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Less work and higher tax can raise wellbeing

Felix FitzRoy | Jim Jin

University of St Andrews, Business School, St Andrews, Scotland, UK

Correspondence
Jim Jin, University of St Andrews, Business School, The Scores, St Andrews, Scotland, KY16 9AR, UK.
Email: jyj@st-andrews.ac.uk

Abstract

Worktime has been falling slowly though real wages have risen dramatically. We show that in a general equilibrium model with CES utility and production functions, worktime falls with real wages if and only if the elasticity of substitution between consumption and leisure is less than that between capital and labour, but always rises with labour's income share and concerns with relative income. While a falling labour share may not reduce worktime due to market inflexibility, stronger income comparison increases inefficient overwork. Hence, more flexibility, higher income taxes and a basic income are needed to reduce working hours and raise social welfare.

KEYWORDS
basic income, labour income share, relative income, working hours

JEL CLASSIFICATION
D63, J22, H23

1 | INTRODUCTION

Working hours have been declining over the long-term but very slowly in recent years despite rapid growth in real wages and labour productivity. In this paper we use a simple general equilibrium model with CES utility and production functions to explain how average working hours are determined. We find that equilibrium worktime falls with real wages if and only if the elasticity of substitution between consumption and leisure is less than that between capital and labour. On the other hand, it is always positively related to the labour's income share and concerns with relative income. The former's fall should reduce working hours, and the latter's rise increase inefficient overwork. An inflexible labour market, however, can block the former downward trend but allow the latter upward pressure which is motivated by "keeping up with the Jones" and reduces social welfare. Thus, we argue for more flexibility in the labour market and higher income taxes to reduce worktime and raise social welfare.

Worktime did not always fall automatically when productivity rose. The Neolithic Revolution about 11,700 years ago transformed hunter-gatherer or forager society to permanent settlements and agriculture in different areas of the world simultaneously (Suzman, 2020), but did not reduce working hours or provide longer lives (Sachs, 2020; Wilson, 2019). As the industrial revolution began about two centuries ago in Britain, formerly independent farmers and peasant tenants, displaced from their land by enclosures and clearances, were forced to work 10–16 h a day, while economic historians often focused on real wages as the sole determinant of 'the standard of living' (e.g., Crafts, 1985). Althorp's Act of 1833 limited children's working hours to 12 per day, and the 'Ten hours Act' (1847) restricted the hours of women and children to 10 a day. Marx and Engels supported the bill (Tuckman, 2005) and considered reduction of worktime essential for human development. Worktime for all was further reduced after decades of campaigning by trade unionists in the 19th and early 20th centuries (Aveling, 1890). The eight-hour day was introduced by Robert Owen (1927) at New Lanark textile mill in the early 1800s, but only gained broad support after Webb and Cox (1891) published *The Eight Hour Day*. International Workers' Day, May 1, commemorates the demonstration in Chicago in 1886 for the eight-hour day. Huberman (2004) shows that the U.K. had the lowest worktime in 1870 but was caught up by Western Europe and North America by 1914. While an eight-hours working day was widely adopted with the establishment of the International Labour Organisation (ILO, 1919), Scottish TUC's demand for a 40-h 5-day week resulted in the "Battle of George Square" or "Bloody Friday" in Glasgow in 1919.

A decade later, Keynes (1930) made an optimistic prediction of a 15-h week by 2030, based on anticipated productivity growth in the next century. After the Second World War the 5-day week was adopted in advanced economies, and worktime continued to decline and average real incomes grew (Doltan, 2017; Giattino et al., 2020). Over the period of 1870––2007, however, the Old World had consistently worked less than the New World according to Huberman and Minns (2007). Blick et al. (2018) provided cross-country evidence for a negative relation between average working hours and per capita income. Nonetheless, average working hours will surely not be 15 per week by 2030 as predicted by Keynes (1930) and their recent decline has been slow, especially in the UK which is behind most European counterparts.

In contrast with the rest of the EU, which has aspired to a 35-h work per week since the 1993 European Working Time Directive (93/104/EC) (Tuckman, 2005), UK hours have remained approximately constant since 1992, at one of the highest levels in Western Europe, while average wages and productivity have stagnated since 2008, and consumer debt has increased alarmingly (Castle et al., 2020; Giattino et al., 2020). According to the TUC (2019),

> Full-time employees in Britain worked an average of 42 hours a week in 2018, nearly two hours more than the EU average – equivalent to an extra two and a half weeks a year.
>
> For example, full-time employees in Germany work 1.8 hours a week less than those in the UK but are 14.6% more productive. And in Denmark – the EU country with

the shortest hours – workers put in over four hours less than UK workers, but productivity in Denmark is 23.5% higher.

Falling collective bargaining coverage from 71% in 1979 to 29% in 2019 (Burke, 2019) is doubtless a major reason. A 4-day week would reduce commuting time, raise job-satisfaction and productivity as workers are more energised after a 3-day weekend – a likely 'win-win' change according to Bloomberg (2021) and several recent studies (Barnes, 2020; Coote et al., 2021; Grosse, 2018; Kallis et al., 2013, 2020; Spencer, 2015, 2019, 2022). However, such a change will require extensive campaigning and national legislation to overcome traditional opposition from employers. In the US, Rep. Mark Takano reintroduces a bill for a 4-day work week, which would shrink the standard workweek to 32 h. The California Democrat argues the bill would "improve the quality-of-life of workers, meeting the demand for a more truncated workweek that allows room to live, play, and enjoy life more fully outside of work."[1]

Keynes (1930) assumed that higher productivity implies higher real wages and more leisure due to the income effect. However, there are other factors which could affect working hours. Labour's share of GDP has been falling, possibly due to labour-saving technological progress, such as automation and artificial intelligence, as well as growing employer market power (Stoller, 2019; Teachout, 2020). Recent technology developments raise the productivity of a skilled minority, typically in the high-tech industries as markets become more concentrated in a few dominant firms. Meanwhile, automation and AI tend to reduce productivity of a low-skilled majority. Thus, the marginal labour productivity may fall despite capital intensity increases, which raises average productivity. This leads to a growing wage gap between a highly skilled minority and a low-skilled majority, a divergence between productivity and wage growth. Karabarbounis and Neiman (2014) documented a general decline of labour share across countries, sectors and labour groups.[2] While this should reduce worktime, the inflexibility of the labour market may prevent it from happening as most full-time employees cannot choose shorter hours.

Another factor crucially affecting worktime is concerns for relative income, which goes back to Veblen's (1899) discussion of wasteful consumption of positional goods. It helps to explain the 'Easterlin Paradox', constant happiness despite rapid GDP growth in developed countries,[3] even though the latter is still considered the main measure of national welfare.[4] Due to income comparison, many people work more than is socially optimal to "keep up with the Jones" (KUJ). As relative positions remain largely unchanged, but everyone's income imposes a negative externality on others, everyone suffers from overworking, a prisoner's dilemma. KUJ has become increasingly widespread due to advertising and social media, which lower subjective wellbeing (Nesi & Prinstein, 2015; Twenge et al., 2018). Partially due to income comparison and competition for promotion, many in the UK must accept unpaid overtime (Sellers, 2019). Real wages for most workers have stagnated or even declined since the 1980s in the US, and since the financial crash of 2008 in the UK. Most of the benefits of growth have gone to the highest earners, especially the top 1%, whose share of national income has doubled in the UK to reach the highest level since the 1920s (IFS, 2019). Ironically, in a reversal of the

[1] https://www.semafor.com/article/03/01/2023/the-bill-that-would-give-americans-a-four-day-workweek.

[2] Irmen (2021) shows that population ageing could lead to lower labour share in a general equilibrium model.

[3] Easterlin, 1974, 1995, 2010, 2021; Easterlin & O'Connor, 2023; In Rojas, 2019; FitzRoy et al., 2014.

[4] For detailed accounts of the failure of unsustainable capitalist growth to raise general wellbeing, see Hickel (2020), Jackson (2017, 2021), Kallis et al. (2020).

secular trends, the highest paid workers/managers often have the longest hours (Costa, 2000; Frederiksen et al., 2018). Junior bankers at Goldman Sachs have complained of 'inhumane' 96-h average work week (Makortoff, 2021).

This upward pressure from income comparison is often self-motivated and cannot be easily eliminated by regulation. To reduce this social inefficiency, Ljungqvist and Uhlig (2000), Dupor and Liu (2003) and Guo (2005) suggested a consumption tax to counter the consumption comparison externality. Corneo (2002) showed that progressive income taxes can be a Pareto improvement. FitzRoy et al. (2002) find that shorter working hours can raise employment with utilitarian benefits. Mujcic and Frijters (2015) and FitzRoy and Nolan (2016) recommend higher taxes to discourage overwork and benefit a poor majority. FitzRoy et al. (2023) show that an optimal tax will reverse KUJ in response to stronger income comparison.

Worktime has been intensively studied in the literature. Early researchers often use Cobb-Douglas utility and production functions and obtained sensible solutions (e.g., Eichenbaum et al., 1988; Kydland & Prescott, 1982; Prescott, 2004). However, these simple functions cannot capture certain plausible behaviour, for example, the backward bending labour supply curve. Some of its predictions may be too restrictive, for example, constant worktime despite the significant rise in real wages and productivity. Recently, Boppart and Krusell (2020) show that given a stable CES utility function in the Ramsey model, labour supply in a balanced growth path can fall at a constant rate, as widely observed empirically. Their model can explain why rapid increase in real wages and productivity only lead to slow decline of worktime, with the income effect dominating the substitution effect. Irmen (2023) uses an overlapping generation general equilibrium model to obtain similar results.

This paper follows the earlier models and allows CES utility and production functions. We explain the determinants of worktime, including real wages but focusing on labour's share of GDP and income comparison. We first examine the labour supply function and find it can be upward or downward sloping and backward or forward bending which has been scarcely discussed in the literature. Then we obtain equilibrium worktime in a steady state and show that it increases with preference for consumption, labour's income share, income comparison, saving rate, decreases with income tax monotonically, but falls with real wages if and only if the elasticity of substitution between consumption and leisure is less than that between capital and labour. When the two elasticities are equal, including the case of Cobb-Douglas utility and production functions, worktime becomes independent of real wages, thus will not fall when the economy grows. To the best of our knowledge, these results are new in the literature. While worktime should fall as labour's share does, this is often blocked by the inflexibility of labour market. The effect of stronger income comparison is driven by self-motivation and cannot be easily regulated. Consequently, worktime tends to be higher than the social optimum and should be reduced by increased flexibility of labour markets and higher income taxes.

The next section presents our general equilibrium model with CES utility and production functions. Section 3 presents equilibrium worktime and comparative statics. Section 4 discusses policy implications, and the last section concludes.

2 | THE MODEL

Real wages affect labour supply in two opposite directions through income and substitution effects, and possibly result in a backward bending supply curve. Moreover, average worktime does not only depend on the supply side, but also the demand. The equilibrium real wage is not exogeneous, but determined in a general equilibrium, which is constantly shifting due to technology improvement and capital accumulation. While this is well understood, surprisingly, explicit solutions for individual labour supply curves and average worktime with CES utility and production functions are still elusive in the literature.

The economy consists of n consumer-workers. Each individual i has a CES utility function of consumption c_i and leisure. Due to concerns for relative incomes, an individual's effective consumption is their own consumption c_i minus a fraction b of the average consumption $c\left(=\sum_{i=1}^{n} c_i/n\right)$, that is, $c_i - bc$ with $0 \leq b < 1$. This assumption follows Ljungqvist and Uhlig (2000) and others in the literature on income comparison. Instead of assuming a representative consumer as usually done in the literature, we allow heterogeneous agents to show different types of labour supply curves dependent on wages and non-labour income. We let T_i be individual i's time available for leisure and work, determined by social and biological limits. Let h_i be person i's worktime per period, so $T_i - h_i$ is leisure. Each individual i has a CES utility function:

$$u_i = \{\alpha(c_i - bc)^{\rho} + (1-\alpha)(T_i - h_i)^{\rho}\}^{v/p} \qquad 0<\alpha<1, v > 0 \tag{1}$$

Parameter α indicates preference for consumption relative to leisure, $\rho = (\sigma - 1)/\sigma$ where σ is the elasticity of substitution between consumption and leisure. When $\sigma = 1$, Equation (1) reduces to a Cobb-Douglas function $u_i = (c_i - bc)^{\alpha}(T_i - h_i)^{1-\alpha}$. We denote the total labour endowment $\sum_{i=1}^{n} T_i$ by T, and the aggregate labour supply, $\sum_{i=1}^{n} h_i$ by L.

With wage rate w, person i's earnings are wh_i.The government imposes a flat tax t on everyone's labour earnings and receives the total tax revenue twL. One's labour earnings after tax are $=(1-t)w\,h_i$. With a capital ownership share $\theta_i \geq 0$, individual i's capital income is $\theta_i rK$, where r is the interest rate and K is the total capital stock. The capital K is owned by all consumers, that is, $\sum_{i=1}^{n} \theta_i = 1$. Individual i receives a money transfer from the government, $m_i \geq 0$ and deducts a fixed saving $s_i \geq 0$. For simplicity, we do not consider dynamic optimization of optimal saving, while s_i can be optimally chosen. The disposable income $(1-t)w\,h_i + \theta_i rK + m_i - s_i$ will be used for consumption $c_i p$, where p is the price of consumption good. Hence, the individual budget constraint is:

$$c_i p = (1 - t)w\,h_i + \theta_i rK + m_i - s_i \tag{2}$$

We assume heterogeneous consumers in terms of T_i, θ_i, m_i and s_i to show how an individual labour supply can be different due to these values. The literature usually uses a representative consumer to indicate the average fraction of total time (often normalized to 1) used for working. However, it is not clear how the average should be calculated when T_i differs. If we use the simple average of h_i/T_i, the outcome will depend on the distribution of T_i and other individual characteristics. We will use L/T for the average fraction of worktime to the total time endowment, which is also the ratio of worktime per person to the average time endowment. This implies that we weight each person's work ratio of h_i/T_i by T_i/T to calculate the average worktime ratio. This average fraction will be shown indeed to be independent of individual characteristics of T_i, θ_i, m_i and s_i, and only depends on the aggregate features. The validity of using a representative consumer can thus be confirmed.

In the aggregate terms, $\sum_{i=1}^{n} m_i$ is total transfer and $\sum_{i=1}^{n} s_i$ is total private saving. The tax revenue minus the transfer, $twL - \sum_{i=1}^{n} m_i$, is the public saving. Adding it to private saving, that is, $twL - \sum_{i=1}^{n} m_i + \sum_{i=1}^{n} s_i$ is the total saving. Let s be the aggregate saving rate with $0 < s < 1$ and Y be total production. pY is the value of total production and spY is the total saving, that is, $twL - \sum_{i=1}^{n} m_i + \sum_{i=1}^{n} s_i = spY$. The total consumption is the total output minus total saving, that is, $nc = (1 - s)Y$. For simplicity, we assume saving to be exogenous, which can be an approximation in the aggregate level. Hence, we avoid dealing with the optimal choice of total saving.

On the supply side we assume a competitive market. For simple presentation, we first consider a Cobb-Douglas production function and will generalize it to a CES function later. The function has constant returns to scale and two inputs, labour L and capital K:

$$Y = AL^{\beta}K^{1-\beta}, \quad 0 < \beta < 1. \tag{3}$$

Constant A is determined by technology and natural resources. Parameter β is the labour elasticity of production which is also the labour's share of GDP. Given wage w, interest rate r and output price p, L and K are chosen to maximize the profit:

$$\pi = pAL^{\beta}K^{1-\beta} - wL - rK \tag{4}$$

Competition implies zero profit, that is, $wL + rK = pY$. As the economy has aggregate saving spY, the capital stock will increase after depreciation. Nonetheless, our model focuses on the steady state and ignore the dynamic optimization. Capital accumulation generally raises A and K. The total labour endowment T should also increase as population rises. The ratio of K/T indicate capital per capita and should increase overtime as capital rises faster than population. In the next section we will show that A and K/T are the main factors of economic growth, especially in terms of real wages w/p and labour productivity Y/L but may not significantly affect equilibrium worktime as often expected.

3 | COMPARATIVE STATICS

Given our simple model, we first solve for individual labour supply and show that it can be upward or downward sloping and backward or forward bending. Substituting c_i from the budget constraint (2) into the utility function Equation (1), we get:

$$u_i = \left[\alpha\left(\frac{(1-t)wh_i + \theta_i rK + m_i - s_i}{p} - bc\right)^{\rho} + (1-\alpha)(T_i - h_i)^{\rho}\right]^{v/\rho} \tag{5}$$

The first-order condition (FOC) for the optimal h_i to maximize u_i in Equation (5) is:

$$\frac{(1-t)w\alpha}{p}\left(\frac{(1-t)wh_i + \theta_i rK + m_i - s_i}{p} - bc\right)^{\rho-1} = (1-\alpha)(T_i - h_i)^{\rho-1} \tag{6}$$

As $\rho - 1 = -1/\sigma$, we let $g \equiv \left[\frac{(1-\alpha)p}{(1-t)\alpha w}\right]^{\sigma}$ and simplify Equation (6) to:

$$[(1-t)h_i w + \theta_i rK + m_i - s_i - pbc]g = p(T_i - h_i)^{\rho} \tag{7}$$

From Equation (7) we can solve individual i's optimal labour supply as:

$$h_i = \frac{pT_i - (\theta_i rK + m_i - s_i - bpc)g}{p + (1-t)wg} \tag{8}$$

If $\sigma = 1$, the utility function becomes Cobb-Douglas, and the labour supply in Equation (8) reduces to $h_i = \alpha T_i - \frac{1-\alpha}{(1-t)w}(\theta_i rK + m_i - s_i - pbc)$, which is increasing with wage rate w if and only if $\theta_i rK + m_i - s_i - pbc > 0$. Hence, the substitution effect dominates the income effect if and only if one's non-labour income exceeds their saving plus the value of income comparison, and this is independent of w and h_i.

When $\sigma \neq 1$, the situation becomes more complicated. Differentiating h_i in Equation (8) with respect to w we obtain the necessary and sufficient condition for an upward sloping labour supply, which depends on σ, as shown below (see Appendix A).

Proposition 1 *The individual labour supply h_i increases with wage rate w if and only if $\sigma(\theta_i rK + m_i - s_i - bpc) > (1-\sigma)(1-t)h_i w$.*

This condition means the effective non-labour income is sufficiently higher than the net earnings, with relative weights of σ and $1 - \sigma$. The slope of the supply curve differs in the following four cases. (i) $\sigma \leq 1$, (a)$\theta_i rK + m_i - s_i - bc \leq 0$, the labour supply h_i will be downward sloping, that is, the income effect dominates the substitution effect. (b)$\theta_i rK + m_i - s_i - bc > 0$, the supply will be upward sloping when w is low and downward sloping when w is high, backward bending at $h_i = \frac{\sigma(\theta_i rK + m_i - s_i - bc)}{(1-\sigma)(1-t)w}$. (ii) $\sigma > 1$, (a)$\theta_i rK + m_i - s_i - bc \geq 0$, the labour supply will be upward sloping, that is, the substitution effect dominates the income effect. (b) $\theta_i rK + m_i - s_i - bc < 0$, the labour supply will be downward sloping when w is low and upward sloping when w is high, forward bending at $h_i = \frac{\sigma(\theta_i rK + m_i - s_i - bc)}{(1-\sigma)(1-t)w}$. While a forward bending labour supply is rarely discussed in the literature, it seems reasonable for certain individuals. When wages are very low, they must work a lot to meet basic needs. With higher wages, they can afford more leisure and work less. When wages are very higher, they resume to more work.

Next, we consider average worktime in equilibrium. In this case the labour demand must be taken into account and the worktime will depend on real wages, w/p, rather than the nominal wage w. We sum up h_i in Equation (8) to obtain the aggregate labour supply. Recall that we assume $\sum_{i=1}^n T_i = T, \sum_{i=1}^n \theta_i = 1, twL - \sum_{i=1}^n m_i + \sum_{i=1}^n s_i = spY$, that is, $\sum_{i=1}^n m_i - \sum_{i=1}^n s_i = twL - spY$. When we sum up the average consumption $\sum_{i=1}^n c$, we obtain the total consumption $\sum_{i=1}^n c_i$, which is assumed to be equal to $(1-s)Y$. Substituting these into the sum of Equation (8), we get

$$L = \frac{pT - [rK + twL - spY - b(1-s)pY]g}{p + (1-t)wg} \tag{9}$$

To find L, we now consider the supply side of the economy. The FOCs for L to maximize profit $\pi = pAL^\beta K^{1-\beta} - wL - rK$ in Equation (4) is $\beta pA(K/L)^{1-\beta} = w$, which imply $\beta pY = wL$. Zero profit, $wL + rK = pY$ implies $rK = pY - wL = (1-\beta)wL/\beta$. Moreover, since $w/p = \beta Y/L$, real wage is proportional to labour productivity Y/L. Given β, real wage rises if and only if the productivity does. When β falls, the growth of real wages is slower than labour productivity, as we observe in the recent decades.

Substituting $pY = wL/\beta$ and $rK = (1-\beta)wL/\beta$ into Equation (9), we can solve for L in equilibrium as a fraction of the total labour endowment T (see Appendix B). To simplify our solution, we define a positive variable R as:

$$R \equiv \frac{(1-s)(1-b)}{\beta}\left[\frac{1-\alpha}{(1-t)\alpha}\right]^{\sigma}\left(\frac{w}{p}\right)^{1-\sigma} \tag{10}$$

Proposition 2 *The ratio of equilibrium worktime and total time* $\frac{L}{T} = \frac{1}{1+R}$.

Given the total available time T, L rises if and only if R falls. Since $R > 0$, we have $\partial R/\partial\alpha < 0$, $\partial R/\partial\beta < 0$, $\partial R/\partial b < 0$, $\partial R/\partial s < 0$, $\partial R/\partial t > 0$. Hence, L must rise with preference for consumption, labour share, income comparison and saving rate, and decreases with tax. As R rises with w/p if and only if $\sigma < 1$, L falls with real wages if and only if $\sigma < 1$.

Proposition 3 *Given real wages w/p, L/T rises with α, β, b, s and falls with t; given α, β, b, s and t, L/T falls with real wages if and only if $\sigma < 1$.*

The results are quite intuitive. For instance, working time is expected to increase when people have stronger preference for consumption and stronger concerns for relative income. Higher labour's income shares mean working is more rewarding and more saving requires more earnings to satisfy consumption needs, hence both should raise worktime. Taxes reduce incentives to work and should lower worktime. Nonetheless, some relations are not expected, for example, the impact of real wages. Intuitively, the real wages indicate the opportunity cost of working. Here they reduce worktime if and only if the elasticity of substitution between consumption and leisure is less than one, that is, 1% increase of real wages should change the ratio of leisure to consumption by less than 1%. In this case, consumption and leisure are gross complements. It is not expected that the impact of real wages on worktime only depends on the feature of the CES utility function itself. This will change when the production function is also CES type, rather than a Cobb-Douglas.

Our formula of R also allows us to evaluate cross derivatives and see how the impact of one parameter can be affected by another. For instance, the effectiveness of a tax change can be affected by β as $\frac{\partial^2 R}{\partial\beta\partial t} < 0$. It means that lowering β will increase the value of $\partial R/\partial t$. Thus, a tax increase will reduce the worktime more effectively when β is lower. Alternatively, when t is high, $\partial R/\partial\beta$ will be lower, that is, lowering β will reduce worktime more.

If $\sigma = 1$, Equation (1) reduces to a Cobb-Douglas function and R becomes $\frac{(1-s)(1-b)(1-\alpha)}{(1-t)\alpha\beta}$. Then worktime is independent of real wages. As $\frac{w}{p} = \beta\frac{Y}{L}$, we can write R as a function of the labour productivity: $R = (1-s)\ (1-b)\left[\frac{1-\alpha}{(1-t)\alpha\beta}\right]^{\sigma}\left(\frac{Y}{L}\right)^{1-\sigma}$ If $\sigma = 1$, the worktime is also independent of labour productivity, given other parameters fixed.

If $\sigma \neq 1$, worktime will depend on real wages, which in turn depend on other parameters in our model. In this case it is not sufficient to show, as we did in Proposition 3, how L depends on parameters α, β, b, s and t, given real wages which should be treated as endogenous. Instead, we need to find how L depends on these parameters, including A and K/T, and allow real wages to change. In this case we cannot obtain the precise effects explicitly but can still obtain qualitative relations (see Appendix C).

Proposition 4 *The worktime ratio rises with s, b, α and β, and falls with t always, and falls with A and K/T if and only if σ < 1.*

Our result shows that normally defined economic growth in terms of A and K/T may not have a strong impact on the worktime if σ is close to one. On the other hand, they could have a significant impact on the equilibrium level of real wages. When $\sigma = 1$, R is reduced to $\frac{(1-s)(1-b)(1-\alpha)}{(1-t)\alpha\beta}$, and $w/p = \beta Y/L = \beta A\left(\frac{K}{L}\right)^{1-\beta} = \beta A\left(\frac{K}{T}\right)^{1-\beta}\left[1+\frac{(1-b)(1-s)(1-\alpha)}{\alpha\beta(1-t)}\right]^{1-\beta}$. Hence the real wage must rise with A, K/T and t always, and falls with b, s, and α. The same relation must apply to labour productivity Y/L. Even in this simple case, however, the impact of β on real wages cannot be determined monotonically, but its impact on labour productivity must be negative as $\left[1+\frac{(1-b)(1-s)(1-\alpha)}{\alpha\beta(1-t)}\right]^{1-\beta}$ is monotonically decreasing with β.

Once again, the relationship becomes less clear when $\sigma \neq 1$ as real wage will affect worktime and vice versa. Nonetheless, we can still show that real wage w/p rises with A, K/T, and t, falls with b, s, and α qualitatively (see Appendix D).

Proposition 5 *Real wage w/p rises with A, K/T and t, and falls with s, b and α.*

Hence, the qualitative results from the case of $\sigma = 1$ still hold when $\sigma \neq 1$. These results are also quite intuitive. For example, real wages are expected to rise with technology and capital per capita. Income taxes on labour discourage work and raise real wages. Stronger preference for consumption and income comparison will encourage work and lower real wages. Higher savings reduce available consumption, raise the price and reduce real wages too. Given β, as productivity, Y/L, is proportional to w/p, it must be affected in the same way as real wages are. As economic growth is associated with higher A and K/T, we observe higher real wages and labour productivity, but not significantly lower worktimes as shown in our model.

To show the robustness of our findings, we now extend our Cobb-Douglas production function to a CES function and obtain a result similar to Proposition 2. Although CES production functions are widely used in the economics literature, the corresponding equilibrium worktime has not been explicitly solved. Instead of Equation (3), we assume that the new aggregate production function becomes:

$$Y = A\left[\beta L^{\delta} + (1-\beta)K^{\beta}\right]^{1/\delta} \tag{11}$$

Similar to the CES utility function, we have $\delta = (\varepsilon - 1)/\varepsilon$, where ε is the elasticity of substitution between labour and capital. When $\varepsilon = 1$, Equation (11) reduces to a Cobb-Douglas function Equation (3). The first-order condition for L to maximize the profit function $\pi = pY - wL - rK$ is $Ap\beta[\beta L^{\delta} + (1-\beta)K^{\delta}]^{1/\delta - 1} L^{\delta - 1} = w$, that is, $A^{\delta}p\beta Y^{1-\delta} = wL^{1-\delta}$, which can be written as $wL = BpY$, where $B = \beta^{1/(1-\delta)}(pA/w)^{\delta/(1-\delta)}$, and is equal to the labour's income share. As $\delta = (\varepsilon - 1)/\varepsilon$, we can write B as $\beta^{\varepsilon}(pA/w)^{\varepsilon - 1}$. When $\varepsilon = 1$, $B = \beta$. The zero profit condition, $wL + rK = pY$ implies $rK = (1-B)wL/B$. This is identical to the case of a Cobb-Douglas production function except for replacing β by B. We can use the previous result to obtain a new one.

The CES production function does not affect the aggregate labour supply function Equation (9). We can substitute $pY = wL/B$ and $rK = (1-B)wL/B$ into Equation (9) to solve for L. It is identical to the previous case except for replacing β by B. To simplify our expression, we generalize our previous variable R with β replaced by B as:

$$R = \frac{(1-s)(1-b)}{B}\left[\frac{1-\alpha}{(1-t)\alpha}\right]^{\sigma}\left(\frac{w}{p}\right)^{1-\sigma} \tag{12}$$

Hence, we can easily generalize Proposition 2 as:

Proposition 6 *The worktime ratio* $\frac{L}{T} = \frac{1}{1+R}$.

We again see that income comparison and labour income share have positive impacts on equilibrium worktime, even though the latter now is no longer simply equal to β. Moreover, as $B = \beta^{\varepsilon}(pA/w)^{\varepsilon-1}$, we can write R as $(1-s)\,(1-b)\beta^{-\varepsilon}A^{1-\varepsilon}\left[\frac{1-\alpha}{(1-t)\alpha}\right]^{\sigma}\left(\frac{w}{p}\right)^{\varepsilon-\sigma}$, which rises with real wage w/p if and only if $\varepsilon-\sigma > 0$. Therefore, we can generalize Proposition 3 as:

Proposition 7 *Given real wages w/p, L/T rises with α, β, b, s and falls with t, it rises with A if and only if $\varepsilon > 1$. Given α, β, b, s, t* and *A, L/T falls with w/p if and only if $\sigma < \varepsilon$.*

If we do not precisely know the value of σ and ε, it is not clear how real wages affect equilibrium worktime. On the other hand, we have a good idea how other parameters affect the worktime, especially the labour share and income comparison. Given our results, we will discuss their policy implications in the next section.

4 | DISCUSSION

As we discussed earlier, labour's income share has been falling across the world. This should reduce equilibrium worktime as shown in our model. This worktime reduction should be Pareto efficient since a competitive labour market should be efficient when it does not involve externality. However, as demonstrated by our historical review, worktime reduction was not achieved automatically in free markets in the past. Currently, shorter working hours are often not an option for full-time workers in the labour market. In fact, flexible working hours would be preferred by 95% of survey respondents (WSJ, 2022), but only the Netherlands offers such flexibility in the OECD (Warzel & Peterson, 2021).

Lack of flexibility in the labour market, an important reason for long working hours, is often ignored in the literature. Worktime is slow to respond to individual preferences and demand for change. Even under collective bargaining, working hours are only infrequently negotiated. About 3 million British workers want more than their current, usually part time hours, that is, 'underemployed', and a similar number, about 10% of the working population, want shorter hours even with less pay, that is, 'Overemployed (ONS)'. The UK has the second lowest rate of part-time employment in the OECD, at around 20%, most of which is unskilled, low paid and female. In contrast the Netherlands has the highest, about 37% part-time employment and the highest proportion of highly skilled part-timers (with tertiary education). 'Over 25% of workers in highly skilled managerial, professional, and technical occupations also work part-time – well over twice the OECD average for people in these roles' (OECD, 2019). Average hours for part-time workers are the shortest and for full-time only slightly longer than Norway and Denmark.

According to the 'Better Life Index', the Netherlands ranks top in work-life balance and in the top five of happiness or subjective well-being rankings, well above the UK and US, which have longer working hours, lower productivity and happiness rankings, worse work-life balance and higher adult and child poverty rates for the last 4 decades (Dorling & Koljonen, 2020; Martela et al., 2020; Wilkinson & Pickett, 2018).

The campaign for shorter working hours responds to broad evidence of overwork and its social costs and the benefits of more leisure even at the expense of reduced income.[5] Current working hours are downward 'sticky' as employers usually prefer longer hours rather than more employment, reflected in the prevalence of unpaid overtime and opposition to reducing hours (Banerjee & Duflo, 2019; Barnes, 2020; Coote et al., 2021; Grosse, 2018; Spencer, 2019). Recent experiments in the form of 4-day weeks in several countries including in the UK have shown little or no decline in productivity, and substantial increases in worker satisfaction with longer weekends and less commuting, which is one of most stressful activities in the average working day. The large-scale trials with shorter hours in Iceland have been described as an 'overwhelming success' (Autonomy, 2021).

The rapid expansion of homeworking in response to the Covid-19 pandemic, from around 5% to nearly half of all employees has brought additional appeals for flexible work as a permanent option. For most office or 'white collar' employees the future pattern seems likely to involve a hybrid mix of home and office working (BBC, 2021; Microsoft, 2021). The refusal of many employers to allow home working prior to the pandemic is an example of power abuse by 'tyrannical private government' (Anderson, 2017; Chomsky & Waterstone, 2021). The right to work at home needs to be enshrined in labour legislation to 'build back better' with more workplace democracy. As in the Netherlands, flexibility should be a basic right, and all employees should be entitled to have their request seriously considered by the employer, with a detailed response and reasons in case of rejection.

On the other hand, our result shows that income comparison can significantly increase worktime and has likely become stronger with widespread social media. This excessive overwork is Pareto inefficient as KUJ leads to a prisoner's dilemma. Moreover, overtime work, especially if self-motivated, is not constrained by the standard worktime. Employers who are reluctant to allow flexible and shorter working hours for their employees often encourage overwork. Workers can also be forced to overwork due to peer pressure or implicit threats. For example, "karoshi" (death from overwork) remains a serious problem in Japan despite government regulation as overworking employees must declare it is "voluntary".

Shortening worktime does not only require downward flexibility, but also a disincentive against self-motivated overwork. This can be achieved by an income tax as shown in our model, R rises with t. The tax revenue can be used for redistribution. If the money transfer m_i in our model is distributed equally as a universal basic income (UBI), the redistribution will reduce growing inequality as well as Pareto inefficient KUJ. This is urgently needed. Since 1st April 2023, the Compulsory Minimum Wage is £10.42 per hour, a full-time worker with average 36.2 h can earn £377 per week. By comparison, the poverty level income (60% of median) for a couple in outer London was £308. Many workers are paid far less than the living wage. The scourge of growing inequality and persistent poverty needs to be reversed by redistribution, not only by unsustainable growth (FitzRoy & Spencer, 2020).

[5] Barnes, 2020; Coote et al., 2021; Susskind, 2020; Kallis et al., 2013; Kallis et al., 2020; Spencer, 2015, 2019; https://www.theguardian.com/money/2023/feb/21/four-day-week-uk-trial-success-pattern.

Moreover, UBI would encourage more leisure by the income effect as incomes of low earners rise (The Green Institute, 2016). This possibility is demonstrated by our forward bending individual labour supply curve but neglected by usually assumed backword bending curves which only allow income effects to dominate for high earners. Therefore, UBI is not only an effective method to combat increasing inequality, but also to reduce worktime. Money will not be 'wasted' on higher earners as it could be clawed back by a higher tax t as described in our model, or by abolishing regressive personal tax and NICs allowance (Baker & Murphy, 2020; FitzRoy & Jin, 2018). A UBI can replace many existing means-tested benefits, thus lower its net cost. Indeed, a £4000 UBI for 54 million adults in the UK would cost approximately the same as current social welfare spending.

Another important reason for reducing worktime is that current levels of consumption and material resource used by rich individuals and countries are unsustainable (Hickel, 2020; Jackson, 2021; Kallis et al., 2020). The idea of permanent 'green growth' in a zero-carbon economy and complete recycling is unrealistic (Jackson, 2021). In our model, more leisure on the aggerate level means less total material consumption as total output will fall. For those not in poverty, leisure can be a substitute for 'positional' and material consumption, allowing for 'prosperity without growth' (Jackson, 2017). Increased leisure in place of material growth is essential for the sustainable or 'steady state economy' long championed by Daly (1973, 2005). Recent versions are the 'doughnut economy' (Raworth, 2017), or 'post growth' economy (Jackson, 2021), to correct policy 'addicted to growth', unsustainable and unable to raise wellbeing.

A change in preferences to prioritize leisure over consumption is represented by a lower value of α in our model. This in turn implies a higher R and thus shorter worktime. Less material consumption will not only benefit the environment but also result from greater environmental awareness and could be encouraged by restricting advertising and subsidised repairability and durability of consumer goods.

Moreover, shorter working hours do not mean higher unemployment but may even increase the demand for workers. Large scale public expenditure in a green new deal (GND) would also create jobs, reduce fossil fuel consumption and emissions, and minimise unemployment (FitzRoy, 2019; Rivkin, 2019). A job guarantee, as proposed by the Scottish Labour Party, should also be offered throughout the UK for the minority who remain workless (FitzRoy & Jin, 2018; Labour List, 2021; Layard, 2020; Tcherneva, 2018; TUC, 2020). A combination of these reforms could improve work-life balance for all and minimise the incidence of both overwork and under- or un-employment. Moreover, as more equal distribution increases consumer demand, shorter and flexible worktime will encourage job sharing, and thus alleviate precarious non-standard employment and self-employment (Standing, 2020).[6]

As AI and automation will replace many routine jobs and raise the average productivity of remaining workers, the demand for more leisure and the benefits of 'job sharing' are likely to increase. Our result indicates that real wages rise with income taxes and counterbalance the negative impact from stronger income comparison. Thus, worktime reduction via income taxes is also a positive response to the challenge presented by artificial intelligence and automation (Anderson, 2017; Chomsky & Waterstone, 2021; McCallum, 2020; Susskind, 2020).

[6]Evidence comes from the Stockton (California) Economic Empowerment Demonstration (SEED) trial, 'the nation's first mayor-led guaranteed income demonstration'. https://phys.org/news/2021-03-income-employment-financial-physical-health.html.

5 | CONCLUSION

Our analysis suggests that more flexibility in labour markets and higher income taxes can reduce worktime and increase social welfare. While there seems to be an overwhelming case for a 4-day working week, it is also important to emphasise that needs and preferences for shorter worktime vary more than just between 5 days and 4 days, or between full-time and part-time work as usually defined. Accommodating a range of individual working hours in a large organisation obviously requires additional managerial effort and time, but the welfare, motivational and productivity benefits are likely to far outweigh the costs. The full benefits are indeed only likely to emerge after a new generation, whose parents had more time for them than their parents did, has come of age (Boushey, 2016). Increased flexibility is also needed to respond to the expected progress of automation and AI, which will probably have far-reaching effects on work and the labour market (Suzman, 2020). It is high time to reverse the 'long-hours culture' in the UK and US with all the associated benefits of worktime reduction, most practically in the form of a 4-day working week as the new norm.

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ORCID

Jim Jin https://orcid.org/0000-0003-0306-3640

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APPENDIX A: PROOF OF PROPOSITION 1

Rewrite h_i in Equation (8) as $\frac{pT_i - Fw^{-\sigma}}{p + Dw^{1-\sigma}}$, where $F = (\theta_i rK + m_i - s_i - bc)\left[\frac{(1-\alpha)p}{(1-t)\alpha}\right]^{\sigma}$ and $D = \left[\frac{(1-\alpha)p}{\alpha}\right]^{\sigma}(1-t)^{1-\sigma}$. So, $\frac{\partial h_i}{\partial w} > 0$ if and only if $(p + Dw^{1-\sigma})F\sigma w^{-1} > (1-\sigma)D(p\,T_i - Fw^{-\sigma})$.

As $\frac{pT_i - Fw^{-\sigma}}{p + Dw^{1-\sigma}} = h_i$, the inequality becomes $F\sigma > (1-\sigma)Dw\,h_i$, which can be further simplified to $\sigma(\theta_i rK + m_i - s_i - bc) > (1-t)\,(1-\sigma)w\,h_i$.

APPENDIX B: PROOF OF PROPOSITION 2

Substituting $rK = (1-\beta)wL/\beta$ and $pY = wL/\beta$ into Equation (9), we obtain

$$[p + (1-t)wg]L = pT - [(1-\beta)wL/\beta + twL - swL/\beta - (1-s)bwL/\beta]g \text{ or}$$

$$pT = \{p + [1 - t + (1-\beta)/\beta + t - s/\beta - (1-s)b/\beta]wg\}L \text{ or}$$

$$T = \{1 + [1/\beta - s/\beta - (1-s)b/\beta]wg/p\}L = \{1 + (1-s)(1-b)wg/p\beta\}L$$

Hence, $\frac{L}{T} = \frac{1}{1+R}$ where $R = \frac{(1-s)(1-b)wg}{\beta p} = \frac{(1-s)(1-b)}{\beta}\left[\frac{1-\alpha}{(1-t)\alpha}\right]^{\sigma}\left(\frac{w}{p}\right)^{1-\sigma}$.

APPENDIX C: PROOF OF PROPOSITION 4

Since $L = \frac{T}{1+R}$, $\frac{w}{p} = \beta\frac{Y}{L} = \beta A\left[\frac{K(1+R)}{T}\right]^{1-\beta}$. Substitute it into R in Equation (12), we get:

$$R = \frac{(1-s)(1-b)}{\beta}\left[\frac{1-\alpha}{(1-t)\alpha}\right]^{\sigma}(\beta A)^{1-\sigma}\left[\frac{K(1+R)}{T}\right]^{(1-\beta)(1-\sigma)}, \text{i.e.,}$$

$$\frac{\mathrm{R}}{(1+R)^{(1-\beta)(1-\sigma)}} = (1-s)(1-b)\left[\frac{1-\alpha}{(1-t)\alpha\beta}\right]^{\sigma}\left[\mathrm{A}\left(\frac{\mathrm{K}}{\mathrm{T}}\right)^{(1-\beta)}\right]^{(1-\sigma)} \tag{C1}$$

The left-hand side of Equation (C1) always rises when R increases. Therefore, R must increase when the right-hand side does, which happens when s, b, α and β fall and t rises, and when A and K/T rise if and only if $\sigma < 1$. Therefore, L must inversely depend on the right-hand side of Equation (C1). A variable raising the latter must reduce L and vice versa.

APPENDIX D: PROOF OF PROPOSITION 5

Substituting R in Equation (12) into $\frac{w}{p} = \beta A\left[\frac{K(1+R)}{T}\right]^{1-\beta}$, we get

$$\left(\frac{w}{p}\right)^{1/(1-\beta)} = (\beta A)^{1/(1-\beta)}\frac{\mathrm{K}}{\mathrm{T}}\left\{1 + \frac{(1-s)(1-b)}{\beta}\left[\frac{1-\alpha}{(1-t)\alpha}\right]^{\sigma}\left(\frac{w}{p}\right)^{1-\sigma}\right\} \tag{D1}$$

Dividing both sides of (D1) by $\left(\frac{w}{p}\right)^{1/(1-\beta)}$, we obtain

$$1 = (\beta A)^{1/(1-\beta)}\frac{K}{T}\left\{\left(\frac{P}{w}\right)^{1/(1-\beta)} + \frac{(1-s)(1-b)}{\beta}\left[\frac{1-\alpha}{(1-t)\alpha}\right]^{\sigma}\left(\frac{P}{w}\right)^{\sigma+\beta/(1-\beta)}\right\} \tag{D2}$$

The right-hand side falls with w/p, increases with A, K/T, t, decreases with s, b and α. Hence, w/p must increase when A, K/T and t rise and s, b and α fall.