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Optimism or pessimism? A composite view on English living standards during the Industrial Revolution

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This article examines the evolution of English living standards during the early phase of industrialization (1760–1850). We take a multi-dimensional perspective and apply an indicator that combines four key dimensions of well-being: material living standards, health, working time, and inequality. Contrary to other composite measures of well-being, our welfare metric draws on standard economic theory to aggregate its underlying components. We find decreasing welfare during the late eighteenth century due to rising working time and income inequality, despite improving health. After 1800, workers' conditions improved when real wages started to rise, although the cumulative effect was not substantial by 1850.

1. Introduction

The consequences of industrialization for the living standards of the mass of the population have been intensively debated ever since the days of William Blake, Karl Marx, and Charles Dickens. Over a period of roughly 100 years after ca. 1750, Great Britain set the basis for a dynamic and self-sustained process of economic development that eventually would improve the lives of millions of people. Although the positive outcomes of this process for human well-being since 1850 are not disputed, the same does not apply to the century between 1750 and 1850.

On one side, a branch of the literature, represented by the so-called *optimists*, has argued that the benefits of improved methods of production trickled down in the form of substantial real wage increases after the Napoleonic wars (Lindert & Williamson, 1983a, 1985; Clark, 2005). On the other side, the so-called *pessimists* have found that the increase in real wages was much less pronounced than what the optimists claim (Feinstein, 1998; Allen, 2001, 2009). Further supporting the pessimists' case, health levels stagnated—and even deteriorated in urban areas—after the 1820s (Wrigley, Davies, Oeppen, & Schofield, 1997; Szreter & Mooney, 1998); annual working time reached new heights in the 1830s (Voth, 2000, 2001; Allen & Weisdorf, 2011; Humphries & Weisdorf, 2019); and inequality remained at high levels (Broadberry, Campbell, Klein, Overton, & van Leeuwen, 2015; Allen, 2019).[1]

[1] Our categorization of pessimists and optimists differs from that of an earlier literature. Hobsbawm (1957, p. 46) refers to the classical view (e.g., Ricardo, Marx) as the pessimistic one. Moreover, his degree of pessimism is larger

The lack of consensus on the evolution of living standards during the classical years of the industrial revolution partially stems from the study of a large number of indicators individually.[2] This can be problematic because these variables often exhibit opposite trends, thus having disparate implications for the analysis of well-being (Voth, 2004, p. 269). Taking a more encompassing approach, a different literature has built composite indices of well-being combining information on a number of key aspects of people's lives into a single metric such as the Human Development Index (HDI) or the Dasgupta and Weale (DW) index (Crafts, 1997; Floud & Harris, 1997; Voth, 2004). However, these attempts present two methodological limitations. First, the weighting scheme of the HDI and similar measures tends to show convergence due to the linear transformation that it applies to its social dimensions (Prados de la Escosura, 2015; Gallardo-Albarrán, 2019). Second, some of the indicators applied in the literature do not include key aspects of workers' lives that underwent important changes during the period 1760–1850 and influenced their living standards such as working time or inequality (Voth, 2001; Allen, 2019).

We provide a new perspective on the study of workers' living standards during the early phase of industrialization by applying a new indicator inspired by Jones and Klenow (2016) that combines four dimensions of well-being: income, health, working time, and inequality. This composite index is based on the calculation of utility flows that individuals may expect from these aspects of well-being, thus dealing differently with the aggregation procedure used in the HDI and the DW index. Our exercise puts together four important dimensions of well-being for contemporaries in a way that consistently accounts for lifetime expected resources and for risk aversion.[3] A further useful property of our indicator is that it is directly comparable with GDP per capita, which we then use to quantify the extent to which income per capita underestimates (or overestimates) changes in overall living standards. The methodology used in this article also contributes to a branch of the literature that has employed measures grounded in standard economic theory combining income with health or leisure (Williamson, 1984; Costa & Steckel, 1997; Voth, 2001, 2004). By using a framework that aggregates four different aspects of well-being jointly, we provide a more comprehensive picture of broader welfare than earlier studies. A further value added of our study is that we consider the results of recent additions to the literature that have enhanced our understanding of the evolution of income per capita, real wages, and inequality (Allen, 2007, 2019; Broadberry *et al*., 2015).

Our analysis of the evolution of workers' well-being during the traditional period of early industrialization (i.e., 1760–1850) presents two main findings. First, unlike earlier composite indices or income per capita, our broad welfare series points to worsening living standards until 1800. This is the result of a steep rise in both working time and income inequality after

than that of more recent authors, since he challenges that most of the population experienced any increase in the standard of living after 1790 (Hobsbawm, 1957, pp. 60–61). For a critique of this view, see Hartwell (1961) and Hartwell and Engerman (1975). More generally, Taylor (1975) provides a comprehensive overview of this earlier literature.

[2] We will use the terms *living standards, well-being*, *and welfare* indistinctively hereafter. We will refer to measures of purchasing power of goods and services such as gross domestic product (GDP), wages, and consumption as *material living standards.*

[3] To be sure, our approach cannot be judged to be superior (or inferior) to that of the HDI, since these are not directly comparable (Klugman, Rodríguez, & Choi, 2011, p. 277). Rather, we think our study provides an unexplored perspective into the evolution of English well-being taking a widely used approach in the economics literature.

1760 that is not accounted for by other traditional indicators. Welfare growth rates could have been highly negative if life expectancy had not increased by 5 years between 1760 and 1800.

Second, our metric indicates that well-being improved after 1800 when real wages started rising and the negative effect of longer working time and higher inequality reached a plateau. Although well-being grew by almost 0.7 percentage points annually during these years, the resulting average level of welfare by the mid-nineteenth century does not support an optimistic interpretation of the evolution of workers' living standards. According to our results, welfare was only 22 percent higher in 1850 than in 1760. This overall change is less pronounced than that of GDP per capita and suggests that national income tends to overestimate welfare growth for the average citizen during the period by 20 percent.

To examine the forces driving this long-term increase in well-being, we examine the relative contribution of each dimension. After life expectancy reached a plateau in the 1810s due to rising urbanization and worsening of health conditions, the main source of welfare improvements shifted to real wages, and to a lesser extent working time and inequality that declined slightly after reaching their zenith in 1830 and 1800, respectively. Therefore, our measure suggests that welfare gains from health and material living standards slightly compensated for the negative effects of increasing levels of working time and inequality over the period 1760–1850.

Our exercise also contributes to the literature that has employed different composite indices to analyze welfare in historical contexts. For instance, Prados de la Escosura (2015) developed a new indicator—the Historical Index of Human Development (HIHD)—aimed to overcome the tendency of the HDI to stress convergence. While this is clearly a relevant improvement of the traditional HDI, the HIHD follows the same aggregating procedure as the HDI. We take an alternative approach by drawing on the tools from welfare economics and incorporate the notion that the relative importance of well-being dimensions can change over time. Another branch of the literature uses indices grounded in utility theory to account for health improvements (Usher, 1980; Nordhaus, 2003; Becker, Philipson, & Soares, 2005). Our study highlights the importance of adding more dimensions such as working time and inequality in this type of frameworks in order to account for changes in key aspects of people's lives. In the particular case of workers' living standards during the industrial revolution, accounting for changes in working time and inequality is crucial to put into perspective changes in material living standards.

The remainder of this paper is structured as follows. First, we present an overview of the evolution of living standards during the early phase of industrialization by reviewing several indicators individually. Second, we outline the theoretical framework of our composite metric and discuss the indicators we use for each aspect of welfare considered, their interpretation, and their sources. Then, we present the results along with robustness tests, and conclude.

2. Perspectives on living standards

In the last decades, research in economics and economic history has increasingly criticized the use of GDP as a comprehensive measure of welfare (Sen, 1985; Crafts, 1997; Murphy & Topel, 2006; Prados de la Escosura, 2015; Gallardo-Albarrán, 2019). While being crucial for understanding economic growth, GDP does not incorporate non-market activity, leisure, or changes in the quality of life (Stiglitz, Sen, & Fitoussi, 2009). Easterlin (2000, p. 9) shows that these dimensions feature predominantly in what people think is important in life using the results of an international survey conducted in developed and developing countries.

Concerns about aspects of well-being beyond income are far from new, as the writings of social reformers and thinkers of the nineteenth century show. In particular, three elements received significant attention: inequality, working time, and health. Regarding inequality, Karl Marx highlighted the relationship between the widespread economic misery of the working class and the unequal distribution of the modes of production of the emerging industrial society. The accumulation of capital by a small class of owners with political power exerted a downward pressure on workers' wages (Marx, 1867). But even in a context of rising real wages, considering changes in inequality is important, since it can greatly undermine the extent to which improved output and income affect the working class as a whole. Besides material living standards, Friedrich Engels highlighted the long working hours that children and adults experienced in factories in his writings about the condition of the working class published in 1845. Citing various testimonies by mill workers, Engels illustrated the consequences of putting in long hours around the mid-nineteenth century such as stress, neglect of children, and bad health conditions (Engels, 1892). The third aspect of citizens' well-being receiving widespread attention was health. Edwin Chadwick brought it to the forefront by surveying the social and environmental conditions of the working class in a large number of towns and cities (Chadwick, 1842). In his report, Chadwick emphasized the social costs of economic progress and, therefore, the need to create an effective public health policy. Similarly, Octavia Hill—an English social reformer based in London—vividly showed the deplorable housing conditions of the poor and the consequences for their health (Hill, 1883). These accounts motivate our subsequent focus on the condition of the English working class in terms of material living standards, health, working time, and inequality.

To be sure, nineteenth-century commentators not only emphasized these four dimensions of well-being. For instance, Engels (1892) complained about the lack of means to educate the working class, as schools were scant and of poor quality. In cultural terms, workers employed in factories experienced a shock, since their habits sometimes differed significantly from the strict demands of the new production system (Pollard, 1965, pp. 160–162). Remarks about air pollution in cities with coal-powered industries were also frequent, as shown by some of the literary work of Charles Dickens and pieces in newspapers about the negative effects of smoke on vegetation (Mosley, 2008, pp. 36–37). As we will show later, our methodological framework does not allow for including these elements. However, we think our indicator captures an important part of workers' living standards during the industrial revolution, since both nineteenth-century contemporaries, and twentieth-century academic scholars have focused on them (de Jong, 2015, pp. 58–60).

How did these different aspects of workers' living standards evolve during the industrial revolution? Wrigley *et al*. (1997, p. 283) show that health, measured by life expectancy at birth, improved between 1760 and 1800. The origins of these health improvements are part of a long-term development starting in the first decades of the eighteenth century and were so remarkable that large industrial towns such as London ceased to be places where the number of deaths exceeded the number of births by the end of the century. However, this positive trend experienced a clear discontinuity during the second quarter of the nineteenth century when health levels stagnated at the national level and even worsened in some urban areas. The expansion of urban settlements and the insufficient response of public authorities led to a deterioration of health levels due to overcrowded housing, inefficient human waste disposal, and contaminated drinking water.

Working time increased sharply after the mid-eighteenth century. According to Voth (2001, p. 1078), English workers added almost 800 hours per year to the amount of time they spent in their workplace between 1760 and 1830. This was not so much an increase in hours per

day, but rather an increase in the number of working days since non-working days in the mid-eighteenth century like Mondays and holy days became regular working days in the nineteenth century. During the second quarter of the nineteenth century, annual working time decreased slightly, but not enough to compensate for the substantial rise that had occurred since 1760 (Voth, 2001, p. 1080).

If we turn to indicators of purchasing power, assessing the evolution of living standards becomes even more challenging because these measures do not follow the patterns described until now. Broadberry *et al.* (2015) show that income per capita rose, although far from steadily, during the period 1760–1850. However, the extent to which rising national income trickled down to the working classes has been subject to debate. On the one hand, Lindert and Williamson (1983a) and Clark (2005) argue that real wages increased substantially between 1760 and 1850. On the other hand, evidence from Feinstein (1998) and Allen (2001, 2007, 2009) imply that while workers earned higher wages by the mid-nineteenth century, the increase is much lower than what the *optimists* indicate.

Different trends in economic output and real wages have implications for inequality. A period of constant real wages in the midst of rising economic output and inequality is consistent with what Robert Allen has coined "Engels' pause." As technology increases demand for capital, the profit rate rises and so does the capital share (Allen, 2009, 2019). These trends in inequality suggest that the benefits of economic growth trickled down to the working class not before the mid-nineteenth century, thus reinforcing the idea of stagnant (or declining) living standards during this period.

The evidence discussed so far clearly shows the difficulty of drawing unambiguous conclusions about the evolution of living standards during the early phase of industrialization. The benefits of achieving higher wages and life expectancy by 1850 have to be weighed against longer working time and rising inequality. The same applies to sub-periods within the analyzed time frame, since mortality decreases substantially before 1800 whereas the remaining indicators show no signs of improvement. Consequently, a composite measure can shed new light on the overall evolution of well-being during this period.

3. Constructing a composite index

3.1. Methodology

While GDP per capita may correlate with some other non-income indicators (Oulton, 2012), its use for assessing broader living standards during the early phase of the industrial revolution is limited. The aforementioned trends in non-income dimensions are (at best) incompletely captured by this measure (Stiglitz *et al.*, 2009). For this reason, we propose a new welfare index drawing on Jones and Klenow (2016) that includes material living standards, health, working time, and inequality. We create a consumption-equivalent metric of living standards that calculates the well-being of individuals by adding up (or subtracting) utility flows from changes in its underlying components. This methodology grounded in utility theory resembles previous indices of well-being applied to the living standard debate combining wages with life expectancy or leisure (Williamson, 1984; Voth, 2001).

Our metric compares overall living standards over time by taking as a reference the mid-nineteenth century—in fact, this is similar to choosing a base year for a wage index—and observing the evolution of the four variables with respect to that year. Moreover, in the same spirit as exercises using average nominal wages and consumption baskets to calculate

average real wages for the working class (Feinstein, 1998, p. 627), we refer in the following to an average worker. Theoretically, our methodology confronts this average person—behind a veil of ignorance as emphasized by Rawls (1971)—with the following question: what is the proportion of her yearly consumption living in, say, 1760 that would have to be adjusted so that she is as well off as her counterpart in 1850? For example, consider a certain increase in consumption between 1760 and 1850, and suppose that the rest of well-being dimensions stay constant. In this case, the improvement in living standards using our welfare measure will be the proportion of consumption that would have to be increased so that an average English worker in 1760 is as well off as she was in 1850. The resulting welfare level in 1760 would be the same as the level measured by a consumption index. If one of the other variables differs over time, the resulting change in well-being will depend on its individual contribution (be it negative or positive) to overall welfare. For example, given that working time and inequality had risen by 1800, the change in welfare throughout the period would be the increase in expected utility derived from higher consumption minus the negative effect of working longer hours and living in a more unequal society. In our setting, expected life time utility is given by

$$V = e \bullet u\,(c, h)\,, \tag{1}$$

where V is welfare (or utility) that depends on the years an individual is expected to live (e), annual consumption (c) and time spent in the workplace (h).[4] To account for the contribution of income and working time to well-being, we consider the following function

$$u\,(c, h) = \overline{u} + \log(c) - v(h), \tag{2}$$

where $\overline{u}$ is a constant to incorporate the idea that people have a basic (or minimum) welfare level regardless of their income or leisure, and $v(h)$ is a function that captures the negative welfare effect of working time. Beginning with how material living standards contribute to well-being, we choose a logarithmic function that introduces diminishing returns, in line with other long-term analyses of living standards (Crafts, 2002; Prados de la Escosura, 2015; Gallardo-Albarrán, 2019).[5] An advantage of this functional form is that it allows for including inequality in the composite indicator. We assume that the distribution of consumption is log-normally distributed, independent of age and mortality, with mean c and variance of log income σ^2 so that: E(log C) = log c—$\sigma^2/2$.[6] This formulation follows from the idea

[4] See Gallardo-Albarrán (2019) for a historical application of this framework using age-specific mortality rates. Since we lack such detailed and reliable data, we use life expectancy at birth, which is essentially a summary measure of age-specific mortality rates: $e \equiv \sum_a S(a)$, where $S(a)$ is the probability that an individual survives to age a (Jones & Klenow, 2016, p. 2431).

[5] In the capability approach income is not valued in itself, but rather the things that people can do with it. Thus, the logarithmic transformation implies that there are diminishing returns in how income translates into capabilities (Anand & Sen, 2000, p. 100; Klugman *et al*., 2011, p. 272).

[6] The distribution of a variable follows a lognormal distribution if its natural logarithm is normally distributed. Its usefulness for our setting lies in that this distribution is right-skewed, thus implying that a large number of people earned a relatively low wage (and had low consumption levels), while a few earned high incomes. This is in line with the evidence presented by Allen (2019, pp. 18-19) showing that workers' families represented more than 60 percent of the population and their annual income was just 3 percent of the landed families, which only accounted for 1 percent of the total population.

that logarithmic utility in consumption implies risk aversion (Atkinson, 1970). The expected welfare or utility from (log) consumption of a risk-averse individual declines as the variance (or inequality) of the distribution increases, because a higher variance implies a higher uncertainty (or risk) of obtaining the mean value of the distribution.[7] To be sure, we are aware that concerns about inequality may go beyond risk aversion and individual consumption. For instance, one may be concerned about the interaction between inequality and political power or the ethical implications of an unequal society (Rawls, 1971). While we agree that these broader concerns ideally should be included in a comprehensive measure of well-being, our methodological framework does not allow us to do so. Thus, the inequality component of our index has a narrower interpretation.

The last term in equation (2)—$v(h)$—measures the contribution of working time to living standards. Given that workers put in longer hours between 1760 and 1850, changes in welfare derived from improved material living standards have to be adjusted for declining leisure time. For this purpose, we created a measure of the time that workers spent at the workplace taking into account that their total time endowment is 5840 hours (16 hours per day multiplied by 365 days). For instance, an average worker in 1800 spent almost 57 percent of her time in the workplace given that she was expected to work for 3328 hours annually (Voth, 2001, p. 1078). To measure the toll paid for these long working hours in terms of welfare—$v(h)$ in equation (2)—Jones and Klenow (2016) assume that disutility from working takes a form implying a constant Frisch elasticity of labor supply. This gives $v(h) = -\frac{\theta\varepsilon}{1+\varepsilon}h^{\frac{1+\varepsilon}{\varepsilon}}$, where ϵ is the Frisch elasticity of labor supply and shows how workers respond to wage changes, and θ is a parameter that measures disutility from working. This way of calculating the negative contribution of increased working time to welfare is similar to that used by Voth (2001, p. 1080) in that we look at the negative effect of working longer hours without taking into account their intensity.

With the chosen functional forms for consumption and working time, we can extend equation (1) as follows:

$$V\ (e, c, h, \sigma) = e\left(\overline{u} + \log(c) - v(h) - \frac{1}{2}\sigma^2\right). \tag{3}$$

To make the welfare comparisons over time we alluded to earlier, we add a time subscript to the previous equation and calculate the factor by which average consumption in a given year has to be adjusted so that welfare is the same in 1850. Inverting this number results in λ_t, our compensating variation measure of welfare:[8]

$$V\ (e_{t*}, c_{t*}, h_{t*}, \sigma_{t*}) = V\ (e_t, c_t/\lambda_t, h_t, \sigma_t), \tag{4}$$

[7] Following Córdoba and Verdier (2008) and Jones and Klenow (2016), the Gini coefficients are converted into the standard deviation of log wages inverting the formula suggested in Aitchison and Brown (1957): $G = 2\Phi\frac{\sigma}{\sqrt{2}} - 1$, where Φ is the cumulative distribution function of the standard normal distribution.

[8] Our calculations can be performed using the compensating and the equivalent variation (Jones & Klenow, 2016, pp. 2433–2434). Although we use the former because we find it more intuitive, both procedures yield almost identical results.

where t^* is 1850, t is any year between 1760 and 1850, and λ_t is our consumption-equivalent measure of welfare. Finally, we use the following equation to compute welfare growth:

$$\begin{aligned}\log(\lambda_t) = &\frac{e_t - e_{t*}}{e_t}\left(\overline{u} + \log(c_{t*}) - v(h_{t*}) - \frac{1}{2}\sigma_{t*}^2\right)\\ &+ \log(c_t) - \log(c_{t*})\\ &+ \mathrm{v}(h_t) - \mathrm{v}(h_{t*})\\ &- \frac{1}{2}\left(\sigma_t^2 - \sigma_{t*}^2\right).\end{aligned} \tag{5}$$

This is the main equation we will use in the next section to calculate welfare growth over time. Note that $\log(\lambda_t)$ refers to total welfare growth between t and t^*. Therefore, we need to divide it by the number of years comprising the analyzed period (i.e., $t^* - t$) to obtain annual growth rates. Equation (5) also shows how we calculate the individual contribution of each underlying component to overall welfare.

A final remark about our indicator relates to the non-linear contribution of its components to welfare. Sen (1981, p. 292) argues that improvements in some dimensions of well-being, such as life expectancy, require a larger amount of resources as they reach higher levels. Thus, raising life expectancy when longevity is already high becomes more of an achievement than at low levels.[9] Our welfare indicator incorporates this idea for its non-income dimensions. Consider how changes in life expectancy contribute to welfare in the first element of equation (5). As economic resources for consumption (or leisure) increase, rises in longevity represent higher achievements in terms of well-being.[10]

3.2. Calibration

To calculate how rising working time contributes negatively to welfare, $v(h)$ in equation (5), we first need to calibrate the parameter measuring disutility from working. In our setting, $\theta = h^{-\frac{1+\varepsilon}{\varepsilon}}$, h is time spent working and ε is the elasticity of labor supply.[11] Assuming ε is one,[12] θ becomes 1.83. Using a constant parameter to value the welfare effect of working time implies that the opportunity cost of working longer hours did not change with the income level. We show in the robustness tests that allowing θ to change with wages and choosing a different base year for our index does not affect our results.

The last parameter of the model that needs to be calibrated is $\overline{u}$, which is key for valuing health improvements (see equation (5)).[13] To choose a value for this parameter, we follow a long-standing literature looking into trade-offs involving health risks and income. Since

[9] This issue is particularly important when combining bounded and non-bounded indicators in a single composite measure, since bounded measures will tend to converge (Prados de la Escosura, 2015).

[10] Working time and inequality also have a non-linear effect on welfare. Using a value of one for the Frisch elasticity of labor supply, annual hours worked exhibit an exponential progression ($h^{\frac{1+\varepsilon}{\varepsilon}}$). The same applies to inequality when the standard deviations obtained from Gini coefficients are turned into variances (σ^2).

[11] Given that the first-order condition for the labor-leisure choice is $u_{1-h}/u_c = w(1-\tau)$—where τ is the marginal tax rate—our functional form results in $\theta = w(1-\tau)h^{-1/\varepsilon}/c$ (Jones & Klenow, 2016, p. 2438). In our analyses, we assume τ is zero and, the ratio of wages to consumption is one.

[12] Our results are robust to using different values for ε.

[13] We are not applying any discount in our temporal comparisons in the main results for two reasons. First, equations (3) and (5) become much more intuitive because living standards in a certain year equal the expected

health risks are undesirable, individuals receive a compensation for accepting those risks. With this information, we can infer the value individuals put into mortality risks to get estimates of the so-called value of a statistical life (VSL) by dividing the wage compensation by the risk (Hammitt & Robinson, 2011, pp. 1–2). In line with earlier research drawing on these compensations to calculate a VSL, we will use a benchmark estimate of $6 million (Gallardo-Albarrán, 2019, p. 65; Murphy & Topel, 2006, p. 885). However, this value is too high for the nineteenth century because risk compensation has risen over time alongside with income (Costa & Kahn, 2004), thus implying that the relative importance of health was much lower in the past than nowadays—this is something that the HDI does not take into account. Therefore, we will use the suggested income elasticity of VSL from Costa and Kahn (2004) to translate current values into historical ones as done in previous studies (Cutler & Miller, 2005, pp. 19–20; Gallardo-Albarrán, 2019, p. 66). The resulting calibration is a conservative one, since the average VSLs found by Costa and Kahn (2004, p. 173) and Viscusi and Aldy (2003, p. 42) are 30 and 80 percent larger than ours (measured in 2007 prices), respectively.[14] Moreover, in the robustness tests we show that our calibration yields a lower-bound welfare effect of the range suggested by earlier studies.

3.2. Data

The aim of our indicator is to summarize the average welfare experience of the working class during the first decades of the industrial revolution. Given the lack of data for a consistent unit of analysis, we arranged a set of sources that we consider to be representative of the average English experience. For health, we use life expectancy at birth from Wrigley *et al*. (1997) who draw on a number of English parishes to reconstruct the demographic history of the country. Using these data has two implications for our welfare measure that are worth discussing. First, a national aggregate may not accurately represent health developments of some specific regions of the country. This issue is particularly relevant for large urban centers during the first half of the nineteenth century, since life expectancy was well below the national average in fast-growing cities such as Manchester or Liverpool due to overcrowding and poor urban sanitary conditions (Szreter & Mooney, 1998, p. 105). Even though between 1 and 5 percent of the population lived in municipalities above 100,000 inhabitants, excluding London, during the first decades of the nineteenth century (Szreter & Mooney, 1998, p. 104), our welfare calculations cannot be used to depict the experience of these large urban centers.

The second implication of choosing life expectancy at birth in our framework relates to its interpretation. This indicator takes the perspective of an English newborn and shows how many years she was expected to live. Thus, by using this measure we implicitly consider that mortality developments happening to both infants and adults are relevant to assess health and welfare developments over time. This is a useful perspective because our measure takes into account that a year of life is valuable for everyone in society who is alive, consumes, and enjoys leisure. Excluding changes in the lives of infants in a comprehensive welfare measure is arbitrary, since this would result in ignoring an important part of the population whose fate was deeply affected during the industrial revolution (Huck, 1995). Moreover, other studies constructing composite indicators of English well-being have employed this (or a similar)

value of realizing the income and leisure levels observed in one particular year. Second, Jones and Klenow (2016) and Gallardo-Albarrán (2019) show that this parameter does not affect their results.

[14] In our setting, $\overline{u}$ is 2.56 and it refers to 1850 because we use age-specific mortality rates to calibrate the model for the period 1838–1854 (our VSL in 1990 US dollars is $0.11 million).

mortality measure (Williamson, 1984; Crafts, 1997; Voth, 2004). And finally, Williamson (1990) shows that English workers earned higher wages in places where infant mortality was higher to compensate for working in unhealthy urban environments. Therefore, even if one was only interested in the well-being of adults or workers, including infant mortality would capture indirectly an aspect of their lives that mattered to them beyond obvious human considerations.

An alternative health measure that has been widely used to assess changes in English living standards during the analyzed period is heights. Stature reflects the nutritional status of individuals, a net measure of energy used for body growth once demands for body maintenance, disease, and work are accounted for (Floud, Fogel, Harris, & Hong, 2011, p. 11). While including heights in our welfare measure would certainly be informative of the health status of the English population, our theoretical framework does not allow this. If we turn to equation (1) briefly, we can see that welfare in our framework is given as the expected utility flows from consumption (adjusted for inequality) and working time. Given that expected utility depends on the probability of reaching a certain age (and not stature), we require a mortality metric for our calculations.

For working time, we use annual hours worked from Voth (2001). These data are based on courtroom evidence from London and the North of England. Although the former was not a major industrial center and one may question the representativeness of Voth's sample, Allen and Weisdorf (2011, p. 719) and Humphries and Weisdorf (2019, p. 2880) have provided further support for the view that working time was on the rise during the analyzed period.

Given that our welfare metric takes the perspective of a newborn by using life expectancy at birth, we adjust our model to take into account that changes in working time do not affect an individual throughout her lifetime, but rather as a worker. For this purpose, we correct the welfare effect of spending longer hours in the workplace using labor force participation rates.[15]

The literature has provided various measures of economic inequality during this period such as the ratio of income per worker and the unskilled wage, the inequality extraction ratio, top income shares, or the Gini index. While each has its own strengths and weaknesses, our methodology uses Gini coefficients to obtain a measure of income variance that is then used in equation (5). We draw on Allen (2019, pp. 110–111) who extends earlier work using social tables by Lindert and Williamson (1982, 1983b) and provides data for an additional benchmark in 1847, precisely when our analyzed period ends. These Gini coefficients refer to England and Wales, which we, in the absence of similar data for England exclusively, consider to be representative of the English experience.

To measure private consumption, or material living standards, we use real wages because they are closely related to the potential of private consumption of material goods of services by the working class (Feinstein, 1998, pp. 626–627). Moreover, this indicator has been widely used in the literature in this context, as we discussed above. We use the nominal weekly earnings series by Feinstein (1998) for Great Britain, which is widely cited and agrees with the series by Lindert and Williamson (1983a) for England and Wales (Allen, 2019, p. 101).[16] For

[15] More specifically, we adjust the third term of equation (5) as follows: $\frac{pr_t+pr_{t*}}{2}\,[v(h_t)-v(h_{t*})]$, where pr is the labor force participation rate. In the robustness tests, we also provide welfare calculations without this adjustment.

[16] Given that nominal wages from Feinstein (1998, pp. 652–653) start in 1770 and our time period begins in 1760, we used English nominal wages from Allen, Bassino, Ma, Moll-Murata, and van Zanden (2011) to extrapolate backwards.

Table 1. *Indicators of English living standards, 1760–1850*

Years	Real wage (1850 = 100)	Life expectancy at birth (years)	Working time (annual hours)	Inequality (Gini coefficient in %)
1760	87	35	2576	53
1780	77	36	–	–
1800	79	40	3328	60
1830	84	41	3356	–
1850	100	40	3185	58

Sources: Feinstein (1998, pp. 652–653) for nominal wages after 1770; we assume nominal wages did not change between 1760 and 1770 according to the English wage series by Allen *et al.* (2011). We deflated the resulting index using Allen (link). The reported real wages is a 5-year average series centered at each benchmark to avoid year-to-year fluctuations. Wrigley *et al.* (1997, p. 614) for life expectancy at birth; strictly speaking the data refer to 5-year averages following (and including) the following benchmarks: 1761, 1781, 1801, 1831, and 1851. Voth (2001, p. 1078) reports working time for several benchmark years: 1750, 1800, 1830. For 1760, we used annual hours of work in 1750; for 1850, we used Voth (2001, p. 1080). Allen (2019, pp. 110–111) for inequality; strictly speaking, they refer to 1759, 1798, and 1846.

the price index, we draw on the historical prices provided by Allen.[17] The resulting real wage series exhibits a lower growth than GDP per capita that is in line with the pattern of rising inequality identified by the literature (Broadberry *et al.*, 2015; Allen, 2019); a rather modest increase in working-class expenditure (Horrell, 2014, pp. 255–256); and stagnant levels of calorie availability (Meredith & Oxley, 2014, pp. 144–145).

Table 1 presents the data we compiled from the aforementioned sources for several benchmarks of the period 1760–1850.[18] Unfortunately, lack of information on working time and inequality results in incomplete data coverage for 1780 and 1830. Consequently, in the following we will focus on long-term welfare trends between 1760, 1800, and 1850. The indicators displayed in table 1 show the disparate trends we discussed earlier. For instance, the positive effects of health improvements and mild real wage improvements during the period contrast with the bleaker picture portrayed by rising working time and inequality. Similarly, rising life expectancy during the late eighteenth century contrasts starkly with worsening material living standards and rising working time and inequality.

4. Results

4.1. Workers' living standards during industrialization

Table 2 presents the results of our welfare indicator combining material living standards, health, working time, and inequality. We used equation (5), the parameters discussed above, and the data from table 1 to calculate annual growth rates of overall welfare and each individual component.

Beginning with the period 1760–1850, Column I shows that material living standards improved slightly, as real wages grew by 0.15 percentage points annually. The rise in life expectancy contributed to higher well-being, and to a larger extent than wages. Our calculations suggest that the almost 5-year increase in this indicator added 0.27 percentage

[17] See Allen (link).
[18] We focus on this period following Crafts (1997, pp. 623–625) and Voth (2004, p. 271).

Table 2. *Welfare growth during the period 1760–1850*

Period	Annual contribution to living standards (in %)		
	1760–1850 (I)	**1760–1800 (II)**	**1800–1850 (III)**
A. Material living standards	0.15	−0.27	0.48
Real wage index (1850 = 100)	*87–100*	*87–79*	*79–100*
B. Health	0.27	0.56	0.04
Life expectancy (years)	*35.37–40.46*	*35.37–40.02*	*40.02–40.46*
C. Working time	−0.05	−0.16	0.03
Annual working load (hours)	*2576–3185*	*2576–3328*	*3328–3185*
D. Inequality	−0.14	−0.47	0.12
Gini index (points)	*53–58*	*53–60*	*60–58*
Welfare growth (A + B + C + D)	0.22	−0.33	0.66

Source: we use equation (5) and divide it by the number of years in each time period to obtain annual growth rates. See table 1 for the underlying data and its explanatory note for the sources. As explained in the text, the contribution of working time to welfare is adjusted by the average labor force participation rate at the beginning and end year of each period (see also footnote 15). These data are taken from Voth (2001, p. 1078); we use the participation rates in 1830 for our last benchmark. The small discrepancy between overall welfare and the sum of its sub-components is due to rounding.

points per annum to welfare growth. The positive effect of this dimension for workers' living standards was partially offset by longer working hours and rising income inequality, since they reduced welfare growth by 0.05 and 0.14 percentage points annually. Abstracting away from health improvements, these figures completely offset any increase in material living standards coming from real wage increases.

Table 2 also provides welfare growth rates for the sub-periods 1760–1800 and 1800–1850 (Columns II and III) to assess some dynamics during the analyzed period. Beginning with the former, we can see that material living standards worsened during the last decades of the nineteenth century, since real wages decreased by almost 0.3 percentage points annually. At the same time, health improvements between 1760 and 1800 added significantly to welfare. Our calculations imply that the (roughly) 5-year increase in life expectancy contributed to annual welfare growth by 0.56 percentage points, thus offsetting the well-being losses from declining real wages. However, the picture these figures convey have to be weighed against the negative impact of rising working time and inequality on living standards, which curtail annual welfare growth by 0.16 and 0.47 percentage points, respectively. As a result of the conflicting trends of the four indicators, our measure suggests that the net (or overall) growth in broader living standards was negative between 1760 and 1800.

The second sub-period shows a very different pattern, since the increasing detrimental effects of working time and inequality came to a halt and even declined slightly after 1800. As we can see in Column III, the small drop in working time added 0.03 percentage points to annual growth in living standards, after hours of work had reached their zenith in 1830. The fall in inequality between 1800 and the mid-nineteenth century added 0.12 percentage points, thus offsetting part of the negative effect of this dimension during the first years of

Table 3. *Welfare, material living standards and other composite indices of well-being, 1760–1850*

Year	Welfare (1760 = 100) (I)	GDP p.c. (1760 = 100) (II)	HDI (III)	DW Index (IV)
1760	100	100	0.27	6
1800	88	113	0.30	4
1850	122	149	0.41	1

Note: the figures in Column I for 1800 and 1850 were calculated using the growth rates of table 2, Columns 2 and 1, respectively. For instance, the value for 1800 can be obtained as follows: exp(−0.33/100*40)*100. GDP per capita (Column II) refers to England and draws on Broadberry *et al*. (2015); we provide 5-year averages centered at each benchmark to avoid year-to-year fluctuations. Data for the HDI (Column III) and the DW index (Column IV) come from Crafts (1997, p. 625).

the analyzed period. However, these mild improvements in citizens' lives, while important for contemporaries did not bring much to well-being growth (0.15 percentage points per annum). As opposed to the last decades of the eighteenth century, the main contributor to welfare after 1800 growth was not health, but material living standards (0.48 percentage points per annum). When life expectancy reached a plateau in the 1810s due to overcrowding and congestion in urban areas (Huck, 1995; Szreter & Mooney, 1998), the main source of welfare improvements shifted to increasing levels of real wages. A further notable point in table 2 has to do with the relative importance of each dimension of well-being over time. Between 1760 and 1800, the negative effects of increasing working time and inequality offset any positive contribution that the increase in life expectancy could bring to workers' well-being (see Column II). By the end of the period, this is no longer true (see Column I). Consequently, a measure of living standards that does not include life expectancy will tend to underestimate the full extent of improvements in broader well-being by 1850.

4.2. Comparison with other measures of well-being

Table 3 presents the results of our indicator in index form drawing on the growth rates of table 2. Column I shows that welfare levels declined by slightly more than 10 percent during the last decades of the eighteenth century and then increased substantially. By 1850, our results suggest that the welfare level of an average English worker in 1850 was about 22 percent higher than in 1760. Comparing these trends with those of GDP per capita (Column II), we can see that they do not align well, especially during the first sub-period. Contrary to the more pessimistic picture portrayed by our welfare measure, income increased by 13 percent during the last decades of the nineteenth century. This discrepancy can be explained by the limitations of the reconstructed national accounts to reflect the increasingly longer working hours in combination with rising inequality (see table 2). After 1800, our welfare measure and GDP per capita move in the same direction, when real wages started increasing and inequality and working time stopped rising. These different trends have two implications for our understanding of workers' living standards during this period. First, our measure rejects the view that the English working class achieved any meaningful gains in welfare before 1800. Second, GDP per capita tends to overestimate gains in living standards throughout the period.

The last two columns of table 3 present the findings of two alternative approaches to measuring well-being from Crafts (1997, p. 625): the HDI and the Dasgupta and Weale index.[19] Despite the methodological differences between these two indicators in terms of both aggregating procedures and underlying indicators, they show a clear improving pattern between benchmarks (Columns III and IV). Our composite index shows a much more pessimistic pattern, especially before 1800. Working longer hours and living in a more unequal society prevented any significant increase in living standards until (at least) 1800, two aspects that are not considered by the HDI and the DW index.[20]

In sum, our welfare metric exhibits much lower growth than GDP per capita and alternative composite indicators of well-being. Consequently, our calculations support a pessimistic view of workers' living standards during the period.

4.3. Robustness tests

In this section, we perform several alternative analyses to test the robustness of our main findings to changes in the parameters of the utility model. Beginning with working time, we examine how changes in the elasticity of labor supply (ε) affects our results. Using the lower and upper values suggested by Jones and Klenow (2016, p. 2438), we can see in table 4 that the results are almost identical to that of our benchmark calculations. Next, we take into account that the opportunity cost of leisure time (θ) changed over time. In this way, if material living standards rise (see table 1), then the opportunity cost of working longer hours increases too. Our results confirm this intuition, since the negative effect of working longer hours decreases slightly, as compared to our benchmark results. Reassuringly, neither welfare growth rates nor levels differ significantly from our baseline results.

The following test does not adjust the welfare contribution of working time using labor force participation rates. In this way, we assume that rising working time affected workers and their families, including children and the elderly. The results show that this dimension reduced overall welfare by 0.10 percentage points, 0.05 percentage points more than in our main results (see table 2). This difference has a small effect on welfare levels, since the 1850 values of our baseline and alternative indices are 122 and 117, respectively. According to the estimates of Voth (2001, p. 1080), annual consumption per capita during the period 1760-1830 declined from 0.38 to 0.05 percentage points, if changes in labor supply are taken into account. This implies an almost 90-percent downward adjustment. Our calculations also point to an important degree of deterioration in living standards, but not that large: 34 percent.[21]

Another aspect of our results that we test in table 4 concerns the relative importance of health in our framework. As highlighted in the text, the VSL we choose for calibrating $\bar{u}$ influences the relative contribution of health to welfare. For this purpose, we perform an alternative analysis assuming a benchmark VSL of $7 million, which is in line with the range

[19] The DW index provides an ordinal ranking of well-being using the 'Borda rule' to aggregate information on political and civil rights, as well as income, education, and health variables (Dasgupta & Weale, 1992).

[20] This conclusion also holds for the HDI calculations adjusted for inequality and gender-related differentials by Crafts (1997, p. 625), and other HDI figures by Floud and Harris (1997, p. 116). Voth (2004, pp. 288–291) also argues that Crafts' optimistic results do not hold when using modified versions of the HDI and the DW index.

[21] Using our results in table 4 (fifth row), we calculate that rising working time contributed negatively to annual welfare growth by 0.13 percentage points between 1760 and 1830.

Table 4. *Robustness tests*

	Annual growth rate (in %)			Level (1760 = 100)		
	1760–1850	1760–1800	1800–1850	1760	1800	1850
Benchmark results	0.22	−0.33	0.66	100	88	122
Frisch elasticity = 0.5	0.23	−0.32	0.66	100	88	123
Frisch elasticity = 2	0.22	−0.34	0.66	100	87	122
Changing opportunity cost of working	0.21	−0.28	0.60	100	89	121
Unadjusted working time	0.17	−0.47	0.68	100	83	117
Higher VSL	0.29	−0.20	0.67	100	92	129
Rebase in 1800	0.16	−0.45	0.65	100	83	116

Note: the benchmark results are taken from tables 2 and 3. θ becomes 3.36 (1.35), if we use $\varepsilon = 0.5$ ($\varepsilon = 2$). We allow for the opportunity cost of working time to change with wages using the real wage series presented in table 1, Column 1; θ equals 1.6, 1.4, and 1.8 for 1760, 1800, and 1850, respectively. The fifth row does not adjust the negative contribution of leisure using labor force participation rates. The sixth row uses a VSL of $7 million ($\overline{u}$ becomes 3.01). Rebasing our index in 1800 results yields $\overline{u} = 2.3$ and $\theta = 1.75$.

discussed by Viscusi and Aldy (2003) and Jones and Klenow (2016) for current-day VSLs. As we can see in table 4, this calibration yields slightly higher growth rates, although our main conclusions remain unaltered.

Finally, we test the sensitiveness of our results to choosing 1800 as the base year for calibrating the parameters of our index. Our calculations show a lower growth rate for the period 1760–1850, which adds to the pessimistic view of the period conveyed by our baseline results.

5. Conclusion

The last decades of research into the consequences of the industrial revolution have brought a large amount of evidence on a number of economic, demographic, and social aspects of English workers' lives in the 18th and 19th centuries. An important part of this new evidence is characterized by painting a more complex picture of what earlier generations of scholars initially brought forward and by adding new indicators that revealed opposite movements of well-being for sub-periods.

This article uses an encompassing framework of living standards to put together information about four key aspects of the lives of citizens at that time: material living standards, health, working time, and inequality. Drawing on standard economic theory, we provide a new perspective to studies using composite measures of living standards such as the HDI or the DW index. We find that these studies are too optimistic about trends before 1800, since they do not fully take into account rising annual working time and increasing inequality. Our calculations suggest that welfare levels at the turn of the nineteenth century were slightly below those in 1760.

After 1800, our findings show that living standards increased until mid-century when life expectancy reached a plateau in the 1810s due to rising urbanization and the main source of welfare improvements shifted to real wages. By 1850, our calculations show that welfare was 22 percent higher than in 1760 (20 percent less than the improvement in living standards

suggested by GDP per capita). Therefore, welfare gains from health and material living standards slightly compensated for the negative effects of increasing levels of working time and inequality.

While encompassing, our indicator does not measure other important aspects of England's welfare at the time, such as access to knowledge through education, environmental damage, or the social costs of the factory system. Their study in the future may reinforce our view that workers' lives would not change substantially until the post-1850 period when the productivity benefits of the new forms of production trickled down to the working classes and public health regulation tackled the poor health conditions of the population.

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