The Effects of Labor Market Conditions on Working Time: A Look at the US-EU Experience*

Claudio Michelacci
CEMFI and CEPR

Josep Pijoan-Mas
CEMFI and CEPR

May 2006
(Very Preliminary and Incomplete)

Abstract

In a standard competitive labor market model, workers choose how many hours to work by equating the marginal utility of leisure to the marginal value of current income. The only variables that affect the choice are the current market wage and the worker's wealth. In practice individuals often decide to work longer hours to increase future as well as current income. By working longer hours they acquire greater skills and can obtain better jobs. In a market with search frictions, several features of the labor market can then influence the decision on working time. We show that a higher probability of becoming unemployed, a longer duration of unemployment, and in general a less tight labor market discourage working time. Wage inequality gives instead incentives to work longer hours. We argue that the different evolution of labor market conditions in the US and in Continental Europe in the post World-War-II period can explain a substantial part of the diverging evolution of the number of hours worked per employee across the two sides of the Atlantic.

JEL classification: G31, J31, E24

Keywords: working hours, learning-by-doing, Europe, US

*The authors gratefully acknowledge *Fundación Ramón Areces* for financial support. Postal address: CEMFI, Casado del Alisal 5, 28014 Madrid, Spain. E-mail: c.michelacci@cemfi.es, pijoan@cemfi.es

1 Introduction

In a standard competitive labor market model, workers choose how many hours to work by equating the marginal utility of leisure to the marginal value of *current* income. The current market wage and the worker's wealth are the main determinants of the choice. In practice however individuals may decide to work longer hours in order to increase future as well as current income. By working longer hours they acquire greater skills, get promoted in the current job, and obtain better jobs. In this paper we analyze the determinants of the working time decision in a labor market subject to search frictions when hours worked are a means of accumulating human capital. We argue that individual working time decisions are intrinsically interrelated with several aggregate features of the labor market.

Our model is an extension of the standard search model of unemployment originally due to McCall (1970) where we allow for on-the-job search and a working hours decision. Hours worked increase current as well as future income. By working longer hours workers can acquire greater skills and increase their opportunities to obtain job offers. Thus hours worked have both an intra-temporal and inter-temporal return. Workers can become unemployed. If unemployed, they search for a new job. If employed, they can receive job offers from a given wage distribution.[1] Thus there is wage dispersion and identical workers can earn different income. Workers are risk averse, so wage changes exert both an income and a substitution effect on working time decisions.

We show that a higher probability of becoming unemployed, and a longer duration of unemployment reduce the rate of use of the stock of human capital accumulated through working time and thereby reduce the incentive to work longer hours. A rise in wage inequality instead raises the gains from obtaining better jobs and gives workers greater incentives to work longer hours.

These considerations can help explain the different evolution of working time in the US and in Continental Europe in the post World-War-II period. The number of hours worked per employee has fallen in Continental Europe (Germany, France, Italy) while it has remained roughly constant in the US. See for example OECD (2004) for some evidence. It is also well known that, since the 70's, the labor market has evolved quite differently across the two sides of the Atlantic. In particular:

[1]Postulating an exogenous wage distribution has some key advantages given the question at hand. First, wage determination may differ substantially in Continental Europe and in the US. Second the wage distribution has evolved differently over time and there is yet no consensus of why this happened, see Hornstein, Krusell, and Violante (Forthcoming) for a survey on possible explanations. We sidestepped this debate by considering an exogenous wage offer distribution.

1. The return to skill has increased substantially in the US while it has increased little in Europe. See Eckstein and Nagypal (2004), Katz and Autor (1999) and Goldin and Katz (1999) for evidence specific to the US and Gottschalk and Smeeding (1997) for a cross-country comparison.

2. Within-skill wage inequality has increased dramatically in the US while it has remained roughly constant in Europe. See Juhn, Murphy, and Pierce (1993) for evidence specific to the US, and Flinn (2002) and Gosling and Meghir (2000) for evidence specific to Italy and the UK, respectively. See also Bertola and Ichino (1955) and Gottschalk and Smeeding (1997) for a cross-country comparison.

3. The unemployment rate has increased substantially in Europe while it has remained roughly constant in the US. [2] See Blanchard and Wolfers (2000) for a comparison of the evolution of unemployment in the US and Europe.

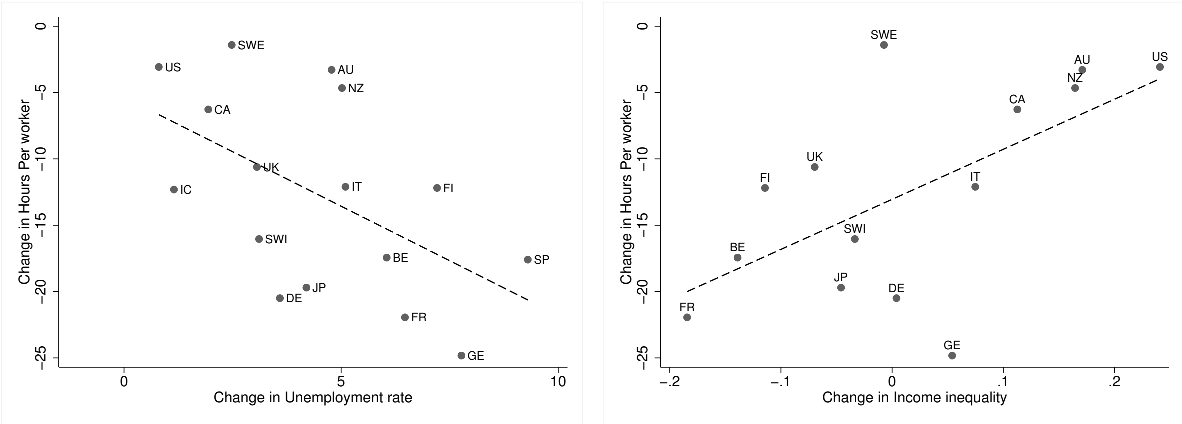
Fact 1 and 2 document the different evolution of the two main determinants of wage inequality. Fact 3 deals with unemployment dynamics. We argue that these changes in the labor market conditions have affected the choice of working hours. In figure 1 we plot the percentage change in hours worked per employee for selected OECD countries against the changes in unemployment rate (panel a) and in earnings inequality (panel b) respectively. Changes are calculated over the 1970-2002 period. The correlation between changes in hours worked and change in unemployment is around minus sixty percent. The analogous correlation with income inequality changes is around sixty percent; both are statistically significant at a five percent level of significance. They also have independent explanatory power, since they remain significant (at a ten percent level) when simultaneously included in a regression explaining changes in working hours. Although just suggestive, this evidence hints at a potentially interesting link between working time decisions and labor market conditions. Since labor market conditions in the US and Europe have started to diverge mainly after the 70's, these considerations can help to explain why Europeans now work less than Americans, while they were working similar hours back in the 50's.[3]

We use data from the Panel Study of Income Dynamics (PSID), and the German Socio-Economic Panel (GSOEP), to analyze the evolution of the inter-temporal return to hours worked in the US and in Germany. In both countries we find that hours worked

[2]The rise in the EU unemployment rate is mainly explained by a fall in the exit rate from unemployment in the EU relative to the US. The job separation rate has instead remained roughly constant, both in the US and in the EU.

[3]For example Germans were working longer hours than Americans in the 50's while they now work around 20% less hours than Americans. The Americans started to work longer hours than Germans in the mid 70's, see Bell and Freeman (1995).

Figure 1: Hours worked and labor market conditions



(a) Unemployment Rate and Hours per Worker (b) Income Inequality and Hours per Worker

Note: Changes over the 1970-2002 period. Source OECD, see "http://www.oecd.org". Changes in Hours per Worker are percentage changes in the average annual hours worked per employee in the 1970-2002 period. Changes in the unemployment rate are level variations over the same period. Changes in income inequality are calculated as variations in the log difference of the ninth and the first decile of the distribution of gross earnings in main job of full-time workers; the sample period used differs because of data availability. We always select the available data closest to 2002 and to 1970, respectively.

yield a significant inter-temporal return. Moreover, the inter-temporal return to working time has increased in the US since the 70's, while it has remained roughly constant in Germany. We argue that the different evolution of the return to skill and in within-skill wage inequality explain a substantial part of the different evolution of the return to hours worked.

Differences in the inter-temporal return to hours worked can contribute to explain differences in the evolution of working time in the US and the EU. To quantify the contribution of labor market conditions, we calibrate the model to match a variety of statistics at the micro level from GSOEP, PSID and other sources. We analyze the effects of reducing the reemployment probabilities of unemployed workers so as to reproduce the raise in unemployment in the EU over the last thirty years. We then analyze the effects of increasing the return to skill and within-skill wage inequality so as to match the rise in wage inequality experienced by the US since the 70's. A preliminary analysis suggests that the different evolution of the labor market in the US and the EU (in terms of inequality and unemployment) explain between one half and two thirds of the US-EU differences in the evolution of working time.

The idea that labor market conditions play a role in explaining working time differences is novel. Prescott (2004) attributes the relative fall in hours worked in Europe to the sharp increase in taxes experienced by several European countries. This tends to reduce the *net* return to hours worked and discourages working time. We provide evidence that the *gross* return to working longer hours has evolved differently across the two sides of the Atlantic. This suggests that taxes can not be the only reason why working time has evolved differently. Blanchard (2004) argues that Europeans work less than Americans because they have a stronger preference toward leisure. In our model this happens not because Europeans are intrinsically different from Americans, but because they lack career prospects due to the sluggish labor market. Alesina, Glaeser, and Sacerdote (2005) argue that trade unions introduced work sharing arrangements. They restricted the number of hours worked per employee so as to maintain a higher employment level. Our analysis suggests that the observed different evolution of wage inequality and unemployment in the US and the EU, could simply be part of a trade unions' attempt to make work sharing politically sustainable. Working time restrictions, imposed by law or collective bargaining agreements, become incentive compatible because Europeans do not prefer to work longer hours given the existing labor market conditions. OECD (2004) documents that the difference between actual and desired working time is generally small for European workers. Bell and Freeman (2001) also document that the fraction of workers that would prefer to work longer hours for given hourly wages is higher in the US than in Germany.

Our analysis is also related to Bell and Freeman (1995), Bell and Freeman (2001) and Kuhn and Lozano (2005). Bell and Freeman (1995) have also argued that higher wage inequality gives greater incentives to work longer hours. Looking at the NLSY for the US and at the GSOEP for Germany, Bell and Freeman (2001) show that occupations with larger wage inequality are also occupations with larger annual hours. Kuhn and Lozano (2005) uncover the same relationship by using data from the Current Population Survey for the U.S. [4] Our work complements these findings by showing that, at the individual level, higher work effort is associated to larger future income. We provide a model and specify an explicit channel whereby wage inequality affects the returns to working longer hours. We analyze how the mechanism interacts with standard income and substitution effects in labor supply decisions. Furthermore we investigate how several features of the labor market affect working time decisions aside from wage inequality. Finally we quantify the role of each feature of the labor market in accounting for the diverging evolution of working time in the US and the EU.

The idea that hours worked increase worker's human capital is not entirely novel. The idea has been put forward by Imai and Keane (2004). They use data from the NLSY to test a model of wage dynamics where hours worked increase the future labor

[4] Kuhn and Lozano (2005) focus on the determinants of the fraction of men working more than 50 hours per week rather than on average hours worked.

earnings of the worker due to learning-by-doing. They show that hours worked are an important source of accumulation of human capital. Our work emphasizes that hours worked decisions interact with several salient features of the labor market when i) hours worked are a source of accumulation of human capital and ii) the labor market is subject to search frictions.

In a world where any job income is determined by collective agreements, workers can only increase their income by either obtaining better jobs or getting promoted in the current one. In an European-like set-up the inter-temporal return to hours worked is always relatively more important than the intra-temporal return. So the mechanisms emphasized by this paper should also be relevant in these economies. Indeed we find a positive intertemporal return to hours worked both in the German and in the US data.

The plan of the paper is as follows. In the next section we describe a simple two period model that highlights how labor market variables affect the inter-temporal returns to hours worked and working time decisions. Section 3 extends the model to allow for infinitely lived agents and general specification of technology and preferences. Section 4 calibrates the model. We use a variety of statistics calculated from PSID and GSOEP. Section 5 quantifies the role of labor market conditions in accounting for the diverging evolution of working time in the US and the EU. Section 6 considers some extensions. Section 7 concludes.

2 A two-period stylized model

In this section we study the determinants of the inter-temporal returns to hours worked. We show how labor market conditions affects working time decisions. We do so in a purposely very stylized model. There are two reasons for this. First, we want to highlight some basic channels whereby labor market conditions affect the inter-temporal returns to hours worked and the choice of hours. A more general model for quantitative analysis is presented in Section 3. Second, this simple model will naturally suggest ways to identify key parameters of the general model in the data. This will play an important role in the discussion on calibration in Section 4.

In this simple model the economy lasts for two periods. In the first period workers are employed. Their initial stock of human capital is $H \in \mathbb{R}_+$. By working h hours they produce an amount of efficiency units of labor $H^\alpha h^\theta$. The job remunerates efficiency units of work at rate ω. We refer to ω as to the *wage* rate of the job. Then the worker's income is $\omega H^\alpha h^\beta$. Next period's stock of human capital H' is related to the number of hours worked in the current period: $H' = a\,h$, where a is the rate at which human capital is accumulated. Note that this specification imposes that the human capital at the start of the first period gets totally depreciated at the beginning of the second periods.

Next period workers are unemployed with probability ϕ. In practice ϕ is the joint probability that a worker becomes unemployed *and* that he does not find a new job in the period. Thus ϕ is increasing in the job separation probability and decreasing in the job finding probability. An unemployed worker obtains logged income that yields him utility equal to b.

If the job is not destroyed, the worker can receive a job offer from a firm that pays a wage ω'. Job offers are received with probability $p_e(H')$, which is increasing in the stock of the worker's human capital H'.[5] This captures the idea that high skilled workers can obtain better job offers than low skilled workers. The probability $p_e()$ should be interpreted as the product of a parameter related to the tightness in the labor market and the number of efficiency units of search of the worker—the latter being increasing in the stock of human capital of the worker. Job offers are a random draw from a given wage distribution $F(\omega)$. The distribution F captures within-skill wage inequality. In equilibrium workers will accept offers whenever $\omega' > \omega$. For simplicity we assume that the wage offer distribution has mass $1-q$ at the point ω_1 and q at the point ω_2, with $\omega_1 < \omega_2$.

Preferences over consumption and leisure are given by the following utility function,

$$u(c,h) = \ln c - \lambda h.$$

This choice of preferences implies that the income and the substitution effects cancel out exactly, so that permanent wage changes have no effects on hours worked. For simplicity we assume that workers do not save and can not borrow. Therefore, consumption is simply equal to labor income.

We start to solve the model backwards. In the second period the problem of the workers is given by

$$V_2(\omega', H') = \max_{h'} \left\{ \ln\left(\omega' H'^{\alpha} h'^{\theta}\right) - \lambda h' \right\},$$

which implies a very simple expression for the optimal choice of hours,

$$h' = \frac{\theta}{\lambda}.$$

[5]For simplicity in this version of the model we assume that the unemployment probability ϕ is unrelated to H'. This is made just to simplify the analysis.

Substituting this result in the previous expression yields

$$V_2(\omega', H') = \ln \omega' + \alpha \ln H' + \theta \ln \theta - \theta \ln \lambda - \theta. \tag{1}$$

In the first period the optimal choice of hours h for a worker with human capital H in a job with wage ω can be obtained by solving the following Bellman equation:

$$\begin{aligned} V_1(\omega, H) &= \max_h \Bigg\{ u\left(\omega H^\alpha h^\theta, h\right) + \beta \phi b \\ &+ \beta (1-\phi) \left[V_2(\omega, H') + p_e(H') \int_{\mathbb{R}} \max\{V_2(s, H') - V_2(\omega, H'), 0\} \, dF(s) \right] \Bigg\} \\ &\text{s.t. } H' = ah. \end{aligned} \tag{2}$$

Using our simple wage offer distribution we can rewrite $V_1(w, H)$ as

$$V_1(\omega, H) = \max_h \left\{ \ln\left(\omega H^\alpha h^\theta\right) - \lambda h + \beta \phi \, b + \beta (1-\phi) \left[V_2(\omega, H') + p_e(H') \, q \left(\ln \omega_2 - \ln \omega\right) \right] \right\}$$

Then, the first order condition for h reads as

$$\lambda = \frac{\theta}{h} + \beta (1-\phi) \left[\frac{\alpha}{h} + \frac{dp_e}{dH'} \, a \, q (\ln \omega_2 - \ln \omega) \right], \tag{3}$$

which says that hours worked are chosen by equating the marginal disutility of working to the marginal return of an hour of work. The marginal return is the sum of the value of the marginal increase in current income, equal to θ/h, and the expected marginal increase in future income—which corresponds to the second term in the right hand side of equation (3). There are two different components in the inter-temporal returns to hours worked. First, the return to skill, α. Second, the increase in the probability of getting a job offer. It is to this second channel that wage inequality is related. Additionally, both effects depend on the rate of utilization of human capital, $(1-\phi)$. Therefore, the marginal increase in future income is zero if both the return to skill, α, is zero, and hours worked do not increase the stock of human capital, $a = 0$. It is also zero if the worker is unemployed with probability one in the next period. To obtain an explicit expression for h we assume that the following approximation holds:

$$p_e(H') \simeq p_0 + p_1 \left(\ln H' - \overline{\ln H'}\right) \tag{4}$$

where $\overline{\ln H'}$ is an appropriately defined constant while p_1 is the elasticity of the job offer probability to the stock of human capital. In general p_1 is higher in a tighter labor market. This allows to solve for h so as to obtain that

$$h = \frac{\theta + \beta\,(1-\phi)\,[\alpha + p_1\,q\,(\ln\omega_2 - \ln\omega)]}{\lambda}. \tag{5}$$

Notice that the intra-temporal returns to hours worked (the first term in the numerator of the right-hand side of equation 5) is independent of ω. This is because with log preferences the income and the substitution effect cancel out. The inter-temporal return to hours worked (the second term in the numerator) is instead decreasing in ω, because the chances of obtaining better job decrease as the current wage rate increases. This discourages working time. The inter-temporal return to hours worked is also decreasing in the unemployment probability ϕ, because a higher ϕ reduces the rate of use of the accumulated stock of human capital H', while it is increasing in the rate of return to human capital α. Thus:

1. The amount of hours worked is higher in a tighter labor market—i.e. when the unemployment probability ϕ is smaller or p_1 is higher.

2. The amount of hours worked is higher if within-skill wage inequality, modeled as a mean preserving spread in the wage offer distribution F, increases.

3. The amount of hours worked increase if the return to skill α rises.

3 The general model

We now extend the model in three main directions. We allow for (i) more general preferences for consumption and leisure, (ii) endogenous unemployment probability and (iii) infinitely lived workers. The first extension allows us to generate a constant level of hours worked in the US by allowing for an income effect. The second extension allows to quantify the effects of unemployment on hours worked. The third extension is introduced for robustness and permits to separately analyze the effects of the job separation rate and the job finding rate on hours worked decisions. We will use this model to study whether differences in labor market conditions can explain the different evolution of the number of hours worked per employee in the US and in Europe.

3.1 Model description

Workers are infinitely lived. An employed worker is characterized by her stock of human capital $H \in \mathbb{R}_+$ and by the job wage rate $\omega \in \Omega \subset \mathbb{R}_+$. When employed, the worker decides how many hours to work. Hours of work generate a flow of income $\omega H^\alpha h^\theta$ in the current period and increase the stock of human capital in the next period, $H' = (1 - \delta_e) H + a\, h$, where $\delta_e \in [0, 1]$ is the depreciation rate of human capital while employed and a is the contribution of one hour of work to human capital accumulation.

Between any two periods, three events may happen to the employed worker: she may lose her job, she may receive another job offer, nothing new happens. The separation rate is given by p_s. We will later consider an extension where the stock of human capital affects the separation probability. The probability of receiving a job offer is given by $p_e(H')$. Thus greater human capital allows the worker to obtain better jobs. Workers accept job offers that yields him greater utility. The problem of an employed workers reads as follows:

$$
\begin{aligned}
W(\omega, H) &= \max_h \Bigg\{ u(c, h) + \beta p_s V(b', H') \\
&+ \beta (1 - p_s) \left[W(\omega, H') + p_e(H') \int_{\mathbb{R}} \max\left[W(s, H') - W(\omega, H'), 0\right] dF(s) \right] \Bigg\} \\
\text{s.t.} \quad & c = \omega H^\alpha h^\theta \\
& b' = \iota\, \omega H^\alpha h^\theta \\
& H' = (1 - \delta_e) H + a\, h
\end{aligned}
$$

where $\beta \in (0, 1)$ is the inter-temporal discount factor and $V(b, H)$ is the value of unemployment that depends just on the worker's stock of human capital and on the level of unemployment benefit b. Unemployment benefits are a fraction ι of the last income while employed.

An unemployed worker receives job offers with probability p_u. In that case he decides whether to accept it. Thus the decision problem is characterized by a reservation wage rate ω_r such that only wage offers above ω_r are accepted. The problem of an unemployed workers can then be expressed as follows:

$$\begin{aligned} V(b,H) &= \max_{\omega_r} \left\{ u(c,h) + \beta\Big[1 - p_u\left(1 - F(\omega_r)\right)\Big] V(b',H') + \beta p_u \int_{\omega_r}^{\infty} W(s,H')\, dF(s) \right\} \\ \text{s.t.} \quad & c = b \\ & H' = (1-\delta_u) H \end{aligned}$$

where δ_u is the depreciation rate of human capital during unemployment.

3.2 Functional forms

We choose some specific functional forms for the problem. Preferences between leisure $(1-h)$ and consumption of market goods c are given by,

$$u(c,h) = \frac{c^{1-\sigma}-1}{1-\sigma} + \lambda \frac{(1-h)^{1-\eta}-1}{1-\eta}$$

Depending on the value of σ, the income or the substitution effects of a permanent increase in hourly wages can dominate. η determines the sensitivity of hours worked to labor market conditions.

The probability of receiving job offers is given by:

$$p_e(H') = \bar{p}_e \left(1 - e^{-\gamma_e H' - (1-\gamma_e)}\right)$$

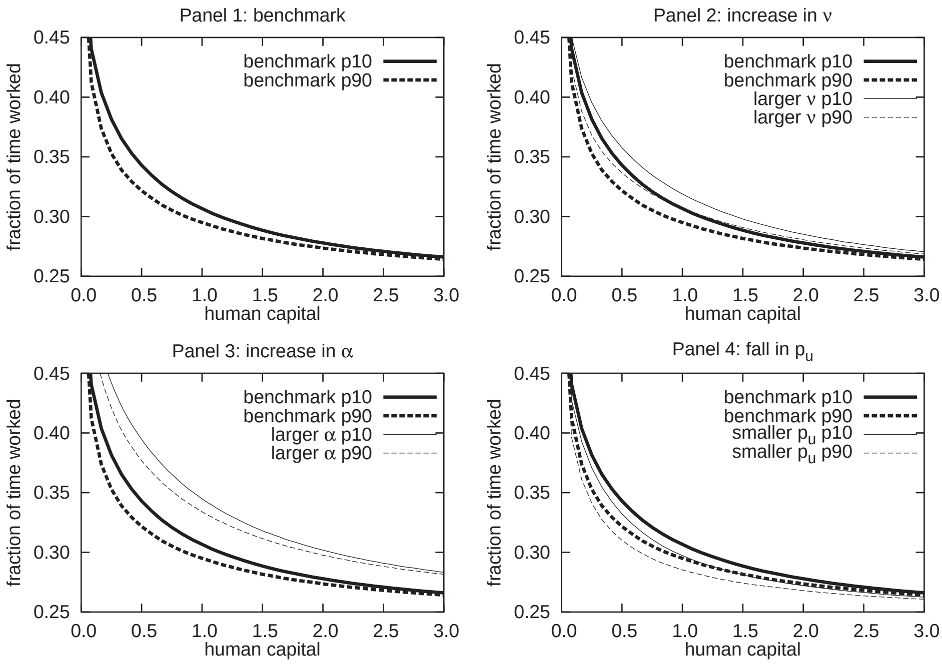
We think of $\bar{p}_e$ as the probability of receiving a job offer for a given unit of search efficiency units. The term in brackets is instead the stock of search efficiency units of the workers: the higher the worker's stock of human capital the greater are the worker's search efficiency units. $\bar{p}_e$ is generally affected by labor market conditions. The tighter the labor market, the higher is $\bar{p}_e$. γ_e gauges how human capital affects workers' ability to search in the labor market.

We assume that the distribution of job offers F is log normal with mean one and variance equal to $e^{\nu}-1$:

$$\log \omega \sim N\left(-\frac{\nu}{2}, \nu\right)$$

Note that this formulation implies that the mean of the wage offer distribution is invariant to changes in dispersion.

Figure 2: Policy functions



3.3 Solution of the model

The solution to the individual problem described in section 3.1 is given by a pair of decision rules $g^h(\omega, H)$ and $g^{\omega_r}(b, H)$ that determine the hours worked and the reservation wage as a function of the relevant state variables. Figure 2 plots the decision rule $g^h(\omega, H)$ for some specific parameters value. The numerical example is provided only for illustrative purposes. A formal quantitative exercise will be conducted in section 4. Panel 1 plots the policy function for employed workers as a function of the worker's stock of human capital H for given ω. The solid line corresponds to a low value of ω whereas the dotted line to a low value of ω. The policy function is decreasing in H: the greater the stock of human capital, the lower the amount of hours worked. The reason is that the marginal gain of increasing search efficiency while employed decreases with H and so does the intertemporal return to hours worked. Moreover the marginal utility of income decreases with H. In general individuals with lower ω work longer hours because they want to obtain better jobs. The difference is more pronounced when the stock of human capital is low. When H is high all workers work the same number of hours. This is because, with high H, increasing human capital increases little the probability of job offers (p_1 in Section 2 goes to zero when H goes to infinity). The figure also shows the effect on individual behavior of a mean preserving spread in the wage offer distribution, ν (panel 2), of an increase in the returns to skill α (panel 3) and of a fall in the reemployment probability p_u. An increase in ν and α shift the policy functions upwards and increase the incentives to work longer hours whereas the fall in p_u shifts the policy function downwards and discourages individuals from working longer hours.

The economy is fully characterized by the distribution of individuals over their state space. We focus on steady states. Let X_e and X_u denote the probability measure of workers in the corresponding state if employed and unemployed, respectively. Then the average number of hours worked per worker can be expressed as

$$E[h] = \int_{\Omega \times \mathbb{R}_+} g^h(\omega, H)\, dX_e$$

This expression implies that changes in the shape of the cross-sectional distribution affect the average number of hours worked per worker. We now study how labor market conditions determine aggregate hours worked by taking into account effects on policy functions and on the cross-sectional distribution.

4 Calibration

We calibrate the model to the U.S. at the monthly frequency. Several labor market transitions occur at this frequency. Calibrating the model at a quarterly or a yearly frequency would fail to properly characterize key labor market transitions. For instance, according to Shimer (2005) the average duration of unemployment is around 2 months.

Our model is described by 15 parameters: 4 of them refer to preferences, 4 to transition probabilities (from job to job, from employment to unemployment and viceversa), 1 to the job offer distribution, 5 to technology and finally there is 1 policy parameter corresponding to the structure of unemployment benefits. 5 of these parameters are set either off the shelves or chosen to simplify the model. The remaining 10 parameters are calibrated in equilibrium such that the model matches 10 statistics from data. We use as targets a set of statistics obtained from some other empirical studies and from some micro data from the US and Germany. To help the reader, the targets used in the calibration are summarized in Table 5.

The US data come from the Michigan Panel Study of Income Dynamics (PSID) which cover the period 1967-2002. Data are annual up to 1997 and bi-annual thereafter. We restrict our samples to prime aged male (between 25 and 55 years old) who are head of households. Hourly wages are computed as annual labor earnings divided annual hours worked. We consider two measures for hours worked. The fist denoted *Yearly hours* is the total annual hours worked for money by the worker in any job. The second denoted *Weekly hours* is the number of hours usually work per week in the main job, when at work. Labor income measures are in real terms by deflating them with the output deflator. We express them in 1992 dollars. Table 11 in the appendix contains some descriptive statistics for the baseline sample. We will also consider measures of the number of years of schooling and potential experience (measured as current age minus years of schooling), see Appendix for further details.

For the sake of comparison we will also consider some data from Germany. The German data come from the German Socieoconmic Panel (GSOEP). The data refer to the period 1984-2002. Again we restrict our sample to prime aged male (between 25 and 55 years old) who are head of households and who reside in the former Federal Republic of Germany, see Appendix for further details.

Preferences. We start considering a log utility and set σ equal to one — so the substitution and income effects cancel out. We set η, the curvature of the marginal utility of leisure, equal to 3. In equilibrium this implies a Frisch elasticity of labor supply equal to 0.66, which is just a bit above most micro studies for prime-aged males actively engaged in the labor market. We set β, the discount factor, equal to 0.9966. This follows Hagedorn and Manovskii (2005). The value of λ, that determines the relative weight of leisure in the utility function, is chosen so that the average fraction of time spent at work is 1/3, as in Cooley and Prescott (1995).

Labor market transitions. We have three transition probabilities and four parameters. According to Shimer (2005), at the monthly level the separation rate is around 3.4% and the probability of finding a job is around 45%. We interpret the event of accepting a new job offer when employed as a job to job transition. This is not uncontroversial since the mechanics of the model may work though offers and counter-offers, without the worker having to change his job. Under this interpretation, our third moment condition comes from Fallick and Fleischman (2001). They show that every month 3% of workers experience a job-to-job transition.

Our fourth condition comes from the PSID and the GSOEP. In the data we do not observe job offers but job-to-job transitions. In our model economy the probability of a job-to-job transition is the product of the probability of obtaining a job offer and the probability of the offer being above the current wage rate. To identify γ_e we use the relationship between past hours worked and the probability of a job-to-job transition.

Table 1: Probability of changing job

A) PSID

Hours measure:	Annual		Usual weekly	
	[1]	[2]	[1]	[2]
Log past hours	0.03	0.02	0.03	0.02
	(4.22)	(3.04)	(2.64)	(2.88)

B) GSOEP

Hours measure:	Annual		Usual weekly	
	[1]	[2]	[1]	[2]
log past hours	0.05	0.03	0.07	0.05
	(4.37)	(2.01)	(5.46)	(3.50)

*N*ote: In column [1] OLS estimates, in column [2] GLS fixed-effects estimates. t-statistics in parentheses. All regressions include year and education dummies and potential experience (in levels and squared). Hours are measured as five years averages.

We construct a dummy variable that equals one if the individual experiences a job-to-job transition in the following year. We regress this variable against the log of the average hours worked by the individual in the past five years:

$$\text{job-to-job} = \text{cte.} + \alpha_h \ln h$$

One prediction of our model is that past hours worked increase the probability of a job to job transition. We use the PSID and the GSOEP to evaluate this effect. Table 1 presents the results. In the regressions we also control for education and experience. These controls have no counterpart in our simple model, but are regarded as important in the empirical literature. We also consider a specification where we control for an individual fixed effect, see column 2. We find that in the US α_h is around 0.03 and in Germany between 0.06 and 0.07.

Wage Offer distribution. The wage offer distribution is fully characterized by ν. We calibrate it in equilibrium to match the dispersion of start-up wages after an unemployment spell. Table 2 present the evolution of these statistics in the PSID and GSOEP data. In the US, we measure the standard deviation of log wages after unemployment to be around 0.5 in the 70's and around 0.75 in the 90's. In contrast, in Germany we do not observe any increase in the dispersion of start-up wages upon re-employment.

Technology. We have five technology parameters: α, θ, δ_e, δ_u and a. We calibrate all of them to equilibrium statistics. We need five moment conditions. The first two come from Jacobson, LaLonde, and Sullivan (1993) who study the evolution of workers' wages

Table 2: Dynamics of SD of start-up wages after unemployment

A) PSID

Controls	Only time dummies	More controls
$SD_{3,70-80}$	0.52	0.49
$SD_{3,81-90}$	0.62	0.58
$SD_{3,91-02}$	0.77	0.70
n	55,000	54,681

B) GSOEP

Controls	Only time dummies	More controls
$SD_{3,84-91}$	0.43	0.43
$SD_{3,92-02}$	0.43	0.42
n	6,321	6,321

*N*ote: Standard Deviation of logged real hourly wage of workers who experienced an unemployment spell in the year. In column 2 we also control for years and education dummies, tenure (in levels and squared) and potential experience (in levels and squared).

after an unemployment spell. They find that the ratio between the hourly wage after an unemployment spell and the last wage before unemployment is around 0.75. Given the other parameters of the model, this moment implicitly measures the human capital loss during unemployment, which allow us to pin down δ_u. Jacobson, LaLonde, and Sullivan (1993) also show that wages increase at an average monthly rate of 1.88 percent in the first one year and a half after re-employment. This implicitly pins down a. δ_e will be set to match the serial correlation of wages in the data.

The model implies that hours worked raise future income. To identify α and θ, we estimate an equation relating current income to current and past hours by using the PSID and GSOEP. The equation can be explicitly motivated by considering the two-periods model discussed in Section 2. Consider the second period logged hourly wage. This is the difference of log income and log hours:

$$\ln w' = \left[\ln \omega' + \alpha \ln H' + (\theta - 1) \ln h'\right]. \tag{6}$$

The log of the wage rate $\ln \omega'$ evolves as

$$\ln \omega' = \ln \omega + p_e(H')\, q\, (\ln \omega_2 - \ln \omega) + \epsilon$$

where ϵ denotes a zero mean expectational error. Now use equation (4) to approximate $p_e(H')$ and then linearize the resulting expression with respect to $\ln H'$ and $\ln \omega$ around $\overline{\ln H'}$ and the average logged wage rate $\overline{\ln \omega}$. Using equation (2) to express H' in terms of h we obtain:

$$\ln \omega' \simeq cte + p_1 q \left(\ln \omega_2 - \overline{\ln \omega}\right) \ln h + (1 - p_0 q) \ln \omega + \epsilon \tag{7}$$

where cte is an appropriately defined constant. By using the expression for logged hourly wage at time zero

$$\ln w = \ln \omega + \alpha \ln H + (\theta - 1) \ln h$$

we can obtain an expression for $\ln \omega$ that can be substituted into (7). The resulting expression can then be used to substitute out $\ln \omega'$ in (6) so as to obtain

$$\ln w' = cte + (1 - p_0 q) \ln w - (1 - \theta) \ln h' + \left[\alpha + p_1 q \left(\ln \omega_2 - \overline{\ln \omega}\right) + (1 - \theta)(1 - p_0 q)\right] \ln h + \varepsilon \tag{8}$$

where again cte denotes an appropriately defined constant whose exact value is omitted to save space and $\varepsilon \equiv \epsilon + \alpha (1 - p_0 q) \ln H$. [6]

We can estimate equation 8 with the PSID and GSOEP data, to obtain moments that allow us to identify α and θ. This suggests estimating:

$$\ln w_{i,t} = \gamma_0 + \gamma_1 \ln w_{i,t-1} + \gamma_2 \ln h_{i,t} + \gamma_3 \ln h_{i,t-1} + \varepsilon_{i,t} \tag{9}$$

where $w_{i,t}$ is the average hourly wage of individual i. Note that these expressions suggest that the coefficient on past logged hours is positive only if there is a significant intertemporal return to working longer hours and that this coefficient tends to increase in response to (a) an increase in the return to skill α, and to (b) an increase in within-skill wage inequality, modeled as a mean preserving spread in the wage offer distribution F.

Table 3 presents the results from estimating equation 9. Since several authors argue that the returns to education and experience have increased over time, we also consider an alternative specification where education and experience are interacted with time dummies. This allows the return to experience and education to change over time. We report the results in the columns labeled as [2] in the table. We find that the results are almost unchanged.

The results in Table 3 provide direct evidence of the positive relationship between

[6] Notice that the error term includes an unobserved individual fixed effect term, due to the initial stock of human capital. This term is correlated with $\ln y$ and $\ln h$.

Table 3: The intertemporal return

A) PSID

Hours measure:	Annual		Usual weekly	
	[1]	[2]	[1]	[2]
γ_1	0.81	0.48	0.81	0.43
	(192.4)	(3.57)	(189.2)	(2.7)
γ_2	-0.43	-0.56	-0.35	-0.56
	(-41.4)	(-10.5)	(-34.2)	(-10.1)
γ_3	0.51	0.42	0.49	0.75
	(45.7)	(5.3)	(35.06)	(4.2)
n	31,636	28,105	31,633	28,101

B) GSOEP

Hours measure:	Annual		Usual weekly	
	[1]	[2]	[1]	[2]
γ_1	0.65	0.15	0.67	0.09
	(73.76)	(2.0)	(73.8)	(1.4)
γ_2	-0.63	-1.05	-0.64	-1.03
	(-24.7)	(-11.0)	(-24.2)	(-10.2)
γ_3	0.56	0.23	0.61	0.24
	(23.1)	(2.9)	(22.9)	(2.1)
n	6,371	5,515	6,120	5,261

*N*ote: In column [1] OLS estimates, in column [2] fixed effects estimates. Fixed effects estimates are based on on two steps Arellano and Bond (1991) estimator (difference GMM estimator). Standard errors are corrected for a finite sample bias as in Windmeijer (2005). Instruments are lagged values of past five years averages. t-statistics in parentheses. The dependent variable is the logged real hourly wage. Hours and wages are measured as five years averages. All regressions include year and education dummies and potential experience (in levels and squared).

current hours and future income. In a sense, this result complements the findings of Bell and Freeman (2001) and Kuhn and Lozano (2005), who found a positive relationship between hours of work and income inequality.

δ_e, α and θ are calibrated to match the value of γ_1, γ_2, and γ_3, as reported in table 3.

Policy. For simplicity we set the replacement rate ι equal to zero and give unemployed workers a minimal amount of income independent of their past income.

4.1 Parameters value

From the previous analysis it follows that we have 11 parameters to determine in equilibrium: λ, $\bar{p}_e$, γ_e, ν, p_u, p_s, a, δ_u, δ_e, α, and θ. The calibrated parameters appear in Table 4.

Table 4: Parameter values in baseline calibration

Parameter	definition	target	value	type of fit
β	patience	monthly interest rate	0.9966	direct
σ	curvature consumption	*simplification*	1	direct
η	curvature leisure	Frisch elasticity	3	direct
λ	weight leisure	average hours worked	0.140	equilibrium
γ_e	weight H' in search, employed	elasticity of job-to-job transition to H	0.75	equilibrium
$\bar{p}_e$	average tightness, employed	av. prob. job-to-job transition	0.27	equilibrium
p_u	job offer probability, unemployed	av. prob. leaving unemployment	0.45	equilibrium
p_s	separation probability	av. separation rate	0.034	direct
ν	variance log ω	dispersion of reemployment log wages	0.28	equilibrium
α	hours elasticity	elasticity of wages to current hours	0.08	equilibrium
θ	human capital elasticity	elasticity of wages to past hours	0.10	equilibrium
δ_e	depreciation H, employed	autocorrelation of wages	0.0005	equilibrium
δ_u	depreciation H, unemployment	wage loss upon displacement	0.12	equilibrium
a	learning-by-doing rate	wage growth upon reemployment	0.012	equilibrium
ι	replacement rate	*simplification*	0.00	direct

In table 5 we summarize the statistics from the data used for the calibration. We compare those statistics with the analogous statistics generated from the model economy. The model fit is reasonable for most statistics. Yet there are three exceptions. First, the model is unable to produce an autocorrelation for wages—the coefficient γ_1 in equation 9—as large as in the actual data. In our model, wages are serially correlated because human capital does not fully depreciate in each period and because workers may remain in the same job and receive the same wage rate in two consecutive periods. We find that these two mechanisms are not enough to induce an autocorrelation of wages (after controlling for current and past hours worked) above 0.30, while in the data such value is around 0.80. One may argue that in the data serial correlation is so high also because of some unobserved fixed heterogeneity that is not present in the model. This makes the

Table 5: Model and data statistics

Statistic	data	model
Average hours worked	0.33	0.34
Average prob. of a job-to-job transition	0.03	0.03
Average prob. leaving unemployment	0.45	0.41
Elasticity of job-to-job transition to H	0.03	0.05
Average prob. of an emp.-unemp. transition	0.03	0.03
Standard deviation of reemployment log wages	0.49	0.48
Elasticity of wages to current hours	-0.43	-0.55
Elasticity of wages to past hours	0.45	0.68
Autocorrelation of wages	0.81	0.30
Wage loss upon displacement	0.75	0.82
Wage growth upon reemployment	0.25	0.24

model unable to match this statistic. In future versions of the model we plan to include this source of heterogeneity in the model. The other two statistics that are a bit off target are the elasticities of wages to current and past hours — the coefficients γ_2 and γ_3 in equation 9. We think that there is no fundamental reason why the model should not match these statistics perfectly. We will improve this fit in future versions of the paper—after better matching the serial correlation of wages.

5 The evolution of hours worked in the US and EU

The aggregate number of hours worked per capita has evolved quite differently in the US and in Continental Europe over the 1970-2001 period. Changes in aggregate hours my be due to changes in the unemployment rate, in the participation rate, in hours worked per worker or in the fraction of working age population over the total population. In brief aggregate hours worked per capita can be decomposed as follows:

$$\frac{\text{h}}{\text{pop}} = \frac{\text{h}}{\text{emp}} \times \frac{\text{emp}}{\text{part}} \times \frac{\text{part}}{\text{wa}} \times \frac{\text{wa}}{\text{pop}}$$

where ‘h’, ‘pop’, ‘emp’, ‘part’, and ‘wa’ denote the aggregate number of hours worked, total population, the number of employed workers, the size of the labor force and of the working age population, respectively. The percentage changes of the various components underlying the dynamics of ‘h’ over the period 1970-2001 for some selected countries are summarized in Table 6. The table evidences how aggregate hours worked per worker accounts for around 50 per cent of the differences in aggregate hours worked per capita in the US and in France, Germany, Spain, and Italy.

We think of the US as an economy where within skill wage inequality has increased (the variance of F has increased), the return to skill α has risen and where the unemployment

Table 6: Evolution of aggregate hours worked, Total (1970-2001)

	$\frac{h}{pop}$	$\frac{h}{emp}$	$\frac{emp}{part}$	$\frac{part}{wa}$	$\frac{wa}{pop}$
Absolute Percentage Changes					
U.S.	15	-5	0	13	7
France	-22	-23	-6	3	4
Germany	-24	-26	-7	4	6
Italy	-14	-14	-4	4	2
Spain	-6	-14	-9	10	10
U.K.	-8	-12	-3	4	4
Japan	-14	-19	-4	11	-1
Percentage changes relative to the US					
U.S.	0	0	0	0	0
France	-37	-17	-6	-10	-3
Germany	-39	-21	-7	-9	-1
Italy	-29	-9	-4	-9	-6
Spain	-21	-9	-9	-3	3
U.K.	-23	-7	-3	-9	-3
Japan	-29	-14	-4	-2	-8

Source OECD. '$\frac{h}{emp}$' is average actual annual hours worked per person in employment, 'emp' is total employment, 'part' is total labor force, 'wa' is population aged 15 to 64 years, and 'pop' is total population.

Table 7: Evolution of aggregate hours worked, Men Only (1970-2001)

	$\frac{h}{pop}$	$\frac{h}{emp}$	$\frac{emp}{part}$	$\frac{part}{wa}$	$\frac{wa}{pop}$
Absolute Percentage Changes					
U.S.	3	.5	-.5	-5	8
France	-24	-10	-5	-13	4
Germany	-24	-11	-7	-14	8
Spain	-23	-12	-7	-16	12
U.K.	-10	-2	-2	-10	4
Japan	-7	-9	-5	4	1
Percentage changes relative to the US					
U.S.	0	0	0	0	0
France	-27	-10.5	-4.5	-8	-4
Germany	-27	-11.5	-4.5	-11	0
Spain	-26	-12.5	-6.5	-11	4
U.K.	-13	-2.5	-6.5	-5	-4
Japan	-10	-9.5	-4.5	9	-7

Source OECD and ILO. 'emp', 'part', 'wa', and 'pop' is as in Table 6. Data are from OECD and are for men only. '$\frac{h}{emp}$' is the average number of hours paid per week and is from ILO. Sample period for '$\frac{h}{emp}$' differs: for France is 1993-2002, for Germany is 1973-1995 (and refers former Federal Republic), for Japan is 1972-2001, for Spain is 1978-2001, for UK is 1986-2001, for the US is 1970-2001.

probability has remained stable. We think of the EU as an economy where labor market tightness has fallen. This has reduced the probability of receiving job offers for both unemployed and employed workers ($\bar{p}_e$ and $\bar{p}_u$ have fallen). We will use the model to quantify how the different evolution in wage inequality and unemployment in the EU and the US can explain the different evolution of the number of hours worked per employee in the US and in Europe. We think of our baseline economy as representing the US and the EU in the early 70's.

5.1 U.S. in the 90's

To quantify the increase of α and ν in the US we use two statistics. First, table 2 shows that the standard deviation of log wages after an unemployment spell has increased from around 0.50 in the 70's to around 0.75 in the 90's. Therefore, we target and increase in this standard deviation of 0.25 points. Second, we can estimate equation (9) after allowing for a change in the effect of past hours on current wages. This characterizes the evolution of the inter-temporal returns to hours worked. If the inter-temporal return to past hours worked ha increased, we expect γ_3 in equation (9) to have increased as well. Table 8 confirms this prediction for the US. γ_3 has increased of approximately 0.2 points.[7] This increase will provide a second target to represent the US economy in the 90's.

The two targets together allow to separately identify the increases in α and ν experienced by the US economy. We find that the US economy in the 90's is characterized by $\alpha = 0.25$ and $\nu = 0.60$. With these parameters values the standard deviation of the log of reemployment wages increases of 0.25 points up to 0.73 while the coefficient of past hours in equation (9), γ_3, increases by 0.15 up to 0.83.

5.2 Europe in the 90's

In Europe wage inequality has not increased much, while re-employment probability has fallen substantially. The evidence from the GSOEP confirms the view that inequality has increased little in Europe. Table 2 shows no evidence that the standard deviation of reemployment wages has increased in Germany in the 80's and the 90's. Moreover, when we re-estimate equation (9) by allowing for a time varying effects of past hours worked on current income, we do not find any evidence that the intertemporal return to hours worked has increased in Germany, see the second panel in Table 8. This evidence

[7] Violante (2002) provides evidence that wages grow faster on the job in the 80's and in the 90's than in the 70's. This does not necessarily imply that the return to past hours worked has also increased, but it is consistent with this interpretation.

Table 8: Evolution of the intertemporal return

A) PSID

Hours measure:	Annual [1]	Annual [2]	Usual weekly [1]	Usual weekly [2]
$\gamma_{3,70-75}$	0.43	0.41	0.44	0.58
	(15.7)	(4.9)	(12.8)	(4.6)
$\gamma_{3,76-80}$	0.47	0.41	0.47	0.58
	(21.0)	(5.3)	(16.5)	(4.7)
$\gamma_{3,81-85}$	0.46	0.40	0.42	0.56
	(22.1)	(5.1)	(14.8)	(4.5)
$\gamma_{3,86-90}$	0.51	0.41	0.49	0.56
	(28.0)	(5.4)	(20.1)	(4.4)
$\gamma_{3,91-95}$	0.58	0.50	0.61	0.67
	(29.1)	(5.8)	(24.3)	(4.7)
$\gamma_{3,96-00}$	0.60	0.51	0.59	0.64
	(13.3)	(5.5)	(10.1)	(4.6)
$\gamma_{3,70-80}$	0.46	0.42	0.45	0.75
	(25.1)	(5.3)	(20.1)	(4.3)
$\gamma_{3,81-90}$	0.49	0.40	0.45	0.74
	(33.7)	(5.3)	(23.6)	(4.2)
$\gamma_{3,91-00}$	0.59	0.50	0.61	0.86
	(31.4)	(5.6)	(25.9)	(4.6)
Test:				
$\gamma_{3,70-80} = \gamma_{3,81-90}$	.17	.39	.50	.50
$\gamma_{3,70-80} = \gamma_{3,91-00}$	.00	.07	.00	.09
$\gamma_{3,81-90} = \gamma_{3,91-00}$	.00	.00	.00	.03

B) GSOEP

	Annual Hours [1]	Annual Hours [2]	Usual weekly hours [1]	Usual weekly hours [2]
$\gamma_{3,84-88}$	0.53	0.27	0.57	0.30
	(13.0)	(3.1)	(14.0)	(2.5)
$\gamma_{3,89-93}$	0.60	0.27	0.71	0.30
	(19.1)	(2.8)	(19.6)	(2.0)
$\gamma_{3,94-98}$	0.57	0.22	0.56	0.26
	(15.3)	(2.9)	(14.3)	(2.0)
$\gamma_{3,84-91}$	0.58	0.25	0.63	0.28
	(19.3)	(2.9)	(20.0)	(1.97)
$\gamma_{3,92-02}$	0.56	0.19	0.58	0.22
	(17.8)	(2.3)	(17.1)	(1.8)
Test:				
$\gamma_{3,85-92} = \gamma_{3,93-02}$	.63	.09	.17	0.10

Note: In column [1] OLS estimates, in column [2] fixed effects estimates. Fixed effects estimates are based on on two steps Arellano and Bond (1991) estimator (difference GMM estimator). Standard errors are corrected for finite sample bias as in Windmeijer (2005). Instruments are lagged values of past five years averages. t-statistics in parentheses. All regressions include year dummies and controls for education and potential experience and we allow for a time varying return to education and experience. The first two columns use total annual hours in all jobs whereas the second two columns use usual weekly hours worked in main job. Hours and wages are measured as five years averages.

is consistent with the predictions of the model.

The rise in the EU unemployment rate is mainly explained by a fall in the exit rate from unemployment in the EU relative to the US. The job separation rate has instead remained roughly constant, both in the US and in the EU. To match the different evolution of unemployment between EU and the US, we assume that labor market tightness determines the arrival rate of job offers to employed and unemployed workers. This affects $\bar{p}_e$ and p_u. We assume that the value of $\bar{p}_e$ relative to p_u remains unchanged.

The employment rate has fallen by 8 per cent in Europe relative to the US, see Table ??. In steady state the employment rate is equal $p_u/(p_s + p_u)$. After taking logs and log-linearizing this expression with respect to p_u, we obtain that

$$d\ln(1-u) = \frac{p_s}{p_s + p_u}\; d\ln p_u$$

Given a value for the unemployment rate of six per cent this equation means that a fall of the employment rate of eight percent, implies a fall in $\ln p_u$ of (8/6) -1.33, that implies that p_u is now approximately one fourth of its level in the seventies. This identifies the changes in reemployment probability in the EU relative to the US.

5.3 Results

In the first column of table 9 we can see the average hours worked in the three economies. As a result of the changes in parameters, hours worked per worker increase in both the US and the EU. Hours worked increase by 4.2 percent in Europe and by 17.3 percent in the US. In principle, these figures are far away from the 5 and 20 percent falls observed in data, see Table ??. At this stage we try to explain the changes in hours worked in the US relative to Europe. We think that actual changes can be easily matched by allowing for preferences where the income effect of wage changes dominates the substitution effect. The relative change is 11.1 percentage points. This figure is around two thirds of the relative change in hours per employee between France and the US and about one half of the relative change in hours per employee between Germany and the US. This suggests that the combined evolution of the returns to skill, residual wage inequality and unemployment rates can go a long way in explaining the relative evolution of hours worked between U.S. and Europe.

In our simulated economy, the fall of the labor market tightness in Europe makes hours worked increase. This is at odds with the decision rules showed in the fourth panel of Figure 2. When p_u falls unemployment duration increases. This reduces the rate of use of human capital, and discourages workers from working longer hours, for *given* stock of human capital. But as individuals remain longer in unemployment, their human capital depreciate quickly. So the average human capital of employed workers falls and the mass of workers with low levels of human capital increases. But since hours worked are inversely related to the stock of human capital (figure 2), this effect makes aggregate hours worked increase. In our economy, this distributional effect dominates, and a fall in p_u leads to an increase in the average number of hours worked per worker.

Table 9: Changes in hours worked per worker in the model and the data

Economy	average hours	Diff to (1) (%)	Diff between US and EU (%)
(1) Benchmark economy	0.335	-	-
(2) EU in the 90's	0.349	4.2	-
(3) US in the 90's	0.393	17.3	11.1

6 Extensions (incomplete)

We now analyze the robustness of our conclusions when the income and the substitution effects in labor supply do not cancel out exactly. Indeed there is evidence that the income effect tends to dominate. We also recognize that human capital can affect the probability of unemployment. More productive workers may be less likely to enter unemployment and can find a job more easily. This can give greater incentives to work longer hours to workers in a sluggish labor market.

6.1 Stronger income effects (incomplete)

We now discuss how results get modified when income effects dominate substitution effects. This appears to be consistent with the post World War II evidence for the US. Real hourly wages have increased while hours worked per employee have fallen, see for example McGrattan and Rogerson (1998) and McGrattan and Rogerson (2004)

6.2 Endogenous unemployment probabilities (incomplete)

In the simple model studied so far the unemployment probability is not affected by the individuals' stock of human capital. In general, more able workers find jobs more easily. We now allow for human capital to affect both the job-separation probability and the reemployment probability. Allowing separation rates to decrease with human capital has several important effects: (a) it gives an extra incentive to high-wage workers to supply long hours; (b) it makes workers in economies with low reemployment probabilities willing to work longer hours; and (c) it makes workers with high human capital more willing to

Table 10: Probability of unemployment

A) PSID

Hours measure:	Annual		Usual weekly	
	[1]	[2]	[1]	[2]
Log hours	-0.05	-0.05	-0.05	-0.04
	(9.08)	(7.17)	(7.17)	(4.72)

B) GSOEP

Hours measure:	Annual		Usual weekly	
	[1]	[2]	[1]	[2]
Log hours	-0.02	-0.04	-0.01	-0.02
	(4.98)	(8.81)	(3.4)	(5.76)

Note: In column [1] OLS estimates, in column [2] GLS fixed-effects estimates. t-statistics in parentheses. The dependant variable is the fraction of weeks (in PSID) or months (in GSOEP) spent in unemployment over the current five years. Hours are measured as five years averages in the previous five years. OLS regressions. All regressions include year and education dummies,potential experience (in levels and squared), and past fraction of weeks (or months) spent into unemployment.

supply long hours. We allow reemployment probabilities to be a function of human capital as well because this should introduce an offsetting force to the last element. And fourth, following Ljungqvist and Sargent (1998) we make unemployment income a function of human capital. Since replacement rates differ substantially between the U.S. and most European countries, this element allows us to capture a further reason for different working patterns.

There is evidence that these effects are present in the data. We estimate how past hours worked affect the fraction of time that individuals spend in unemployment. Let this fraction be denoted by ϕ. We use GSOEP and PSID to run the following regression:

$$\phi' = cte + \beta_h \ln h + \beta_\phi \phi$$

where a ‘’ denotes the average time spent into unemployment in the next five years. We include ϕ as a control for unemployment persistence. The results from estimating the equation appear in Table 10. The results suggest that past hours worked reduces the probability of unemployment.

Past hours worked can reduce the probability of unemployment by reducing the probability that a worker experiences an employment-unemployment transition, by increasing the re-employment probability in case the workers become unemployment or both. To check for this possibilities we estimate

$$\text{employment to unemployment} = cte + \beta_s \ln h$$

and

$$\text{duration of unemployment}=cte + \beta_u \ln h$$

We find that $\beta_s \sim -0.3 < 0$ and $\beta_u \sim -8.8 < 0$. This may suggest that, in a sluggish labor market workers may want to work harder to keep their job and to reduce the duration of unemployment in case the worker become unemployed.

We now analyze the effects of allowing for these effects in the model. We assume that

$$\begin{aligned} p_u(H') &= \bar{p}_u \left(1 - e^{-\gamma_u H' - (1-\gamma_u)}\right) \\ p_s(H') &= \bar{p}_s \left(1 - e^{-\gamma_s H' - (1-\gamma_s)}\right) \end{aligned}$$

and we analyze how results get modified under this alternative formulation. We calibrate γ_u and γ_s to match the previously reported values for β_s and β_u.

7 Conclusions

In a standard competitive labor market model, workers choose how many hours to work by equating the marginal utility of leisure to the marginal value of current income. The only variables that affect the choice are the current market wage and the worker's wealth. In practice individuals often decide to work longer hours to increase future as well as current income. By working longer hours they acquire greater skills and can obtain better jobs. In a market with search frictions, several features of the labor market can then influence the decision on working time. We show that a higher probability of becoming unemployed, a longer duration of unemployment, and in general a less tight labor market discourage working time. Wage inequality gives instead incentives to work longer hours.

We use data from the Panel Study of Income Dynamics (PSID), and the German Socio-Economic Panel (GSOEP), to analyze the evolution of the inter-temporal return to hours worked in the US and in Germany. In both countries we find that hours worked yield a significant inter-temporal return. Moreover, the inter-temporal return to working time has increased in the US since the 70's, while it has remained roughly constant in Germany. Preliminary evidence suggests that the different evolution of the return to skill and in within-skill wage inequality explain a substantial part of the different evolution of the return to hours worked. Overall the different evolution of the labor market appears to explain between one half and two thirds of the US-EU differences.

A Data appendix

A.1 PSID

We select all male household head who are in the age group 25-55. We exclude the SEO sample. Data start in 1968 and ends in 2001. Following is a description of the variables we use in the analysis. We include individuals for which at least 3 observations in a 5 year period are available. Table 11 contains some descriptive statistics

Labor income. total annual labor income from all jobs (applies to heads and wives). Self-employed income is split between labor and capital part and only the labor part is added.
Yearly hours. Total annual hours worked for money, from family files. It refers to all possible jobs of the worker. It includes overtime.
Weekly hours. Hours usually work per week in main job, top coded at 98 hours per week.
Tenure. Months with present employer. Since data for the Since data for the 1968-1974 period are bracketed, tenure for those years is measured by the mid point of the interval.
Race Race code for individual, from family file. We consider three dummies corresponding to white, black, or others.
Years of education Highest grade completed, 1-17 classification.
Hourly wage Labor income dived by yearly Hours divided by the GDP deflator. They are expressed in 1992 dollars.
Weeks unemployed Number of weeks spent in weeks of unemployment over the last year. In 1968 and 1969 this information is bracketed and with only one interval from 6 weeks onwards. The information is also for heads.
Weeks worked Number of weeks worked in main job.
Experience Measured as age minus six minus years of education.
Job-to-job An individual experiences a job-to job transition during the year that goes from t to $t+1$ if i) he is employed at t, ii) he is employed at $t+1$, iii) he has experienced less than two weeks in unemployment over the year, iv)he has a tenure less than 12 months at time $t+1$, and v)tenure at $t+1$ is smaller than tenure at t plus six. This last requirement try to correct for measurement error in the tenure measure.
Fraction of time in unemployment In each survey year, we have information on the number of weeks of unemployment experienced by the worker. The fraction of time in unemployment is calculated as the difference between 52 and this variable. The result is divided by 52.
Employment to unemployment An individual experiences a transition from employment to unemployment during the year that goes from t to $t+1$ if i) he is employed at t, ii) he experiences more than than two weeks in unemployment over the year.
Unemployment duration This the number of weeks in unemployment during an unemployment spell.

A.2 GSOEP

We select all male household head who are in the age group 25-55. We focus on individuals leaving in West Germany. Data start in 1985 and ends in 2002. The survey is annual up to 1997 and bi-annual thereafter. Following is a description of the variables we use in the analysis. Panel B of Table 11 contains some descriptive statistics

Labor income. Total annual labour earnings in the previous year. Labour earnings include wage and salary from all employment including training, primary and secondary jobs, and self-employment, plus income from bonuses, overtime and profit-sharing. Specifically, this is the sum of income from primary job, secondary job, self-employment, 13th month pay, 14th month pay, Christmas bonus pay, holiday bonus pay, miscellaneous bonus pay, and profit sharing income. It is obtained from Cross National-Equivalent Files.

Yearly hours. Total annual hours worked for money. Annual Work Hours of Individual in the previous year. Estimated annual hours of full-time, part-time and short-time work. It is obtained from Cross National-Equivalent Files.

Weekly hours. Original variable is "tatzeit". Actual work time per week in main job. This is the response to the question: "How many hours per week do your actual working-hours consist of including possible over-time? " The question refers to the respondent's main job.

Tenure. Original variable "erwzeit". Length Of time with current firm (in years).

Years of education Number of Years of Education completed at the time of survey. It is obtained from Cross National-Equivalent Files.

Hourly wage Labor income dived by yearly Hours divided by the CPI index. They are expressed in 2001 marks.

Months unemployed Number of months received unemployment benefits or unemployment reliefs.

Months worked In the previous Year for how many months you received wages and salary as employee? It refers to main job.

Experience Measured as age minus six minus years of education.

Job-to-job An individual experiences a job-to job transition during the year that goes from t to $t+1$ if i) he is employed at t, ii) he is employed at $t+1$, iii) he has experienced less than one month in unemployment over the year, iv) he has a tenure less than one year at time $t+1$, and v)tenure at $t+1$ is smaller than tenure at t plus 0.5. This last requirement try to correct for measurement error in the tenure measure.

Fraction of time in unemployment In each survey year, we have information on the number of months the workers received wages and salary as employee. The fraction of time in unemployment is calculated as the difference between 12 and this variable. The result is divided by 12.

Employment to unemployment An individual experiences a transition from employment to unemployment during the year that goes from t to $t+1$ if i) he is employed at t, ii) he experiences more than one month in unemployment over the year.

Unemployment duration This the number of months in unemployment during an unemployment spell.

Table 11: Descriptive statistics PSID and GSOEP

A) PSID

Year	Mean Wage	SD log-Wage	Weekly hours	Yearly hours	Yrs of schooling	Experience	Tenure
1968	15.2	.53	44.5	2126.6	11.6	22.1	103.7
1969	15.2	.52	45.5	2188.2	11.7	22.0	100.5
1970	15.5	.52	46.2	2224.8	11.9	21.4	99.6
1971	15.6	.51	45.8	2167.9	12.1	21.1	96.5
1972	15.9	.53	45.7	2150.6	12.2	20.7	89.2
1973	15.8	.53	46.0	2192.2	12.4	19.8	86.4
1974	15.9	.51	46.0	2198.5	12.5	19.3	84.3
1975	16.4	.54	46.0	2157.2	12.7	18.9	86.7
1976	15.4	.53	45.8	2115.7	12.7	18.7	91.0
1977	15.9	.54	46.1	2141.9	12.8	18.3	82.1
1978	16.1	.54	46.3	2154.5	12.8	18.0	75.0
1979	16.6	.53	45.8	2146.9	12.9	17.8	74.8
1980	16.3	.53	45.8	2152.3	12.9	17.7	77.4
1981	16.7	.56	45.1	2096.2	13.0	17.6	80.0
1982	16.3	.56	45.1	2086.8	13.0	17.6	79.0
1983	17.1	.59	44.9	2036.6	13.2	17.4	77.8
1984	16.2	.59	44.9	2061.6	13.2	17.4	81.1
1985	16.9	.61	46.0	2149.7	13.5	17.1	81.2
1986	16.3	.61	46.5	2158.9	13.5	17.2	76.9
1987	16.7	.63	46.3	2156.5	13.6	17.3	83.5
1988	18.1	.64	46.5	2185.4	13.5	17.5	81.8
1989	17.7	.64	46.7	2203.7	13.6	17.6	78.9
1990	17.8	.65	46.7	2201.8	13.6	17.9	78.9
1991	17.7	.65	46.7	2212.1	13.5	18.3	80.9
1992	18.2	.66	46.4	2169.3	13.6	18.6	81.6
1993	19.9	.67	45.3	2111.9	13.6	18.9	86.4
1994	19.3	.66	46.2	2193.1	13.6	19.4	81.3
1995	18.6	.64	46.1	2218.4	13.6	19.6	80.4
1996	19.2	.66	46.4	2248.1	13.6	19.8	81.7
1997	19.3	.65	46.1	2213.4	13.6	20.1	85.8
1999	20.5	.66	46.2	2219.3	13.6	20.5	86.9
2001	20.8	.67	46.3	2217.2	13.6	20.6	87.4

B) GSOEP

Year	Mean Wage	SD log-Wage	Weekly hours	Yearly hours	Yrs of schooling	Experience	Tenure
1984	21.4	.47	44.8	2289.0	11.8	21.8	12.6
1985	24.7	.53	44.4	2235.2	11.8	21.9	12.6
1986	24.3	.52	44.8	2258.2	11.9	22.1	12.6
1987	25.9	.52	44.5	2254.2	11.9	22.2	12.8
1988	26.7	.51	44.0	2236.2	11.9	22.6	13.1
1989	25.8	.47	44.7	2285.2	11.9	22.9	13.1
1990	25.5	.42	43.9	2275.9	12.0	23.3	13.1
1991	27.2	.45	44.0	2269.7	12.0	23.5	13.2
1992	29.1	.44	43.9	2273.5	12.1	23.6	12.8
1993	30.6	.44	43.7	2272.8	12.1	23.6	12.8
1994	31.0	.41	43.7	2267.4	12.1	24.0	13.2
1995	33.3	.47	43.8	2256.6	12.2	24.1	12.8
1996	33.4	.45	43.8	2265.3	12.2	24.2	12.1
1997	33.1	.43	44.1	2313.3	12.2	24.7	12.2
1998	36.3	.50	43.7	2262.5	12.2	27.5	13.1
1999	35.3	.50	43.8	2324.5	12.2	25.5	12.0
2000	36.7	.48	43.8	2324.7	12.3	27.1	12.3
2001	37.0	.44	44.1	2348.2	12.4	26.5	12.3
2002	38.8	.47	43.7	2334.3	12.4	27.5	12.6

Notes: The total number of observations in PSID is 65.492. The total number of observations in GSOEP is 14.270. Tenure is measured in months in PSID in years in GSOEP. Experience is measured in years.

B Computational appendix

B.1 Solving for the decision rules

The two decision problems described in section 3.1 contain two unknown functions, $W : \mathbb{R}_+^2 \rightarrow \mathbb{R}_+$ and $V : \mathbb{R}_+^2 \rightarrow \mathbb{R}_+$, that describe the value of a job and the value of unemployment. Let's define $\mathcal{V}$ as the space of the real-valued continuous functions on the $\mathbb{R}_+^2$ domain. Then, we can see see the two Bellman equations as an operator $T : \mathcal{V} \times \mathcal{V} \rightarrow \mathcal{V} \times \mathcal{V}$ and the pair of value functions $\{W, V\}$ as a fixed point of this operator. We will look for this fixed point by a successive approximations method: we guess an initial pair $\{W_0, V_0\} \in \mathcal{V} \times \mathcal{V}$, apply the operator T, obtain a new pair $\{W_1, V_1\}$, apply the operator T and so on until the distance between two successive pairs is small enough. However, to find this fixed point by use of a computer, we first need to define an analogous approximated problem.

We start by a normalization. Since new offers $\omega \in \mathbb{R}_+$ are distributed log-normally, we rewrite the state space such that new offers follow a standard normal distribution. The standardized offer $z \in \mathbb{R}$ is given by,

$$z = \frac{\log \omega + \frac{\nu}{2}}{\sqrt{\nu}} \tag{10}$$

and we can replace the distribution F by Φ, the *cdf* of the $N(0,1)$ distribution. Then, we discretize the state space such that $H \in \hat{H} \equiv \{H_1, H_2, \ldots, H_{N_H}\}$, $\hat{B} \equiv \{b_1, b_2, \ldots, b_{N_b}\}$ and $z \in \hat{Z} \equiv \{z_1, z_2, \ldots, z_{N_Z}\}$.[8] Then, we look for the approximated functions $\hat{W} : \hat{Z} \times \hat{H} \rightarrow \mathbb{R}_+$ and $\hat{V} : \hat{B} \times \hat{H} \rightarrow \mathbb{R}_+$ that define the value of employment and unemployment. The last step to characterize the approximated problem is to define the appropriate approximated operator $\hat{T}$, that is to say, we need to redefine equations (**??**) and (**??**).

The first thing to note is that we may need to evaluate W and V at points outside the grids. In this case we will just interpolate. In order to solve the problem of the unemployed we differentiate the Bellman equation (**??**) with respect to the reservation wage. This gives us a simple first order condition,

$$V\left(b, (1-\delta_u) H\right) - W\left(\exp\left(z_r\sqrt{\nu} - \frac{\nu}{2}\right), (1-\delta_u) H\right) = 0$$

that we solve for the reservation offer z_r using Brent's method at all points in the set $\hat{B} \times \hat{H}$. This gives us the approximated decision rule $\hat{g}^{z_r} : \hat{B} \times \hat{H} \rightarrow \mathbb{R}_+$. To solve the problem of the employed workers we impose h to belong to the discrete set $\hat{h} \equiv \{h_1, h_2, \ldots, h_{N_h}\}$.[9] Then, $\forall \{z, H\} \in \hat{Z} \times \hat{H}$, we just search for the $h \in \hat{h}$ that maximizes the Bellman equation. This gives us an approximated decision rule $\hat{g}^h : \hat{Z} \times \hat{H} \rightarrow \mathbb{R}_+$.

[8] We choose $N_H = 64$, $N_B = 2$ and $N_Z = 45$. Note that the domain of offers z is the real line and instead $\hat{Z}$ is bounded. We choose $z_1 = -3.5$ and $z_{N_\omega} = 3.5$ and therefore we only lose about 0.046% of the probability distribution.

[9] We work with $N_h = 3000$

To update the value functions we need to compute integrals of the type,

$$G(z) = \int_{z}^{\infty} f(s)\,\phi(s)\,ds \tag{11}$$

where $\phi(\cdot)$ is the density function of the $N(0,1)$ distribution and $f(\cdot)$ is a function of z that will be described by a vector on $\mathbb{R}^{N_z}$. One approach is to use a quadrature method over this integral. The problem is that since we will need to compute these integrals $\forall z \in \mathbb{R}$ the level of accuracy of the solutions will differ substantially for different values of z. Besides, using quadrature methods directly to approximate expression (11) might be too expensive in computer time. There are two reasons for this. First, because it would require to evaluate the integral at many points outside $\hat{Z}$, which requires interpolating the function $f(\cdot)$; and second because it would also require to evaluate $\phi(\cdot)$ at different points in $\mathbb{R}$ for each approximation. Therefore, we will follow a different approach. First, let's define $\hat{\Phi}(z_1) = 0$. Then, $\forall z_i \in \{z_2, z_3, \ldots, z_{N_z}\}$ we define $\hat{\Phi}(z_i)$ as

$$\hat{\Phi}(z_i) = \hat{\Phi}(z_{i-1}) + \int_{z_{i-1}}^{z_i} \phi(z)\,dz$$

where the integral on the right hand side is approximated by Newton-Coates quadrature. Then, $\forall z_i \in \hat{Z}$ we approximate expression (11) as

$$G(z_i) = \int_{z_i}^{\infty} f(s)\,\phi(s)\,ds \simeq \sum_{j=i}^{N_z-1} \frac{f(z_j) + f(z_{j+1})}{2} \left[\hat{\Phi}(z_{j+1}) - \hat{\Phi}(z_j)\right] \tag{12}$$

Since $\hat{\Phi}(z_j)$ can be tabulated $\forall z_j \in \hat{Z}$, all the expectations are very fast to compute. In addition we do not need to evaluate $f(z)$ outside the grid $\hat{Z}$. Finally, to compute $G(z)$ for $z \notin \hat{Z}$ we just interpolate.

B.2 Finding the aggregate distribution

In order to find the stationary distribution X we work with a finite sample of 10,000 individuals. We simulate 725 periods and drop the first 600. The remaining 125 periods gives us 10 years of monthly data for our model economy.

References

ALESINA, A., E. GLAESER, AND B. SACERDOTE (2005): "Work and Leisure in the US and Europe: Why so different?," in *NBER Macroeconomics Annual 2005*, ed. by M. Gertler, and K. Rogoff, pp. 101–31. MIT Press, Boston.

ARELLANO, M., AND S. BOND (1991): "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations," *Review of Economic Studies*, 58, 277–297.

BELL, L., AND R. FREEMAN (1995): "Why Do Americans and Germans Work Different Hours?," in *Institutional frameworks and labor market performance: Comparative views on the U.S. and German economies*, ed. by F. Buttler, W. Franz, R. Schettkat, and D. Soskice, pp. 101–31. Routledge, London and New York.

——— (2001): "The Incentive for Working Hard: Explaining Hours Worked Differences in the US and Germany," *Labour Economics*, 8(2), 181–202.

BERTOLA, G., AND A. ICHINO (1955): "Wage Inequality and Unemployment: United States vs. Europe," in *NBER Macroeconomics Annual*, ed. by B. Bernanke, and J. Rotemberg, pp. 13–54. MIT Press, Boston.

BLANCHARD, O. (2004): "The Economic Future of Europe," *Journal of Economic Perspectives*, 18(4), 3–26.

BLANCHARD, O., AND J. WOLFERS (2000): "The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence," *Economic Journal*, 110, C1–C33.

COOLEY, T. F., AND E. C. PRESCOTT (1995): "Economic Growth and Business Cycles," in *Frontiers of Business Cycle Research*, ed. by T. F. Cooley, chap. 1. Princeton University Press, Princeton.

ECKSTEIN, Z., AND E. NAGYPAL (2004): "US Earnings and Employment Dynamics 1961-2002: Facts and Interpretation," Mimeo, Northwestern University.

FALLICK, B., AND C. FLEISCHMAN (2001): "The Importance of Employer-to-Employer Flows in the US Labour Market," Federal Reserve Board Finance and Economics Discussion Paper # 2001-18.

FLINN, C. (2002): "Labour Market Structure and Inequality: A Comparison of Italy and the U.S.," *Review of Economic Studies*, 69, 611–45.

GOLDIN, C., AND L. F. KATZ (1999): "The return to Skill in the United States across the Twentieth Century," Working Paper 7126, National Bureau of Economic Research.

GOSLING, AMANDA, S. M., AND C. MEGHIR (2000): "The changing distribution of male wages in the UK," *Review of Economic Studies*, 67, 635–666.

Gottschalk, P., and T. Smeeding (1997): "Cross-National Comparions of Eranings and Income Inequality," *Journal of Economic Literature*, 35, 633–687.

Hagedorn, M., and I. Manovskii (2005): "The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited," Mimeo.

Hornstein, A., P. Krusell, and G. Violante (Forthcoming): "The Effects of Technical Change on Labor Market Inequalities," in *Handbook of Economic Growth*, ed. by P. Aghion, and S. Durlauf. Elsevier.

Imai, S., and M. Keane (2004): "Intertemporal Labor Supply and Human Capital Accumulation," *International Economic Review*, 45(2), 601.

Jacobson, L. S., R. J. LaLonde, and D. G. Sullivan (1993): "Earnings Losses of Displaced Workers," *American Economic Review*, 83(4), 685–709.

Juhn, C., K. M. Murphy, and B. Pierce (1993): "Wage Inequality and the Rise in Returns to Skill," *Journal of Political Economy*, 101(3), 410–442.

Katz, L. F., and D. H. Autor (1999): "Changes in the wage structure and earnings inequality," in *Handbook of Labor Economics*, ed. by O. Ashenfelter, and D. Card, vol. 3. Elsevier Science Publishers.

Kuhn, P., and F. Lozano (2005): "The Expanding Workweek? Understanding Trends in Long Work Hours among U.S. Men, 1979-2004," NBER Working Paper 11895.

Ljungqvist, L., and T. J. Sargent (1998): "The European Unemployment Dilemma," *Journal of Political Economy*, 106(3), 514–550.

McCall, J. J. (1970): "Economics of Information and Job Search," *Quarterly Journal of Economics*, 84(1), 113–126.

McGrattan, E., and R. Rogerson (1998): "Changes in Hours Worked Since 1950," *Federal Reserve Bank of Minneapolis Quarterly Review*, pp. 2–19.

——— (2004): "Changes in Hours Worked, 19502000," *Federal Reserve Bank of Minneapolis Quarterly Review*, pp. 14–33.

OECD (2004): *Employment Outlook*. OECD.

Prescott, E. (2004): "Why do Americans Work so much more than Europeans?," *Federal Rserve Bank of Minneaopolis Quarterly Review*, 28(1), 2–13.

Shimer, R. (2005): "Reassessing the Ins and Outs of Unemployment," Mimeo.

Violante, G. (2002): "Technological Acceleration, Skill Transferability and the Rise of Residual Inequality," *Quarterly Journal of Economics*, 117, 297–338.

Windmeijer, F. (2005): "A finite sample correction for the variance of linear efficient two-step GMM estimators," *Journal of Econometrics*, 126, 25–51.