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THE DECLINE OF DRUDGERY AND THE PARADOX OF HARD WORK

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ABSTRACT

We develop a theory that focuses on the general equilibrium and long-run macroeconomic consequences of trends in job utility—the process benefits and costs of work. Given secular increases in job utility, work hours per population can remain approximately constant over time even if the income effect of higher wages on labor supply exceeds the substitution effect. In addition, secular improvements in job utility can be substantial relative to welfare gains from ordinary technological progress. These two implications are connected by an equation flowing from optimal hours choices: improvements in job utility that have a significant effect on labor supply tend to have large welfare effects.

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1 Introduction

In his 1930 essay, "Economic Possibilities for Our Grandchildren," Keynes predicted that a large increase in leisure would take place over the following century, but at the aggregate level robust signs of such a leisure boom have failed to materialize.[1] As shown in Figure 1, for a large set of OECD countries, from 1960 through 2019 aggregate (real) private consumption per capita more than tripled, while (total) work hours per population have been relatively flat. Indeed, compared to 1960, in 2019 work hours in the US were a tad higher (thirteen percent) while work hours in the other OECD countries in our sample were a tad lower (fifteen percent). This means that in absolute value terms changes in work hours were only about five percent of the changes in consumption.

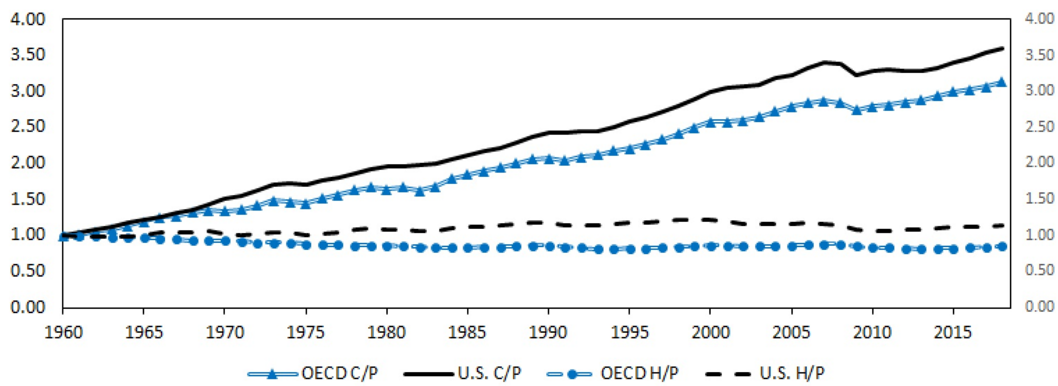

Figure 1: (Data are normalized at 1960.) Hours worked per population (H/P) and private real consumption per capita (C/P)—data are from the Conference Board's Total Economy Database and the OECD (VPVOBARSA consumption)[2]—for the US and (a large number of non-U.S.) OECD countries (simple average of country-specific ratios over Australia, Austria, Belgium, Finland, France, Germany, Greece, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom).

It is not unreasonable to think, as Keynes did, that the extent to which real consumption has increased, along with long-run growth in real wages, should have led to a prominent trend of declining work hours driven by the income effect overtaking the substitution effect. Why are people still working so hard? And, what are the welfare implications of this *paradox*

[1] As related to the US, see for example Neville and Ramey, 2009.

[2] Conference Board: https://www.conference-board.org/data/economydatabase/ OECD: https://stats.oecd.org/

of hard work?[3]

In principle there are five alternative, but not mutually exclusive, explanations through which the paradox of hard work can be explained theoretically. To frame these alternative explanations, consider the following simple utility function, $u(C,H)=\frac{C^{1-\frac{1}{s}}}{1-\frac{1}{s}}-v(H)$, where C is real consumption, H is labor hours, s is the elasticity of intertemporal substitution (EIS), $v'>0$ and $v''>0$. Household optimization implies $W=-u_H/u_C=C^{\frac{1}{s}}v'(H)$. Rearranging and manipulating, this implies in turn that $\frac{(WH/Y)}{(C/Y)}C^{1-\frac{1}{s}}=Hv'(H)=\phi(H)$, where $\frac{WH}{Y}$ is the labor share α_H, and $\frac{C}{Y}$ is the consumption-to-output ratio ζ_C. It follows that $H=\phi'\left(\frac{\alpha_H}{\zeta_C}C^{1-\frac{1}{s}}\right)$. Because ϕ is monotonically increasing, so is ϕ^{-1}. Therefore, with an approximately constant labor share and an approximately constant consumption-to-output ratio (which are empirical regularities), $s<1$, and increasing real consumption, H should be decreasing. That is what Keynes predicted. Given the other assumptions, with $s<1$ and C increasing, the only way to avoid decreasing labor hours H is to have have constant increases in WN/C, which is not easy in general equilibrium.

What are possible ways out of this box?

1. *Assuming the elasticity of intertemporal substitution (EIS) is large*—close to 1 or greater than 1. This is a possibility—and the explanation most often resorted to (at least implicitly). But as we discuss later in this Introduction and the Appendix, on net, extensive empirical studies using various approaches and data suggest the contrary.

2. *An increasing ratio of effective marginal wages to consumption.* This could be the result, for instance, of a reduction in the progressivity of the tax system, an intensification of competition for promotions within firms, and increasing educational debts.[4]

3. *Anything that keeps the marginal utility of consumption high.* This could be, for example, because of habit formation, "keeping up with the Joneses," and the introduction

[3] A well known parallel strand of literature is motivated by *cross-country* differences in hours worked per population. This literature includes, among others, Prescott (2004), Alesina et al. (2005), Rogerson (2006, 2007, and 2009), Faggio and Nickell (2007), Ljungqvist and Sargent (2006), Ohanian et al. (2008), Shimer (2009), McDaniel (2011), and Epstein et al. (2021). Prescott (2004) and Ohanian et al. (2008) argue that in Europe a large fraction of the trend decline in work hours can be attributed to secular increases in labor taxes.

[4] For additional discussion, see, for instance, Kimball and Shapiro (2008).

of new goods.[5]

4. *The income and substitution effects are both basically equal to zero.* This, of course, is consistent with very curved disutility of labor and, ultimately, with flat work hours. However, in the literature there is wide disagreement about the relative size of income effects.

5. *Anything that serves to keep the marginal disutility of work low.* This includes some kinds of technological progress in household production, non-separability between consumption and leisure,[6] and jobs getting more pleasant.

Of these possible explanations for the paradox of hard work, in this paper we focus on jobs becoming more pleasant—one of the factors that can keep the disutility of work hours down. Economists have long understood that cross-sectional differences in job utility give rise to compensating differentials. We develop a theory that focuses on a less-studied topic: the long-run macroeconomic consequences of trends in job utility.

We propose an intertemporal framework for thinking about the causes and effects of secular increases in job utility, that is, of jobs getting nicer. Our framework is a natural, but novel, extension of the static theory of compensating differentials, which was spelled out originally in the first ten chapters of Book I of "The Wealth of Nations" (Smith, 1776) and for which a standard modern reference is Rosen (1986).

In our model, as is standard in macroeconomics, individuals obtain utility from consumption and non-work time. Our additional assumption is that work also has process benefits and process costs—what we call "job utility." Job utility depends on work effort and amenities in the workplace, as well as on the nature of the job itself. Our definition of these variables is very broad, going beyond how they are usually understood.[7] Moreover, firm-side "job-enjoyment technology" affects the mapping of effort and amenities into overall job utility.

[5] See, for instance, Abel (1990), Fuhrer (2000), Luttmer (2005), Rayo and Becker (2007), and Struck (2014). We view external habit formation as a version of "keeping up with the Joneses."

[6] See, among others, King, Plosser, and Rebelo (1988) and Basu and Kimball (2002).

[7] In a narrower sense than our interpretation of amenities, a strand of literature shows that amenities are important. See, for instance, Coulibaly (2006), Becker (2011), Sullivan and To (2014), Taber and Vejlin (2016), Hall and Mueller (2018), and Sorkin (2018).

Some of the questions that our framework provides answers to, with clear intertemporal implications, are the following.

- How do effort, amenities, job-enjoyment technology, and labor-augmenting technology interact?
- What are the key determinants of long-run labor supply in the light of job utility?
- How does job utility matter for firms' optimization problems and firms' ongoing ability to operate, attract workers, and establish job parameters given long-run changes in labor-augmenting technology and job-enjoyment technology?
- What are the long-run welfare effects of changes in job utility?

In turn, the answers to these questions lead to two contributions to the macro and labor economics literatures. First, we show that secular improvements in job utility—*the decline of drudgery*—can cause work hours to remain approximately constant over time even if the income effect of higher wages on labor supply exceeds the substitution effect of higher wages. Therefore, the paradox of hard work is not necessarily evidence that the elasticity of intertemporal substitution is large, that preferences are strongly non-separable, or that preferences have some other feature such as habit formation (though each of these *might* be part of the explanation of the paradox). Second, we argue that secular improvements in job utility can be substantial even in comparison to the welfare gains from ordinary (say, labor-augmenting) technological progress. These two implications are connected by an equation: improvements in job utility that have a significant effect on labor supply tend to have large welfare effects. It is worth noting that our theoretical analysis also yields many insights if, for instance, the income effect is less than the substitution effect, so we make a substantial theoretical contribution regardless of one's specific views on parameter values.

Empirical evidence on the income effect on labor supply—as measured by the (negative) marginal propensity to earn (MPE)—is subject to two key concerns. First, short-run frictions such as the costs of negotiating with an employer for different hours can depress measures of the absolute value of the marginal propensity to earn from short-run natural experiments and artificial experiments. By contrast, our theory is focused on the long-run, defined as a period of time long enough that a worker is likely to have changed jobs in any case, giving the worker a chance to reflect any change in preference ranking of types of jobs in actual job choice. Second, theory suggests that the income effect as measured by the marginal propensity to earn should become substantially larger as an individual approaches his or her intended retirement age. As a result, estimates of the marginal propensity to earn should depend to an important degree on the age of those for whom it is being measured. For a more extensive discussion of the literature on the MPE up to 2008, we refer readers to Miles Kimball and Matthew Shapiro (2008), "Labor Supply: Are the Income and Substitution Effects Both Large or Both Small?" Subsection 6.2.3.[8] Kimball and Shapiro (2008), using hypothetical choices that arguably abstract from short-run frictions, and a sample of older individuals, find an MPE of $-.37$.

Studies that use data on unconditional cash transfers (for example Jones and Marinescu, 2018) and lottery wins (for instance, Imbens, Rubin and Sacerdote, 2001) often find small MPEs. But unconditional cash transfer results can be affected by income effects from the cash transfers and macro labor-demand effects having opposite signs. Moreover, research using

[8] Here is the relevant subsection in full: "Evidence on the MPE from the literature is also disparate. Pencavel cites estimates ranging from zero to -0.7, though he discounts the larger ones. Ashenfelter and Heckman (1973) report a median estimate of -0.27, not too far from what we find. These estimates are typically based on the role of non-labor income in labor supply, which is typically hard to measure and relatively small. Evidence from tax changes, especially the British studies discussed by Pencavel (1986) and Blundell and MaCurdy (1999), show larger MPEs.

In contrast, negative income tax experiments typically find small MPEs. Given that income and substitution effects go in the same direction in these experiments, this evidence points away from elastic behavior.

There are a few studies that look at how wealth windfalls affect labor supply. Joulfaian and Wilhelm (1994) study the role of inheritances on consumption and labor supply. They find that inheritances have only a small effect on consumption and an even smaller effect on labor supply. There are reasons to believe, however, that these estimates are attenuated relative to true utility function parameters. As they point out, but cannot fully correct for, inheritances may be anticipated. Moreover, they are typically very small, so small as to not overcome the frictions affecting behavior discussed in the next section.

In an important study that closely parallels our design, Imbens, Rubin, and Sacerdote (2001) survey state lottery winners about their labor supply. This study has the important features that we advocate, i.e., an experimental design with large shocks (for at least some of the respondents). They also take into account the fundamental nonlinearity owing to quits by including a quadratic term. Their headline results seem to suggest relatively low MPEs, but these include values of zero for the non-workers. Additionally, unlike our structural estimates that take into account the differences in the cost of quitting as a function of time to retirement, it is hard to compare their results across ages. The raw MPE in the Imbens, Rubin, and Sacerdote results for the 55 to 65 age group, which substantially overlaps the HRS sample, is -0.291 (= -0.124-0.167, p. 791), which is only a little smaller than our comparable figure of -0.373. They find smaller MPEs for younger workers. Hence, the findings from the hypothetical sweepstakes are quite similar to those of the actually lottery winners. They also find little difference between men and women. As the discussion in the previous section shows, these ranges of estimates imply high structural elasticities of labor supply."

lottery wins results often has a relatively small (and arguably unrepresentative) treatment group.

Recent studies that focus on social insurance programs and their associated labor supply and program substitution effects find comparatively larger MPEs in absolute value terms. For instance, Gelber et al. (2016, 2017) examine the 1977 Social Security Act amendments on the employment decisions of older individuals. This policy resulted in marked changes in the Social Security Old-Age and Survivors Insurance depending on date of birth. The authors find an upper bound for the MPE of men equal to about -0.6 for and -0.9 for women. In addition, Guipponi (2019) uses data on policy changes in the Italian survivor insurance program, and finds an MPE close to -1. That is, survivors fully offset an implemented reduction of surviving spousal benefits, doing so mainly through labor force participation.[9]

Turning to the EIS, it is well known that this parameter is a critical parameter for macroeconomic models, since it governs the extent to which consumption responds to changes in the real interest rate. It is also well known that in order to explain the data, in general, macroeconomic models require that the EIS be at least equal to 1. Given the fundamental importance of the EIS for macroeconomic modeling, there is a vast literature that focuses on estimating this parameter. A majority of results imply an EIS that is less than 1, and many of these studies suggest that the EIS is very small or statistically insignificant. We review representative research in the Appendix.

At this point, though it is important to note that a recent meta-analysis by Havránek (2015) finds that the mean estimate of the EIS across the literature is 0.5 and that a majority of research on the EIS reports values less than 1. Moreover, he concludes that calibrations with values of the EIS greater than 0.8 are inconsistent with the empirical evidence. Havránek's meta-analysis is based on a large number of published papers that provide estimates of the EIS (in fact, 2,735 estimates of the EIS across 169 publications that use data from 104 countries and different time periods). He studies the dependence of these reported estimates on method choices and on "selective reporting."

Havránek develops an analytical framework to get at these issues and applies it em-

[9] Guipponi (2019) earned the Best Paper Award on Gender Economics 9th Edition, UniCredit Foundation and the Young Economist Award from European Economic Association.

pirically to assess the EIS estimates from published papers that he studies. He assesses selective reporting by exploiting the fact that the ratio of the point estimate of the EIS to its standard error has a t-distribution, which implies that estimates should not be correlated with their standard errors. However, in running regressions of EIS point estimates on these standard errors Havránek finds a coefficient of about 2 across many specifications. Havránek argues that this finding is consistent with authors giving preference to reporting positive and statistically significant estimates of the EIS.

Turning to the impact of method choices, for each estimate of the EIS in the literature that Havránek assesses, he gathers information on methodological techniques, ranging from the utility function used to characteristics of the data used for analysis and even publication characteristics, such as journal impact factor. Then, Havránek assesses the impact of method choices by regressing EIS estimates on these characteristics of methodology.

All told, Havránek argues that his results reveal a considerable amount of "upward bias," which he argues is consistent with selective reporting: researchers prefer not to report results that are small and insignificant. In addition, his results also suggest that selective reporting bias is considerably stronger than bias owing to method choices. Finally, Havránek argues that once selective reporting bias and biases owing to method choices are controlled for, the implied EIS across published papers is statistically significant and, on average, equal to about 0.3 (over a third lower than the average point estimate in the literature, which Havránek reports is equal to 0.5).

This paper proceeds as follows. Section 2 relates our work to the static theory of compensating differentials. Section 3 provides a general overview of our framework. Section 4 discusses the variables we focus on and how our formulation maps into the real world. Sections 5 and 6 focus, respectively, on the optimization problems of individuals and firms. Section 7 highlights certain implications from our theory. Section 8 deals with the economy's general equilibrium. Section 9 addresses the welfare consequence of changes in job utility. Section 10 concludes.

2 The Static Theory of Compensating Differentials

The natural point of reference for our analysis is the theory of compensating differentials, spelled out originally in the first ten chapters of Book I of "The Wealth of Nations" (Smith, 1776). A standard modern reference on compensating differentials is Rosen (1986).

2.1 Worker and Firm Choices

The solid line in the left panel of Figure 2 is a wage/job-utility frontier: jobs offering lower job utility will, in principle, compensate by offering higher real wages (in the figure W is the real wage and J is job utility). Thus, all else equal, individuals face a trade-off between these two variables. Conditional on individual preferences, a particular worker optimizes by choosing a feasible point on the (solid) frontier in the (W, J) plane.

The solid line in the right panel of Figure 2 is a job-utility/output frontier: in order to improve job utility firms must divert part of their resources away from the production of output (Y). Given its idiosyncratic costs of job utility in terms of output, a particular firm optimizes by choosing a feasible point on the (solid) frontier in the (Y, J) plane.

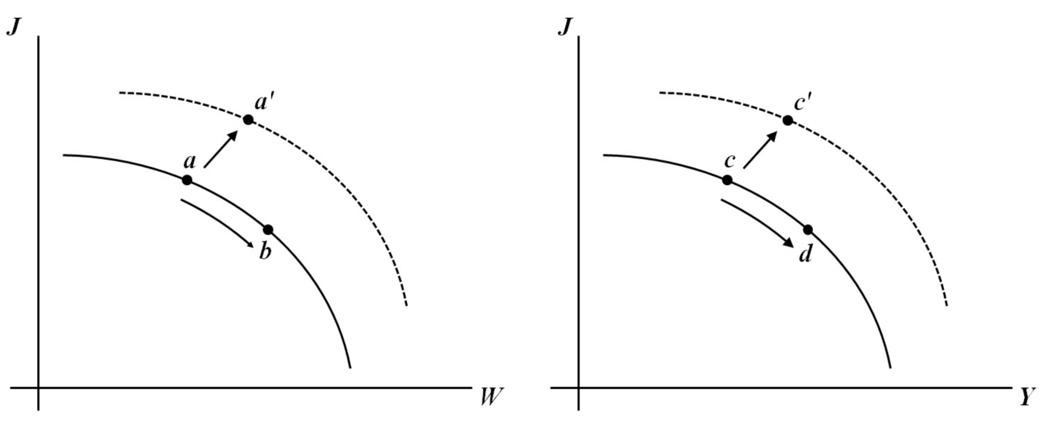

Figure 2: Theory of compensating differentials and beyond. Left panel: real wage (W) / job utility (J) frontier faced by workers. Right panel: job utility / output (Y) frontier faced by firms.

2.2 Movements Along the Frontiers

Suppose higher output and higher real wages came from movements *along* the solid frontiers (a to b in the left panel and c to d in the right panel). As argued in Kimball and Shapiro (2008), income effects on labor supply are substantial. So, the higher real wage implied by moving from point a to point b would tend to reduce work hours. In addition, if work hours are increasing in job utility, then the lower job utility implied by moving from point a to point b also puts downward pressure on work hours.

2.3 Movements of the Frontiers

However, the frontiers themselves can shift (the dashed lines in Figure 2). As the economy's choice set expands, optimal choices can entail moving to points such as a' and c', in which case job utility, output, and real wages all rise, and increases in job utility emerge as potentially *offsetting* to income effects.

The theory we develop in this paper focuses attention on understanding the dynamic general equilibrium implications and endogenous foundations of such intertemporal changes in the economy's choice set. This understanding is complementary to the long-standing static, partial equilibrium microeconomic framework of compensating differentials.

Although we focus in this paper on the decline of drudgery over time, it is worth noting that cross-sectional differences in job utility can be helpful in explaining why differences are as small as they are in working hours for workers at different wage levels, even if income effects exceed substitution effects. Firms, in their efforts to provide workers a reservation utility level at minimum cost, are likely to offer both higher wages and pleasant job attributes to higher skill workers and both lower wages and unpleasant job attributes to lower skill workers. When the pleasantness of a job tends to covary positively with a job's wage, the pleasantness of a job can help keep a worker willing to work longer hours despite an income effect that exceeds the substitution effect of the higher wage.

3 The Social Planner's Perspective

There are no distortions in our model; therefore, the planning version of the economy is equivalent to a decentralized economy with perfect competition. Both perspectives are valuable. We begin with the social planning perspective.

Consider individuals who obtain utility from consumption and non-work time. A standard assumption is that any time devoted to work subtracts from leisure time, with leisure a good in the utility function. Our alternative assumption is that in addition to the effect of work on leisure time, work has process benefits and process costs—what we call "job utility."

The problem that an idealized social planner would face helps summarize our overall framework. The social planner's problem involves choosing consumption, capital, work hours devoted to particular jobs, effort demands by a particular job (per hour of work), and amenities provided by a particular job, in order to maximize a household's lifetime utility given firms' production structures and other standard constraints.

3.1 Baseline Assumptions

We consider a small open economy in which agents can freely borrow and lend at an exogenously determined real interest rate r (equal to ρ, the rate at which all economic agents discount the future). Capital is freely mobile across firms and borders. We assume that all benefits and costs to firms and workers other than the utility from leisure and consumption are proportional to work hours. These assumptions plus the assumption of full information for all parties jointly guarantee that there will never be any disagreement between workers and firms about job parameters other than the wage. Furthermore, given fully mobile capital and the exogenous world interest rate, one can focus on steady state analysis since the absence of state variables implies that changes between steady states occur instantaneously. The model is cast in continuous time (we omit time indices in order to avoid notational clutter).

3.2 Individuals and Firms

The economy is inhabited by $i = 1,...,I$ firms, all of which are producers of the same final good and a continuum of individuals whose mass is normalized to one. Households each have only one individual, so we will use the terms household and worker interchangeably.

Utility depends on consumption, the division of time between work time and non-work time, and job utility per hour of work. Job utility depends on effort, amenities, and *job-enjoyment technology* (we elaborate on all of these further below).

Firms produce output using capital and *effective labor input* (the product of hours, effort and labor-augmenting technology), and can vary in their real wage and job utility offerings.

3.3 Planning Problem

Table 1 below lays out our notation. In that notation, the planning problem is:

$$\max_{C,\, H_i,\, E_i,\, A_i,\, K_i} \int e^{-\rho t}\mathcal{U}(C, T-H, \textstyle\sum_i H_i J_i(E_i, A_i, \Psi_i))dt$$

$$\text{such that} \quad \textstyle\sum_i Y_i(K_i, Z_i E_i H_i) + \Pi = C + \dot{K} - \delta K + \sum_i A_i H_i,$$

$$\text{and} \quad \textstyle\sum_i H_i = H.$$

For any variable X, $\dot{X}$ refers to its change over time.

Table 1: Variables and Parameters

Variable	Description	Parameter	Description
C	Total consumption of final output	J_i	Job utility function
H_i	Work hours devoted to ith firm		associated with the ith firm
E_i	Effort demands of ith firm	Ψ_i	Job-enjoyment technology
A_i	Amenities provision of ith firm		of ith firm
K_i	Capital use of ith firm	Y_i	Final output of ith firm
ρ	Discount rate	Z_i	Labor-augmenting technology
t	Time		of ith firm
$\mathcal{U}$	Instantaneous utility	Π	Non-labor, non-interest income
T	Time endowment		(including from foreign sources)
H	Total work hours	δ	Depreciation rate

4 From the Planning Problem to the Real World

Our objective is to deal with many real world features of jobs without adding too much to the complexity of our model. So, we have a broad interpretation of consumption, work hours, effort, amenities, and job utility that allows each to address multiple dimensions of the real world. For example, job-enjoyment technology is meant to capture both innovations in the nature of work proper and innovations in the nature of the work environment.

4.1 Consumption and Work Hours

4.1.1 Consumption

Consumption, C, is meant to capture all the richness of how resources other than time affect life outside of working hours. For instance, a broad notion of consumption must take into account fringe benefits.

4.1.2 Work Hours

Work hours, H, is meant to capture every way in which a person's job interferes with the quantity and enjoyment of non-work time and home production. For example, if an individual is unable to stop thinking about work issues while at home and this interferes with other activities at home, then that can be considered an effective reduction in leisure—and hence an increase in H. Also, consider time spent away from home due to work-related travel. Travel may boost the utility of non-work time if it provides pleasant and interesting experiences. However, work-related travel can also hamper the enjoyment of non-work time because of being away from friends and family. In either case, an adjustment to H may be warranted.

4.2 Job Utility

4.2.1 Effort

Effort, E, is meant to capture all aspects of a job that generate proportionate changes in effective productive input from labor. Effort has many dimensions. For example, the intensity of a worker's concentration on a task while at his or her work station, the amount of time spent at the water cooler or in other forms of on-the-job leisure, own time spent cleaning and beautifying the work place, time spent in office parties or morale building exercises during work hours, and amount of time spent pursuing worker interests that have some productivity to the firm but would not be the boss's first priority, are all positive or negative dimensions of effort.

4.2.2 Amenities

Amenities, A, are job characteristics whose cost to the firm is in terms of goods. The real-world characterization of amenities is just as rich as the characterization of effort. For instance, amenities include the number of parking spots, the quality of air conditioning, and the quality and capacity relative to number of employees of the office gym.

4.2.3 Job-Enjoyment Technology

Job-enjoyment technology affects the mapping of effort and amenities into overall job utility. Therefore, changes in job-enjoyment technology can be interpreted as capturing both innovations in the nature of work proper and innovations related to the work environment.

Innovations in the Nature of Work Proper Innovations in the nature of work proper come in many forms. For example,

- working in groups,
- establishing clear guidelines about what is expected from the worker,
- allowing workers to have greater discretion in the way projects are carried out,
- developing creative ways to give workers feedback on their performance (including constructive criticism techniques rather than, say, yelling at the worker about what he or she is doing wrong),
- improving the organizational structure of the firm in terms of who does what, how they do it and when they do it,
- allowing individuals greater flexibility in determining the time during which work is carried out.

all count historically as innovations in the nature of work proper.

Innovations in the Nature of the External Work Environment Innovations related to the external work environment come in many forms as well. In particular, think of

- the advent of air conditioning,
- the provision of on-site childcare, exercise, and laundry facilities,
- the institution of measures to reduce the incidence of sexual harassment.

There is also one set of innovations that have had an important effect on both the nature of work proper and on the work environment:

- the distribution, design, and allocation of physical work space (such as cubicalization or open office environments).

4.2.4 Interpretation of the Job Utility Function

The job utility function J_i itself is the optimum over many possible ways of doing things. For example, consider two production techniques, as shown in Figure 3 in (E, J) space. Production technique 1, yielding $\mathcal{J}_i^1$, results in relatively higher job utility at lower levels of effort, while production technique 2, yielding $\mathcal{J}_i^2$, results in relatively higher job utility at higher levels of effort. Then, J_i itself is the upper envelope (bold) of these two techniques. The analytical framework that we develop is robust to such non-concavities in job-utility functions.

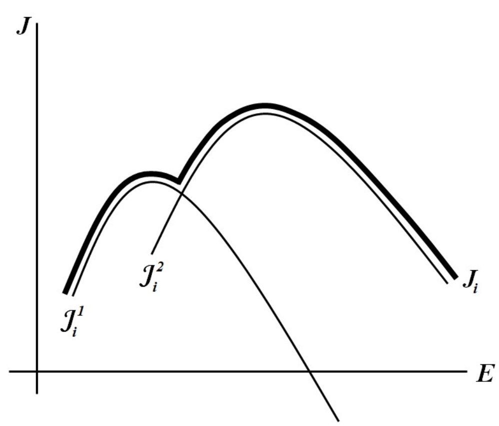

Figure 3: The job-utility function, J_i, as the upper envelope of the two different production techniques J_i^1 and J_i^2.

4.2.5 Reducing the Number of Dimensions for the Arguments of Job Utility

The function $J_i = \mathcal{J}_i(\mathcal{E}_i, \mathcal{A}_i, \Psi_i)$ maps $\mathcal{E}_i$, $\mathcal{A}_i$, and Ψ_i into the hourly utility associated with being at work. $\mathcal{E}_i$ is a vector describing aspects of effort—all dimensions of what the average hour of work is like that affect productivity (including the fraction of time spent in each different activity at work). $\mathcal{A}_i$ is a vector of aspects of amenities. Ψ_i is job-utility technology as above. $\mathcal{E}_i$ and $\mathcal{A}_i$ are determined optimally by firms.

The reduced form job utility function comes from maximizing over these vectors, subject to keeping effort-related productivity and the cost of amenities the same, that is,

$$J_i(E_i, A_i, \Psi_i) = \max_{\mathcal{E}_i,\, \mathcal{A}_i} \{\mathcal{J}_i(\mathcal{E}_i, \mathcal{A}_i, \Psi_i)\}$$

$$\text{such that} \quad E_i = E_i(\mathcal{E}_i) \quad \text{and} \quad A_i = p_{\mathcal{A}_i} \cdot \mathcal{A}_i,$$

where $p_{\mathcal{A}_i}$ is a vector of real amenity prices. So, the number E_i—hourly effort per worker—gives effective productive input from an hour of labor before multiplication by labor-augmenting technology, while the number A_i summarizes the expenditure on amenities per hour of work.[10]

We allow for the possibility of J_i being either positive or negative and for the possibility that job utility is increasing in effort at relatively small levels of effort.[11] However, we assume it must be decreasing in effort at relatively high levels of effort if only because physical and mental exhaustion eventually push J_i toward $-\infty$ (otherwise there would be no upper limit to feasible E_i). We also assume that $\partial J_i/\partial A_i > 0$ and $\partial J_i/\partial \Psi_i > 0$.

[10] Thus, using a vertically integrated perspective, we treat the relative price of amenities as part of the job-employment technology Ψ_i. Think of production of firm i's kth ammenity as

$$\mathcal{A}_i^k = \theta_i^k Y_i^K,$$

where θ_i^k is technology and Y_i^K is the amount of the firm's total output, Y_i, devoted to producing the amenity. Then, the firm's total expenditure on amenity k is $(1/\theta_i^k)\mathcal{A}_i^k = Y_i^K$ and we define $p_{\mathcal{A}_i}^k \equiv (1/\theta_i^k)$. Thus, for instance, an improvement in the amenity technology θ_i^k decreases the relative price of the kth amenity. Except when the real prices of amenities are visible in markets it might be impossible to distinguish between an improvement in job-enjoyment technology and a fall in the price of an amenity.

[11] We consider this to be the more intuitive case for many jobs, although our results are unaltered by assuming that job utility is always decreasing in effort.

5 The Household

5.1 Optimization

We now focus on the decentralized version of the representative worker's optimization problem. We show that this problem can be broken into three optimization subproblems that jointly answer the following question: Once job utility is accounted for, what are the key determinants of labor supply?

5.1.1 Main Problem

We assume the household utility is additively separable between consumption C and all the dimensions of labor (in the Appendix we show that our main messages are robust to relaxing this assumption). Given financial wealth M and job opportunities, the worker chooses consumption C, total work hours H, and work hours devoted to each job H_i, to maximize utility

$$\max_{C,\, H,\, H_i} \int e^{-\rho t}[U(C) + \Phi(T - H) + \textstyle\sum_i H_i J_i]dt,$$

$$\text{such that} \quad \dot{M} = rM + \Pi + \textstyle\sum_i W_i H_i - C, \tag{1}$$

$$\textstyle\sum_i H_i = H, \ \text{ and } \ H_i \geq 0.$$

Overall flow utility comes from consumption utility U, utility from off-the-job leisure Φ, and the job utility from each job multiplied by hours on that job $\sum_i H_i J_i$. W_i is the real wage offered by the ith job, which the worker takes as given. We assume that $U' > 0$, $U'' < 0$, $\Phi' > 0$, and $\Phi'' < 0$. The choice of job is represented simply as the choice of whether to devote strictly positive work hours to any one job in particular.

5.1.2 Optimization Subproblems

The current-value Hamiltonian associated with the worker's problem is

$$\begin{aligned}\mathcal{H} &= U(C) + \Phi(T - H) + \textstyle\sum_i H_i J_i \\ &\quad + b(H - \textstyle\sum_i H_i) + \textstyle\sum_i \mu_i H_i + \lambda(rM + \Pi + \textstyle\sum_i W_i H_i - C).\end{aligned}$$

This maximization problem can be broken down into three optimization subproblems:

$$\begin{aligned}\max\ \mathcal{H} = & \max_{C}\{U(C) - \lambda C\} + \lambda(rM + \Pi)\\ & + \max_{H}\{\Phi(T - H) + bH\}\\ & + \max_{H_i}\{\textstyle\sum_i \mu_i H_i + \sum_i H_i(\underbrace{J_i + \lambda W_i}_{=B_i}) - b\sum_i H_i\}.\end{aligned}$$

Above, λ is the costate variable giving the marginal value of real wealth; the Euler equation is $\dot{\lambda} = \rho - r = 0$. b is the multiplier on the overall time constraint. μ_i is the multiplier on the nonnegativity constraint for hours at each possible job.[12] Finally, B_i denotes the *marginal hourly net job benefits* associated with a job of type i. In the order we will discuss them, the three optimization subproblems nested within the overall maximization of the current-value Hamiltonian are: (1) the consumption decision; (2) job choice and the decision about work hours for each job; and (3) the overall hours decision.

In the additively separable case here we can normalize the accounting between J_i and Φ so that $\Phi'(T) = 0$.[13] Given this normalization, $J_i > 0$ means that a worker would be willing to spend at least some time on a job even if unpaid, should that be the only job available. On the other hand, $J_i < 0$ means that a worker would never do such a job unless paid.

Choice of Consumption As shown in the left panel of Figure 4, the solution to the first optimization sub-problem, $\max_{C}\{U(C) - \lambda C\}$, is to choose consumption to satisfy the first order condition $U' = \lambda$.

[12]The worker's problem would be dramatically different if it were possible to devote negative work hours to unpleasant, badly paid jobs.

[13]Consider $U + \tilde{\Phi} + H\tilde{J}_i$ with $\tilde{\Phi}'(T) = \kappa$, where κ is a constant. Define $\Phi(X) = \tilde{\Phi}(X) - \kappa X$ and $J_i = \tilde{J}_i + \kappa$. Then, $\Phi'(T) = 0$, and

$$\begin{aligned}\mathcal{U} &= U + \tilde{\Phi}(T - H) + \textstyle\sum_i H_i \tilde{J}_i - \kappa T\\ &= U + \Phi(T - H) + \textstyle\sum_i H_i J_i + \kappa\underbrace{(H - \sum_i H_i)}_{=0}.\end{aligned}$$

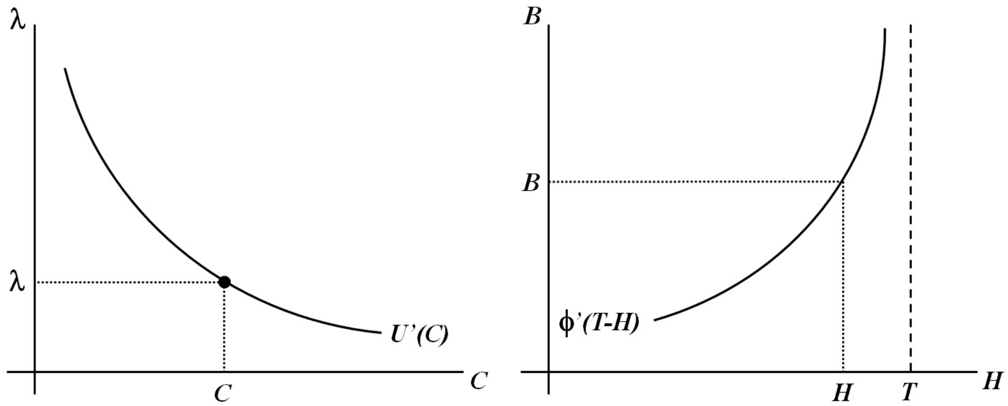

Figure 4: Household solution to choice of consumption, C, and total work hours, H.

Choice of Jobs and Hours at Each Job Job choice involves surveying all possible job types and choosing the job or jobs with the highest B_i. At an optimum $B = \max_i B_i$. It follows that if total work hours are spread across more than one job type each job with positive hours for the individual must be offering the same level of (hourly marginal net) job benefits—although they need not be offering the same combination of real wage and job utility. We elaborate on the fraction of time devoted to each job later.

Choice of Overall Work Hours Combining job choice with the choice of work hours at each job, optimization requires $H_i = 0$ if $J_i + \lambda W_i < b$ and $J_i + \lambda W_i = b$ when $H_i > 0$. This implies that $b = B$: the marginal benefit of overall work hours is equal to the marginal benefit of hours at the job with the highest job benefits. Therefore, total work hours should be chosen to satisfy $\Phi' = B$. In words, at the optimal level of work hours, the marginal utility from off-the-job leisure is equal to the job benefits B of the most attractive job. The right panel of Figure 4 shows the determination of the optimal choice of H. Note that the *labor-hours supply function* is Φ', and the equivalent to a market clearing price for work hours is job benefits B. (We postpone discussion of the determination of the general equilibrium value of B to Section 8.)

6 Firms

In the decentralized version of the optimization problem for firms, the firms are price takers in the product market. Each firm's production function takes as inputs capital and effective labor input (the product of hours, effort, and labor-augmenting technology). The firm rents capital at an exogenous rental rate (determined by the international real interest rate). The hourly cost of labor is captured by the *inclusive wage*: the sum of the real wage and the hourly cost of amenities. That is, writing $\mathcal{W}_i$ for the *inclusive wage*, $\mathcal{W}_i = W_i + A_i$. As such, in payment for their labor, workers receive the real wage W_i (which includes fringe benefits), and as indirect payment—through job utility—amenities A_i. The solution to the firm's cost minimization problem implies that its cost function can be stated as a function of the rental rate of capital and the *effective wage:* the ratio of the inclusive wage to *effective* labor productivity (the product of effort and labor-augmenting technology). Minimization of the effective wage is the focus of the firm's optimization subproblems.

6.1 Cost Minimization

Consider a representative firm providing a job with job-enjoyment technology Ψ_i. The firm's production function is $Y_i = K_i^{\alpha} \left(Z_i E_i H_i\right)^{1-\alpha}$, where capital's share is $\alpha \in (0,1)$ and other variables are as defined earlier. Let R denote the rental rate of capital, which is exogenous to the firm. (There are no adjustment costs, so $R = r + \delta$).

For any output level $\bar{Y}_i$ a firm's cost minimization problem involves choosing capital K_i, and total work hours H_i, to minimize total cost $RK_i + \mathcal{W}_i H_i$ subject to $K_i^{\alpha} \left(Z_i E_i H_i\right)^{1-\alpha} = \bar{Y}_i$.

The solution to the firm's cost minimization problem is standard. The firm's total cost is a function of the desired level of output, Y_i, the rental rate of capital, R, and the *effective wage*, ω_i. The effective wage ω_i is equal to the inclusive wage per labor effectiveness: $\omega_i = \mathcal{W}_i / \left(Z_i E_i\right)$. Thus, the firm's cost function is

$$\mathcal{C}\left(\omega_i, R, Y_i\right) = R^{\alpha} \omega_i^{1-\alpha} Y_i / (\alpha^{\alpha} \left(1-\alpha\right)^{1-\alpha}). \tag{2}$$

6.2 Optimization Subproblems for Firms

The rental rate of capital is exogenous, but the effective wage is a function of the real wage, effort, and amenities, all of which are choice variables: How should the firm analyze its decision? First, unless the firm is going to shut down, the firm must choose the effective wage so that the job benefits the firm offers are at least as high as equilibrium job benefits. Then, two nested subproblems follow. The first subproblem involves the choice of amenities. Given the optimal choice of amenities, the firm then faces a decision about the real wage and effort. The solution to both of these nested subproblems can be represented as tangency conditions.

6.2.1 Central Subproblem: Minimizing the Effective Wage

Given equation (2), any firm continuing to operate should minimize its effective wage subject to the constraint on job benefits:

$$\min_{\mathcal{W}_i,\, E_i} \omega_i = \mathcal{W}_i / (Z_i E_i)$$

$$\text{such that } \underbrace{\lambda (\mathcal{W}_i - A_i) + J_i (E_i, A_i, \Psi_i)}_{=B_i} \geq B,$$

where we have substituted in $\mathcal{W}_i - A_i$ for W_i.

In solving this optimization subproblem, firms take the marginal value of wealth λ, the rental rate of capital R, and equilibrium job benefits B, as given. However, both the inclusive real wage $\mathcal{W}_i$ and amenities A_i, are choice variables. For simplicity, let us assume here additive separability in job utility between effort and amenities:

$$J_i (E_i, A_i, \Psi_i) = F_i \left(E_i, \psi_i^E\right) + G_i \left(A_i, \psi_i^A, p_{\mathcal{A}_i}\right), \tag{3}$$

where ψ_i^E captures innovations in the nature of work proper and ψ_i^A captures innovations in the nature of the work environment. We will write $\Psi_i = (\psi_i^E, \psi_i^A, p_{\mathcal{A}_i})$ and $\Psi_i^A = (\psi_i^A, p_{\mathcal{A}_i})$.

6.2.2 First Nested Subproblem: Choice of Amenities

By the definitions of the inclusive and effective wages $\lambda W_i = \lambda\left(\mathcal{W}_i - A_i\right)$ so $\lambda W_i = \lambda\left(\omega_i Z_i E_i - A_i\right)$. Substituting this last equation into the firm's problem of meeting the market level of B so it can attract workers (which must bind at the optimal solution) it follows that

$$\lambda\omega_i Z_i E_i \ + \ \underbrace{F_i(E_i, \psi_i^E) + G_i(A_i, \Psi_i^A)}_{=J_i(E_i, A_i, \Psi_i)} \ - \ \lambda A_i = B.$$

This implies the nested subproblem: $\max_{A_i} G(A_i, \Psi_i^A) - \lambda A_i$. Thus, the choice of amenities should satisfy the tangency condition $\partial G_i/\partial A = \lambda$. This optimality condition is shown graphically in (A, G) space in the left panel of Figure 5.

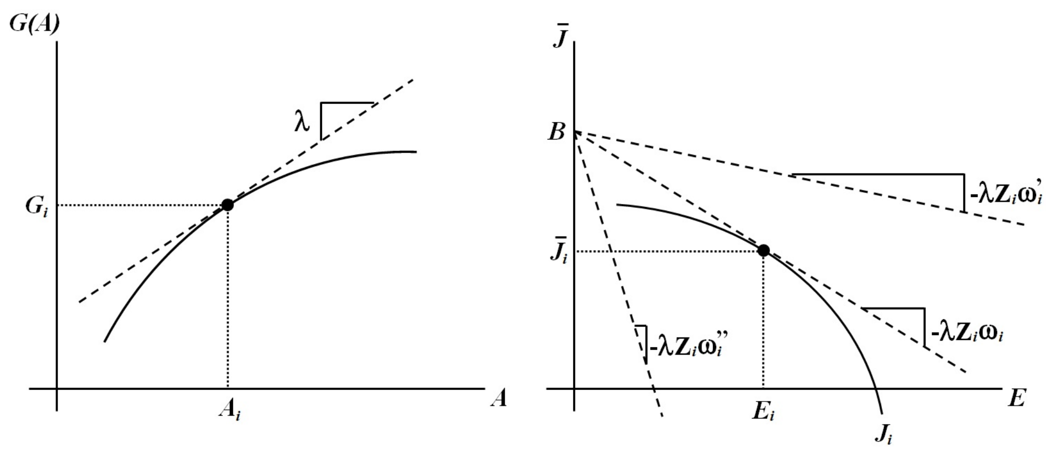

Figure 5: Solution to a representative firm's optimization subproblems.

It is helpful to define $S\left(\lambda, \Psi_i^A\right) \equiv \max_{A_i}\left\{G(A_i, \Psi_i^A) - \lambda A_i\right\}$: the individual surplus received from the firm's optimal choice of amenities. Note that $S_\lambda < 0$ by the envelope theorem. Thus, the lower the marginal value of wealth (intuitively, the richer a worker is), the greater the surplus from amenities.

6.2.3 Second Nested Subproblem: Choice of Effort

Given the optimal choice of amenities, the firm's problem of minimizing the effective wage reduces to a second nested subproblem:

$$\min_{W_i,\, E_i} \ \omega_i = \frac{\mathcal{W}_i}{Z_i E_i}$$

$$\text{such that } \lambda \omega_i Z_i E_i + \underbrace{F(E_i, \psi_i^E) + S\left(\lambda, \Psi_i^A\right)}_{\bar{J}_i(E_i, \lambda, \Psi_i)} = B, \tag{4}$$

where $\bar{J}_i$ is the net job utility function (net of the costs of amenity provision measured in utils). Rearranging,

$$B - \lambda Z_i \omega_i E_i = \bar{J}_i \left(E_i, \lambda, \Psi_i\right) \tag{5}$$

and the objective is to find a feasible value of $\bar{J}_i$ corresponding to the lowest ω_i. In $\left(E, \bar{J}\right)$ space equation (5) traces out all effort and job-utility combinations that are consistent with any given effective wage: the firm's isocost lines are shown as downward sloping lines in the right panel of Figure 5. In that same panel the job utility function is shown as a concave curve. The firm's objective is to find the tangency that yields an isocost line with the intercept at B and minimum negative slope that touches the job utility curve.

In other words, given B, the solution to the firm's optimization subproblem is implicitly captured by the isocost line that has the flattest (algebraically greatest) feasible slope. Feasibility is determined by the net job utility function, which captures all net job utility and effort combinations that a firm is able to offer. As seen in the right panel of Figure 5, $\omega_i'' > \omega_i > \omega_i'$ and ω_i is the firm's optimal effective wage: it can do better than ω_i'', and although ω_i' is preferred to ω_i, the former is not feasible given the firm's net job utility function.

6.2.4 Why Increased Effort is Unpleasant at the Optimum

Despite the fact that job utility can be increasing in effort for some part of the range, the tangency condition shown in the right panel of Figure 5 implies that additional effort will be unpleasant at the optimum. Indeed, at the optimum:

$$\partial \bar{J}_i / \partial E_i = -\lambda Z_i \omega_i = \partial J_i / \partial E_i \implies \partial J_i / \partial E_i \cdot E_i = -\lambda \left(W_i + A_i \right).$$

Then, $\lambda > 0$ and $E_i > 0$ imply that for positive wages (and nonnegative amenities), $\partial J_i / \partial E_i < 0$ at the optimal choice of effort. That is, the optimal choice of effort occurs where job utility is decreasing in effort. In other words, since effort is productive it would make no sense to limit effort when additional effort is also pleasant. Effort should be increased until additional effort is painful enough that it counterbalances the extra productivity.

7 Implications

We now address three important questions. First, how do long-run changes in work hours depend on job utility? Second, assuming there is more than one viable employment opportunity available (that is, assuming more than one firm is able to offer the highest job benefits), how does the worker allocate work hours between jobs? Third, how do short-run changes in work hours depend on job utility?

7.1 Long Run Labor Supply

Kimball and Shapiro (2008) argue that income effects on labor supply are likely to be substantial. They then look at what that would imply for the Frisch (marginal value of wealth held constant) labor supply elasticity if income and substitution effects on labor supply canceled out. But, our framework allows for work hours to remain relatively constant even if the income effect dominates the substitution effect. Consider the effects when consumption and real wages rise.

Recall that $B = \lambda W_i + J_i$, and that work hours are increasing in B (as shown in the right panel of Figure 4). If the income effect dominates the substitution effect, then λW_i is decreasing (W_i is growing, but λ is declining with increases in consumption at a faster rate than W_i increases). All else equal that makes B—and therefore work hours—decrease as well.

But if job utility, J_i, is rising sufficiently, then the income effect seen in the fall in λ can be counterbalanced by the combination of the increase in W_i and the increase in J_i.

There is another surprising implication. Even if $\lambda W_i \to 0$ because the income effect overwhelms the substitution effect (λ declines more quickly than W_i increases), work hours will tend to some constant $\bar{H} > 0$ as long as job utility J_i tends to some positive constant $\bar{J}_i > \Phi'(0) = 0$. That is, even if people face quickly declining marginal utility for additional consumption, a positive asymptote for work hours can exist if there are jobs people enjoy as much as the marginal non-work activity they would otherwise fill out their days with.

7.2 Job Choices

If two jobs have both the same wages and the same job utility, the division of time between them can only be pinned down by general equilibrium forces. But, when two jobs have the same net job benefits but different combinations of wages and job utility, the endogenous determination of λ can lead to a determinate interior optimum based on worker optimization alone. Suppose $B_1 = B_2$ with $W_1 > W_2$ but $J_1 < J_2$. That is, job 1 is higher paid but job 2 is more pleasant. Let χ be the fraction of total work hours that the worker devotes to working for firm 1. At an interior optimum for a worker

$$B_1 = \lambda W_1 + J_1 = \lambda_2 W_2 + J_2 = B_2,$$

so $\lambda = \frac{J_2 - J_1}{W_1 - W_2}$.Given the labor-hours supply function, the optimal level of work hours satisfies $H = T - \Phi'^{-1}(B)$. Substituting into the worker's budget constraint implies that

$$C = \left(T - \Phi'^{-1}(B)\right) \cdot (\chi W_1 + (1-\chi) W_2) + rM + \Pi,$$

which after rearrangement yields

$$\chi = \frac{1}{W_1 - W_2}\left(\frac{U'^{-1}(\lambda) - rM - \Pi}{T - \Phi'^{-1}(B)} - W_2\right).$$

It follows that for any given marginal value of wealth λ and job benefits B, higher exogenous wealth is associated with greater work hours being devoted to jobs with higher job utility and lower wages. Alternatively, at any given set of wages and equilibrium job benefits, the higher λ is the more work hours are devoted to the job with the higher wage.

In the event that more than two jobs have the same net job benefits, any but the extremes of this set of jobs—the one with the highest wage and lowest job utility and the one with the lowest wage and highest job utility—is equivalent from the worker's perspective to a convex combination of time devoted to the extreme jobs. Therefore, the analysis for three or more jobs is essentially the same as for two jobs. (Note that we are assuming for simplicity no fixed costs of going to work. If there are tiny fixed costs per job, the worker might slightly prefer an in-between job and would never choose three jobs.)

7.3 Short Run Labor Supply

At any given level of job benefits B, having a more pleasant, lower-paying job will result in a lower (Frisch) labor supply elasticity. To see this, rewrite $B = \lambda W_i + J_i$ as $\lambda(W_i\,(1-\zeta_i))$, where $\zeta_i \equiv -J_i/\lambda W_i$ is the fraction of the wage that is a compensating differential for a job being unpleasant. Define the elasticity of work hours with respect to B by $\bar{\eta} = \frac{\Phi'(T-H)}{H\Phi''(T-H)}$. Then $d\ln H = \bar{\eta} d\ln B$. Holding everything constant except wages, $d\ln B = d\ln W_i/\,(1-\zeta_i)$.[14] So, with J_i and λ held constant the Frisch elasticity of labor supply is

$$\eta_i = \frac{d\ln H}{d\ln W_i} = \frac{d\ln H}{d\ln B_i}\frac{d\ln B_i}{d\ln W_i} = \frac{\bar{\eta}}{(1-\zeta_i)}. \tag{6}$$

Thus, high job utility tends to make for a lower labor supply elasticity with respect to temporary changes in the real wage and low job utility tends to make for a high labor supply elasticity with respect to the real wage. The intuition is that if much of a wage is just making up for it being an unpleasant job, a 1% higher wage makes net job benefits more than 1%

[14] Alternatively, note that

$$B = \lambda W_i + J_i \to dB = \lambda dW_i \to \frac{dB_i}{B_i} = \frac{W_i}{B_i}\lambda\frac{dW_i}{W_i} \to \frac{dB_i}{B_i} = \frac{W_i}{B_i}\lambda\frac{dW_i}{W_i}$$
$$\to d\ln B_i = \frac{W_i\lambda}{\lambda W_i + J_i} d\ln W_i \to d\ln B_i = \left(\frac{\lambda W_i + J_i}{W_i\lambda}\right)^{-1} d\ln W_i$$
$$\to d\ln B_i = \left(1 + \frac{J_i}{W_i\lambda}\right)^{-1} d\ln W_i \to d\ln B_i = \frac{1}{1+\frac{J_i}{W_i\lambda}} d\ln W_i.$$

higher. On the other hand, if much of the attraction of a job is in its non-wage features, a 1% increase in the wage leads to less than a 1% increase in job benefits.

The results about multiple jobs in Section 7.2 suggest that as economies become richer, workers are likely to switch to jobs with higher job utility. Therefore, if $\bar{\eta}$ as determined by the curvature of Φ stays relatively constant as an economy gets richer, the volatility of work hours will fall relative to the volatility of temporary changes in the real wage. Cross-sectionally, according to the same logic, workers employed in jobs that they "hate" should have a higher Frisch labor supply elasticity if the relevant curvature of Φ is similar across workers in these different jobs.

8 Equilibrium

The next question is: How are equilibrium job benefits and the marginal value of wealth determined?

8.1 Job Benefits

Perfect competition in both product and capital rental markets equalizes across firms not only prices but also the effective wage ω_i for all firms with positive output. From any firm's point of view the firm-specific effective wage, ω_i, must equal the prevailing market value of the effective ω for the firm to have positive output. Perfect competition in the product market implies that, in equilibrium, each firm's marginal cost is equal to the price of final output—which is normalized to 1. Given the cost function in equation (2), that means firms with positive output must have

$$1 = \left(R^{\alpha}/\left(\alpha^{\alpha}\left(1-\alpha\right)^{1-\alpha}\right)\right)\omega_i^{1-\alpha},$$

$$\text{which implies } \underbrace{\frac{W_i + A_i}{Z_i E_i}}_{=\omega_i} = \underbrace{\left(\frac{\alpha^{\alpha}\left(1-\alpha\right)^{1-\alpha}}{R^{\alpha}}\right)^{1/(1-\alpha)}}_{=\omega}.$$

Figure 6 extends the intuition from Figure 5 to this case in which, as far as a representative firm is concerned, the slope of an isocost line $-\lambda Z_i \omega$ is exogenously determined. Because cost minimization must hold, optimality continues to require being at a point of tangency between the net job utility function and an isocost line. Amenities A_i are determined as earlier.

Given the values of λ, Z_i, and ω the firm faces, the left panel of Figure 6 shows optimal effort requirements, E_i, and net job utility, $\bar{J}_i$. These determine the optimal real wage $W_i = \omega / Z_i E_i - A_i$, and job utility J_i.

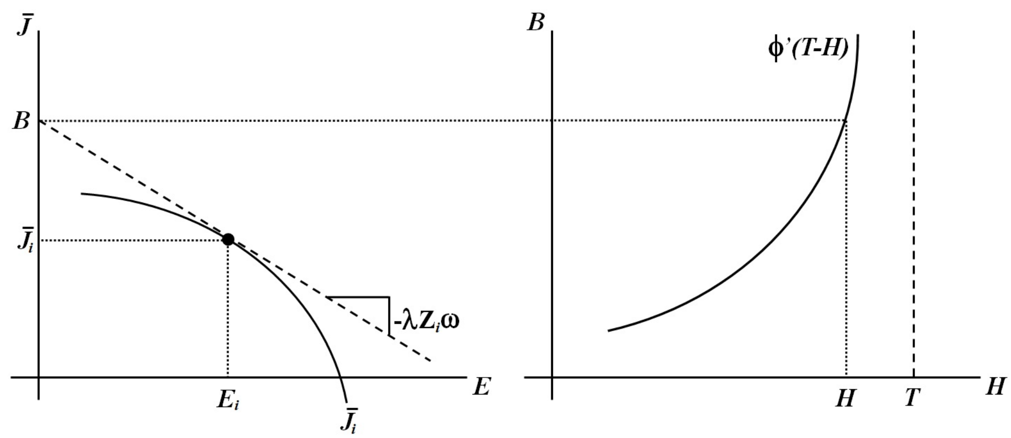

Figure 6: Determination of total work hours under perfect competition.

The intersection of the firm's isocost line with the horizontal axis now determines equilibrium job benefits B. Given this equilibrium level of B, the right panel of Figure 6 shows the determination of total work hours, H. This logic can be expressed by the functions $E_i = E_i(\omega\lambda Z_i, \lambda, \Psi_i)$ and $B_i = B_i(\omega\lambda Z_i, \lambda, \Psi_i)$ (where the appearance of λ is only about the amenities choice). Note that the firms that are able to offer the highest job benefits are the firms that implicitly set the economy's equilibrium level of job benefits.

8.2 The Marginal Value of Wealth

8.2.1 The Labor Earnings Functions

Our small open economy general equilibrium framework has $r = \rho$, so C is constant at $C = rM + \Pi + H \sum_i \chi_i W_i$, where χ_i is the fraction of total work hours that the individual devotes to firm i ($\sum_i \chi_i = 1$). Let $\mathbb{W} = \sum_i \chi_i W_i$ denote the wage averaged across jobs. Given the individual's first-order condition for consumption, a labor-earnings demand function (LE^D) can be defined as follows:

$$\mathbb{W}H = U'^{-1}(\lambda) - rM - \Pi = LE^D. \tag{7}$$

Since $W_i = Z_i \omega E_i - A_i$, a labor-earnings supply function (LE^S) can be defined thus:

$$\mathbb{W}H = \textstyle\sum_i \left[Z_i \omega \cdot E_i(\omega\lambda Z_i, \Psi_i) - A_i\left(\lambda, \Psi_i^A\right)\right] \cdot H_i\left(B\left(\omega\lambda Z_i, \Psi_i\right)\right) = LE^S, \tag{8}$$

where once again we have made use of the definition of the average wage and, also, we used the fact that H_i is a function of B: $H_i(B(\cdot))$ in LE^S.

8.2.2 Graphing Labor-Earnings Demand and Labor-Earnings Supply

Labor-Earnings Demand $U'(\cdot)$ is decreasing in C. Therefore, equation (7) implies a negative relationship between λ and labor-earnings demand as measured by $\mathbb{W}H$. Thus, in $(\mathbb{W}H, \lambda)$ space the labor earnings demand function is downward sloping.

Labor Earnings Supply For labor earnings supply consider first the case in which only clones of firm i exist. Then, LE^S is given by

$$\mathbb{W}H = \left[Z_i \omega \cdot E_i(\omega\lambda Z_i, \Psi_i) - A_i\left(\lambda, \Psi_i^A\right)\right] \cdot H_i\left(B\left(\omega\lambda Z_i, \Psi_i\right)\right).$$

Showing that in $(\mathbb{W}H, \lambda)$ space labor-earnings supply is downward sloping requires answering the following three questions.

(a) *What does a change in λ imply for amenities*? Suppose that the marginal value of wealth λ rises to λ'. Then, as shown in the left panel of Figure 7, amenities decrease. This means that the surplus from amenities received by individuals, $S\left(\lambda, \Psi_i^A\right)$, declines, which—as shown in the right panel of Figure 7—induces a parallel downward shift in the net job utility function in $\left(E, \bar{J}\right)$ space.

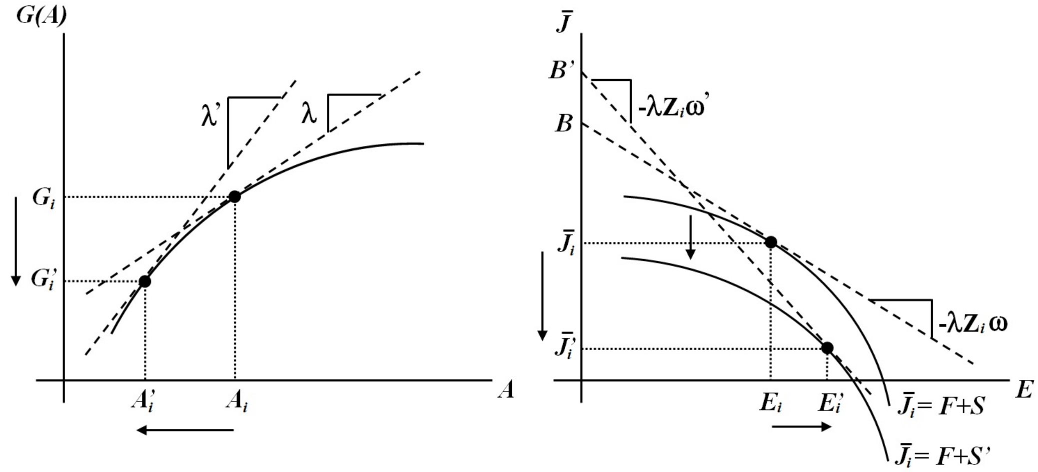

Figure 7: Derivation of labor earnings supply curve.

(b) *What does a change in* λ *imply for the isocost lines*? The right panel of Figure 7 shows that higher λ' implies a steeper isocost line, which in turn leads to a decline in net job utility and a rise in effort. Also, although the change can seem ambiguous, job benefits rise to B', which leads to higher work hours.[15] $dB/d\lambda > 0$ means that the H in $\mathbb{W}H$ goes up.

(c) *How do real wages factor in*? If all firms are identical $\mathbb{W}$ is trivially equal to W_i. The analysis behind Figure 7 shows that the consequences of higher marginal value of wealth include lower amenities, A_i, and higher effort, E_i. ω is unchanged, and since $W_i = Z_i \omega E_i - A_i$

$$dW_i/d\lambda = Z_i \omega dE_i/d\lambda - dA_i/d\lambda > 0.$$

[15] Firms maximize net job benefits given the constraints they face. In particular,

$$B_i = \max_{E_i, A_i} \left\{ \lambda \omega Z_i E_i + F\left(E_i, \psi_i^E\right) + \left(A_i, \psi_i^A\right) - \lambda A_i \right\}.$$

The envelope theorem implies that when λ changes

$$dB_i = (\omega Z_i E_i - A_i)\, d\lambda = (\mathcal{W}_i - A_i)\, d\lambda = W_i d\lambda > 0$$

whenever $W_i > 0$. Since this is true for all jobs, the maximum B_i over all i must also increase.

The fact that $dB/d\lambda > 0$ highlights an interesting role for amenities. Consider a decline in the marginal value of wealth. In the absence of amenities, in $(E, \bar{J})$ space the job utility function would remain fixed while isocost curves became less steep and job benefits declined. Yet, once amenities are considered, a lower marginal value of wealth shifts the net job utility function shifts up in $(E, \bar{J})$ space. Because of the logic of the envelope theorem job benefits must still decline, but not as much as they would in the absence of amenities. Thus, endogenous provision of amenities blunts the effect of lower λ. In other words, changes in amenities serve as endogenous buffers to income effects on labor supply.

Taken together, the answers to these three questions imply that labor earnings is increasing in λ so that LE^S is upward sloping in $(\mathbb{W}H, \lambda)$ space.

Determination of the Marginal Value of Wealth Figure 8 shows LE^D and LE^S, and the determination of equilibrium λ and labor earnings $\mathbb{W}H$ when all firms are identical.

What about the determination of the marginal value of wealth and labor earnings when firms with a range of wage/effort combinations are operational? For simplicity, consider the case of two types of firms indexed by $i = 1, 2$, which, as noted in Section 7.2, can be thought of as the relevant extremes.

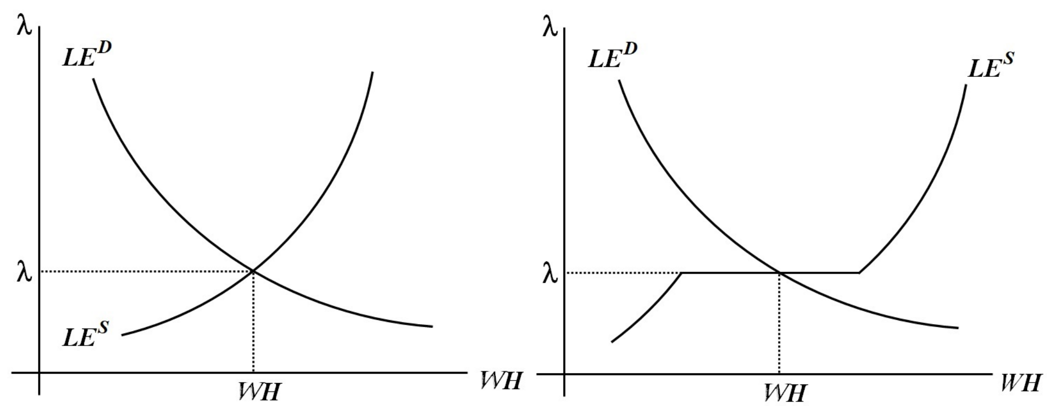

Figure 8 (left panel): Equilibrium labor earnings and the marginal value of wealth using labor-earnings supply and demand. Figure 9 (right panel): Labor earnings supply and demand with two firms.

Suppose these two types of firms have job utility functions given by $J_1 = \mathcal{J}_1$ and $J_2 = \mathcal{J}_2$ as depicted in Figure 3. Then, what is relevant is the upper envelope of these job utility functions. For a sufficiently low marginal value of real wealth, say λ', firm 1 is able to offer the highest marginal net job benefits and type 2 firms do not operate. For a higher marginal value of real wealth, say, $\lambda'' > \lambda'$ both type 1 and type 2 firms are able to offer the same marginal net job benefits and workers allocate hours across firms according to the logic in Section 7.2. Finally, for even higher marginal values of real wealth such as, say, $\lambda''' > \lambda''$— type 2 firms are able to offer the highest marginal net job benefits, and type 1 firms are unable to operate.

Market equilibrium can be shown in the labor-earnings supply and demand diagram.

LE^D is a simple extension of what we derived above. In particular, labor earnings demand is described by

$$\lambda = U'\left(rM + \Pi + \left(\chi_1 W_1 + \left(1 - \chi_1\right) W_2\right) H\right),$$

where χ_1 is the fraction of total work hours devoted to firms of type 1.

The appropriate version of labor-earnings supply, however, has a new wrinkle. For sufficiently low values of λ only firms of type 1 operate and the associated real wages, marginal net job benefits, and work hours are relatively low. Therefore, in terms of labor earnings supply, low values of λ are associated with low labor earnings. At the critical value λ'' noted above both types of firms are operational. Figure 9 shows an equilibrium in which both types of firms are operational. Wages, marginal net job benefits, and hours are higher than under λ'—and therefore so are labor earnings. However at λ'' any level of labor earnings within a certain range is on the labor earnings supply curve, implying a perfectly elastic portion of the labor-earnings supply curve. In this region, an increase in non-labor income that shifts LE^D out leads to the allocation of more hours to the more pleasant job without changing λ. Finally, for higher values of λ, only firms of type 2 are operational. This is associated with higher wages, marginal net job benefits, and hours. Thus, in terms of labor earnings supply high values of λ are associated with high values of labor earnings.

8.3 Further Implications

Our framework allows us to address several additional questions. For instance: How does a firm's overall technology matter for its competitiveness? What are the effects of changes in labor-augmenting technology and job-enjoyment technology on labor earnings and the marginal value of wealth? Which changes in technology are consistent with higher real wages and trendless labor hours if the income effect outweighs the substitution effect?

In the Appendix, we show the following. First, within our framework, differences in job-enjoyment technology between firms can counterbalance differences in labor-augmenting technology, and vice versa. In particular, a firm that falls behind in labor-augmenting technological progress can keep up its ability to attract workers even with lower wages if its job enjoyment technology advances sufficiently. Second, within our framework, each of (a) a permanent increase in labor augmenting technology, (b) a permanent positive innovation in the nature of work proper, or (c) a permanent positive innovation in the nature of the work environment can lead simultaneously to higher (i) labor earnings, (ii) a lower marginal value of real wealth, and (iii) trendless or nearly trendless work hours. In essence, then, anything that "regular" technology can do, job enjoyment technology can do as well.[16]

9 Welfare

We argue above that an upward trend in job utility makes it possible for work hours to remain approximately constant over time even if the income effect of higher real wages on labor supply exceeds the substitution effect of higher real wages. The question that immediately follows is: "What are the welfare effects of such changes?" In this section, we elaborate on the relationship between job utility and welfare, point to ways theoretical relationships can be operationalized and give a numerical example for the potential welfare gains associated with secular changes in job utility.

9.1 Measuring Welfare

Because transitions between steady states are instantaneous, changes in welfare induced by changes in exogenous parameters are well assessed via comparative steady-state analysis. In steady state, given $r = \rho$, an individual's problem is equivalent to the static optimization problem

$$\max_{C,\ H,\ H_i \geq 0} U(C) + \Phi(T - H) + \textstyle\sum_i H_i J_i$$

$$\text{such that} \quad C = rM + \Pi + \textstyle\sum_i W_i H_i, \quad \text{and} \quad H = \textstyle\sum_i H_i.$$

Given the multipliers λ and b, let

$$\mathcal{L}^* = \max_{C,\ H,\ H_i \geq 0} \{U(C) + \Phi(T - H) + \textstyle\sum_i H_i J_i + b\,(H - \sum_i H_i) + \lambda\,(rM + \Pi + \sum_i W_i H_i - C)\}.$$

[16] To the extent that higher job utility matters for competitiveness, it is even plausible that firms might set what would otherwise be slightly above-optimal effort requirements in order to induce workers themselves to think of ways to increase job utility. This amounts to a low cost form of research and development in job enjoyment technology.

Recall that the optimal choice of H_i yields two cases: $H_i = 0$ and $J_i + \lambda W_i < b$, or $H_i > 0$ and $J_i + \lambda W_i = b$. Therefore, $b = B$, where, B denotes the economy's level of equilibrium marginal net job benefits.

Using the envelope theorem,

$$\lambda^{-1} d\mathcal{L}^* = \lambda^{-1} \sum_i H_i dJ_i + \sum_i H_i dW_i + d\left(\Pi + rM\right). \tag{9}$$

Above, each of the three terms on the right-hand side highlights distinct ways in which the economy's opportunity set becomes larger. Changes in welfare from changes in job utility are captured by the first term; changes in welfare from changes in wages are reflected in the second term; and changes in welfare from changes in exogenous wealth appear in the last term. The first term $\sum_i H_i dJ_i/\lambda$ can be interpreted as the portion of the change in the maximized value of utility that answers the question: "How much would the worker have to be paid per year in order to be willing to go back to working in yesterday's conditions?"

9.2 Towards Pinning Down the Implied Increase in Welfare

To better understand the implications of the envelope theorem as laid out in equation (9), note that the second term on the right-hand side of equation (9 is the change in wages for narrowly defined job categories and satisfies

$$\sum_i H_i dW_i = d\left(\sum_i H_i W_i\right) - \sum_i W_i dH_i.$$

Therefore, to gauge this component of welfare, we need to adjust the change in overall labor earnings by subtracting not only extra earnings from people working longer hours overall, but also extra earnings coming from people switching towards jobs that are more highly paid and have lower job utility. If λW is moving down, then the overall trend should involve compositional shifts toward jobs with higher job utility and relatively lower pay than other available jobs. This means that the increase in labor earnings will tend to understate the true increase in welfare (leaving aside changes in overall hours, which obviously need to be accounted for).

To understand the remaining terms for the change in welfare, note that since $B = J_i + \lambda W_i$ implies

$$dB = dJ_i + \lambda dW_i + W_i d\lambda. \tag{10}$$

$$\lambda^{-1} dJ_i = \lambda^{-1} dB - \lambda^{-1} W_i d\lambda - dW_i.$$

Pinning down dJ_i calls for looking at labor hours (to gauge dB), consumption (to gauge $d\lambda/\lambda$), and hourly wages. Substituting this last equation into equation (9) and rearranging yields

$$\frac{d\mathcal{L}^*}{\lambda \sum_i H_i W_i} = \frac{H}{\sum_i H_i W_i} \frac{dB}{\lambda} - \frac{d\lambda}{\lambda} + \frac{d\left(\Pi + rM\right)}{\sum_i H_i W_i}. \tag{11}$$

The last term on the right-hand side—the value of extra non-labor income—is easy to understand. Hence, we will focus on getting measures for the first two terms on the right-hand side of equation (11).

Define $\gamma = -CU_{CC}/U_C$. (That is, $1/\gamma$ is the elasticity of intertemporal substitution). Then $d\lambda/\lambda = -\gamma dC/C$. Moreover, as discussed earlier (recall equation (6), which was derived for multiple jobs), for any i $\eta_i = \bar{\eta}/\left(1 - \zeta_i\right)$, where η_i is the Frisch elasticity of labor supply, ζ_i is the fraction of the wage that is a compensating differential, and $\bar{\eta} = \Phi'\left(T - H\right) / \left(H\phi''\left(T - H\right)\right)$. Also, the definition of ζ_i as the fraction of the wage that is a compensating differential can be rewritten as $\frac{B}{\lambda W} = 1 - \zeta_i$. It follows that

$$dB/B = \left(1/\bar{\eta}\right) dH/H \implies dB = \frac{\left(\left(1 - \zeta_i\right) \lambda W_i\right)}{\bar{\eta}} dH/H \implies dB/\lambda = \left(W_i/\eta_i\right) dH/H.$$

Substituting the appropriate expressions into equation (11) and simplifying yields

$$\frac{d\mathcal{L}^*}{\lambda \sum_i H_i W_i} = \frac{\left(W_i/\eta_i\right) dH}{\sum_i H_i W_i} + \frac{\gamma dC}{C} + \frac{d\left(\Pi + rM\right)}{\sum_i H_i W_i}. \tag{12}$$

The intuition for equation (12) is that (in the additively separable case) γ tells how many times bigger the income effect is than the substitution effect. If hours are relatively constant despite increasing wages, then there must be substantial increases in job utility to counteract the income effect associated with increases in consumption. On the other hand, if hours H move in the direction indicated by the income effect it gives less hint of improvements in job utility. (If $\gamma = 1$, income and substitution effects cancel, but increases in consumption still have the usual effect on welfare.)

9.3 Calibrating γ from job choices

In addition to evidence from the effects of interest rates on the path of consumption, in principle evidence about γ can be found from workers' job choices. Consider an individual working two jobs satisfying $J_2 > J_1$. Then, $\lambda W_1 + J_1 = \lambda W_2 + J_2$, meaning that

$$\lambda = \frac{J_2 - J_1}{W_2 - W_1} \implies \frac{d\lambda}{\lambda} = \frac{dJ_1 - dJ_2}{J_1 - J_2} - \frac{dW_1 - dW_2}{W_1 - W_2}.$$

For any individual with $dJ_1 - dJ_2 = 0$, for example, $dJ_1, dJ_2 = 0$,

$$\lambda^{-1} d\lambda = -\left(dW_1 - dW_2\right) / \left(W_1 - W_2\right),$$

and using $d\lambda/\lambda = -\gamma dC/C$ it follows that

$$\gamma = \left[\left(dW_1 - dW_2\right) / \left(W_1 - W_2\right)\right] / \left(dC/C\right).$$

That is, the elasticity with respect to consumption of a within-person compensating differential *relative to its initial size* is equal to γ. Crucially, this means that if $\gamma > 1$, economic growth will tend to make compensating differentials larger as a fraction ζ of the relevant wages. Thus, if income effects exceed substitution effects, we can look forward to a future in which compensating differentials become a more and more important aspect of labor markets. Conversely, if, in general, compensating differential between pairs of (possibly therefore unusual) jobs that are as nearly unchanging as possible are growing faster than the wages—and therefore the consumption that can be supported by those jobs—it provides important evidence that $\gamma > 1$, with all that implies.

9.4 Illustrating the Calculation of Welfare Gains

It is helpful to work with a numerical example. (The derivations below are also helpful in doing other numerical examples.) Suppose that the long-run elasticity of intertemporal substitution is 0.5, in which case $\gamma = 2$. Using this value for γ along with equation (12) implies that for $d\Pi = 0$, $dM = 0$, and $dH = 0$, $\frac{d\mathcal{L}^*}{\lambda \sum_i H_i W_i} = 2\frac{dC}{C}$ and, therefore, a 1% increase in consumption would be associated with a welfare increase of 2%.

A natural question that follows is what fraction of welfare gains are attributable to higher job utility. To see this, continue to assume that $d\Pi = dM = 0$. Moreover, allow for $dH \neq 0$. Dividing equation (9) by $\sum_i H_i W_i$ and using equation (12) on can arrive at the following expression:

$$\frac{\sum_i H_i dJ_i}{\lambda \sum_i H_i W_i} + \frac{\sum_i H_i dW_i}{\sum_i H_i W_i} = \frac{(W_i/\eta_i)\, dH}{\sum_i H_i W_i} + \frac{\gamma dC}{C}.$$

Using the identity

$$\textstyle\sum_i d\left(H_i W_i\right) = \sum_i W_i dH_i + \sum_i H_i dW_i \tag{13}$$

to substitute out the second term in the left-hand side of the preceding equation we obtain, after rearranging,

$$\frac{\sum_i H_i dJ_i}{\lambda \sum_i H_i W_i} - \frac{\sum_i W_i dH_i}{\sum_i H_i W_i} = \left[\gamma \frac{dC}{C} - \frac{\sum_i d\left(H_i W_i\right)}{\sum_i H_i W_i}\right] + \frac{(W_i/\eta_i)\, dH}{\sum_i H_i W_i}. \tag{14}$$

On the left hand side of this equation the first term indicates changes in job utility from particular jobs becoming more pleasant, while the second term indicates the additions to job utility coming from switching between jobs (since willingness to take lower wages indicates higher job utility in the new jobs), both measured in relation to total labor income. For convenience, the right-hand side of this equation can be thought of as having two terms: the term in square brackets and the term with dH. Suppose that consumption and labor income are increasing at the same rate. Then, the term in square brackets is $\gamma - 1$ times this rate of change. It follows that this term in brackets is the change in the marginal rate of substitution between labor and consumption that one would expect if $\gamma \neq 1$ and there were no improvement in job utility. Indeed, in this case equation (14) becomes

$$\frac{(W_i/\eta_i)\,dH}{\sum_i H_i W_i} = -\underbrace{\left[\gamma \frac{dC}{C} - \frac{\sum_i d\,(H_i W_i)}{\sum_i H_i W_i}\right]}_{=(\gamma-1)dC/C}.$$

That said, in the case in which labor hours are approximately trendless, meaning that $dH = 0$, then the term in square brackets indicates how great a change in job utility is needed to explain the behavior of labor hours. In this case equation (14) becomes

$$\frac{\sum_i H_i dJ_i}{\lambda \sum_i H_i W_i} - \frac{\sum_i W_i dH_i}{\sum_i H_i W_i} = \underbrace{\left[\gamma \frac{dC}{C} - \frac{\sum_i d\,(H_i W_i)}{\sum_i H_i W_i}\right]}_{=(\gamma-1)dC/C} \tag{15}$$

In words: given approximately trendless labor hours, $\gamma - 1$ times the rate of increase of consumption and labor income must be accounted for by improvements in job utility. (The welfare effects of this change in job utility are measured in terms of consumption that would yield the same amount of extra utility.)

Coming full circle with our numerical example, we began this section of the paper noting that with $\gamma = 2$ along with $d\Pi = 0$, $dM = 0$, and $dH = 0$, then $\frac{d\mathcal{L}^*}{\lambda \sum_i H_i W_i} = 2\frac{dC}{C}$ and welfare gains were 2 percent. Continuing to assume that the rate of increase of consumption and labor income is the same, inspection of equation (15) implies that in this case improvements in job utility account for half of the increase in total welfare (1 percentage point of the 2%).

Here, we emphasize trends in how pleasant jobs are as an explanation for why labor hours might be trendless even if income effects are stronger than substitution effects. Bringing other explanations into the picture would change the calculations; but what is likely to remain true in extensions of the model designed to allow for other possible explanation is the idea that it is difficult for a trend in the pleasantness of jobs to have a big effect on the trend in labor hours without also having a big effect on the trend in welfare.

10 Conclusions

The paradox of hard work is this: for decades, work hours per population among adults have remained roughly trendless, despite strong trends in consumption and real wages. In principle, the paradox of hard work can be rationalized in several different ways. Of these alternatives, we focus on the general equilibrium effects of secular changes that make work more pleasant. Economists have long understood that cross-sectional differences in job utility at a particular time give rise to compensating differentials. In this paper, we develop a theory that focuses on the less-studied long-run macroeconomic consequences of trends in job utility.

Our theory allows for the interaction between *work hours*—which stands in for all aspects of the job that interfere with leisure and home production—and *effort*—which stands in for all aspects of a job whose cost is in terms of proportionate changes in effective productive input per labor hour. We also consider the role of *amenities*—which we define to be job characteristics whose cost is in terms of goods—and the role of secular increases in job utility—that is, secular declines in drudgery, which can stem from changes in standard notions of technology, such as labor-augmenting technology, and also from changes in job-enjoyment technology. General equilibrium can be analyzed through two curves we define: *labor-earnings supply and labor-earnings demand.*

Two key implications emerge. First, secular improvements in job utility imply that work hours can remain approximately constant over time even if the income effect of higher wages on labor supply exceeds the substitution effect of higher wages. Second, secular improvements in job utility can themselves be a substantial component of the welfare gains from technological progress. These two implications are connected by an equation flowing from optimal hours choices: improvements in job utility that have a significant effect on labor supply tend to have large welfare effects.

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Appendix

A The Elasticity of Intertemporal Substitution

A series of studies makes use of aggregate data and suggest that the EIS is quite small. Most prominently, Hall (1988) estimates the EIS using econometric specifications based on a representative agent consumption Euler equation. His study uses data on consumption of nondurable goods (excluding services) and standard measures of the nominal interest rate—data on stock prices and Treasury bills. Hall's EIS estimates are not statistically significant and imply that the EIS is not above 0.2. Of note, Hall argues that in light of his analysis, previous studies that find values of the EIS close to 1, such as Hansen and Singleton (1983) and Summers (1982), do so in part because of the particular time period over which their data spans and also because they use instruments that are correlated with the innovation in their measures of real returns.

More recent work emphasizes the extent to which estimation methodology and assumptions on the utility function can impact estimates of the EIS. On net, these studies also report values of the EIS that are fairly small. Related to estimation methodology, Hansen and Singleton (1996) revisit the framework in Hall (1988) using a proposed efficient generalized methods of moments estimator that is scale invariant and asymptotically efficient. Using this estimator, they find that the EIS can be significantly different than zero, as large as 0.6, but as small as 0.08. That said, in general, they do not find much evidence against the null that the EIS is zero.

Regarding the role of utility specifications, Basu and Kimball (2002) use King-Plosser-Rebelo preferences as their benchmark utility specification and various econometric techniques. They find, on net, a statistically significant value of the EIS equal to about 0.5. Of note, Basu and Kimball argue that including data on labor is important, since it improves the empirical performance of the permanent income hypothesis substantially and, therefore, considerably weakens arguments against this hypothesis proposed by studies such as Campbell and Mankiw (1989). Also, Okubo (2008) studies the extent to which the assumption of homotheticity can bias estimates of the EIS and finds that homotheticity is strongly rejected.

Okubo argues that given nonhomotheticity the EIS is about 0.2 and statistically significant.

As generally related to both estimation methodology and utility specifications, Atkenson and Ogaki (1996) develop and estimate a model with preference heterogeneity: low-income consumers can have a lower EIS compared to high-income consumers. Using Indian panel data on food consumption they report a mean low-income EIS equal to 0.5 and a mean high-income EIS equal to 0.8. In turn, using aggregate Indian data they find a mean EIS equal 0.3, and applying their model to the US, also using aggregate data, they find a mean EIS equal to 0.4. Ogaki and Reinhart (1998) propose a two-step estimation process in which the first step is a cointegration regression that estimates the utility function, and the second step is generalized method of moments applied to the Euler equation. They find an EIS that is statistically significant and equal to about 0.4. Moreover, Vissing-Jørgensen (2002) finds that the EIS is statistically significant and between 0.3-0.4 for stock-holding households, and statistically significant and between 0.8-1 for bond-holding households. She also finds that the EIS is larger for households with larger asset holdings.

Other studies emphasize how the type of data used affects estimates of the EIS. EIS estimates from these studies range from being quite small to considerably large. As an example of this research finding EIS values on the smaller side, Barsky et al. (1997) use survey data in which individuals respond to hypothetical situations and they find a significant EIS that is, on average equal to about 0.2. Hahm (1998) argues that the housing component of consumption of nondurable goods should not be included in estimates of the EIS, since intertemporal substitution of housing is extremely costly. Excluding this component Hahm estimates a statistically significant EIS equal to about 0.3. Also, Cashin and Unayama (2016) use data from Japan to estimate the EIS in order to exploit a natural experiment: a preannounced increase in Japan's consumption tax rate against the backdrop of no change in other factors that affect the real interest rate. They find the EIS to be about 0.2, but not statistically significant, and furthermore that the EIS is significantly less than 1. Best et al. (2018) use data from the UK, where banks offer notched mortgage interest rate schedules, interest rates jump considerably at each notch, and there is considerable "bunching" below every notch—which is intuitively in line with individuals smoothing consumption just below each notch in order to remain at a lower interest rate. They find a statistically significant value for the EIS equal to about 0.1. Moreover, also using survey data like Barsky et al. (1997), Kimball et al. (2019) find a highly significant value for the EIS of approximately 0.09.

Some literature that also highlights the role of data reports more medium-sized EIS estimates. For example, Skinner (1985) argues that for an individual with no bequest motive a change in the mortality probability should be equivalent to the substitution effect of an equal change in the interest rate. Using data on mortality probabilities, Skinner's estimates of the EIS are statistically significant and suggest that the EIS can be as high as 0.6. Attanasio and Weber (1993) contrast EIS estimates obtained using U.K. average cohort consumption growth rates versus EIS estimates obtained using aggregate consumption data. Aggregate results suggest an EIS somewhat above 0.3 and not always significant. However, results using cohort data suggest that the EIS can be as high as 0.8 and significant. Attanasio and Weber (1995) use U.S. micro data from the Consumer Expenditure Survey survey and find that the EIS can be as high as 0.7 and significant. Also, Engelhardt and Kumar (2009) estimate the EIS using a life-cycle consistent econometric model and Health and Retirement Study data. They report a significant EIS that is equal to roughly 0.75.

Literature highlighting the role of data also reports considerably larger estimates of the EIS. For instance, Beaudry and van Wincoop (1996) use state-level panel data, which they argue has the ability to bypass asset return measurement problems, and find a statistically significant EIS equal to about 1. Mulligan (2002) argues that the relevant interest rate for estimating the EIS is the expected return on a representative piece of capital, and that tax policy changes can help disentangle the demand for capital from intertemporal preferences. Using these data, Mulligan finds EIS estimates that are, on net, statistically significant and greater than 1. Moreover, his analysis suggests that the EIS can be as high as 2. More recently, Gruber (2013) argues that time series on interest rates are correlated with variables that cause changes in consumption and savings, and that standard instruments—such as lagged interest rates—cannot assess this problem. Gruber instruments using the interest rate with cross-section data and time series variation in capital taxation, and he finds a statistically significant value of the EIS equal to about 2. Moreover, Gruber argues that earlier work that used income taxation to estimate the EIS (such as, for example, Zeldes, 1989, Lawrance, 1991, and Shea, 1995) suffers from various limitations, such as the precision of estimates depending on year dummies, identification, and type of data used.

Of course, in light of the earlier research noted as well as the results from Havránek (2015) highlighted in the Introduction, results from Beaudry and van Wincoop (1996), Mulligan (2002), and Gruber (2013) can be thought of as being outliers. Regarding Beaudry and Wincoop, with two decades of additional data since their publication, it would be timely to reassess the robustness of their results by using an out-of-sample methodology. Regarding the work of Mulligan and Gruber, it is important to know that in their papers values of the EIS less than 1 cannot be rejected. Moreover, it is not clear that tax changes are exogenous preference shocks, since, for example, if the average level of patience for US households increased (which would tend to raise the expected growth rate of consumption), there might well be political pressures for lower capital taxation.

B The Role of Technology

B.1 Competitiveness

Across firms, differences in job-enjoyment technology can counterbalance differences in labor-augmenting technology, and vice versa. To see this, consider firms 1 and 2 as shown in Figure A1, where $\Psi_2 < \Psi_1$, $Z_2 > Z_1$, so that firms differ in their net job utility curves. As depicted, although firm 1 has lower labor-augmenting technology, given its higher job-enjoyment technology it is the one that would implicitly set the economy's equilibrium level of job benefits (recall that, all else equal, higher Ψ_i shifts the job utility curve up). Because workers take jobs with the highest B, firm 2 is unable to attract workers—and therefore must shut down.

For a higher value of Ψ_2 (which would shift $\bar{J}_2$ sufficiently high up) or a higher Z_2 (which would make firm 2's isocost lines sufficiently steep) firm 2 could offer the exact same level of job benefits as firm 1—in which case both firms would be able to operate—or even higher job benefits—in which case firm 2 would be the one to implicitly establish economy-wide equilibrium B, and firm 1 would be unable to attract workers.

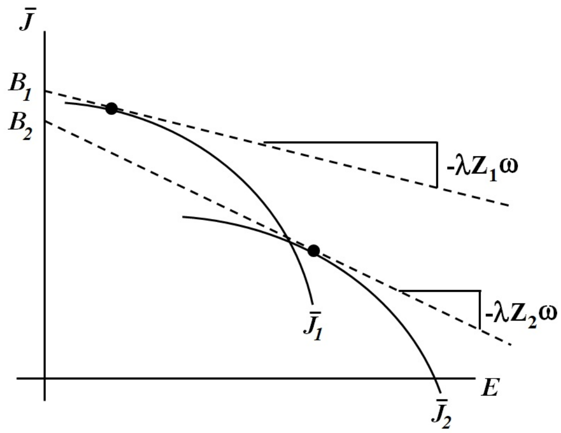

Figure A1: A difference in job utility overwhelming a difference in labor-augmenting technology.

B.2 Labor Earnings and the Marginal Value of Wealth

For the sake of intuition, throughout the remainder of this section we make four simplifying assumptions. 1) We revert to assuming that there is only one firm and therefore avoid i indexes. 2) For the effects of changes in the nature of work proper, ψ^E, three possibilities emerge depending on whether $\partial F_E/\partial\psi^E = 0$, $\partial F_E/\partial\psi^E < 0$, or $\partial F_E/\partial\psi^E > 0$. $\partial F_E/\partial\psi^E = 0$ means that changes in ψ^E do not affect how onerous extra effort is. $\partial F_E/\partial\psi^E < 0$ means that higher ψ^E makes extra effort more onerous. $\partial F_E/\partial\psi^E > 0$ means that higher ψ^E makes increases in effort less onerous. We focus on $\partial F_E/\partial\psi^E \geq 0$ since it is the most intuitively appealing possibility. 3) We focus on cases in which $\partial G_A/\partial\psi^A > 0$ or which $\partial G_A/\partial\psi^A > 0$. The strict inequality corresponds to an innovation in amenities increasing the marginal benefit from spending on amenities. 4) We continue to assume the additively separable case $J = F + G$. Relaxing these assumption leads to interesting analysis but not quite interesting enough to include here.

B.2.1 The Effect of a Rise in Z on λ and $\mathbb{W}H$

Suppose labor-augmenting technology increases from Z to $\tilde{Z} > Z$. The left panel of Figure A2 shows that, all else equal, higher Z leads to higher job benefits (meaning higher work hours) and higher effort, which leads to higher real wages because the effective wage is constant. These changes jointly imply higher $\mathbb{W}H$. Now, consider the implications of higher

$\mathbb{W}H$. LE^S shifts out because at any given λ higher Z is consistent with higher labor earnings. This outward shift in LE^S implies a decrease in equilibrium λ and an increase in equilibrium $\mathbb{W}H$ (the lower λ induces changes exactly opposite to those in the left panel of Figure 8 in the main text).

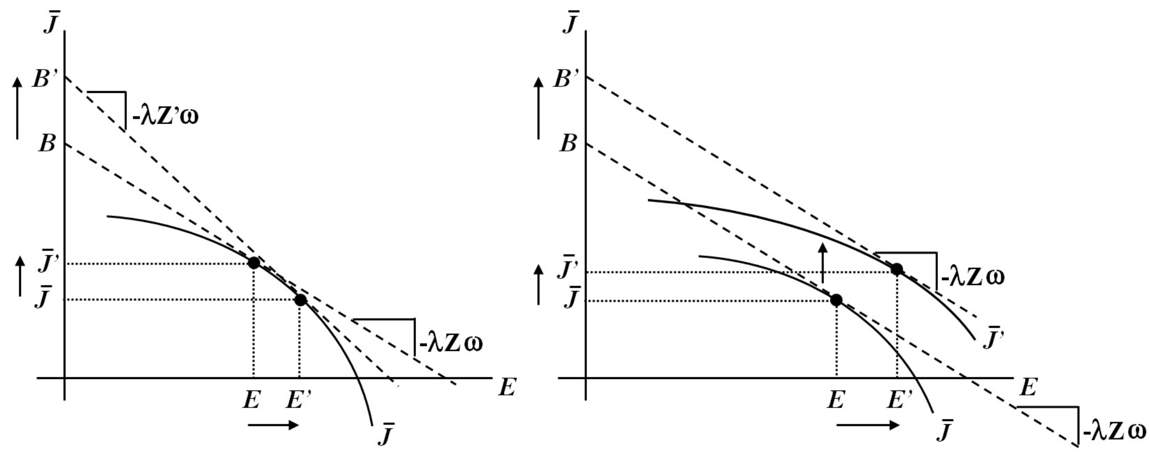

Figure A2: Effects of increase in labor-augmenting technology (left) and effects of positive innovation in the nature of work proper (right).

B.2.2 Effect of a Rise in ψ^E on λ and $\mathbb{W}H$

Consider an increase in ψ^E to $\tilde{\psi}^E > \psi^E$ (that is, a positive innovation in the nature of work proper). Start from the right panel of Figure A2, where $\partial F_E/\partial\psi^E > 0$ is assumed: all else equal, higher ψ^E is consistent with higher job benefits (meaning higher work hours) and higher effort (meaning—because the effective wage is an exogenous constant— higher real wages). If $\partial F_E/\partial\psi^E = 0$ the new ψ^E effort remains unchanged but job benefits rise. In either case, labor earnings rise. All other changes are then analogous to those in Section B.2.1.

B.2.3 Effect of a Rise in ψ^A on λ and $\mathbb{W}H$

If $\partial G_A/\partial\psi^A > 0$ and ψ^A rises (that is, an innovation expands the scope for amenities to make things better for the worker), the optimal level of amenities rises as shown in the left panel of Figure A3. This induces an upward shift in the net job utility function akin to that shown in the right panel of Figure 8 in the main text, but without any accompanying change in the slope of isocost lines. Therefore, effort remains fixed. Because the effective wage is an exogenously determined constant, all else equal, higher amenities imply that real wages must decline. Thus, although job benefits are higher, the net effect on labor earnings, $\mathbb{W}H$, is ambiguous. In this case, the increased scope for valuable amenities acts much like the introduction of new goods, keeping λ from falling as much as it otherwise would.

If instead $\partial G_A/\partial\psi^A = 0$ and ψ^E rises, as shown in the right panel of Figure A3 the level of amenities remains fixed, but the surplus from amenities rises. This induces an upward shift in the net job utility function, which is consistent with effort remaining fixed and job benefits rising. Because the effective wage must remain constant, real wages rise, and all other change are analogous to those in Section B.2.1.

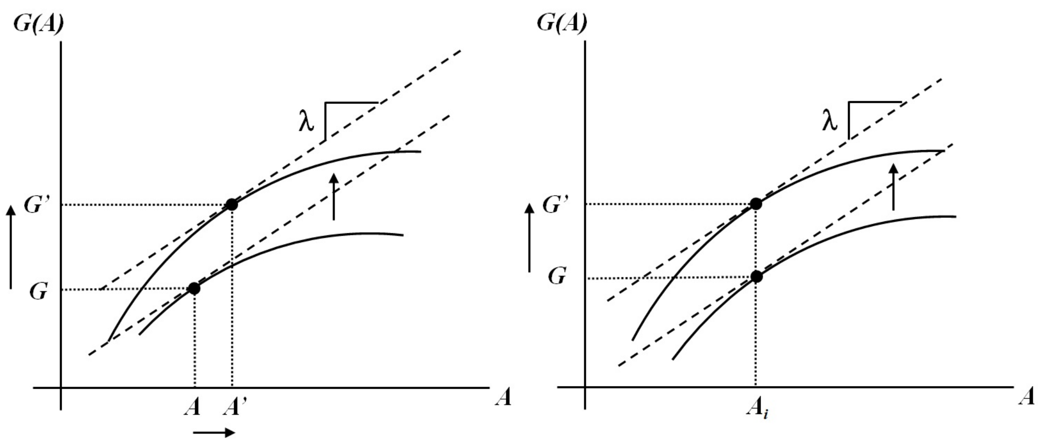

Figure A3: Effect of positive innovation in the nature of the work environment with $\partial G_A/\partial\psi^A > 0$ (left) and $\partial G_A/\partial\psi^A = 0$ (right).

B.3 Real Wages and Trendless Work Hours

B.3.1 Unaltered Slope of Net Job Utility

Consider an initial equilibrium such as point A in the left panel of Figure A4, which corresponds to an isocost line with slope $-\lambda Z\omega$. Then, if labor-augmenting technology rises, or there is a positive innovation in the nature of work proper and $\partial F_E/\partial\psi^E = 0$, or there is a positive innovation in the nature of the work environment and $\partial G_A/\partial\psi^A = 0$, as shown in

Section B.2 labor earnings rise and the marginal value of wealth decreases. And, at lower λ amenities are optimally higher, and the surplus from amenities is also higher—which is consistent with an upward shift in the net job utility function (with no change in its slope) and less steep isocost lines. If there is no change in labor hours, then the new equilibrium must be at a point such as A' in the left panel of Figure A4. There, effort is lower but the effective wage $\omega = (W + A) / (EZ)$ is unchanged.[17]

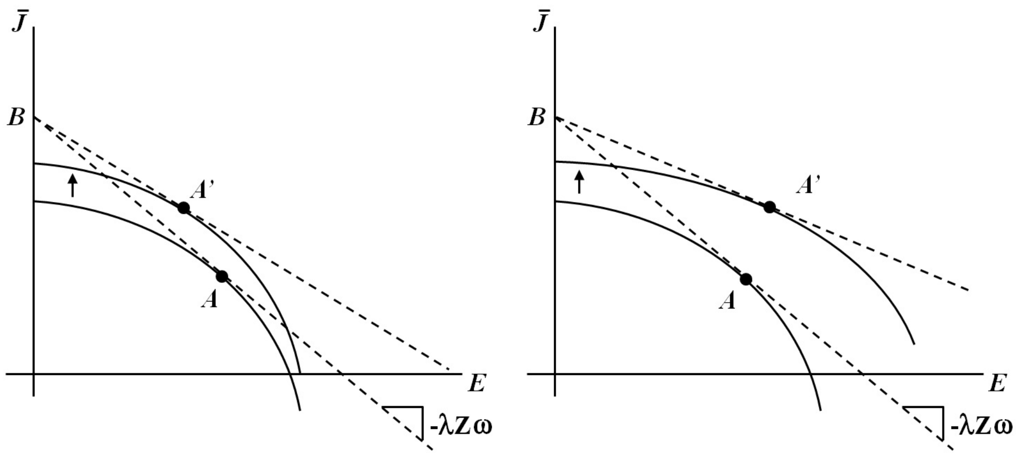

Figure A4: Impact of technological changes.

Increase in Labor-Augmenting Technology In the case in which Z rises, because effort declines and amenities rise, the real wage can only be higher after the increase in labor-augmenting technology if the product EZ is higher and greater enough to pay for the increase in amenities. Formally, because the effective wage must remain constant, then a rise in Z triggers a rise in real wages only if

$$d \ln Z > \frac{A}{W + A} d \ln A - d \ln E.$$

In this case, after the rise in Z real wages are higher and job utility are higher. It is possible for work hours to remain constant as a result of the rise in job utility countervailing the income effect's outweighing of the substitution effect. So, an increase in labor-augmenting

[17] Note that

$$d \ln \omega + d \ln E + d \ln Z = \frac{W}{W + A} d \ln W + \frac{A}{W + A} d \ln A$$

technology can indeed be consistent with higher real wages and trendless labor hours (and higher effective labor productivity).

Positive Innovations in Job-Enjoyment Technology If labor-augmenting technology rises, or there is a positive innovation in the nature of work proper and $\partial F_E/\partial\psi^E = 0$, or there is a positive innovation in the nature of the work environment and $\partial G_A/\partial\psi^A = 0$, then, again, at point A' effort is lower. Because amenities are higher and the effective wage must remain constant, then given that the product EZ is lower real wages must decline. This decline must exactly satisfy

$$d\ln W = \frac{W+A}{W} d\ln E - A \cdot d\ln A.$$

Thus, all else equal, neither a positive innovation in the nature of work proper with $\partial F_E/\partial\psi^E = 0$ nor a positive innovation in the nature of the work environment with $\partial G_A/\partial\psi^A = 0$ are consistent with both trendless work hours and higher real wages.

B.3.2 Altered Slope of Net Job Utility

Consider an initial equilibrium such as point A in the right panel of Figure A5, which corresponds to an isocost line with slope $-\lambda Z\omega$. Then, given a positive innovation in the nature of work proper with $\partial F_E/\partial\psi^E > 0$, as shown in Section B.2.2 labor earnings rise and the marginal value of real wealth decreases. At lower λ amenities are optimally higher, and the surplus from amenities is also higher—which is consistent with an upward shift in the net job utility function (with change in slope as implied by $\partial F_E/\partial\psi^E > 0$) and less steep isocost lines. If there is no change in labor hours but the income effect outweighs the substitution effect, then the new equilibrium must be at a point such as A' in the left panel of Figure A4—job utility must be higher. At point A' effort is higher but the effective wage $\omega = (W+A)/(EZ)$ must remain unchanged. Because amenities are also higher, real wages are higher only if

$$d\ln E > \frac{W}{W+A} d\ln A.$$

So, when positive innovations in the nature of work proper make effort less taxing, a rise in ψ^E can indeed be consistent with higher real wages and trendless labor hours (and higher effective labor productivity) if effort rises enough due to complementarity between the improvement in intrinsic job employment technology ψ^E and effort.

B.3.3 Technological Equivalence

Comparison of the left and right panels of Figure A4 along with results from Sections B.3.1 and B.3.2 imply that the effects of a positive innovation in the nature of work proper can be qualitatively similar to an increase in labor-augmenting technology.

C Welfare Under Non-separability

Suppose that

$$\mathcal{U} = \mathbb{U}\left(C, H\right) + \textstyle\sum_i H_i J_i,$$

where $\mathbb{U}_C > 0$, $\mathbb{U}_H < 0$, and $\mathbb{U}_{CH} > 0$. Then, an individual's problem involves choosing C, H, and $H_i \geq 0$ to maximize $\mathcal{U}$ such that $C = rM + \Pi + \sum_i W_i H_i$ and total hours $H = \sum_i H_i$.

Let

$$\mathcal{L}^* = \max_{C,\ H,\ H_i} \ \mathbb{U}\left(C, H\right) + \textstyle\sum_i H_i J_i + \lambda\left(rM + \Pi + \sum_i W_i H_i - C\right) + B\left(H - \sum_i H_i\right).$$

Then,

$$d\mathcal{L}^* = \textstyle\sum_i H_i\left(dJ_i + \lambda dW_i\right) + \lambda\left(d\Pi + rdM\right).$$

Using equation (10) from the main text, summing over hours, and dividing by λC the previous can be stated as

$$d\mathcal{L}^*/\lambda C = \left(H/C\right)\cdot dB/\lambda - \left(\textstyle\sum_i H_i W_i/C\right)\cdot d\lambda/\lambda + \left(d\Pi + rdM\right)/C. \tag{1}$$

Other than dB/λ and $d\lambda/\lambda$, it is straightforward to obtain empirical counterparts to all variables on the right-hand side of the equation (1). Thus, it is of interest to find expressions for dB/λ and $d\lambda/\lambda$ that can be operationalized. To this end, define

$$V(\lambda, H) = \max_{C} \mathbb{U}(C, H) - \lambda C \tag{2}$$

and

$$\max_{H} V(\lambda, H) + \lambda \left(H \sum_i \xi_i W_i + \Pi\right) + H \sum_i \xi_i J_i, \tag{3}$$

where ξ_i is the fraction of total hours that the individual spends on job i. Note that

$$H\left(\lambda \sum_i \xi_i W_i + \sum_i \xi_i J_i\right) = H \sum_i \xi_i \left(\lambda W_i + J_i\right) = HB$$

since in equilibrium $B = \lambda W_i + J_i$, and also $\sum_i \xi_i = 1$. Therefore, the statement in equation (3) becomes

$$\max_{H} V(\lambda, H) + H\left(\lambda \sum_i \xi_i W_i + \sum_i \xi_i J_i\right) + \lambda \Pi.$$

The first-order condition is $-V_H(\lambda, H) = B$. Hence, $dB = -V_{HH} dH - V_{H\lambda} d\lambda$. If $d\lambda = 0$, then

$$dB/B = -\left(V_{HH} H/B\right) \cdot dH/H = \left(V_{HH} H/V_H\right) \cdot dH/H,$$

where the second equality follows from the earlier FOC. It follows that,

$$\left(dB/B\right)/\left(dH/H\right) = \left(V_{HH} H/V_H\right) = 1/\bar{\eta},$$

where $\bar{\eta}$ is defined as the λ-held-constant elasticity of H with respect to B. Given

$$dB = -V_{HH} dH - V_{H\lambda} d\lambda,$$

as shown in the appendix

$$dB/\lambda = \left(1 - \zeta_i\right) W_i/\bar{\eta} \cdot dH/H - V_{H\lambda} \cdot d\lambda/\lambda,$$

where $\zeta_i = -J_i/W_i\lambda$.

Let the Frisch elasticity of labor supply for any job i be given by $\eta_i = \bar{\eta}/\left(1 - \zeta_i\right)$.

Therefore the previous can be stated as,

$$dB/\lambda = (W_i/\eta_i) \cdot dH/H - V_{H\lambda} \cdot d\lambda/\lambda. \tag{4}$$

The first term on the right-hand side above has straightforward empirical counterparts. However, we still require an expression for $d\lambda/\lambda$, and are now also in need of one for $V_{H\lambda}$. Note from the expression in (2) that $V_\lambda = -C(\lambda, H)$ and $V_{\lambda H} = -C_H(\lambda, H)$. Furthermore, as shown in in the appendix

$$dC/C = (V_{\lambda\lambda}\lambda/V_\lambda) \cdot d\lambda/\lambda + (V_{\lambda H}H/V_\lambda) \cdot dH/H.$$

Define $-1/\gamma = V_{\lambda\lambda}\lambda/V_\lambda$ and $\Theta = V_{\lambda H}H/V_\lambda$. That is, $\Theta = d\ln C/dH$ for constant λ. Then,

$$d\lambda/\lambda = \gamma(\Theta \cdot dH/H - dC/C). \tag{5}$$

A value for Θ can be estimated by noting that

$$\Delta \ln C + \alpha + \beta r + \Theta \Delta \ln H + \varepsilon.$$

Basu and Kimball (2002) suggest that a higher-end estimate for Θ is 0.3. Moreover,

$$\Theta = V_{\lambda H}H/V_\lambda = -V_{\lambda H}H/C \implies -V_{\lambda H} = \Theta C/H$$

Substituting into equation (4),

$$\begin{aligned} dB/\lambda &= (W_i/\eta_i) \cdot dH/H - V_{H\lambda} \cdot d\lambda/\lambda \\ &\implies dB/\lambda = (W_i/\eta_i) \cdot dH/H + (\Theta C/H) \cdot d\lambda/\lambda. \end{aligned} \tag{6}$$

We set out to search for empirical counterparts to $d\lambda/\lambda$ and dB/λ for use in equation (1), which we now have in equations (5) and (6). Combining these three equations, as shown in the appendix it now follows that

$$\frac{d\mathcal{L}^*}{\lambda C} = \frac{W_i}{\eta_i}\frac{dH}{C} + \left(\Theta - \frac{\sum_i H_i W_i}{C}\right)\gamma\left(\Theta \cdot \frac{dH}{H} - \frac{dC}{C}\right) + \frac{(d\Pi + r dM)}{C}. \tag{7}$$

Consider an example. Suppose $dC/C = 1\%$, $dH = 0$, $\Theta = 0.3$, $\gamma = 2$. Moreover, suppose $\sum_i H_i W_i = C$ so that there is no non-labor income, and $d\Pi = dM = 0$. Then, using equation (7)

$$d\mathcal{L}^*/\lambda C = (.3 - 1) \cdot 2 \cdot (-1\%) = 1.4\%.$$

Hence, in this case .4 percentage points beyond the welfare increase stemming from the increase in consumption owes to changes in on-the-job utility. Note that in terms of welfare there is no fundamental difference between increases in J from compositional effects and increases in J in any given job - it is only a matter of how detailed the definitions of jobs are.

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