Why Do People Work So Hard?

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Abstract

Labor hours tend to fall as an economy develops, but subsequently tend to stabilize. I present a model which explains long-run trends in labor supply by the interaction of two opposing forces: a rising real wage, which lowers labor supply, and increasing product variety, which raises it. Both forces arise from the same source—innovation—and on a balanced growth path their interaction can sustain stable labor hours. Calibrating the model over the period 1959-1999, it can explain on average 80 percent of the discrepancy between hours predicted by the standard CIES one-good model and the data.

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Introduction

Although GDP per capita in the U.S. more than trebled over the past fifty years, Figure 1 shows that labor hours per capita remained roughly stable. Especially given the rise in real wages over time, this is surprising: according to standard preference parameters, rising consumption causes marginal utility to fall quickly, leading to a steady *decline* in labor hours. Using such reasoning, Keynes (1931) predicted a vastly different workplace by this stage: "a fifteen hour week"; a world where "needs are satisfied"; and where Man faced his "permanent problem" of too much leisure. Yet despite the increase in wages and labor-saving technologies, these predictions have failed to materialize. To address this issue, this paper proposes a theory of labor supply consistent with standard preference parameters and observed trends in labor hours over time.

According to the standard labor-leisure model, people supply labor to finance consumption. But faced with diminishing marginal utility and rising wages, consumers quickly become satiated and reduce their labor supply. Introspection leads one to the same conclusion: would people continue to supply similar labor hours, as consumption of the same good rose over time? Although this seems unlikely, this is what standard models predict: labor supply is independent of what you can buy.

In this paper, I endogenize labor supply as a function of product variety. By product variety, I mean distinct product groups—such as cars—and product improvements within each group—such as faster cars. As we shall see, the growth of product groups increases labor supply, while quality improvements reduce it. Yet with a sufficiently high taste for new product groups, greater product variety raises labor hours. By increasing marginal utility, more product variety attenuates the income effect of a rising real wage, raising the incentive to supply labor. Significantly, real wage and variety growth arise from the same underlying force: innovation.

To see the basic idea, consider a simple static model, where the real wage is W, consumption is C, labor hours are l, and utility is $U(C,l) = u(Wl) - h(l)$. With a dominant income effect, a rise in W causes marginal utility to fall quickly, reducing

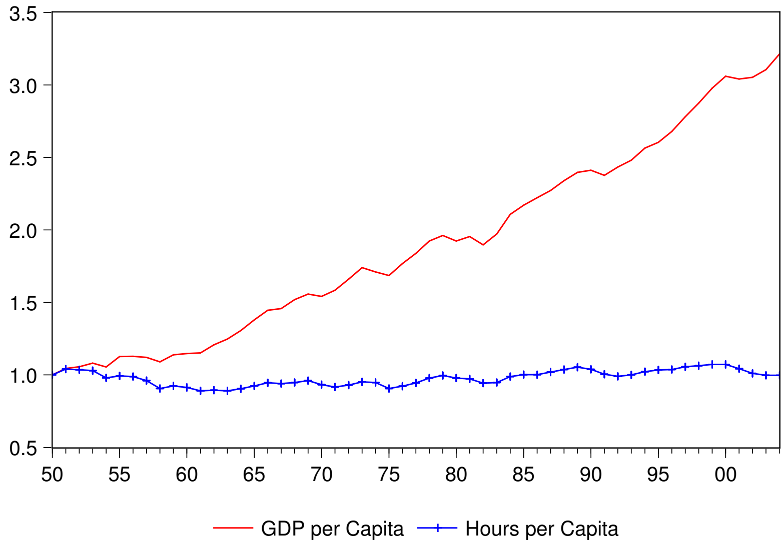

Figure 1: INDICES OF REAL GDP PER CAPITA AND HOURS PER CAPITA: U.S., 1950-2004
Source: Penn World Tables and Francis and Ramey (2009)

labor supply. By contrast, if there are n independent goods, utility reduces to $U(C, l) = nu(\frac{Wl}{n}) - h(l)$. Confronted with greater variety, people now spread expenditure over more goods, causing a rise in marginal utility—and in turn labor supply. Meanwhile, the earnings accruing to this labor supply raises the market for more innovation—leading to further wage and variety growth, and so on. This way, consumer goods can drive growth.

I proceed as follows. I introduce a partial equilibrium model in Section 1. The goal of the model is twofold. First, it outlines the basic insight of the paper: how increasing product variety affects labor hours. Second, it introduces a utility function consistent with the empirical evidence of real wage growth, a dominant income effect, and trendless long-run labor hours. Following this, I provide a quantitative assessment of the model in Section 2. Comparing expenditure shifts across different goods, I estimate product group growth and use this to calibrate the model. For standard preference parameters, the one-good model predicts labor hours fall by 40 percent over the period 1959-1999. Yet in the data hours fell by 6 percent. Incorporating new goods can explain on average 80 percent of this discrepancy. In Section 3 I present suggestive empirical evidence and use the model to discuss the rise in labor hours prior to the Industrial

Revolution—the "Industrious Revolution." Section 4 embeds the idea in a model of long-run growth. Although labor supply is the fundamental source of growth, the labor-leisure margin has received little attention in the growth literature. To address this gap, I incorporate labor supply into a New Growth model. By focusing on the returns to innovation, the model shows how greater labor supply expands the size of the market and raises the incentive to innovate. This innovation leads to further wage and variety growth, and on a balanced growth path, the interaction of both forces can maintain stable labor hours. Finally, Section 5 concludes.

1 Partial Equilibrium Model of Labor Hours and Variety

In this section I present a model where expanding product variety affects labor supply. For now, I take variety growth as exogenous. In Section 4, I present a general equilibrium model which illustrates the other side of the dynamic: how a higher labor supply raises market size and the returns to innovation.

1.1 The Economic Environment

There is a single representative consumer who is infinitely lived. The consumer has preferences over a continuum of existing and potential goods, including leisure. Each period, there is a time endowment of unity. There is latent demand for all potential goods, and no good is essential. The consumer receives interest and wage income. My main concern is labor supply per capita over the long run, so what I mean by "labor supply" is broad: it captures labor effort and intensity, and generally encompasses any activity directed to supplying labor in the marketplace. Because it is a means of raising one's *effective* or quality-adjusted labor supply, it also incorporates human capital accumulation and training. By contrast, leisure incorporates any nonmarket-oriented activity; e.g., home production, child rearing, idleness, and so on.

There are two broad consumption categories. Dynamic categories—such as medicine and consumer durables—are subject to significant innovation, while static categories—such as food and utilities—are not. Each category comprises product groups or simply "goods". These represent product classes—such as cellphones—without close substitutes, and for which demand is relatively inelastic. While there is a single static good, the number of dynamic goods rises over time, and at any time t, a measure $n_t < \infty$ is available for purchase; e.g., the Ipad represents a new good in the consumer durables category. There is a common elasticity of substitution between dynamic goods, and because goods are imperfect substitutes, this is less than one.

Associated with each good at time t is a level of quality, also indexed on $(0, \infty)$. Good quality rises when the consumer derives more utility from a given level of expenditure; the release of a faster Ipad, for instance, would represent a rise in quality.[1] At time t, the quality of the static good is A_t, while each dynamic good has quality B_t.

Dynamic good quality, static good quality, the number of dynamic goods, and nominal wages grow at rates g_{Bt}, g_{At}, g_{nt}, and g_{Wt} respectively. Throughout, g_{Zt} refers to the growth of Z at time t. I index dynamic goods by $i \in [0, n_t]$; thus $c_{it} \geq 0$ denotes the consumption service flow from good i at time t. The static good has a price of one, all existing dynamic goods have a price of p_t at time t, while non-existent goods have infinite prices.

1.2 Consumer Preferences

Instantaneous utility from consuming n_t dynamic goods is

$$U(\{c_{it}\}_{i=0}^{i=n_t}) = n_t^v \int_0^{n_t} u(c_{it})\, di,$$

where $v > -1$, $n_t \in (0, \infty)$ denotes the number of goods available at time t, and

[1]For convenience, I ignore indivisibilities and the non-integral nature of the variable n, and from now on refer to n as a number.

$$u(c_{it}) = \begin{cases} \frac{(B_t^{\gamma} c_{it})^{1-\sigma_d} - n_t^{-v}\epsilon}{1-\sigma_d} & \text{if } c_{it} \geq 0 \\ 0 & \text{if } c_{it} = 0, \end{cases}$$

where $\sigma_d > 1$, $\epsilon > 0$, $\gamma > 0$, and $c_{it} > 0$. The constant ϵ governs the utility gain from consuming a positive quantity of a good. Reflecting the sizable welfare gain to consuming distinct new innovations—which satisfy previously unmet needs—the size of ϵ is sufficiently high to ensure agents consume all existing dynamic goods. The parameter γ governs the taste for quality. The constant $\frac{1}{\sigma_d} < 1$ is the elasticity of intertemporal substitution of consumption services from each dynamic good over time. It is also the elasticity of substitution between dynamic goods.[2] Because groups are imperfect substitutes, while most empirical evidence indicates that the intertemporal elasticity of substitution of consumption is below one, this is a reasonable simplification.

If the agent consumes $\bar{c}_{it}$ of each of n_t dynamic goods, then by symmetry the equilibrium level of utility from consumption of dynamic goods in period t is given by

$$\frac{n^{v+1}(B_t^{\gamma}\bar{c}_{it})^{1-\sigma_d} - n\epsilon}{1-\sigma_d}$$

The parameter v disentangles the degree of love of variety for dynamic goods from the elasticity of substitution between them. An increase in the number of goods consumed has two effects. First, there is the change captured by ϵ, which is the utility rise from consuming even a small quantity of the good. Reflecting complementarity across goods, the marginal utility of further consumption also rises; v captures this effect.

Accounting for the static good, period utility from consumption services when n_t dynamic goods are available for purchase is

$$\mathbb{U}(C_{st}, \{c_{it}\}_{i=0}^{i=\infty}) = \frac{(A_t^{\gamma} C_{st})^{1-\sigma_s}}{1-\sigma_s} + n_t^{v} \int_0^{n_t} u(c_{it})\, di,$$

where $\sigma_s > 1$ and c_{st} denotes the quantity of static goods consumption.

[2] See Browning and Crossley (2000) for a discussion on the tight link between income elasticities and intertemporal elasticities.

1.3 The Complete Problem

Utility is a function of consumption services from goods and labor supply $l_t \in [0,1]$. The consumer has assets of b_t each period, an elasticity of labor supply of $\frac{1}{\theta} > 0$, and a rate of time preference of $\rho > 0$. Labor and consumption are separable in utility.[3] The parameter ψ governs the taste for leisure. The consumer takes the paths of r_t, W_t, n_t, A_t, B_t, p_t, and the initial level of assets, b_0, as given and solves:[4]

$$\max_{(0<l_t\leq 1, b_t, C_{st}\geq 0, \{c_{it}\geq 0\})_{t=0}^{t=\infty}} \int_0^\infty \left(\frac{(A_t^\gamma C_{st})^{1-\sigma_s}}{1-\sigma_s} + n_t^v \int_0^{n_t} u(c_{it})\, di - \psi \frac{l_t^{1+\theta}}{1+\theta} \right) e^{-\rho t}\, dt,$$

subject to:

$$\dot{b}_t \leq r_t b_t + W_t l_t - C_{st} - \int_0^{n_t} p_t c_{it}\, di, \tag{1}$$

$$\lim_{t\to\infty} b_t e^{-\int_0^t r_s\, ds} \geq 0. \tag{2}$$

1.4 The Solution to the Intratemporal Problem

1.4.1 Within-Category Allocation

The Appendix presents a solution. Each period the consumer allocates expenditure across dynamic goods, and then allocates between static and dynamic goods over time. Given equal prices and the form of utility, it is optimal to allocate dynamic goods expenditure equally across existing dynamic goods.[5] Noting equal prices of p_t at time t, the quantity demanded of each existing good is then $c_{it} = \frac{C_{dt}}{n_t}$ for all $i \in [0, n_t]$, where

[3] Campbell and Ludvigson (2001) show separability provides a good description of aggregate data.

[4] The following conditions ensure bounded utility: $\rho > \gamma(1-\sigma_s)g_A + (1-\sigma_s)g_{C_s}$, $\rho > g_n$, and $\rho > \zeta g_n + \gamma(1-\sigma_d)g_B + (1-\sigma_d)g_{C_s}$, where g_{C_s} and g_{C_d} denote the real growth rates of static and dynamic consumption, respectively.

[5] The agent consumes all groups if aggregate dynamic goods consumption C_{dt} satisfies $\epsilon C_{dt}^{\sigma_d - 1} > \zeta n_t^{\zeta - 1}$. Throughout, I assume this condition holds.

C_{dt} denotes real dynamic goods expenditure. This yields indirect utility from dynamic goods each period:

$$V(n_t, B_t, C_{dt}) = \frac{n_t^{\zeta}(B_t^{\gamma} C_{dt})^{1-\sigma_d}}{1-\sigma_d} - \frac{n_t \epsilon}{1-\sigma_d},$$

where $\zeta = v + \sigma_d$. The marginal utility of dynamic goods consumption is

$$V'(C_{dt}) = \frac{n_t^{\zeta}}{B_t^{\gamma(\sigma_d - 1)} C_{dt}^{\sigma_d}}. \tag{3}$$

Because they raise the level of consumption services from a given amount of expenditure on each existing good in a period, increases in quality lead to consumption "deepening." And since consumers prioritize the smoothing of expenditure over goods and time, they quickly become satiated as consumption services rise in a given period. Increases in quality therefore reduce marginal utility.[6] By setting $n_t = B_t = 1$, the resulting indirect utility function represents the same preferences as the standard one-good model.

A rise in the number of groups, n_t, in a period has two effects on marginal utility. First, since $\sigma_d > 1$, consumers have a relatively strong desire to smooth real dynamic goods expenditure C_{dt} across dynamic groups. Therefore, a rise in n_t reduces the consumption of each good, $\frac{C_{dt}}{n_t}$, and this consumption "widening" raises the marginal utility of consumption for each good in period t. Second, there is a direct effect due to v, capturing the degree of complementarity across goods.

Proposition 1 *: A rise in quality, A_t or B_t, in a period reduces the marginal utility of consumption expenditure in that period.*

Proposition 2 *: A rise in the number of groups, n_t, in a period raises the marginal utility of dynamic consumption in that period; i.e., $\frac{\partial^2 V}{\partial n_t \partial C_{dt}} > 0$, where C_{dt} denotes dynamic goods*

[6] Equivalently, when quality rises in a period, the price of consumption services that period falls; i.e., the ideal price index falls. Because $\sigma_d > 1$ and $\sigma_s > 1$, the income effect of this price fall dominates, inducing consumers to smooth the welfare gain and shift consumption services to other periods. Therefore, when quality rises in a given period, the marginal utility of consumption falls that period.

consumption.

1.4.2 Between-Category Allocation

Equating the first-order conditions for static and dynamic goods consumption and taking growth rates yields the dynamic intratemporal condition

$$\sigma_d(g_{p_tC_{dt}} - g_{C_{st}}) = \zeta g_{nt} + \gamma(1-\sigma_d)g_{Bt} - \gamma(1-\sigma_s)g_{At} + (\sigma_d - 1)\, g_{pt} + (\sigma_s - \sigma_d)\, g_{C_{st}}. \tag{4}$$

Controlling for quality growth, price effects, and Engel curves, the excess of dynamic over static goods expenditure growth is the expenditure share shift attributable to the expansion of dynamic goods. As such, variety growth is equivalent to a taste shock, raising dynamic goods expenditure. The excess of dynamic goods growth over static growth rises for three reasons. In the presence of static consumption growth and $\sigma_s > \sigma_d$, the dynamic share rises; namely, dynamic goods are relative luxuries and consumption is rising. Given inelastic demand, a rise in the relative price of dynamic goods raises their expenditure share. Given $\sigma_s > 1$, a rise in static quality raises the dynamic expenditure share. This makes static goods cheaper, and given the desire to smooth consumption across goods, expenditure shifts to dynamic goods.

1.5 Solution: Long-Run Trends in Labor Supply

Combining the first-order conditions for labor supply and dynamic goods expenditure, and taking growth rates yields

$$\theta \frac{\dot{l}_t}{l_t} = \underbrace{\zeta g_{nt} + \gamma(1-\sigma_d)g_{Bt}} - \sigma_d g_{C_{dt}} + g_{wt}, \tag{5}$$

where real wage growth, g_{wt}, is in terms of dynamic goods. Whether labor supply rises or falls depends on the interaction of three forces. Growth in consumption expenditure and quality is associated with falling marginal utility and declining labor supply. New goods growth raises marginal utility, inducing a rise in labor supply. The tastes for variety, ζ and γ, govern the size of these effects. Because of the substitution effect, real wage growth raises labor supply. By contrast, the standard one-good model treats all goods as perfect substitutes, which combine to form aggregate consumption. Faced with a rising real wage, rising quality, and strong diminishing marginal utility, people reduce labor supply in this one-good world.

For stable labor hours, Eq. 5 then implies:

$$\zeta g_{nt} + g_{wt} = \gamma(\sigma_d - 1) g_{Bt} + \sigma_d g_{C_{dt}}. \tag{6}$$

According to this condition, product group growth can sustain stable hours. In this case, the taste for groups, ζ, must be relatively high. This is consistent with the nature of new goods: they are distinct and confer marked welfare improvements. While technological progress ensures both wages and product variety grow over the long run, there is no reason for this condition to hold: depending on the magnitudes of wage and variety growth, labor hours could rise, fall, or remain stable. Nonetheless, the preferences are potentially consistent with balanced growth.

2 Model Calibration

In this section, I provide a quantitative assessment of the model over the forty-year period 1959 to 1999, and examine what proportion of hours variation between 1959-1999 can the model explain. Midway through this period there was a significant turning point in labor supply trends; while hours declined modestly between 1959-79, they rose between 1979-1999, reversing a century-long decline. Apart from incorporating a trend break, the period also coincides with the release of more disaggregated NIPA consumption data.

2.1 Empirical Framework

Rearranging Eq. 4 gives

$$\zeta g_{nt} + \gamma(1-\sigma_d) g_{Bt} = \sigma_d \left(g_{p_t C_{dt}} - g_{C_{St}} - \left(1 - \frac{1}{\sigma_d}\right) g_{pt} - \left(\frac{\sigma_s}{\sigma_d} - 1\right) g_{C_{St}} \right) + \gamma(1-\sigma_s) g_{At}. \tag{7}$$

The goal of this section is to estimate Eq. 5. I first use Eq. 7 above to approximate the term in braces in Eq. 5. To estimate dynamic goods growth, I follow the methodology of Bils and Klenow (2001). First I categorize goods according to their degree of product innovation. Table 1 outlines the list of static goods; I assume all other goods are dynamic.[7] For the period 1959-1979, the dynamic consumption expenditure share rose from .47 to .63. Using cross-sectional household data from the 1980-1996 Consumer Expenditure Surveys (CEX), Bils and Klenow (2001) estimate Engel curves for a large number of static goods with respect to expenditure on nondurables and services consumption. This yields estimates of $\left(\frac{\sigma_s}{\sigma}\right)_i$ for each static good i, where σ is the elasticity for a broad set of nondurable and services goods. For each period, I find expenditure-weighted averages of $\left(\frac{\sigma_s}{\sigma}\right)_i$ across goods—to find $\left(\frac{\sigma_s}{\sigma}\right)_t$)—and then average these over time to find $\frac{\sigma_s}{\sigma}$.[8] Given σ is a weighted average of σ_s and σ_d, I infer a value for $\left(\frac{\sigma_d}{\sigma}\right)_t$ each period and then average over time to find $\frac{\sigma_d}{\sigma}$.[9]

To identify values for σ_s and σ_d, I follow Bils and Klenow (2001) who report an aggregate elasticity of .75, implying $\sigma = 1.33$. Using CES data, they show this figure best matches the empirical response of expenditure shares to relative price changes across 106 product goods. Given the functional form for utility, this value also corresponds to the IES for aggregate consumption. Consistent with this, a value of .75 is in line with common estimates of the IES for aggregate consumption using micro data; e.g.,

[7] Across static goods, the average noncomparable item substitution rate is .006. For all goods the average rate is .014.

[8] Bils and Klenow (2001) show that Engel curves are stable over time.

[9] Formally, $\sigma = s_s\sigma_s + s_d\sigma_d$, where s_s is the consumption share of static goods and s_d is the share of dynamic goods. This implies $\frac{\sigma_d}{\sigma} = \frac{1}{s_d} - \frac{s_s}{s_d}\frac{\sigma_s}{\sigma}$.

Attanasio and Weber (1995) report the same value using FES micro data from Britain. This implies values of $\sigma_s = 1.27$ and $\sigma_d = 1.39$.

The quality terms, g_{At} and g_{Bt}, in Eq. 7 capture the welfare gains due to minor product improvements and improved quality; e.g., more user-friendly products. To the extent the BLS underestimates quality growth, these terms are positive and correspond to quality bias in the CPI.[10] Reviewing all sources of quality bias, Shapiro and Wilcox (1996) document a value of .25 percentage points a year, a value I use for g_{At} and g_{Bt} in the calibration.[11] This is comparable to an aggregate quality bias of .2 to .6 cited by the Boskin Commission and a value of .3 reported by Lebow et al. (1992). I set the taste for quality γ to 1, making proportional changes in quality equivalent to proportional changes in consumption. Using these values, the left-hand side of Eq. 7 averages 2.22 percentage points per annum between 1959-1979 and 2.67 percent between 1979-1999.[12]

In the calibration, I estimate Eq. 5 each period, and derive a time series of predicted hours for a range of values of the intertemporal and Frisch elasticities. Typical values of the Frisch elasticity range from .2 to .6. Yet the relevant Frisch elasticity here is the macroeconomic one. Chetty et al. (2011) report a value of .75, which I take as a benchmark. Yet given uncertainty surrounding this parameter, I consider a range of values in the calibration. Table 4 presents relevant parameter values and data for the periods 1959-1979 and 1979-1999. Because a downward trend in labor hours is a

[10]As an example, the Boskin Commission estimated that the greater variety of food and beverages available today introduces an annual quality bias of 0.1 percentage points into the CPI.

[11]This has little quantitative bearing on results. There is no concrete evidence on the time variation of this bias. Given greater variety growth after 1979, it is plausible the bias was higher over the period 1979-1999. Greater variety growth, however, was accompanied by more intensive efforts by the BLS to redress the bias over this period. Gordon (1987) maintains the quality bias was higher before 1973 than after.

[12]Independent sources provide additional evidence of greater product innovation over the period 1979-1999. Baker (2015) reports that the noncomparable substitution rate rose between 1980 and 2000. While this could reflect changes in methodology, the most natural interpretation is it reflects greater innovation and product turnover. Additional evidence comes from the upward trend in patent and trademark growth over this period. Observing the decline in the food share over this period, some authors infer an underestimation of economic growth; see e.g., Hamilton (2001), Costa (2000), Nakamura (1995), Costa (2001).

pervasive feature of development, I set the maximum value of the aggregate IES to one. A value exceeding this implies rising labor hours over time.

In the baseline calibration, I set wage growth each period equal to average annual wage growth over the entire period 1959-1999. This way, I isolate the role of new goods on labor supply movements.[13] For wage growth, I use growth in labor compensation per hour for the nonfarm business sector available from the Bureau of Labor Statistics. I also perform the calibration using annual wage growth each period. Per capita consumption growth is from NIPA and averages 2.56 percent per year over the first period, and 2.48 percent over the second. Data on labor hours per employee is from the OECD. To maintain as much homogeneity as possible and abstract from the large increase in female labor participation and the entry of the baby boomers over this period, I use labor hours per worker as a benchmark.

2.1.1 Calibration Results and Discussion

Table 3 shows the results for the baseline calibration. Absent variety growth, the one-good model predicts labor hours fall by 40 percent over the period 1959-1999, which represents a continuation of the existing century-long decline. The new goods model predicts labor hours fall by 13 percent over the period 1959-1999, closer to the actual decline of 6 percent. The model's performance improves over the period 1979-1999, when the central channel—variety growth—becomes more pronounced. The model predicts labor hours rise by 6 percent over this period. For comparison, the table shows predicted labor hours for the standard one-good model. Figure 8 illustrates the path of predicted labor hours. Figure 9 shows the model's predictions where I incorporate wage variation. While this variation also provides a reasonable fit, it fails to capture the break in the trend over the period 1979-1999. Despite higher variety growth over this

[13] Given the measure of wage growth at any point in time masks significant cross-sectional variation, incorporating wage variation would potentially distort the results. For example, despite relatively low average wage growth over the period 1979-1999, upper-income earners experienced significant wage gains. Given firms frequently target new goods at upper-income earners, this group is particularly important for the analysis. For this reason, variation in average wage growth is not a useful metric here.

period, average wage growth was relatively low, and this led to a decline in predicted labor hours.

According to the calibration, a higher value of σ (i.e., a lower IES) reduces predicted labor hours through two channels. At the intratemporal level, it implies consumers have a strong desire to smooth consumption across groups, even in the face of price increases. Given the relative price of dynamic goods rose over the period 1979-1999, a higher σ implies the estimation procedure attributes more of the expenditure shift to relative price changes, reducing implied variety growth. Second, from Eq. 5, a higher σ implies a stronger income effect, reducing labor supply as consumption rises. Taken together, a higher σ reduces predicted labor hours. Values of the IES exceeding .75 correcly imply a rise in labor hours over the period 1979-1999. Meanwhile, a Frisch elasticity of .2—in line with estimates from micro data—matches the data better. Throughout, an increase in this elasticity reduces the level of labor hours growth.

Related to the identification of dynamic goods is the concept of the item substitution rate. This is the frequency with which the BLS encounters discontinued goods, obliging them to find a product replacement. The noncomparable substitution rate measures how frequent the BLS must replace an item with a "noncomparable" (i.e., relatively poor) substitute. Because this typically occurs when firms introduce goods with substantive new features, a higher rate reflects greater product innovation. The static goods have a expenditure-weighted noncomparable substitution rate of .006 per month, while the average rate for all consumption goods (excluding housing) is .014. This is consistent with new goods inducing shifts in expenditure patterns.

While trends independent of income or prices—such as demographics—could independently lead to shifts in expenditure shares, a number of factors suggest new goods underlie the expenditure share shifts. First, excluding apparel, the correlation between the noncomparable substitution rate and changes in expenditure shares at the broad category level is .7. Moreover, many of the products consumed in 1999 were non-existent prior to 1980; expenditure shifts towards these goods were almost surely driven by the new services they provide. Figures 6–7 show the increases in expenditure shares across a number of dynamic groups. For these groups, the overall expenditure share rose from 3 percent in 1959 to 10 percent in 1999.[14] The fact the most innovative groups witnessed the largest share increases is suggestive of consumers shifting to dynamic goods in the face of higher prospective marginal utility. Second, in their empirical work, Bils and Klenow (2001) discount the role of shifts in tastes and demography. According to the analysis in Aguiar and Hurst (2013), the entry of the baby boomers to the workforce would lead to a rise in the share of food, transportation, clothing, alcohol and tobacco consumption. This would reduce the dynamic goods share over the period 1979-1999, and suggests changing demographics makes the shift attributable to new goods a conservative estimate.

2.2 Income Heterogeneity

One issue obscured by aggregate data is the distribution of hours changes by income. For higher-income earners, labor hours rose over the period 1979-1999, while they fell for those on lower incomes. In this section, I explore this issue in the context of the model. In the Appendix, I outline a simplified model focussing solely on the role of dynamic goods. As shown, if a firm introduces a new good, while real income rises by a unit, it is optimal to consume a new good if the current level of consumption satisfies the condition

$$\epsilon C_t^{\sigma_d - 1} > \zeta n_t^{\zeta - 1}$$

i.e., the incentive to purchase a new good is greater if the level of consumption or the benefit to consuming a new good, ϵ, is higher.

Underlying this result is the first component of utility. To see this, I consider a stylized example where all goods are dynamic, $A = B = 1$, $v = 0$, and $\theta = 2$. The utility from consuming a single good is now

[14] As already noted, the entire dynamic good share increased from .47 to .63. Thus these goods represent 44 percent of the rise in the dynamic good share.

$$u(c) = \frac{c^{1-\theta} - \epsilon}{1-\theta} = -\frac{1}{c} + \epsilon.$$

The negative term above represents the utility "cost" of consuming a new good. This could capture fixed costs associated with purchasing new goods or costs related to the indivisible nature of goods; e.g., for many goods, purchasing a small amount is impractical. The high relative price of new goods associated with the product life cycle makes this a significant issue in practice. Because the benefit term is constant across agents, while the cost term is decreasing in consumption, the marginal utility of consuming a new good is higher for richer agents.

In the ensuing examples, I assume a firm introduces a new good, while real income increases by one unit. Broadly, this captures the increase in new goods as income rises over time. For ease of exposition, I use discrete time.

2.2.1 Lower-Income Agent

If an agent consumes one good and $c = 1$, utility is

$$u(1) = -\frac{1}{c} + 1 = -\frac{1}{1} + 1 = 0.$$

If the agent spends the extra unit of income on existing goods, utility rises to

$$u(2) = -\frac{1}{2} + 1 = -\frac{1}{1} + 1 = \frac{1}{2}.$$

From above, consuming n goods leads to utility of

$$u(c) = -\frac{n^2}{c} + n\epsilon.$$

Thus if the agent spends the extra unit on a newly introduced good, utility is

$$-\frac{n^2}{c} + n = -\frac{4}{2} + 2 = 0,$$

implying the marginal utility gain of consuming a new good is 0. Intuitively, the agent has insufficient resources to purchase all goods. Hence it is optimal to purchase more of the existing good, implying a marginal utility of .5.

2.2.2 Upper-Income Agent

To broadly match the income disparity in the data, I set $c = 10$. Initial utility is now

$$u(10) = -\frac{1}{10} + 1 = -\frac{1}{10} + 1 = \frac{9}{10}.$$

Consuming an extra unit of the existing good yields

$$u(11) = -\frac{1}{11} + 1 = \frac{10}{11},$$

implying a marginal utility of .009. Consuming an additional unit of the new good, utility rises to

$$u(11) = -\frac{4}{11} + 2 = \frac{18}{11},$$

implying the marginal utility of the rich agent is .74. Thus the optimal decision is to consume the new good. Underlying the different optimal responses is a cost term of $-\frac{4}{11}$ for the rich agent and -2 for the poor one, but an equal benefit—ϵ—for both.

2.3 Heterogeneity: A Review

The stylized example above shows how new goods can have a greater effect on the marginal utility of upper-income households. Indeed, a central feature of the product life cycle is firms initially target new products at higher-income earners. As such, the higher variety growth since the eighties could potentially explain the relatively higher labor hours of higher earners over the period 1979-1999. Empirically, the rise in hours has coincided with a large increase in the consumption of the rich over this period. Aguiar and Bils (2015), for example, report that the consumption of luxury goods rose markedly over this period. Yet they also report increasing underestimation of all expenditures of high-consumption households over time. According to them, the BLS underestimates the consumption of the rich in the national accounts, and this measurement error grows over time. This prohibits a more detailed analysis here.

3 Empirical Evidence

The model makes two main predictions. First, holding variety constant, a permanent rise in the real wage reduces labor supply. Second, holding wages constant, an increase in the number of distinct products raises labor supply. Below I discuss broader evidence for these predictions. Yet because of limited data on product variety changes, this evidence is invariably suggestive.

3.0.1 Other Evidence

Reviewing a vast literature on how labor supply changes in response to a permanent rise in the real wage, Borjas (2004) document a "consensus estimate" of the labor supply elasticity of prime-age males of -0.1. Recently, Ashenfelter et al. (2010) examine how a legislated rise in the fares of certain New York taxi drivers subsequently reduced their hours worked. They estimate an elasticity of -0.2. This is consistent with a dominant income effect, which is a feature of the model here.[15]

Regarding the rise in labor hours since 1980, survey data provides suggestive evidence of an increase in the need to work. Hamermesh and Lee (2007) report that people feel "busy, rushed, and stressed." Such evidence is hard to reconcile with other explanations of higher hours such as a shift from home production to market production, log utility, or a falling disutility of labour supply.

As Figures 2 and 3 show, labor hours in the United States fell markedly in the first half of the twentieth century, but commenced a rise towards the end of 1970. Van-

[15]For benchmark parameters, the model predicts an elasticity of -.29.

denbroucke (2005) attributes the initial fall to a dominant income effect arising from wage growth. Figure 4 shows the general pattern across a number of OECD countries: a decline in hours up until around 1980 followed by a subsequent moderation in the downward trend. This shows any potential explanation is not specific to any country. Focussing on the cross section, the model predicts higher labor hours in poorer countries: while trade ensures many product groups are available worldwide, poorer countries have lower wage rates. This prediction is borne out in Figure 5.

Developing economies provide some suggestive evidence on the role of new goods in labor markets. In developing and primitive economies, low levels of labor input and a backward bending labor supply curve are commonplace. Describing the labor market in such economies, Friedman (1962) observes that "in a primitive society, the initial low wage rate at which the income effect becomes dominant reflects a lack of familiarity with market goods." Confirming this in a study of African labor markets, Berg (1961) notes that "when knowledge of the outside is widespread in the villages, many men no longer quit their jobs sooner when wages rise; they stay as long as they had planned to and are happy to bring back to the villages a richer collection of goods." Similarly, Clark (2007) describes how males in tribal communities work fewer hours than males in modern America; Voth (2001b) documents an average of 4.9 daily labor hours per person in such societies. With developing economies and tribal communities offering limited consumption opportunities, such observations are consistent with the model. In the next section, I discuss related evidence on the rise in hours prior to the Industrial Revolution.

Finally, the capital market provides indirect evidence. Given the model's formulation for marginal utility, it predicts a risk-free rate of 1.7 percent for benchmark parameters. This is in the right ballpark for the level of risk-free rate in the data.

3.1 Model Application: The Industrious Revolution

In this section, I discuss one prominent application of the model: the rise in market-oriented labor hours prior to the Industrial Revolution in Britain and the subsequent growth.

In the pre-industrial economy, market activity was highly regulated, while there were few property rights to protect those engaged in commerce. For these reasons, most production took place in the home, and there was little formal labor market activity. Because this environment stifled the development of a market economy, there was little variety in the goods available to purchase. Clark (2007), for example, reports how "for most of human history. . . the bulk of material consumption has been food, shelter, and clothing."

In these economies, the labor market was well described by the backward-bending supply curve. For example, Weber (1958) notes: "For centuries it was an article of faith that low wages....increased the material results of labor." Rest days and religious holidays were also common, with "Saint Monday" being a regular weekly holiday. Describing early forager societies, Clark refers to what one anthropologist, Sahlins (1974), calls the "primitive affluence"—i.e., abundance of leisure—of such communities. The scant consumption variety, low levels of labor input, and backward-bending supply curve are consistent with the model outlined earlier.

After the Glorious Revolution in Britain in 1688, the economic environment changed. As a result of greater property rights and deregulation, merchants enjoyed more freedom to engage in commerce. Shops opened, imports increased, and the degree of urbanization rose. These changes led to an increase in product variety. De Vries (1994) reports how many literary works dating from this period convey impressions of a rise in commercial activity and desire for material goods. McCracken (1991) documents "an explosion of consumer choices," and describes how "the world of goods expanded dramatically to include. . . furniture, pottery, silver, mirrors, cutlery, gardens, pets, and fabric." Similarly, McKendrick et al. (1982) emphasize a new concern with fashion and social emulation; they describe a "consumer revolution," "rampant consumer behavior," and "an orgy of spending." Evidence from bequests confirms these reports and indicates large rises in the variety of goods consumed over this period. King (1997) reports that the number of goods in inventories rose by seventy two percent from the period 1711-1769 to 1770-1812, and finds consumption variety rose for all classes. Facilitating these dynamics was a relatively more equal distribution of income in Britain, which made emulation possible.

According to De Vries, the desire to purchase new products motivated people to move away from self-sufficiency and into the production of market-oriented goods. Most importantly, he stresses that the new desire to consume promoted work effort and "unleash[ed] a beneficial industriousness"; this, he claims, laid the ground for the Industrial Revolution. Writers from the period support this view. Steuart (1767), for instance, observes: "Men are forced to labor now because they are slaves to their own wants."[16] According to estimates by Voth (2001b), work hours per year rose by almost five hundred over the period 1750 to 1800; particularly important was a sharp fall in the number of observed religious holidays over this period. Significantly, the greatest increase in labor hours took place in London, where variety rose most; over the period 1750-1830, annual hours of labor in London rose by forty percent. Controlling for other factors in his empirical work—such as real wages and the dependency rate—he finds that most of the increase in hours remains unexplained; he attributes the increase to a rising desire to consume. The Industrious Revolution and the associated rise in the market economy changed the economic environment in Britain, and enabled the British government establish a robust system of taxation. Mokyr (2010) maintains that "the fiscal revolution was made possible by the Industrious Revolution."

Lindert and Williamson (1983) estimate that wages remained roughly unchanged

[16]Commenting on how consumer goods promoted work effort, Malthus (1803) observes "a decided taste for the conveniences and comforts of life. . . , and, in consequence a most laudable industry and foresight." Likewise, Hume (1752) notes that "it is a violent method and in most cases impracticable to oblige the labourer to toil in order to raise from the land more than what subsists himself and his family. Furnish him with manufactures and commodities and he will do it himself."

between 1755-1819 and indeed fell for full-time blue collar workers. The combination of higher labor supply and consumption, coupled with stagnant wages, is consistent with a greater taste for consumption goods and a shift outwards in the labor supply curve. But once wages started to grow steadily after 1830, labor hours fell, and women and children began to leave the workforce. Figure 10 shows labor hours in the U.K. over the period 1750–2000. Overall, therefore, the historical accounts are broadly consistent with the model presented here. That is, product variety increased markedly around 1750, thereby raising labor supply. But once wages rose around 1830, labor supply subsequently fell. Together with showing how new consumer goods raise labor supply, this episode also shows how new goods promote growth. Ogilvie (2009) finds similar dynamics in Germany over the same period.

4 Labor Supply and Long-Run Growth

In this section, I present a general equilibrium model. In contrast to the model presented in Section 1, this shows how greater labor supply increases the size of the market and raises the incentive to innovate. This innovation in turn leads to wage and variety growth, and both of these forces sustain a stable labor supply in equilibrium. On the balanced growth path, there is steady growth, and the level of labor supply is a function of the consumption technology: how efficient is the economy at creating new consumer products?

In the model, there is a representative household, a competitive R&D sector, and an expanding range of monopolistically competitive input firms. There are only dynamic goods. Using goods purchased from input firms, the R&D sector produces blueprints for the creation of new input firms. There are no profits in this sector: free entry ensures the price of a patent equals its production cost.

Each period the representative household chooses consumption and leisure, and supplies labor to all input firms. The household's income comprises wage income and dividends from the input firms. Using a home production technology, it transforms inputs purchased from firms into consumer goods. As the number of input firms rises, knowledge spillovers permit the continual growth of new consumer goods. For simplicity, I assume new groups have no direct effect on the utility derived from existing ones.

Facing aggregate demand from the household and the R&D sector, input firms hire labor in a competitive labor market. They set price as a markup over marginal cost, and infinitely lived patents secure their profits. To finance the upfront cost of a blueprint, the firms issue debt to the household. In equilibrium, the cost of a blueprint exhausts all profits accruing to it. Because of economic growth and rising investment, the number of input firms rises over time. More broadly, new input firms represent an increase in the stock of knowledge. As a result of knowledge spillovers, labor productivity and the real wage increase along with the number of input firms.

On the balanced growth path, the number of input firms and the real wage increase, along with the number of consumer products. For certain parameter restrictions, the interaction of real wage growth and increasing consumption variety sustains stable labor hours. The deep parameters of the model determine the steady-state level of labor supply. Throughout, I subscript input firms by i, consumer products by j, and denote the price of input i at time t by p_{it}. I solve the model for a balanced growth path.

4.1 The Economic Environment

An imperfectly competitive equilibrium in this economy is an allocation,

$\{b_t, l_t^s, \{x_{jit}\}_{i=0,j=0}^{i=A_t,j=n_t}, n_t, A_t, \{l_{it}^d\}, \{\pi_{it}\}_{i=0}^{A_t}, \{x_{it}^R\}_{i=0}^{A_t}, Y_t\}_{t=0}^{t=\infty}$,

and a price system, $\{W_t, r_t, p_{At}, \{p_{it}\}_{i=0}^{A_t}\}_{t=0}^{t=\infty}$, where the quantities and prices derive from the following problems:

The Consumer: There is an infinitely lived representative consumer who supplies labor to all firms and takes the path of $\{W_t, r_t, \{p_{it}\}, A_t\}_{t=0}^{\infty}$, and the production technology for new consumption products as given. The variable $A_t \in [0, \infty)$ denotes the number of input firms that exist at time t. The consumer solves:

$$\max_{\{x_{jit} \geq 0,\ b_t,\ 0 < l_t \leq 1\}} \int_0^\infty \left(\int_0^{n_t} u(c_{jt})\, dj - \psi \frac{l_t^{1+\theta}}{1+\theta} \right) e^{-\rho t}\, dt,$$

where $u(c_{jt})$ is as described in Section 1.2 and

$$c_{jt} = A_t^{1-\frac{1}{\alpha}} \left(\int_0^{A_t} x_{jit}^{\alpha}\, di \right)^{\frac{1}{\alpha}},$$

$0 < \alpha < 1$, and $\sigma > 1$. To produce c_{jt}, where $j \in [0, n_t]$, the consumer purchases inputs, x_{jit}, at price p_{it} from firms $i \in [0, A_t]$.

The consumer's budget constraint is

$$\dot{b}_t \leq r_t b_t + W_t l_t^s - \int_0^{n_t} \int_0^{A_t} p_{it} x_{jit} \, di \, dj. \tag{8}$$

The boundary conditions are:

$$\lim_{t \to \infty} b_t e^{-\int_0^t r_s \, ds} \geq 0, \qquad b_0 \quad \text{given.} \tag{9}$$

The household consumption technology gives the number of consumer goods the household can produce at time t:

$$n_t = \phi A_t^{\gamma}, \qquad \phi, \gamma > 0; \qquad A_0 \quad \text{given.}$$

Therefore, A_t also represents the level of nonrival knowledge available to consumers to produce consumer products. The parameters, ϕ and γ, govern the efficiency with which the household can create new consumption goods.

The solution to the household problem gives the time path: $\{\{x_{jit}\}, n_t, l_t^s, b_t\}_{t=0}^{t=\infty}$.

Research and Development: The R&D sector is perfectly competitive, and there is free entry into blueprint production. The representative firm takes $\{A_t, p_{At}, \{p_{it}\}\}_{t=0}^{t=\infty}$ as given and chooses $\{x_{it}^R\}_{t=0}^{t=\infty}$ to create blueprints. The constant returns to scale technology for blueprint manufacture is

$$\dot{A}_t = \frac{A_t^{1-\frac{1}{\alpha}}}{\alpha\eta} \left(\int_0^{A_t} (x_{it}^R)^{\alpha} \, di \right)^{\frac{1}{\alpha}}.$$

For blueprint production, an increase in A makes it both easier and harder to develop new innovations; these are the respective “standing on shoulders” and “stepping on toes” effects. Here, both effects offset. In a symmetric equilibrium, the use of $\frac{\alpha\eta}{A_t}$ units of each input produces a single blueprint, and η therefore governs the size of the startup cost. Competitive entrepreneurs solve:

$$\max_{\{x_{it}^R\}} \; p_{At}\dot{A}_t - \int_0^{A_t} p_{it} x_{it}^R \, di,$$

where p_{At} denotes the price of a patent at time t. This gives $\{x_{it}^R\}_{t=0}^{t=\infty}$ for all i, and free entry determines p_{At}.

Monopolistically Competitive Input Firms: Input firms are monopolistically competitive, hire labor in a competitive market, and take $\{W_t, A_t, p_{At}, \{p_{it}\}, x_{it}(p_{it})\}_{t=0}^{\infty}$ as given. They sell inputs to consumers and to the R&D sector, and purchase patents from the R&D sector. The constant returns to scale production function for firm $i \in [0, A_t]$ is $y_{it} = A_t l_{it}$. Worker efficiency is A_t, and the nominal wage is W_t. Each firm $i \in [0, A_t]$ ignores its impact on the average price level and chooses p_{it} each period to solve:

$$\max_{p_{it}} \pi_{it} = x_{it}(p_{it})\Big(p_{it} - \frac{W_t}{A_t}\Big),$$

where total demand faced by firm i, $x_{it}(p_{it}) = x_{it}^R + \int_0^{n_t} x_{jit} \, dj$, is given from the consumer and R&D problems. Derived demand for labor is then $l_{it}^d = \frac{x_{it}}{A_t}$. This solution gives $\{p_{it}, l_{it}^d, \pi_{it}\}$ for all t and $i \in [0, A_t]$.

Market Clearing:

- The labor market clears: $\int_0^{A_t} l_{it}^d \, di = l_t^s$, where $l_{it}^d = \frac{x_{it}}{A_t}$. This gives the real wage.
- The capital market clears: capital market equilibrium ensures $b_t = p_{At} A_t$.
- The economy's income constraint is: $Y_t = C_t + p_{At}\dot{A}_t$, where $Y_t = \int_0^{A_t} p_{it} y_{it} \, di$, and $C_t = \int_0^{n_t} \int_0^{A_t} p_{it} x_{it} \, di \, dj$.

4.2 Solving for the Equilibrium Allocation

4.2.1 Budget Constraint

The economy's income constraint is

$$Y_t = W_t l_t + r_t b_t = C_t + \dot{A}_t p_{At}.$$

That is, income derives from labor and capital and finances consumption and investment in blueprints. On the balanced growth path, the patent price, the interest rate, profits, and labor supply are all constant. (I will confirm this later.) Dividing across by A_t above shows that Y_t, C_t, W_t, b_t, and A_t all grow at the same rate on a balanced growth path.

4.2.2 Input Firm Optimization

Each firm faces the same demand elasticity from consumers and the R&D sector. Setting marginal cost, $\frac{W_t}{A_t}$, as numeraire, the firm's optimal price is a fixed markup over marginal cost:

$$p_{it} = \frac{1}{\alpha}\frac{W_t}{A_t} = \frac{1}{\alpha} \equiv p,$$

which is constant and the same for all firms. By symmetry, therefore, each firm $i \in [0, A_t]$ will produce the same quantity x and will demand the same amount of labor. From above, the real wage is $\frac{W_t}{p} = \alpha A_t$. Assuming an equilibrium labor supply of l, and noting the form of the production function, each firm produces

$$x = l.$$

As a result, firms produce constant quantities over time, and firm expansion represents an increase in the number of firms, not more existing firms. Because $\frac{1}{\alpha} - 1$ is the profit per unit of output, profits on the balanced growth path are constant for each firm over time and are equal to

$$\pi = \left(\frac{1-\alpha}{\alpha}\right) l.$$

4.2.3 R&D Sector Equilibrium

Substituting $p = \frac{1}{\alpha}$ into the equation for the price of a patent implies that the production cost of a patent is $\frac{\alpha\eta}{A_t} \int_0^{A_t} p \, di = \eta$. Free entry into patent production ensures the constant patent price

$$p_{At} = \eta.$$

4.2.4 Consumer Optimality

Combining the standard Euler equation $\frac{V'(\dot{C}_t)}{V'(C_t)} = \rho - r_t$ with the labor-leisure condition, $\frac{W_t}{p} V'(C_t) = \beta l_t^{\theta}$, noting that $\frac{\dot{W}}{W} = \frac{\dot{C}}{C}$, and imposing constant labor supply gives

$$\frac{\dot{C}_t}{C_t} = r_t - \rho.$$

Confirming our initial assumption, r_t is therefore constant on a balanced growth path. Taking growth rates of the labor-leisure condition and noting that $\frac{\dot{W}_t}{W_t} = \frac{\dot{A}_t}{A_t} = \frac{\dot{C}_t}{C_t}$, a condition for labor stability is:

$$\frac{\dot{n}_t}{n_t} = \frac{\sigma - 1}{\sigma} \frac{\dot{A}_t}{A_t}. \tag{10}$$

Then, recalling the form of the household technology, $n_t = \phi A_t^{\gamma}$, γ must satisfy the parameter restriction, $\gamma = \frac{\sigma-1}{\sigma}$.

4.2.5 Capital Market Equilibrium

The value of a blueprint equals the present discounted value of the profits accruing to it. Denoting this value at time t by $V(t)$, capital market equilibrium ensures that

$$p_{At} = \eta = V(t).$$

Noting that V is constant, this implies $V = \frac{\pi}{r}$ and hence

$$r = \frac{\pi}{\eta} = \frac{(1-\alpha)}{\alpha}\frac{l}{\eta}.$$

Consumption growth now reduces to

$$\frac{\dot{C}_t}{C_t} = r - \rho = \frac{(1-\alpha)}{\alpha}\frac{l}{\eta} - \rho, \tag{11}$$

where the restriction $\frac{(1-\alpha)}{\alpha}\frac{l}{\eta} > \rho$ is necessary for positive growth.[17]

4.2.6 Labor Market Equilibrium

To solve for equilibrium labor supply, l^*, I restrict the analysis to linear disutility, setting $\theta = 0$. Substituting the equation for the real wage into the consumer's labor-leisure condition yields

$$l^* = \frac{\phi}{\beta^{\frac{1}{\sigma}}\alpha^{1-\frac{1}{\sigma}}} - \eta\rho.$$

Overall, therefore:

$$\frac{\dot{C}_t}{C_t} = \frac{\dot{A}_t}{A_t} = \frac{\dot{Y}_t}{Y_t} = \frac{\dot{W}_t}{W_t} = \frac{\sigma}{\sigma-1}\frac{\dot{n}_t}{n_t} = \frac{\phi(1-\alpha)}{\beta^{\frac{1}{\sigma}}\eta\alpha^{2-\frac{1}{\sigma}}} - \frac{\rho}{\alpha} \equiv g.$$

At any point, $Y_t = \frac{A_t l^*}{\alpha}$, where $A_t = A_0 \exp(gt)$ and $A_0 = \eta b_0$.

[17] To ensure utility is bounded, the condition, $\rho > \frac{\sigma-1}{\sigma}g$, must also hold. The parameter ρ trivially always satisfies the transversality condition, which reduces to $\rho > 0$.

4.2.7 Discussion of Model Implications

According to the model, economic growth is an increasing function of *market*-oriented labor hours per household. Analogous to the scale effect in New Growth models, a higher labor supply raises the size of the market and increases the incentive to innovate. As a result, economic growth rises. Although this scale effect is a strong result, the model applies properly to the world: considering the very long run, market-oriented labor activity is a relatively recent phenomenon and coincides with sustained growth. In Section 4, I return to the Industrial Revolution, where this model seems especially relevant.

The expansion of input firms leads to more variety and real wage growth and, on a balanced growth path, both effects combine to yield a constant labor supply. The level of labor supply is a function of the deep parameters of the model. Most importantly, labor supply is increasing in ϕ, which governs the number of consumer goods: a higher ϕ implies greater consumption variety and a higher marginal utility for any given level of consumption. While the exogeneity of ϕ seems arbitrary, it is easy to conceive of ways to raise it; for example, opening up to trade; urbanization; a shift from home production to market-oriented production. By contrast, a higher start-up cost for firms, η, reduces labor supply. This is a standard income effect: a higher start-up cost raises the equilibrium value of a firm, thereby increasing non-labor income and depressing labor supply.

Although labor supply is constant, the household shifts labor hours to new input firms as productivity rises. This corresponds to the kind of sectoral change and labor reallocation that occurs as economies develop. The rising consumption variety that accompanies these changes raises welfare. Introducing capital accumulation would lead to conditional convergence in the model. Because a higher labor supply raises the marginal product of capital, greater product variety growth would induce faster capital accumulation.

5 Conclusion

Compared to cyclical changes, long-run trends in labor supply have received little attention in the macroeconomics literature. This paper presents a model that explains these trends by the interaction of two forces: variety growth, which raises labor supply, and wage growth, which reduces it. According to the model, the interaction of both forces can maintain stable labor hours over time. Incorporating the idea into a general equilibrium growth model shows how the introduction of new goods raises economic growth. In the model, greater product variety raises marginal utility and in turn labor supply. In turn, this higher labor supply increases the size of the market, inducing more innovation and raising the economy's growth rate. The associated scale effect to higher labor supply is broadly consistent with the coincidence of higher market-oriented labor hours and world growth over the very long run.

Calibrating the model over the period 1959-1999, it matches the data along two significant dimensions. While the standard one-good model predicts labor supply falls by 40 percent, the new-goods model predicts a smaller decline of 13 percent—closer to the actual decline of 6 percent. Second, given product variety growth was higher over the period 1979-1999, the model predicts a rise in hours over this period—as in the data. Although the model abstracts from many factors affecting labor supply over this period, it nonetheless captures important features of the data.

The model is consistent with hours variation in Britain over the period of the Industrial Revolution. From 1750 to 1830, the combination of a rise in product variety and stagnant wage growth was associated with a rise in labor hours—the "Industrious Revolution"—while in the period after 1830, wages rose and labor hours fell. In addition, the model is consistent with cross-sectional variation in hours: because trade ensures similar product variety across countries, the model predicts a higher labor supply in poorer countries.

The framework makes two methodological contributions. First, it introduces a utility function that can reconcile a dominant income effect to wage growth with stable labor hours over time. Having a model that can explain long-run trends is important for steady-state analysis and for calibrating, for example, the effects of tax policy. Second, the framework introduces variety growth into a model of intertemporal choice, and more generally has implications for dynamic macroeconomics.

References

Aguiar, M. and M. Bils (2015, September). Has Consumption Inequality Mirrored Income Inequality? *American Economic Review 105*(9), 2725–2756.

Aguiar, M. and E. Hurst (2013). Deconstructing Life Cycle Expenditure. *Journal of Political Economy 121*(3), 437–492.

Ashenfelter, O., K. Doran, and B. Schaller (2010). A Shred of Credible Evidence on the Long-Run Elasticity of Labour Supply. *Economica 77*(308), 637–650.

Attanasio, O. P. and G. Weber (1995, December). Is Consumption Growth Consistent with Intertemporal Optimization? Evidence from the Consumer Expenditure Survey. *Journal of Political Economy 103*(6), 1121–1157.

Baker, D. S. (2015). *Getting Prices Right* (2 ed.). New York: Routledge.

Berg, E. J. (1961). Backward-Sloping Labor Supply Functions in Dual Economies - the Africa Case. *Quarterly Journal of Economics 75*(3), 468–492.

Bils, M. and P. J. Klenow (2001, May). The Acceleration of Variety Growth. *American Economic Review 91*(2), 274–280.

Borjas, G. (2004). *Labor Economics*. New York: McGraw Hill.

Browning, M. and T. F. Crossley (2000, October). Luxuries Are Easier to Postpone: A Proof. *Journal of Political Economy 108*(5), 1022–1026.

Campbell, J. Y. and S. Ludvigson (2001, November). Elasticities of Substitution in Real Business Cycle Models with Home Protection. *Journal of Money, Credit and Banking 33*(4), 847–875.

Chetty, R., A. Guren, D. Manoli, and A. Weber (2011). Are Micro and Macro Labor Supply Elasticities Consistent? A Review of Evidence on the Intensive and Extensive Margins. *American Economic Review 101*(3), 471–75.

Clark, G. (2007). *A Farewell to Alms: A Brief Economic History of the World*. Princeton: Princeton University Press.

Costa, D. L. (2000, April). American Living Standards, 1888-1994: Evidence From Consumer Expenditures. NBER Working Papers 7650, National Bureau of Economic

Research, Inc.

Costa, D. L. (2001, December). Estimating Real Income in the United States from 1888 to 1994: Correcting CPI Bias Using Engel Curves. *Journal of Political Economy 109*(6), 1288–1310.

De Vries, J. (1994). The Industrial Revolution and the Industrious Revolution. *The Journal of Economic History 54*(02), 249–270.

Francis, N. and V. A. Ramey (2009). A Century of Work and Leisure. *American Economic Journal: Macroeconomics 1*(2), 189–224.

Friedman, M. (1962). *Price Theory: A Provisional Text*. Chicago: Aldine Publishing Company.

Gordon, R. J. (1987, April). The Postwar Evolution of Computer Prices. NBER Working Papers 2227, National Bureau of Economic Research, Inc.

Hamermesh, D. S. and J. Lee (2007, May). Stressed Out on Four Continents: Time Crunch or Yuppie Kvetch? *The Review of Economics and Statistics 89*(2), 374–383.

Hamilton, B. W. (2001, June). Using Engel's Law to Estimate CPI Bias. *American Economic Review 91*(3), 619–630.

Hume, D. (1752). *Essays: Moral, Political, and Literary*, Chapter Of Commerce. Part 2. London: Longmans. Reprinted 1989, edited by T.H Green and T.H Grose.

Keynes, J. M. (1931). Economic Possibilities for our Grandchildren. In *Essays in Persuasion*, pp. 358–374. London: The MacMillan Press Ltd.

King, P. (1997). Pauper Inventories and the Material Life of the Poor in the Eighteenth and Early Nineteenth Centuries. In T. Hitchcock, P. King, and P. Sharpe (Eds.), *Chronicling Poverty: The Voices and Strategies of the English Poor, 1640-1840*, pp. 72–98. London: Palgrave Macmillan.

Lebow, D. E., J. M. Roberts, and D. J. Stockton (1992). Economic performance under price stability. Technical report.

Lindert, P. H. and J. G. Williamson (1983). English Workers' Living Standards during the Industrial Revolution: A New Look. *The Economic History Review 36*(1), pp. 1–25.

Malthus, T. (1803). *An Essay on the Principle of Population*. Oxford: Oxford University Press. Reprinted and edited in 1993, with an introduction by Geoffrey Gilbert. Originally published in 1803.

McCracken, G. (1991). *Culture and Consumption*. Bloomington: Indiana University Press.

McKendrick, N., J. Brewer, and J. Plumb (1982). *The Birth of a Consumer Society: The Commercialization of Eighteenth Century England*. Bloomington: Indiana University Press.

Mokyr, J. (2010). *The Enlightened Economy*. New Haven: Yale University Press.

Nakamura, L. I. (1995). Is U.S. economic performance really that bad? Technical report.

Ogilvie, S. (2009). Consumption, Social Capital, and the Industrious Revolution in Early Modern Germany. Cambridge Working Papers in Economics 0943, Faculty of Economics, University of Cambridge.

Sahlins, M. (1974). *Stone Age Economics*. Chicago: Aldine Atherton.

Scholliers, P. and V. Zamagni (1995). *Labour's Reward: Real Wages and Economic Change in the 19th and 20th Century Europe*. Aldershot: Edward Elgar.

Shapiro, M. D. and D. W. Wilcox (1996, May). Mismeasurement in the Consumer Price Index: An Evaluation. NBER Working Papers 5590, National Bureau of Economic Research, Inc.

Steuart, S. J. (1767). *An Inquiry into the Principles of Political Economy*. Chicago: University of Chicago Press. Reprinted, edited, and with an introduction by Andrew S. Skinner. 1966.

Vandenbroucke, G. (2005). A Model of the Trends in Hours. IEPR Working Papers 05.40, Institute of Economic Policy Research (IEPR).

Voth, H. (2001a). The Longest Years: New Estimates of Labor Input in England, 1760-1830. *The Journal of Economic History 61*(04), 1065–1082.

Voth, H. (2001b). *Time and Work in England, 1750-1830*. New York: Clarendon Press.

Weber, M. (1958). *The Protestant Ethic and the Spirit of Capitalism*. London and New York: Routledge. Translated by Talcott Parsons, with an introduction by Anthony Giddens, 1992.

6 Appendix

I solve by two-stage budgeting, ignoring time subscripts. Denoting static consumption by C_s and dynamic consumption by C_d, the budget constraint is

$$\dot{b}_t = r_t b_t + W_t l_t - C_{st} - pC_{dt}$$

Ignoring time subscripts, utility from consumption is

$$\frac{A^{\gamma(1-\sigma_s)} C_s^{1-\sigma_s}}{1-\sigma_s} + n^v \int_0^n \frac{B^{\gamma(1-\sigma_d)} c_i^{1-\sigma_d} - n^{-v}\epsilon}{1-\sigma_d}\, di.$$

Indirect utility from dynamic goods consumption C is

$$V(n, B, C) = \frac{n^\zeta (B^\gamma C_d)^{1-\sigma_d}}{1-\sigma_d} - \frac{n\epsilon}{1-\sigma_d},$$

where $\zeta = v + \sigma_d$. Instantaneous utility is

$$\frac{A^{\gamma(1-\sigma_s)} C_s^{1-\sigma_s}}{1-\sigma_s} + \frac{n^\zeta (B^\gamma C_d)^{1-\sigma_d}}{1-\sigma_d} - \frac{n\epsilon}{1-\sigma_d} - \psi \frac{l^{1+\theta}}{1+\theta}.$$

The Hamiltonian is

$$\mathscr{H} = \frac{A^{\gamma(1-\sigma_s)} C_s^{1-\sigma_s}}{1-\sigma_s} + \frac{n^\zeta (B^\gamma C_d)^{1-\sigma_d}}{1-\sigma_d} - \frac{n\epsilon}{1-\sigma_d} - \beta \frac{l^{1+\theta}}{1+\theta} + \lambda(rb + Wl - C_s - pC_d),$$

implying the first-order conditions with respect to static consumption, dynamic consumption, and labor are:

$$\frac{A^{\gamma(1-\sigma_s)}}{C_s^{\sigma_s}} = \lambda = \frac{B^{\gamma(1-\sigma_d)} n^\zeta}{pC_d^{\sigma_d}} \tag{12}$$

$$\psi l^\theta = \lambda W \Rightarrow \psi l^\theta = \frac{W}{p} \frac{B^{\gamma(1-\sigma_d)} n^\zeta}{C_d^{\sigma_d}}.$$

From 12,

$$\frac{A^{\gamma(1-\sigma_s)}}{C_s^{\sigma_s}} = \frac{B^{\gamma(1-\sigma_d)} n^{\zeta}}{p C_d^{\sigma_d}}.$$

$$\Rightarrow \frac{pC_d}{C_s} = p^{1-\frac{1}{\sigma_d}} C_s^{\frac{\sigma_s}{\sigma_d}-1} n^{\frac{\zeta}{\sigma_d}} B^{\frac{\gamma(1-\sigma_d)}{\sigma_d}} A^{-\frac{\gamma(1-\sigma_s)}{\sigma_d}}.$$

Taking growth rates of each side:

$$\zeta g_n + \gamma(1-\sigma_d) g_B = \sigma_d \left(g_{pC_d} - g_{C_{St}} - \left(1 - \frac{1}{\sigma_d}\right) g_p - \left(\frac{\sigma_s}{\sigma_d} - 1\right) g_{C_s} \right) + \gamma(1-\sigma_s) g_A.$$

Setting $\gamma = 1$, implying proportional increases in quality and consumption have the same effect on welfare yields

$$\zeta g_n + (1-\sigma_d) g_B = \sigma_d \left(g_{pC_d} - g_{C_{St}} - \left(1 - \frac{1}{\sigma_d}\right) g_p - \left(\frac{\sigma_s}{\sigma_d} - 1\right) g_{C_s} \right) + (1-\sigma_s) g_A.$$

Inserting the equation from λ into the labor-leisure condition gives

$$\theta g_l = \zeta g_n + \gamma(1-\sigma_d) g_B - g_p - \sigma_d g_{C_d} + g_W = \zeta g_n + \gamma(1-\sigma_d) g_B - \sigma_d g_{C_d} + g_w,$$

where g_w denotes real wage growth in terms of dynamic goods.

7 Heterogeneity

Assuming the agent consumes n goods and has real consumption C, utility is

$$\frac{n^{\zeta} C^{1-\sigma}}{1-\sigma} + \frac{n\epsilon}{\sigma - 1}$$

The agents receives an extra unit of consumption and at the same time a new good is introduced. If the agent purchases an additional unit of an existing goods, utility is

$$\frac{n^{\zeta}(C+1)^{1-\sigma}}{1-\sigma}+\frac{n\epsilon}{\sigma-1},$$

implying the marginal utility of consuming an extra unit of the existing good is

$$\frac{n^{\zeta}(C+1)^{1-\sigma}}{1-\sigma}-\frac{n^{\zeta}C^{1-\sigma}}{1-\sigma}$$

If the agent spends the real income on the new good, utility is

$$\frac{(n+1)^{\zeta}(C+1)^{1-\sigma}}{1-\sigma}+\frac{(n+1)\epsilon}{\sigma-1},$$

implying the marginal utility of consuming the new good is

$$\frac{(n+1)^{\zeta}(C+1)^{1-\sigma}}{1-\sigma}-\frac{n^{\zeta}C^{1-\sigma}}{1-\sigma}+\frac{\epsilon}{\sigma-1}.$$

Thus the agent will consume the new good if

$$\frac{(n+1)^{\zeta}(C+1)^{1-\sigma}}{1-\sigma}+\frac{\epsilon}{\sigma-1}>\frac{n^{\zeta}(C+1)^{1-\sigma}}{1-\sigma}$$

This holds if

$$\epsilon(C+1)^{\sigma-1}>(n+1)^{\zeta}-n^{\zeta}$$

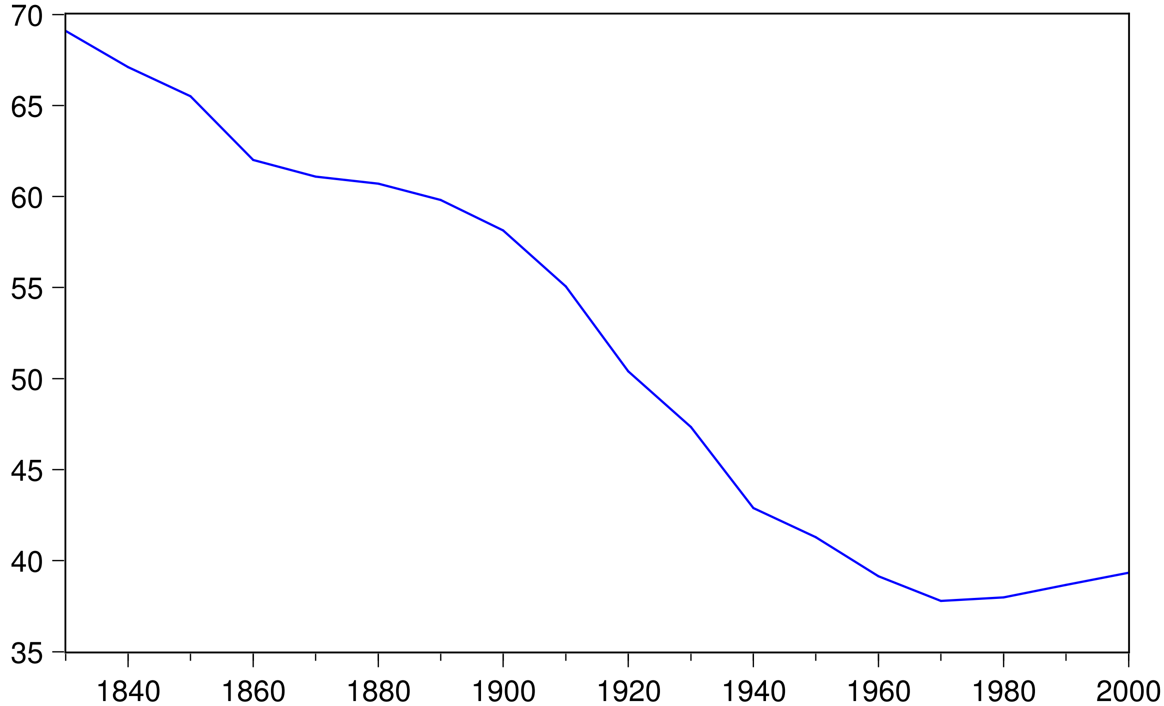

Figure 2: WEEKLY LABOR HOURS: U.S., 1830-2000
Source: Vandenbroucke (2005)

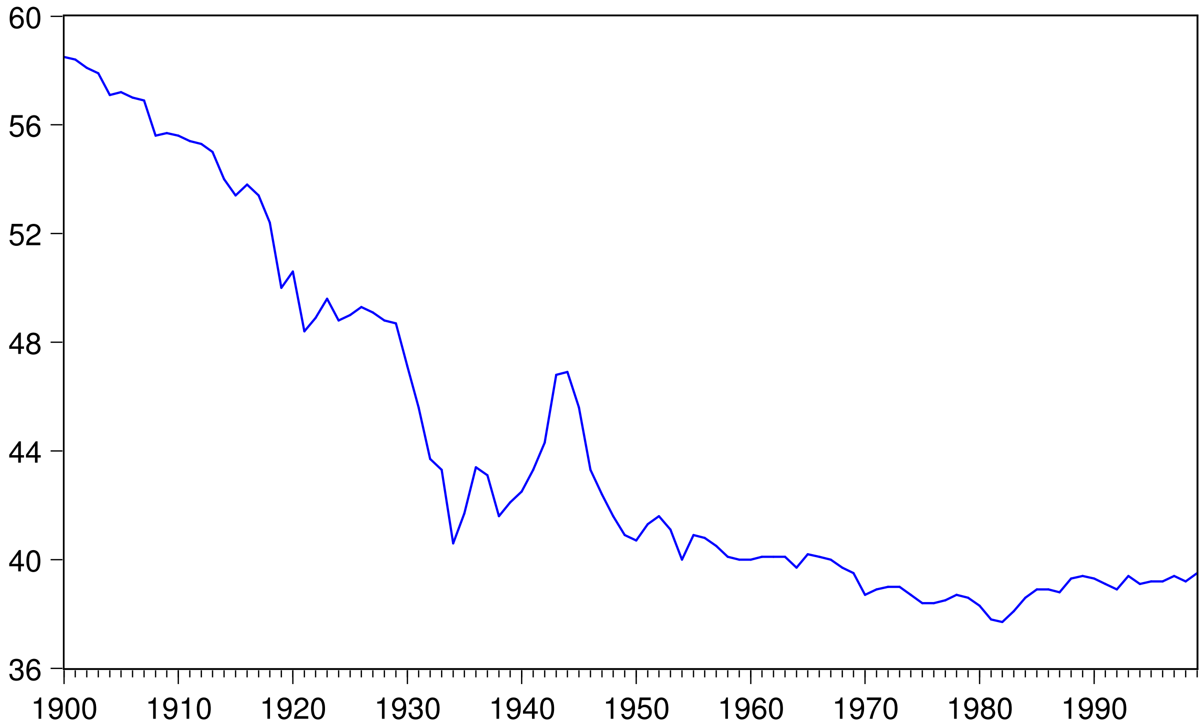

Figure 3: WEEKLY LABOR HOURS OF PRIVATE NONAGRICULTURAL WORKERS: U.S., 1900-2000
Source: Historical Statistics of the United States

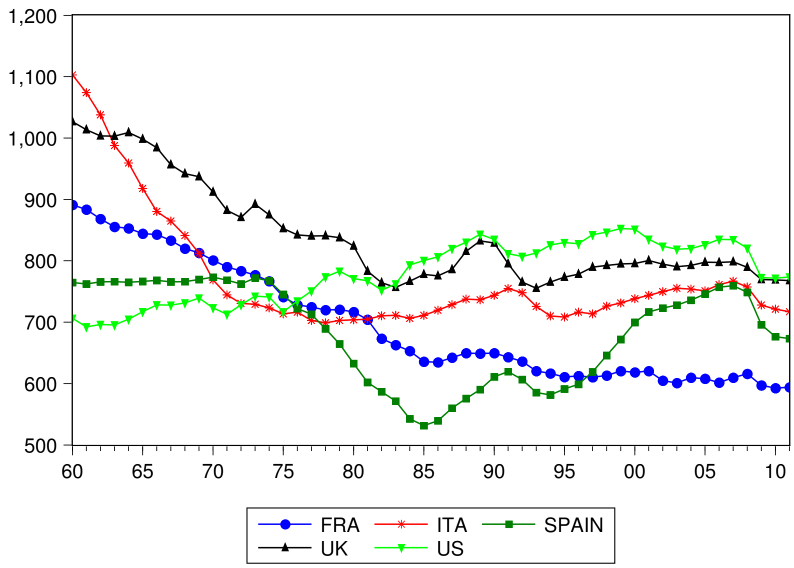

Figure 4: Annual Labor Hours Per Capita: 1960-2011
Source: Groningen Database

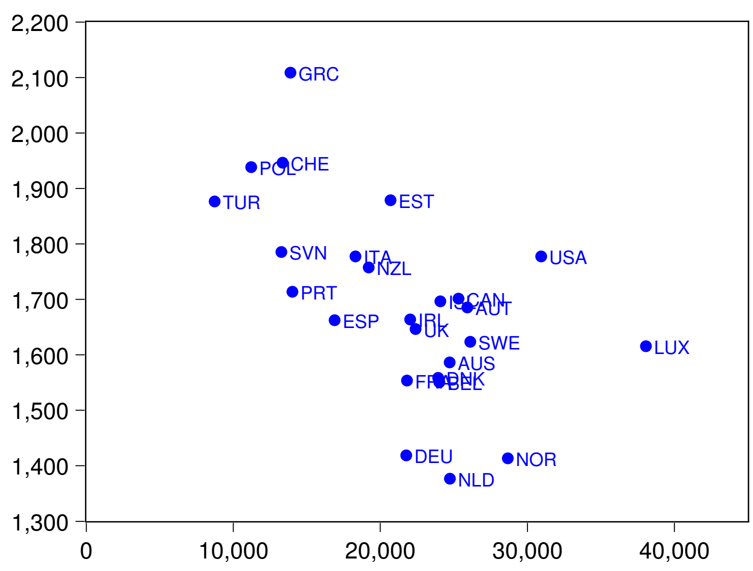

Figure 5: Labor Hours per Worker and GDP per Capita: OECD Countries in 2010
Source: OECD iLibrary

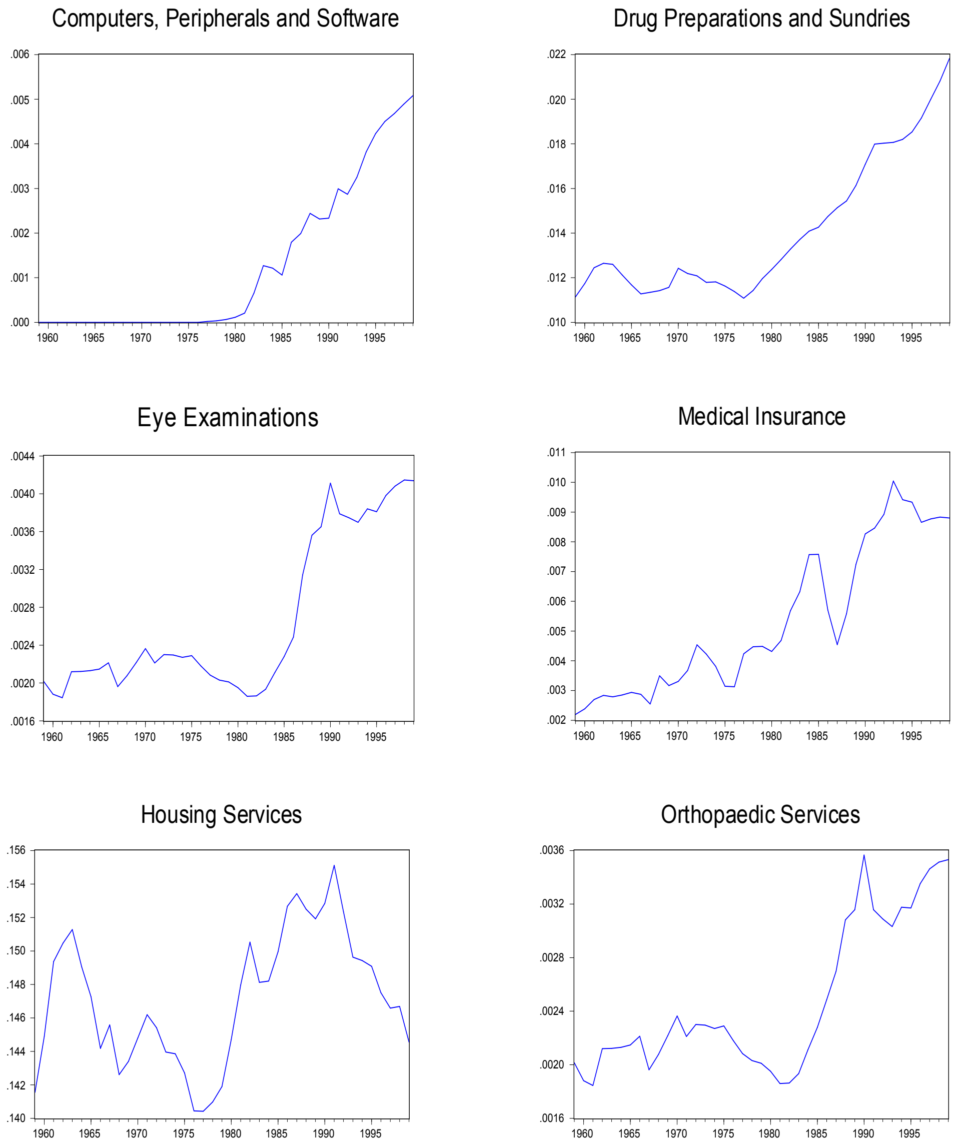

Figure 6: NEWLY INTRODUCED PRODUCTS IN U.S., 1959-2000
Source: *NIPA*.

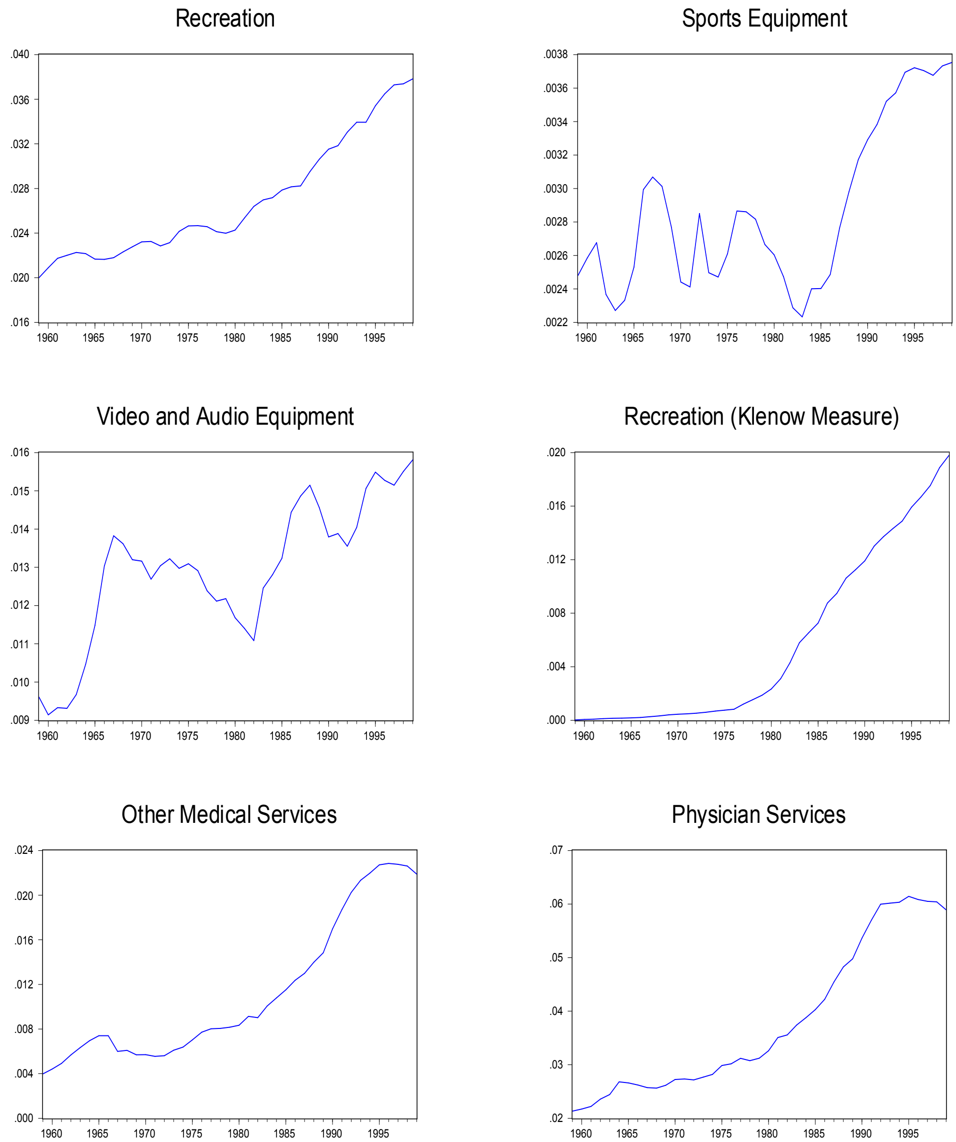

Figure 7: NEWLY INTRODUCED PRODUCTS IN U.S., 1959-2000

Source: *NIPA*.

Table 1: **Static Goods**

Hotels and Motels	Tobacco
Electricity	Refuse Collection
Local Telephone	Long Distance Telephone
Moving and Storage	Rug and Furniture Cleaning
Purchased Intercity Transportation	Sightseeing
Nursing Homes	Beauty Shops
Food (off-premises)	Alcoholic Beverages (off-premises)
Food in Purchased Meals	Alcohol in Purchased Meals
Shoes	Female Clothing
Infant Clothing	Male Clothing
Cleaning, Storage, Clothing Repair	Legal expenses
Alcoholic Beverage	Gas, Fuel, Oil, and Other Energy Goods
Burial Expenses	Water and Sewerage Maintenance
Domestic Service	Postage
Taxicabs	Bridges, Tunnel, Ferry, Road tolls
Bowling and Billiards	Parimutuel Net Receipts
Barber Shops	Education and Research
Religious and Welfare Activities	

Table 2: **Parameters: Annual Frequency**

DESCRIPTION	SYMBOL	1959-79	1980-99
STRUCTURAL PARAMETERS %			
Change Dynamic Share (ppts)		6.28	9.86
Mean Net Group Growth		2.22	2.67
Mean Wage Growth	g_w	1.90	0.94
Mean Consumption growth	g_c	2.56	2.48
Mean Dynamic Cons. Growth	$g_{C_{dt}}$	3.76	2.70
Mean Static Cons. Growth	$g_{C_{st}}$	1.60	1.30
Hours per worker (% Total Change)	g_l	-6.11	1.54
PREFERENCE PARAMETERS			
Agg. Intertemporal Elasticity (IES)	$\frac{1}{\sigma}$	0.75	0.75
IES for Dynamic Goods	$\frac{1}{\sigma_d}$	0.72	0.72
IES for Static Goods	$\frac{1}{\sigma_s}$	0.79	0.79
Frisch Elasticity of Labor Supply	$\frac{1}{\theta}$	0.75	0.75

Table 3: **Predicted % Change in Labor Hours: Constant Wage Growth, Baseline Parameters: $\frac{1}{\theta} = .75$, $\frac{1}{\sigma} = .75$.**

PERIOD	1959-79	1980-1999	1959-79	1980-99
VARIETY GROWTH	Y	Y	N	N
DATA	-6.1	1.5	-6.1	1.5
FRISCH ELASTICITY, $\frac{1}{\theta}$				
.2	-5.3	2.2	-7.9	-5.1
.5	-12.8	5.5	-18.6	-12.3
.75	-19.6	7.9	-26.7	-18.0
1	-24.1	11.1	-34.1	-23.3
1.5	-34.3	16.9	-46.9	-33.2
2	-43.2	22.7	-57.4	-42.1
AGGREGATE IES, $\frac{1}{\sigma}$				
.2	-71.3	-54.3	-85.4	-77.0
.4	-41.2	-17.3	-55.0	-44.1
.6	-26.1	-.19	-35.9	-26.1
.75	-19.6	7.9	-26.7	-18.0
.9	-13.8	13.8	-18.9	-11.0
1	-6.9	13.0	-15.1	-7.7

Table 4: **Predicted % Change in Labor Hours: Variable Wage Growth, Baseline Parameters: $\frac{1}{\theta} = .75$, $\frac{1}{\sigma} = .75$.**

PERIOD	1959-79	1980-1999	1959-79	1980-1999
VARIETY GROWTH	Y	Y	N	N
DATA	-6.1	1.5	-6.1	1.5
FRISCH ELASTICITY, $\frac{1}{\theta}$				
.2	-1.6	-1.7	-5.6	-7.3
.5	-4.0	-4.0	-13.5	-17.4
.75	-6.0	-6.1	-19.7	-25.1
1	-8.0	-8.2	-25.5	-32.1
1.5	-11.9	-12.3	-36.0	-44.4
2	-15.7	-16.4	-45.2	-54.8
AGGREGATE IES, $\frac{1}{\sigma}$				
.2	-66.5	-60.7	-84.0	-79.2
.4	-31.9	-28.4	-51.0	-49.5
.6	-14.5	-13.2	-30.3	-33.1
.75	-6.0	-6.1	-19.7	-25.1
.9	$-.4$	-1.3	-12.1	-19.4
1	4.9	-.8	-8.2	-16.9

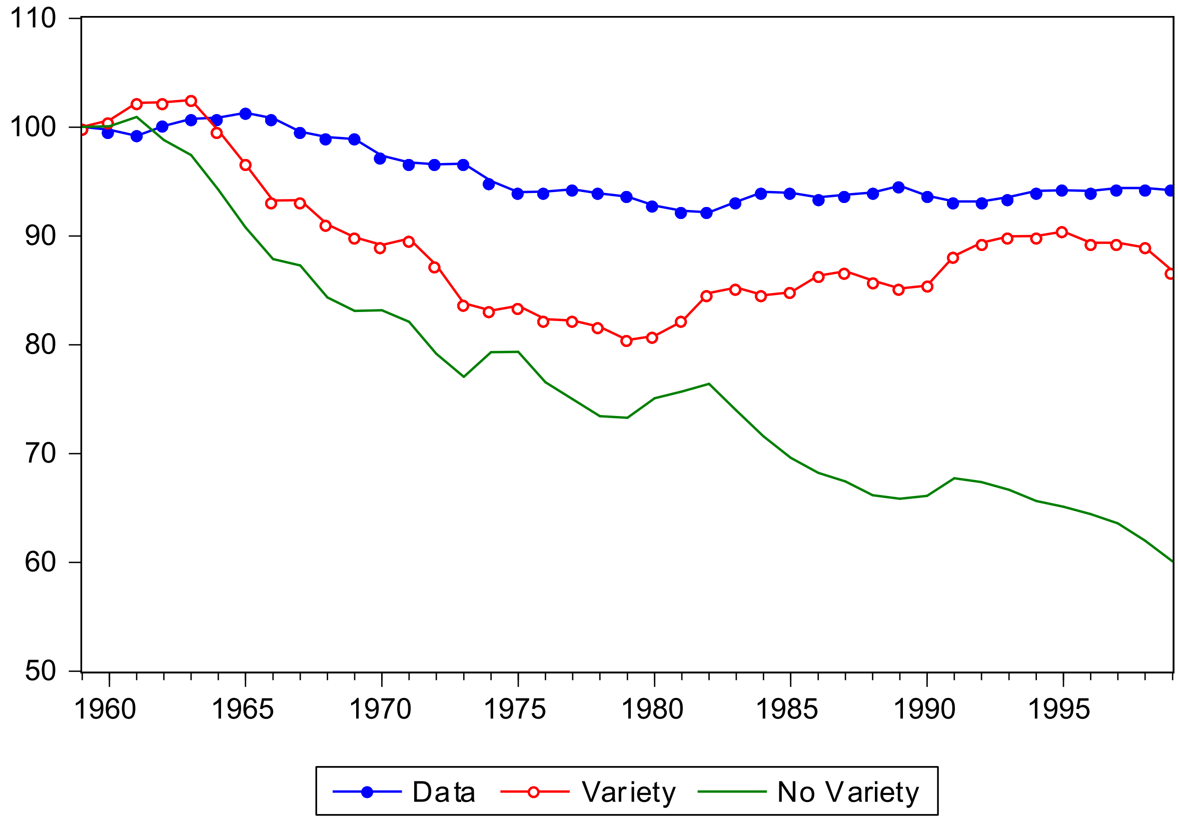

Figure 8: FIXED WAGE GROWTH: PREDICTED LABOR HOURS PER EMPLOYED WORKER FOR BASELINE PARAMETERS (IES, .75; FRISCH ELASTICITY, .75): U.S., 1960-1999. VARIETY REFERS TO THE MODEL INCORPORATING NEW GOODS. NO VARIETY REFERS TO THE STANDARD CIES MODEL.

Source: OECD and author's calculations

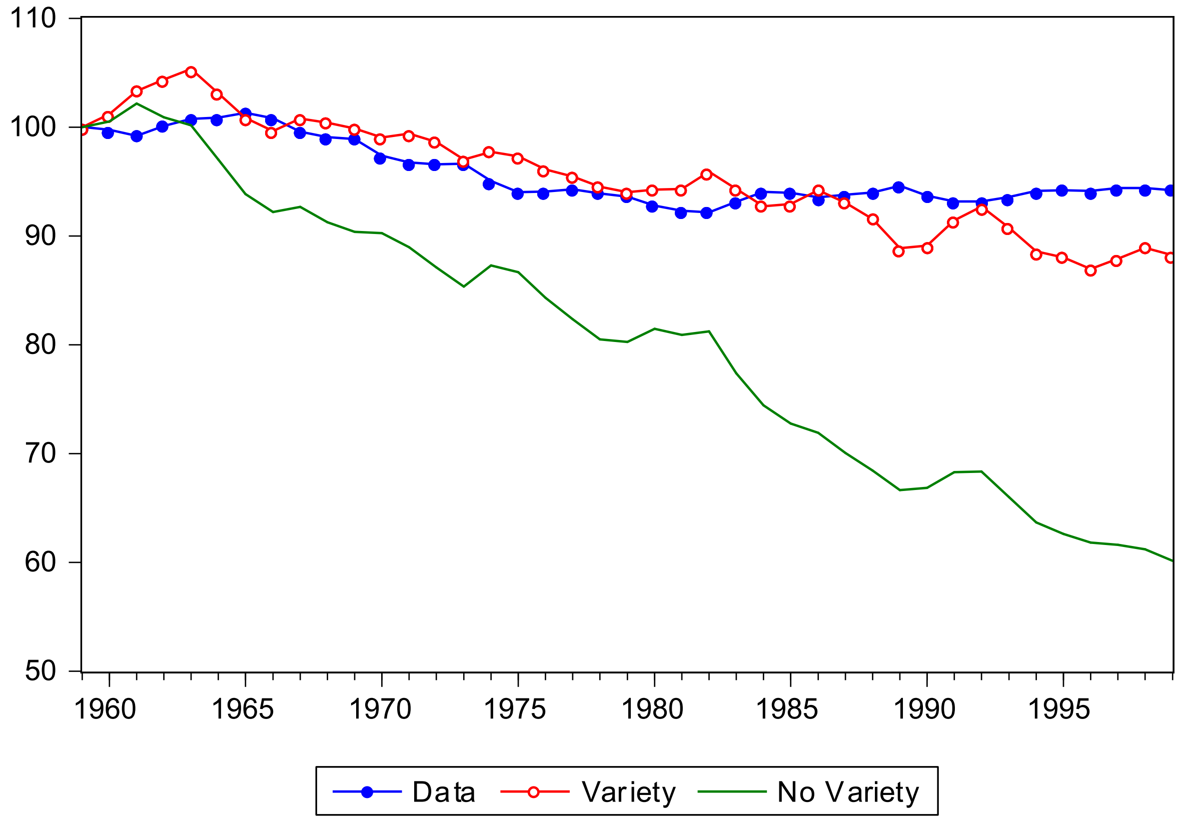

Figure 9: ACTUAL WAGE GROWTH: PREDICTED LABOR HOURS PER EMPLOYED WORKER FOR BASELINE PARAMETERS (IES, .75; FRISCH ELASTICITY, .75): U.S., 1960-1999. VARIETY REFERS TO THE MODEL INCORPORATING NEW GOODS. NO VARIETY REFERS TO THE STANDARD CIES MODEL.

Source: OECD and author's calculations

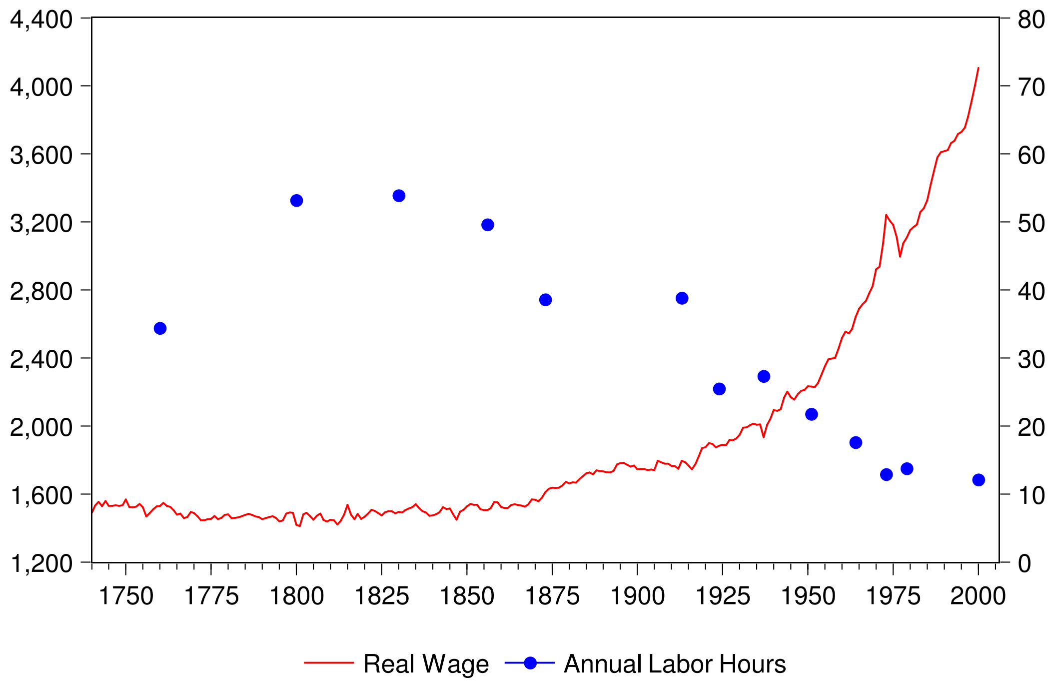

Figure 10: ANNUAL LABOR HOURS AND REAL WAGE INDEX: BRITAIN, 1750-2000
Source: Robert Allen's website, Scholliers and Zamagni (1995), and Voth (2001a)