153] Humphries and Schneider, "Spinning the Industrial Revolution," Figure 7.

[154] Cf. Alexander Tertzakian, "Arkwright Revisited: Factory Work and Wages in Industrial Revolution Britain, 1786–1811," in *Economic History Society Annual Conference* (2022). Tertzakian finds a large distribution of pay rates from a much larger sample that includes the sources used in this study. An average from the data he presents is slightly lower than the 8.7d per day figure used here for continuous operatives in 1790. After 1800, Tables 4–8 use figures from George Henry Wood, *The History of Wages in the Cotton Trade During the Past Hundred Years* (London: Sherratt and Hughes, 1910).

Summary & Comparisons, c. 1750–1830

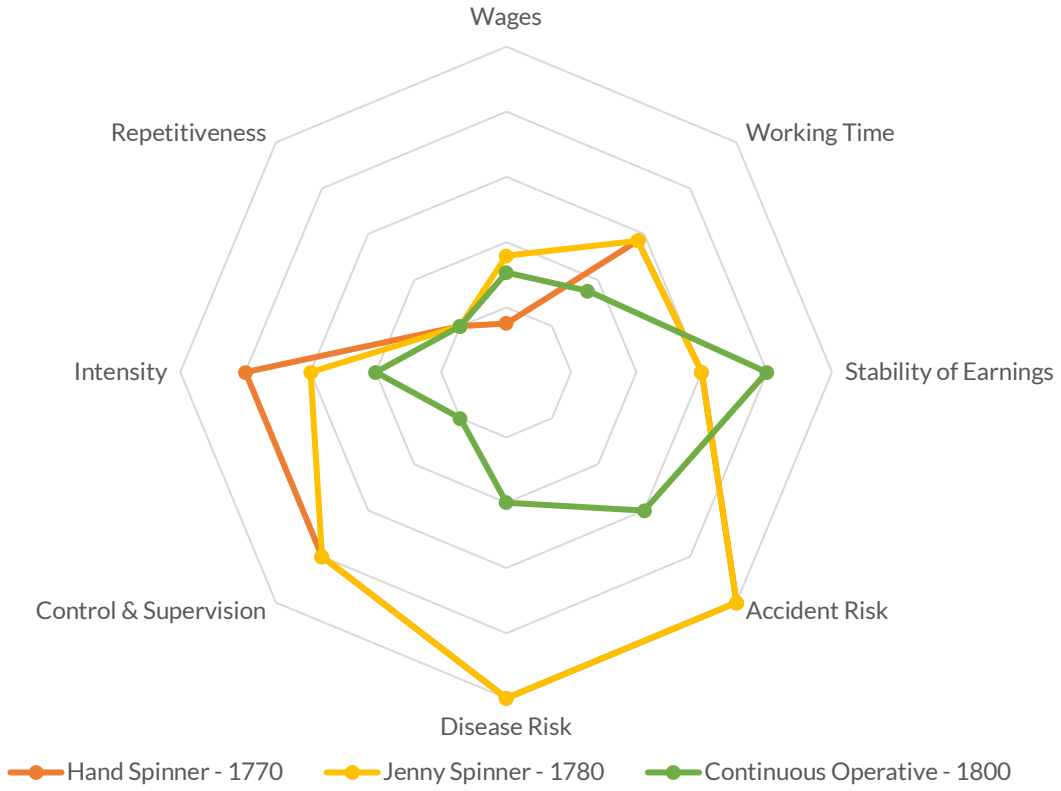
Hand spinning job quality changed little, although stability of earnings and incomes both fell as factory output replaced wheel work. Jenny spinning at home briefly combined the best aspects of hand spinning—high control and low occupational risks—with the best part of factory work—high wages—but it disappeared quickly. In factories, wages were high, but workers endured longer and more intense working hours, most employees had little control, and workers experienced a greater risk of injury and disease. The one common thread was that operative spinning remained repetitive, regardless of technology. Despite higher earnings, substantial turnover among factory workers suggests that higher wages may not have offset factory disamenities.[155] Table 1 (at the end of the paper) summarizes the qualitative evidence of components of job quality for each occupation. Tables 2–8 present the scores of each component of the HOQI and its final outputs.

Figures 1 and 2 below present cross-sections of job quality across the eight HOQI components for selected occupation-decade bin pairs. For wages and working time, they use transformed values (see Appendix II); the actual welfare ratios and hours estimated from evidence of days worked and standard schedules are presented in Tables 2–7. Points are closer to the center when a job is worse on a given dimension, and further from the center for better jobs. Figure 2 compares hand spinning, jenny spinning, and the most female-dominated factory job, operating or "tending" a water frame. This figure shows job quality for the options available to women who lost work in hand spinning and may have been able to shift into factory spinning. Most existing research on wellbeing has focused on only two elements of

[155] Chapman, *Early Factory Masters*, 185.

job quality—wages and working time—and has therefore not systematically incorporated the substantial tradeoffs of factory work that are encapsulated in the figure.

Figure 1: Job Quality for Hand, Jenny, and Throstle Spinners



Sources: See Tables 2–4

Figure 2 compares work across four factory jobs. It shows how the multidimensional approach of the HOQI illuminates the substantial inequality of non-wage elements of wellbeing in the early 19th century. The relationship between technological change and income inequality is well-known, but innovation's impacts on the inequality of other aspects of work have not been demonstrated systematically before.[156] Incorporating these elements shows that inequality rose on multiple dimensions of job-related wellbeing. A sectoral aggregation of job quality would conceal these important differences.

[156] E.g. Peter H. Lindert and Jeffrey G. Williamson, *Unequal Gains: American Growth and Inequality since 1700* (Princeton: Princeton University Press, 2016).

Figure 2: Job Quality, Factory Spinning c. 1830

Sources: See Tables 4–7

Job quality for hand spinners fell modestly as mechanization progressed, and there were large differences in job-related wellbeing across the new factory occupations. This major technological change increased inequality of wellbeing-at-work while creating new jobs. Many non-wage, non-hours aspects of work changed little within the same jobs.

The effect of spinning innovations on job quality was dramatically different for men and women. Hundreds of thousands of women who had been hand spinners lost work, and those who found employment in factories faced much worse conditions on several dimensions.[157] The massive scale of technological unemployment and the scarcity of information about the long-run health impacts of factory labor meant that women and

[157] Ivy Pinchbeck, *Women Workers and the Industrial Revolution, 1750–1850* (London: George Routledge & Sons, Ltd, 1930); Jane Humphries and Benjamin Schneider, "Gender Equality, Growth, and How a Technological Trap Destroyed Female Work," *Economic History of Developing Regions* 36, no. 3 (2021); Schneider, "Technological Unemployment in the Industrial Revolution."

children did not knowingly and willingly trade spinning wheels for the spinning rooms.[158] While wages were higher and more stable, hours were much longer, the work was more dangerous, exhausting, and they ceded control of the work process. In sharp contrast, men entered spinning in large numbers as well-paid mule operatives, overseers, and mechanics or engineers. Many of the male-dominated occupations were also safer, less intense, and had more control. This technological change was not neutral, but male-biased, although contemporaries may have claimed it was skill-biased.[159]

IX

This paper has argued that job quality is an important element of historical living standards. Using evidence of historical workers' perspectives about the capability-enhancing aspects of labor that they valued, it has derived components of good jobs in the past. It has outlined sources for historical job quality and how to measure these components in the past. The HOQI provides a framework to analyze changes in an important part of quality of life in the past. The approach enables analysis of the tradeoffs between occupations and the inequalities of work-related wellbeing, and the systematic criteria allow for long-term comparisons of the availability of decent work.

The case study in Sections VII and VIII shows how the HOQI can be used and demonstrates its value for understanding the multidimensional and distributional effects of occupational shifts. The HOQI clarifies the tradeoffs faced by workers who could find employment in British textile factories and illustrates the previously neglected non-wage

[158] Limited alternative work options and poor information about occupational safety are not considered in Williamson, "The British Standard of Living Debate."
[159] On skill-biased technical change, see e.g. Claudia Goldin and Lawrence F. Katz, *The Race between Education and Technology* (Cambridge: Belknap, 2008).

inequality of wellbeing in the factory division of labor. In this example, the best jobs were claimed by men, which made the mechanization of spinning a male-biased technical change.

An occupational quality approach has value in many areas. At its simplest, job quality research can reveal differences in work quality between historical occupations or regions, and changes across time. It can be used to further analyze the impacts of technology (as here), or to consider the effects of regulation, management practices, and worker representation systems.[160] For living standards research, systematic comparisons of non-wage dimensions of jobs provide a much broader perspective on historical quality of life than wages alone. At first glance, considering job quality complicates wage studies. However, a more holistic analysis of work provides a much firmer empirical basis for research on wages by ensuring that researchers are comparing similar occupations between locations and across time. Finally, the HOQI can be used to analyze employment discrimination on non-wage dimensions, which has been largely ignored by economic historians.

Work has always been much more than a wage. A multidimensional analysis of labor adds to the study of wellbeing in the past, enables holistic comparisons of historical jobs, and allows for analysis of the long-run determinants of decent work.

[160] Cf. *inter alia* Berg et al., "Risks to Job Quality from Digital Technologies."

Table 1: Summary of Qualitative Components of Occupational Quality in British Spinning, c. 1750–1830

Component	Hand Spinner	Jenny Spinner	Continuous Operative	Continuous Overseer	Common Mule Operative	Piecers (Big & Little)
Stability	Somewhat irregular earning, payment times, or payment instruments, and lower stability from c. 1800	Similar to hand spinners	Fairly stable: employment was generally consistent but with demand interruptions, some payment in bills or at long intervals	Very stable	Very stable on most dimensions, mule operatives were very rarely dismissed, especially by the 1830s	Similar to continuous operatives
Immediate Health Risks	Very low risk	Very low risk	Moderate: fairly frequent minor injuries and violence	Low risk (some accidents during machine adjustments)	Low risk (some accidents during machine adjustments)	Moderate: fairly frequent minor injuries and violence
Long-Term Health Risks	Very low risk (except for children)	Very low risk	Fairly high bysinossis risk from fiber dust	Fairly high bysinossis risk from fiber dust	Fairly high bysinossis risk from fiber dust	Fairly high bysinossis risk from fiber dust
Control	High, except for workhouse/spinning school spinners	High, except for workshop jenny spinners	Generally strict oversight of both work actions and personal conduct	High control over most actions, but fixed work location	High control over most tasks, but fixed work location	Minimal control for little piecers, slightly more for big piecers
Intensity	Low for most workers	Higher than for hand spinning but not extreme	Fairly high from constant standing and walking	Moderate: some standing, walking	Fairly high from constant standing, walking, and from putting up the mule	Fairly high from constant standing and walking
Repetitiveness	Very few biomechanical actions: high repetitiveness	Similar to hand spinners	Few, frequently repeated, actions	Some variety of supervisory and administrative tasks and actions	Modest variety of actions, including some maintenance	Modest variety of actions including piecing, doffing, carrying off spun yarn

Sources: See Sections VII and VIII.

Table 2: Occupational Quality for Adult Hand Spinners, 1750–1830

Year	Daily Wage (d)	Consumption Needs (d)	Welfare Ratio	*w*	Hours/Week	Working Time (*t*)	Stability (*s*)	Immediate Health Risks (*a*)	Long-Term Health Risks (*d*)	Control (*c*)	Intensity (*i*)	Repetitiveness (*r*)
1750	3.73	2.48	1.29	0.83	48.00	2.86	3	5	5	4	4	1
1760	3.56	2.66	1.15	0.76	48.00	2.86	3	5	5	4	4	1
1770	4.09	3.11	1.13	0.76	48.00	2.86	3	5	5	4	4	1
1780	3.06	3.09	0.85	0.62	48.00	2.86	3	5	5	4	4	1
1790	3.52	3.24	0.93	0.66	48.00	2.86	3	5	5	4	4	1
1800	4.39	4.59	0.82	0.60	48.00	2.86	2	5	5	4	4	1
1810	3.30	5.49	0.51	0.42	48.00	2.86	2	5	5	4	4	1
1830	2.29	4.07	0.48	0.39	48.00	2.86	2	5	5	4	4	1

Sources for Tables 2–8: See the text, Table 1, Appendix II, manuscript and primary sources in the Bibliography, Allen, "London Prices & Wages Dataset", and Wood, *History of Wages in the Cotton Trade* (1910).

Notes for Tables 2–8: Decade gaps (e.g. 1820 in Table 1) are periods for which there is no wage data. The *w* and t columns are transformed values, presented in Figures 1 and 2, using formulas [1] and [2] in Appendix I. For Hand Spinners, Jenny Spinners, and Continuous Operatives, Consumption Needs are scaled to 85% of an adult male basket; for Little Piecers, Consumption Needs are scaled to 60% (see Appendix II and the text). Continuous Operatives and Overseers worked on water frames or throstles. Hours/Week figures for factory workers are based on scheduled hours (described in the text) and archival evidence of average days worked per week.

Table 3: Occupational Quality for Jenny Spinners, 1770–90

Year	Daily Wage (d)	CN (d)	Welfare Ratio	*w*	Hours/Week	Working Time (*t*)	Stability (*s*)	Immediate Health Risks (*a*)	Long-Term Health Risks (*d*)	Control (*c*)	Intensity (*i*)	Repetitiveness (*r*)
1770	13.50	3.11	3.72	1.55	48.00	2.86	3	5	5	4	3	1
1780	18.00	3.09	5.00	1.79	48.00	2.86	3	5	5	4	3	1
1790	17.00	3.24	4.50	1.70	48.00	2.86	3	5	5	4	3	1

Table 4: Occupational Quality for Continuous (Water Frame or Throstle) Operatives, 1790–1830

Year	Daily Wage (d)	CN (d)	Welfare Ratio	*w*	Hours/Week	Working Time (*t*)	Stability (*s*)	Immediate Health Risks (*a*)	Long-Term Health Risks (*d*)	Control (*c*)	Intensity (*i*)	Repetitiveness (*r*)
1790	8.70	3.24	2.21	1.17	69.24	1.77	4	3	2	1	2	1
1800	20.25	4.59	3.63	1.53	69.24	1.77	4	3	2	1	2	1
1810	16.54	5.49	2.48	1.25	69.24	1.77	4	3	2	1	2	1
1820	19.71	4.65	3.49	1.50	69.24	1.77	4	3	2	1	2	1
1830	16.90	4.07	3.43	1.49	69.24	1.77	4	3	2	1	2	1

Table 5: Occupational Quality for Continuous Overseers, 1790–1830

Year	Daily Wage (d)	CN (d)	Welfare Ratio	*w*	Hours/Week	Working Time (*t*)	Stability (*s*)	Immediate Health Risks (*a*)	Long-Term Health Risks (*d*)	Control (*c*)	Intensity (*i*)	Repetitiveness (*r*)
1790	24.60	3.81	5.44	1.86	70.80	1.61	5	4	2	4	3	3
1810	47.90	6.46	6.24	1.98	70.80	1.61	5	4	2	4	3	3
1820	36.00	5.47	5.54	1.88	70.80	1.61	5	4	2	4	3	3
1830	40.00	4.78	7.05	2.09	70.80	1.61	5	4	2	4	3	3

Table 6: Occupational Quality for Common Mule Operatives, 1790–1830

Year	Daily Wage (d)	CN (d)	Welfare Ratio	*w*	Hours/Week	Working Time (*t*)	Stability (*s*)	Immediate Health Risks (*a*)	Long-Term Health Risks (*d*)	Control (*c*)	Intensity (*i*)	Repetitiveness (*r*)
1790	44.00	3.81	9.07	2.31	66.00	2.03	4	4	2	4	2	2
1800	47.5	5.40	6.91	2.07	66.00	2.03	4	4	2	4	2	2
1810	48.00	6.46	5.83	1.92	66.00	2.03	4	4	2	4	2	2
1820	60.00	5.47	8.61	2.26	66.00	2.03	4	4	2	4	2	2
1830	60.00	4.78	9.86	2.38	66.00	2.03	5	4	2	4	2	2

Table 7: Occupational Quality for Big Piecers, 1810–30

Year	Daily Wage (d)	CN (d)	Welfare Ratio	*w*	Hours/Week	Working Time (*t*)	Stability (*s*)	Immediate Health Risks (*a*)	Long-Term Health Risks (*d*)	Control (*c*)	Intensity (*i*)	Repetitiveness (*r*)
1810	20.00	6.46	2.55	1.27	69.24	1.77	4	3	2	2	2	2
1830	18.00	4.78	3.10	1.41	69.24	1.77	4	3	2	2	2	2

Table 8: Occupational Quality for Little Piecers, 1790–1830

Year	Daily Wage (d)	CN (d)	Welfare Ratio	*w*	Hours/Week	Working Time (*t*)	Stability (*s*)	Immediate Health Risks (*a*)	Long-Term Health Risks (*d*)	Control (*c*)	Intensity (*i*)	Repetitiveness (*r*)
1790	8.00	2.29	2.88	1.36	69.24	1.77	4	3	2	1	2	2
1800	8.64	3.24	2.20	1.16	69.24	1.77	4	3	2	1	2	2
1830	11.50	2.87	3.30	1.46	69.24	1.77	4	3	2	1	2	2

Appendix I

This appendix discusses alternative measurement approaches, provides more detail about the choices used in the index, and notes the transformations used for the graphical representation of the *w* and *t* components in Section VIII.

1. Consumption Demands

When analyzing real wages with welfare ratios, the respectability basket used in the paper is scaled based on the modal type of worker in an occupation. It divides occupations into three categories: jobs in which most workers were adult men (100% basket), adult women (85% basket), or children (60% basket) following Humphries (2013). This increases the *w* value for occupations that were dominated by women or children, compared to *w* values for occupations dominated by men. Applying the same basket to all jobs would reduce the *w* value for jobs primarily employing women and children. Applying the same basket to all occupations is appealing because it standardizes the calculation and means researchers will not need to determine what kinds of workers were employed in the occupation. However, it is not adopted because it would run counter to the capability and positive freedom approach of Sen (1984, 1988) applied here: in terms of income, the capability of different workers to achieve a good life varies based on their nutritional demands.

We can also consider one other alternative standard. The basket could be scaled to account for different wage expectations based on a different type of modal worker. For example, an occupation socially coded as "skilled" could have a higher basket denominator to account for higher wage expectations of skilled workers. This would produce lower *w* values for jobs that have high relative pay and employ workers with high salary expectations; skilled jobs would appear to be lower-quality on this dimension than using the approach outlined in the paper. There are several problems with this approach. First, it would require data on wage *expectations* for different occupations and/or skill levels, which would sharply limit the use of the full set of HOQI dimensions for skilled jobs. While economic historians have explored differences in skill premia by occupation, period, and location, these have usually been explained by the supply of and demand for skills (e.g. Goldin & Katz 2008, Frankema & van Waijenburg 2019), and not workers' expectations about compensation. Second, expectations may adapt to changing wage premia, and finding data on such adaptation will be exceedingly difficult. Finally, while wages relative to expectations may shape subjective wellbeing (satisfaction or utility), a skilled occupation with a higher wage than an unskilled occupation confers a nutritional and therefore a capability advantage, regardless of expectations.

2. Alternative Measurement for Income and Working Time

A different type of alternative construction proposes that instead of measuring income and working time, the first two components should be discarded and an hourly income should be substituted. The main attraction of this approach is *prima facie* simplicity. However, it dispenses with the capability element of the component selection discussed in Section III, by ignoring the measurement of freedom associated with time distribution of labor versus non-labor hours. It also implicitly assumes that workers could (conditional on being employed)

choose their hours of labor, which was not the case for many historical occupations—or, indeed, for present occupations. More importantly, the reduced non-labor time available to workers, and the concomitant limitation on their capabilities, would be ignored.

3. Transformations

Transforming quantitative information into index values is a much-discussed challenge of composite indices. While the HDI uses a concave transformation for income, Prados de la Escosura (2022) has advocated for a convex transformation. As the components of the HOQI Are not aggregated, transformation is only performed to harmonize values for components w and t for presentation alongside the other components.

Here we present transformations for the wage and working time components, which are used in Section VIII. Equation [1] ensures that occupations with welfare ratios less than one do not produce negative transformed values. Following the HDI, equation [2] assumes a maximum plausible working week of 80 hours. Both are transformed with logarithms to produce diminishing returns to either increasing income or reductions in working hours when beginning from a shorter work week.

[1] $w = \ln(WR + 1)$

[2] $t = \ln\left(\frac{80-AH}{5} + 1\right)$

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Appendix II

Historical Occupational Quality Index Codebook

Updated November 2023

Table of Contents

1. Introduction to the Historical Occupational Quality Index

The Historical Occupational Quality Index (HOQI) is a structured multidimensional approach to measure the quality of occupations in the past. The components of the index are based on qualitative and quantitative sources that provide historical workers' perspectives about the aspects of jobs that they valued, that contributed to capability, and that can be compared using historical evidence. This document is a guide to the methodology for computing the quantitative elements and rubrics for scoring qualitative evidence.

1.1 Occupations

The HOQI unit of analysis is the occupation. An occupation is defined as a set of tasks that a person completes for non-leisure reasons, i.e. the individual engages in these tasks *at least in part* to ensure their material survival. The definition encompasses paid, market-facing employment, unpaid (e.g. production for use or household) work, and forced labor. Many occupations will incorporate the same tasks or be composed of related tasks, and occupational titles may change over time despite including similar or even identical tasks. Defining when a worker with multiple jobs stops one occupation and starts another may be determined by one or more of: 1) the employer/source of payment (if there is one); 2) the occupational title; 3) contextual information about location of work and organization (e.g. does the worker move from one worksite to another, collaborate with different colleagues, etc.).

1.2 Timing of Measurement

The second bounding of the HOQI is the timing of observation and measurement. Using historical sources makes precise measurement for a specific date challenging, and the scale of this challenge is inversely related to the amount of data and descriptive evidence available for the occupation(s) under consideration. Measuring year-by-year changes will primarily track changes in the w and t components, because shifts in these components are more easily observed in historical sources. The other six components will generally be more useful for assessing changes over longer periods (e.g. several decades), using benchmark years or multi-year/decadal bins.

1.3 Locations and Employers

The third element that bounds use of the HOQI is the location and/or employer. Job quality for an occupation may vary over space as well as time. The appropriate geographic or firm unit of observation will depend on the historical context in which the HOQI is applied. Researchers may attempt to ascertain if there were meaningful differences in any of the index components between firms or across locations in the analysis (e.g. intra-firm differences in occupational safety, regional pay differentials).

1.4 Actions

The *r* component requires an understanding of the activity composition of the occupation, defined in terms of actions. We use "action" as a sub-unit of the US Department of Labor's concept of an "element" of a job. An "action" is defined here as a physical act (e.g. pulling a rope) or cognitive process (mental addition) or a combination of the two (writing a sentence by hand). An action will end with some change in the state of the worker's surroundings or a nonphysical output (an idea for how to improve a machine).

1.5 Assumption of Invariance Over Time

Capturing changes in the qualitative components is challenging, even more so when there are few sources. A qualitative score for a benchmark year or year bin should be maintained *until a later point at which there is evidence that a different score should be assigned*. Put another way, the HOQI assumes that absence of evidence meant no change in that component of job quality. This assumption is included to avoid the intrusion of strong *a priori* views about occupational changes, whether positive or negative, and to ensure that changes in components can be clearly and directly linked to evidence in historical sources.

2. Components of the HOQI

2.1 Real Compensation – *w*

Real Compensation, which uses the symbol *w*, is computed in several steps.

Total Compensation

The first step is to collect data on Total Compensation [TC]: the total market value of all cash and non-cash remuneration provided to the worker, including perquisites, payments in-kind, and deferred compensation (pensions). All compensation should be converted into current nominal values; deferred compensation should be given a present value at the date of the point-in-time analysis based on a discounting of future income that accounts for historical life expectancy. The unit of analysis for real compensation is one week. For occupations that show substantial variation in Total Compensation over the year, Total Compensation should be the arithmetic mean average for the period when work was available. Variation in earnings is incorporated into occupational quality in the Stability of Earnings [*s*] measure. Total Compensation should be *actual amounts earned* and not probable day rates. Care should be taken to ensure that the amount recorded in historical sources is the actual remuneration to a worker and not payment to an intermediary (see Stephenson 2018).

Consumption Needs

Total Compensation is adjusted for the cost of living using Consumption Needs [CN]. Consumption Needs are measured for the geographical unit of analysis (when exploring regional variation in occupational quality, it will be necessary to gather local price data) at the point-in-time of the occupational quality measurement using Allen's respectability basket and Humphries' (2013) revisions. Just as the unit of analysis for Total Compensation is the week, so is the unit for Consumption Needs. This will normally mean a mismatch between the number of days worked (likely between five and six for many historical occupations) and the seven-day week. The quantity of goods to be purchased in the basket is adjusted based on the metabolic category of worker engaged in the occupation.

CN Conversion Factors

Adult male = 100% basket

Adult female = 85%

Children = 60%

If the occupation includes many categories of workers, the occupational quality scores should be calculated separately for each. Whenever possible, the prices in the basket

should be consumer-facing prices; institutional prices should be converted to retail prices using contextual evidence about markup levels.

Once data for TC and CN have been collected, it is possible to compute the Welfare Ratio [WR].

Formula for WR

$$\mathrm{WR} = \frac{\mathrm{TC}}{\mathrm{CN}}$$

If the components of the index are presented in graphical form, the WR may be transformed. The formula below incorporates diminishing returns from increasing income levels, but avoids negative values from using logarithms when WR < 1. The lowest possible value of w is 1, to match the lowest possible value for the qualitative components.

Formula for w

$$w = \ln(WR + 1)$$

2.2 Working Time – t

Figures for historical working time, especially in the pre-industrial period, are notoriously difficult to locate in primary sources. Therefore, this element may require estimations based on descriptive evidence, possibly drawn from similar jobs or using conventional expectations of the length of the working day. When accounts of working time only provide days worked, these should be matched with qualitative sources about standard working hours. In this way average working hours can be estimated to at least the day or half-day. It may also be possible to calculate standard working hours when the primary source provides an occasional entry for hourly work.

As with the Real Compensation component, Average Hours [AH] should be measured as *average hours actually worked per week*, and *not* standard scheduled hours.

If the components are presented in graphical form, this component may also be transformed. The transformation approach is derived from the Human Development Index, which uses assumed minimum and maximum values for components such as life expectancy and scales the index values between 1 and 0. In this case, the assumed maximum value of AH is 80, and plausible minimum is 0. As for the w transformation, it produces diminishing returns to equal reductions in working hours when the initial level of hours is lower.

Formula for t

$$t = \ln\left(\frac{80 - AH}{5} + 1\right)$$

2.3 Stability and Quality of Earnings – *s*

The *s* component measures the likelihood that a worker consistently receives the full compensation that forms part of the *w* component and how frequently the worker is paid. Less frequent (even if regular) payment, missed payments, payment in money instruments with limited acceptance, discounted instruments, or ease of dismissal (which disrupts earnings) are all factors that will reduce the score for this component. For piece rate occupations, the equivalent of frequent payment is timely payment. Since piece rate work will have started before a bill or invoice is delivered for payment, more than a one-week delay in payment should be considered delayed payment (equivalent to monthly payment), and more than two weeks a long delay in payment (equivalent to quarterly wage payment).

Table 1: Contributing Factors to *s*

Positive Contributing Factors	Negative Contributing Factors
• More frequent or timely payment • Consistent payment • Consistent level of earnings • Low probability of dismissal • Full payment of earnings • Readily usable form of payment	• Less frequent or delayed (e.g. quarterly) payment • Irregular/unpredictable payment • Varying earning levels over a year • High probability of dismissal • Partial payment of earnings • Payment form with limited use

Table 2: Scoring Rubric for *s*

Score	Criteria
5	Very stable earnings. Consistent, frequent, and full payment. Job security is high (firing/layoff/redundancy is very unlikely).
4	Stable earnings. One of the four positive contributing factors is absent, or payment is provided less than once per month.
3	Payment is less frequent (monthly) and either inconsistent or job security is low; alternatively, dismissal probability is moderate and payment is provided less than once a month.
2	Somewhat unstable earnings. No more than one of the positive contributing factors is present.
1	Very unstable earnings. Inconsistent payment at long intervals and little or no job security.

2.4 Short-Term Health Risks – *a*

The *a* component is a qualitative probability component. It captures the chance of suffering a substantial injury (physical or psychological) on the job and the severity of the potential injury (including death). The higher the chance of injury and the more serious the potential injury, the lower the *a* score. Death from an occupational accident is the worst possible outcome. This component also accounts for injuries caused by intentional acts of supervisors, such as corporal punishment of child workers. Any physical harm caused in the course of a work shift, or psychological harm with immediate implications, should be considered as part of the *a* component.

Table 3: Scoring Rubric for *a*

Score	Criteria
5	No occupational risk. No evidence of death or serious injury, minimal chance of minor injuries.
4	Low occupational risk. No evidence of death or serious injury, some chance of minor injuries.
3	Moderate occupational risk. Death or serious injury is rare, but minor injuries are common.
2	Fairly high occupational risk. Death or serious injury is frequent, or a majority of workers suffer minor injuries.
1	High occupational risk. Many workers are killed or seriously injured and/or nearly all workers suffer minor injuries.

2.5 Long-Term Health Risks – *d*

The *d* component captures the chance that a worker will suffer a reduction in their life expectancy or a serious long-term illness (including mental illness) because of their occupation. As in the *a* component, more serious ailments (those that shorten life expectancy or have a greater impact on quality of life) and the greater probability of suffering such an illness will lower the *d* score. Psychological traumas with long-term impacts (beyond one year) should be incorporated in this component rather than the *a* component. As in other components of the HOQI, there may be compounding of multiple deleterious aspects of jobs: work that is dangerous and has a low *a* score may also cause mental illness and a low *d* score.

Table 4: Scoring Rubric for *d*

Score	Criteria
5	No occupational risk. No evidence that this occupation leads to a reduction in life expectancy or reduced quality of life.
4	Low occupational risk. No evidence of a reduction in life expectancy, but a small chance of conditions that may lower quality of life in the long run.
3	Moderate occupational risk. Little evidence of a reduction in life expectancy, but some workers may experience a lower quality of life.
2	Fairly high occupational risk. Some workers suffer a reduction in life expectancy, and/or many have a condition that lowers their quality of life.
1	High occupational risk. Many workers suffer a reduction in life expectancy and/or nearly all workers experience conditions that lower quality of life.

2.6 Control & Supervision – *c*

The *c* component captures worker flexibility in timing and organization of activities. This component implicitly incorporates that the activities and location for an occupation are given by the job requirements. Example: a mason is employed to build a brick wall, which is a fixed outcome; if he has discretion in how he organizes his tools and the order in which he completes his tasks, this occupation should receive a higher score. If an occupation has flexibility in the location and schedule of work it should be scored higher, lack of options in these two areas should mean an occupation receives a lower score.

Note: Discipline that may cause physical or psychological harm is incorporated in the *a* component.

Table 5: Scoring Rubric for *c*

Score	Criteria
5	Complete worker control. The worker in the occupation under consideration has full discretion over the organization of their work, as well as where and when to complete it.
4	Predominant worker control. The worker controls most of their activities, the organization of those activities, and has flexibility in the timing or location of their work.
3	Moderate worker control. The worker controls either the manner of completion or the organization of activities; they may have some control over when or where they work.
2	Low worker control. The worker controls some, but few of their activities, and little control over when or where they work.
1	No worker control. The ordering and manner of action is entirely determined by a supervisor. No control over the place and time of work.

2.7 Intensity – *i*

The intensity *i* of an occupation is the level and frequency of exhaustion that a typical worker experiences by the end of one day of work. This intentionally compounds the component *t* as it reflects both the lack of time available to the worker to complete non-work tasks or enjoy leisure, as well as the worker's exhaustion-induced reduction in physical and mental capacity. Intensity captures both physical and mental exhaustion of workers, and they should be given equal consideration when applying evidence to the rubric below. To the extent that irregular hours (e.g. night shifts) increase exhaustion, such patterns should be incorporated into scoring a job for *i*.

Table 6: Scoring Rubric for *i*

Score	Criteria
5	Very low intensity. Workers do not experience physical or mental exhaustion at the end of their shift.
4	Low intensity. Workers rarely experience physical or mental exhaustion at the end of their shift, and never both.
3	Moderate intensity. Workers occasionally experience physical or mental exhaustion at the end of their shift, but very rarely both.
2	High intensity. Workers are frequently physically or mentally exhausted at the completion of their working shift.
1	Very high intensity. Worker exhaustion (both physical and mental) by the completion of their shift is very common, or one type of exhaustion is universal.

2.8 Repetitiveness – *r*

The frequency with which workers complete the same actions is captured in the *r* component. This requires an understanding of the action composition of the job. To score *r*, the job should be broken down into its tasks, elements, and actions (see discussion and definition in 1.4 above) and the researcher should assess the frequency with which each action is repeated using qualitative sources. A highly repetitive occupation is likely to be one in which there are fewer than ten core physical or cognitive acts that are repeated frequently.

Table 7: Scoring Rubric for *r*

Score	Criteria
5	Highly varied occupation. The occupation consists of many different actions that the worker completes with minimal replication during a shift.
4	Varied occupation. The occupation consists of many actions, but the worker has to complete a few actions repeatedly.
3	Somewhat varied occupation. The occupation consists of many actions, but the worker has to complete a few very frequently; OR the occupation consists of a few actions, but the amount of repetition is lower.
2	Fairly repetitive occupation. The occupation consists of few actions and the worker repeats some of them frequently.
1	Highly repetitive occupation. The occupation consists of very few actions that the worker repeats many times during a shift.

3. Sources for the HOQI

The goal of the HOQI is to produce the most accurate possible picture of jobs in the past, conditional on available sources, and allowing for comparability. Whenever possible, researchers attempting to reconstruct job quality should prefer primary sources to secondary material, while retaining awareness of the potential biases of their sources. Biases can be obvious—firms may have tried to portray their supervision as gentler or more paternalistic than it really was—or opaque—work rules may not have been enforced and payments listed in bills may overstate actual outgoings to workers. This section outlines potential sources that scholars may use to compute or score components of the HOQI, in addition to material available in secondary sources.

3.1 Real Compensation

The best sources for Total Compensation are the original payment records (account books, vouchers, pay slips, etc.) produced by an employer. Individual workers' account books (also described in some contexts as day books or ledgers) can also provide a useful check on institutional sources, allowing researchers to ensure that the amounts recorded in company accounts were actually paid out in full on the specified dates. While scholars may want to use existing, published data on wages, care should be taken to check this data against original material if it was not collected directly from company or individual evidence (e.g. if it is compiled from surveys). Pensions were frequently recorded in separate accounts from payroll, so this information may need to be collected from other sources. Qualitative evidence and business correspondence may also provide information about perquisites or the use of truck. When gathering data on payments for piece work (payment-by-output), researchers should estimate productivity by using dates of payment and output produced and use this to calculate effectively weekly wages for Total Compensation.

Consumption Needs can be calculated either directly from original sources or using published material. While the former is preferable (to ensure the use of genuine consumer prices and goods), it necessitates extensive data collection. Therefore, if there are reliable published sources that provide prices for the respectability basket, they may be an acceptable substitute.

3.2 Working Time

The sources for Working Time will frequently be the same as those for Total Compensation. Most payment-by-time (although not all) will include records of days and sometimes hours worked. When accounts do not itemize hours worked, contemporary qualitative sources such as diaries may describe standard hours. Institutional sources such as company rule books or managerial correspondence can also provide this information. It may also be possible to work backwards from occasional instances where workers are paid hourly to compute the length of a working day by

comparing hourly and daily pay rates. Work on piece rates will generally not provide direct evidence of working time, so researchers should use the alternative approaches suggested above in such cases.

3.3 Stability of Earnings

Payment dates are normally listed in account books or on vouchers, so if it is possible to construct a wage series from such sources, it should be relatively straightforward to determine the frequency of payment (although here caution should be taken to distinguish dates *worked* and *dates of payment*). Long delays between work and payment must be incorporated into the score, as described in Table 1. Incomplete payment of earnings may also be described in account books, in business correspondence, or in sources produced by workers (diaries, petitions, union materials). Discipline books or general employment records can record dismissals, and it is also possible to track consistency of earnings by transcribing long samples from account books and tracking which employees disappear.

3.4 Short-Term Health Risks

Historians are limited to the records kept by contemporaries, but if there are accident books available for the occupation(s) under consideration, these will be the first and best option. Insurers sometimes kept records of injuries when they had to pay claims, and there may also be union records that detail the frequency and severity of accidents. Factory inspectors or other government regulators are a further source that can provide good quality and comprehensive information. In addition to these sources, diaries and letters from workers or business correspondence (e.g. company day books and memoranda books) can supply information about the types, severity, and frequency of accidents. Doctors' records for business with companies in the sector under consideration are an uncommon but very useful source.

3.5 Long-Term Health Risks

Job risks in the long run may not be recorded in company materials, but they can appear in workers' evidence (diaries, memoirs, letters), especially items produced at the end of lives or careers. If the technical components of industries change relatively little, it may be possible to use industrial health studies from the 20th century to capture some of these risks. Occasionally the possibility of industrial disease may also appear as complaints in government reports or the writings of medical professionals.

3.6 Control & Supervision

The initial source for this component should, if available, be company rule books or other records of conduct and discipline. Business correspondence can also illuminate what

behaviors firms permitted and how they managed their employees. Whenever possible, these sources should be supplemented with worker-side information about supervision in case rules were not actually followed or there were informal limitations on conduct not specified in rule books.

3.7 Intensity

The purpose of this component is to capture levels of exhaustion, which necessitates the use of worker-side qualitative sources. Sources mentioned above including diaries, memoirs, and letters will be useful, as well as evidence provided to government regulators. The second-hand accounts of work inspectors or other observers can also be a viable source. If necessary, it may be necessary to extrapolate from other types of evidence: e.g. if job tasks are described as hard physical labor and employees have little control, it is reasonable to expect that workers suffered high levels of physical exhaustion. Similarly, work in trauma-inducing circumstances (military service, emergency medicine) would likely produce mental exhaustion. In these cases, researchers should describe evidence of the challenging tasks, trauma, etc. that produce the score assigned to the occupation.

3.8 Repetitiveness

The best sources for repetitiveness are trade handbooks that describe the activities required in an occupation. Sometimes account books provide basic information about work actions (although this varies widely by sector). A secondary option is to consult historical re-enactors who carry out the same processes for museums or historical societies (these people can also provide information for other job quality components, although their views should be corroborated with historical material). Company rule books may also be helpful, as well as publications from the industry press. Diaries and business correspondence occasionally provide descriptions of work activities.

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is edited by

Victoria Gierok,
Nuffield College, Oxford, OX1 1NF