A Directed Search Model of Ranking by Unemployment Duration*

Javier Fernández-Blanco & Edgar Preugschat

University Carlos III of Madrid & Norwegian School of Management

February 4, 2011

Preliminary and incomplete version

Abstract

Empirical evidence shows that longer spells of unemployment are associated with fewer job offer arrivals, lower job-finding rates and wage offers. Further, workers with longer unemployment duration are discriminated against. This paper sets up a directed search model based on informational stigma to replicate these facts. Firms imperfectly test for the applicants' productivity. Unemployment duration is informative about the applicants' expected productivity: if high-skilled workers perform better at the recruiting processes, then longer unemployment durations signal lower expected productivity. As a result, candidates with shorter unemployment spells are ranked ahead. The intertemporal link leads to constrained inefficiency and makes information sensitive to business cycle fluctuations. Consistent with the empirical evidence from CPS, simulated wages decline faster during economic boom periods.

*We would like to thank Espen Moen, Ricardo Mora, Iliana Reggio, Ludo Visschers, and seminar participants at the Norwegian School of Management, University of Alicante, University Carlos III, University of Girona and University of Barcelona for their comments and suggestions. Javier gratefully acknowledges Spain's Ministry of Science and Technology under Grant Nos. SEJ2007-63098. Corresponding author's email adress:

1 Introduction

Negative duration dependence on job hazard rates and exit wages is well documented. For example, Machin and Manning (1999) show that a 10% increase in unemployment duration reduces the US hazard rate by 4.5%. Using European panel data, Addison, Portugal, and Centeno (2004) estimate the marginal effect of duration on the arrival rate of job offers at -0.131. Keane and Wolpin (1997) in turn estimate that blue-collar workers experience a wage drop by 9.6 % after one year of unemployment, whereas white-collar workers' wages are reduced by 36.5%. As a result of the steady deterioration of job prospects as unemployment progresses, long-term unemployed workers have been a major focus of labor market policies in most OECD countries.[1]

Less known is the effect of unemployment duration on employers' recruiting strategies. Oberholzer-Gee (2008) carries out a field experiment and a survey showing that firms discriminate candidates according to their unemployment duration.More specifically, firms report to infer a low success rate at past interviews from long unemployment duration as the main reason to discriminate against candidates of longer unemployment spells, a mechanism we will refer to as informational stigma.[2]

This paper studies a directed search model based on informational stigma to replicate these facts. We analyze an OLG economy with multilateral meetings and heterogeneity on the supply side of the labor market. There is symmetric incomplete information on workers' productivity, yet firms have access to an imperfect screening technology. If high skilled workers are naturally assumed to be more successful at the tests, then longer unemployment durations signal lower expected productivity. Firms optimally discriminate against less productive workers, and hence rank candidates by their unemployment duration. As a result, the model is consistent with the evidence listed above.

What can be said on the pattern of wages over unemployment duration? Workers are rewarded according to their marginal value. Although we were unable to show analytically that equilibrium

[1] Active Labor Market Policies account for 0.16% of the US GDP, and 2.18% of the Swedish (see Heckman, LaLonde, and Smith (1999)).

[2] Genda, Kondo, and Ohta (2010) find persistent negative effects of unemployment rate at high-school graduation for Japanese men, whereas only temporary effects for US workers. The Japanese school-based hiring system along with its strong employment protection legislation are pointed to be the rationale behind this result. The stigma mechanism is similar to the one posed in this paper: recruiters discriminate in favor of newly graduated high school workers. More generally, it is worth noticiting that this mechanism is not limited to labor markets. It may apply to other markets where it is difficult to evaluate quality, and time on the market is informative. For example, searchers in the housing market may be less interested in ads that have been posted for a long time.

wages fall with unemployment duration, all simulations performed lead to declining wages. This result hinges on the sufficient convexity of the endogenous expected productivity distribution over unemployment duration. Furthermore, there is one straightforward testable implication from the model: namely, shocks on aggregate productivity affect firms' entry, and thus also the information externalities. Less information transmission due to fewer vacancies following a negative aggregate productivity shock make the composition of the unemployed pool change more smoothly with duration. Thus, such productivity fluctuations make hazard rate and exit wage distributions over duration show different trends over the business cycles. In particular, wages decline more smoothly as unemployment progresses during recessions. We test this result with CPS 1994-2008 data. Consistently with our theory, we find a tenfold increase in the negative correlation of accepted wages with duration over booms with respect to recessions, -0.51 vs. -0.05.

The model presented here relates to and benefits from several strands of the literature. This paper is not the first in posing informational stigma. Vishwanath (1989) and Lockwood (1991) model rational stigma along the lines described above: to acquire information on candidates' productivity, workers are tested, and falling hazard rates arise due to the assumption that skilled workers perform better at tests.[3] More specifically, the former is a partial equilibrium model with matching frictions in which the focus is on the supply side, and state dependence is imposed. Lockwood (1991) sets up a general equilibrium model, with two-sided random search. Ranking by duration does not take place as meetings are bilateral. Further, exit wages are at odds with the empirical evidence commented above as they are independent of both unemployment duration and worker's type. The negative duration dependence result regarding job-finding rates in turn relies on two key assumptions: First, the unskilled workers' leisure value is above their market productivity, and, second, workers' search is costless.[4]On the contrary, our model is robust for these two obvious extensions.

Second, ranking of job applicants by unemployment duration has first been introduced by Blanchard and Diamond (1994).[5] They study a random search model where firms rank job candidates

[3]Greenwald (1986)'s approach is different. Multi-worker firms aim to reducing the turnover of their better workers, making the "second hand" labor market formed relatively more by the worse ones.

[4]The first assumption ensures that the pool of candidates deteriorates over time, whereas the second ensures labor market participation. Notice that if the search activity were costly, there would be no job-seekers as the participation constraint would not be satisfied because of lack of commitment on the part of the firm. In our paper, endogenizing costly search effort would generate search discouragement effects because of the ranking mechanism.

[5]Moen (1999)constructs a ranking model by education showing that human capital investments prior to matching are undertaken not only to raise future wages, but also employment prospects. This rat race may lead to overinvest-

by assumption. Further, wages are continuously bargained over being the firms' disagreement point the asset value of vacancies. This is an important difference with respect to our setting because wages capture the marginal value of the candidate with respect to the other applicants. The search process is relevant because they face the valid criticism that those workers who are discriminated against may optimally direct their search to different jobs. In our directed search framework instead, no firms' deviation targetting a subset of workers is profitable as firms offer a menu of wages.

Third, on the directed search literature, this paper is formally close to Shimer (2005), who introduces two-sided heterogeneity into a static model. In contrast to the literature based on two-sided homogeneity, firms play with wages both at the extensive margin (to attract more applicants), and at the intensive margin (to attract candidates of higher expected productivity). Beyond the differences in goals and the dynamic vs. static feature, his paper assumes an exogenous productivity distribution, whereas it is determined endogenously in our paper. This additional structure also enables us to analyze how wages are negatively related to expected productivity, a relationship which remains ambiguous in Shimer's setting, and it is responsible for the different patterns of the wage distribution over unemployment duration due to business cycle fluctuations.

Moreover, other mechanisms of duration dependence have been analyzed in the literature. Gonzalez and Shi (2009) study a competitive search framework with a search discouragement effect. Workers learn about their idiosyncratic job finding abilities and adjust their search intensity over the unemployment spell accordingly. [6]Pissarides (1992) and Ljungqvist and Sargent (1998) model skill attrition and search discouragement over an unemployment spell to show that they may be responsible of the persistent effects of temporary negative shocks on unemployment. Here we show that the informational stigma equilibrium is observationally equivalent to the one derived in a slightly different economy in which skill attrition is the driven mechanism. We show this result by taking as exogenous the equilibrium productivity distribution that arises in our model. Average productivity declines over duration are then no longer caused by compositional changes (implied by testing), but are caused by human capital depreciation. In steady state, the same allocation can therefore be supported by both mechanisms, arising an identification problem. However, not only do the policy implications differ, but also there are no persistent effects on unemployment.

The paper proceeds as follows: First we set-up a directed search model with overlapping gen-

ment in education in equilibrium.

[6]Note, that in contrast to our model productivities are identical across workers, so that all decisions are independent of the distribution of unemployment durations.

erations of unemployed workers, define equilibrium, and study its properties (section 2). Next, we establish that the equilibrium is inefficient and construct a simple policy that restores efficiency . Section 3 shows the data work. Finally, we replace the stigma mechanism with an exogenous process of human capital depreciation, and we conclude. All proofs are in the appendix.

2 Model

This section presents an overlapping generations, directed search model, where there is symmetric incomplete information on workers' productivity and imperfect testing by firms.

2.1 Environment

Time is discrete. There is a measure one of newborn unemployed workers every period, who live for T periods. The economy is populated by a measure T of workers and a continuum of firms determined by free entry in every period. All agents are risk neutral and discount future payoffs at a common rate β. Unemployed workers derive utility from home production b.

Since the focus of this section is on the steady-state, the time index will be suppressed. Workers are identified by a pair (τ, i). $\tau \in \{1, 2, ..., T\}$ denotes their age or, equivalently, unemployment elapsed if jobless. $i \in \{l, h\}$ in turn stands for their ability or productivity level y_i, with $b = y_l < y_h$. The type i is drawn at birth by Nature with probability μ for type h.[7] Let $u_i(\tau)$ denote the non-normalized measure of unemployed workers of type (τ, i) at the begining of period t, which is endogenously determined. As a result of the Law of Large Numbers, a mass $u_h(1) = \mu$ of newborn workers are hence high skilled. The two-dimensional unemployment distribution is the state variable in this economy. Age is assumed to be public information. In contrast, there is symmetric incomplete information on worker's actual productivity: it is unobservable to both the worker herself and potential employers, but imperfectly testable by the latter.

At the beginning of every period, workers can be either employed or unemployed. The unemployed seek job opportunities, whereas employment is an absorbing state.[8] Firms in turn can be

[7] We will refer to type l workers as low-ability, low-skilled or unskilled indistinctly, and analogously for type h agents.

[8] This assumption is made to rule out the scenario in which firm-initiated layoffs provide information to future hiring firms. If firm-initiated layoffs were allowed, employment spells would become a second recruiting criterium along the lines of Gibbons and Katz (1991). Despite its empirical counterpart, we prefer to abstract away from it for

either active (matched to a worker and actively producing) or vacant. We identify one job with one firm. Posting a vacancy is a costly activity, while testing applicants is costless: firms incur a recruitment cost k.

Screening At no cost, firms may imperfectly screen job candidates. The unskilled applicant passes the test with probability $\lambda_l = \lambda \in (0, 1)$, whereas the skilled one always succeeds, $\lambda_h = 1$.[9] If $\lambda = 0$, then testing would be perfect. Test information is not verifiable and cannot be traded. Thus workers do not have access to the test results, and only know the result of the hiring decision. This assumption ensures symmetry, i.e. it prevents job-seekers from learning their type at a different pace than future recruiters. Therefore recurring application failures form a sequence of signals on workers' (expected) type. For later use, it is convenient to denote the expected productivity conditional on passing the test of any given cohort τ, and on the distribution u, by

$$\overline{y}_\tau(u) = \frac{y_h u_h(\tau) + y_l \lambda u_l(\tau)}{u_h(\tau) + \lambda u_l(\tau)} \tag{1}$$

Timing Before describing the remaining details, the following outlines the timing of events within each period:

1. Unit mass of workers are born, and join the pool of unemployed.
2. Firms post job offers (contracts) at a cost k.
3. Workers direct their search and submit at most one application.
4. Matching process takes place:
    (a) Workers take the test.
    (b) Firms select one worker among the pool of applications received.

algebra simplicity.

[9]The normalization $\lambda_h = 1$ is a simplification. The relevant assumption is that type h workers are more likely to pass the test than type l workers. Imperfect testing is widely supported by the human resources literature, which has noted the limitations of the candidates-screening technologies, such as job interviews. See e.g. Arvey and Campion (1982). Similarly, screening is costless to make our life easier. Notice that otherwise firms might have an incentive to not test all candidates if the cost were unitary, or not test at all if the cost were too high. With reasonable and one time testing costs satisfying the Inada conditions, it can be shown that firms (and the social planner) have incentives to invest in screening, and the main results do not change.

5. Successful job-seekers start producing according to their productivity, which is revealed upon hiring. Consumption takes place.

6. Unmatched workers remain unemployed, whereas unfilled vacancies disappear.

Search and Matching Workers and firms come together via search. Firms commit to a contractual offer, and job-seekers direct their search upon browsing through all offers. There is no restriction on the contracting space. Let $w = (w_\tau)_\tau$ be an offered contract, which may stipulate wages contingent on observables. Wages price waiting time, i.e. firms face a trade-off between higher wages and a higher job-filling rate. Interestingly, they play with a menu of wages, increasing wages not only to attract more applications (extensive margin), but may also raise relatively more those wages to better candidates (intensive margin).

In addition to a wage offer w, firms announce a hiring criterium. Employers seek to recruit the most profitable applicant, which has two implications. First, an additional friction: passing the test is a necessary condition for a worker to be shortlisted. Otherwise, unsuccessful candidates would be promised a wage below their home productivity, which would be unacceptable. Second, firms commit to a hiring rule σ, which is a permutation of the set $\{1, ..., T\}$ that reorders age indexes according to their expected profitability. Firms are assumed to randomize among ex-ante equally productive candidates.[10] Further, if two different cohorts had the same expected profitability, then the younger cohort would be ranked ahead. That is, for any $\tau, \tau' \in \{1, ..., T\}$,

$$\sigma(\tau; u) > \sigma(\tau'; u) \text{ iff } J_\tau(w; u) > J_{\tau'}(w; u) \text{ or } J_\tau(w; u) = J_{\tau'}(w; u) \text{ and } \tau < \tau', \qquad (2)$$

where $J_\tau(w; u)$ stands for the firm's expected discounted value upon filling the vacancy with a worker of age τ. It is worth emphasizing that, as it is apparent from the equilibrium condition (2), the permutation depends on the state variable, which pins down the expected productivity distribution

[10]Certainly, this tie-breaking rule is not time consistent as unsuccessful candidates would be willing to outbid the commited wage ex-post. The Bertrand competition would eventually make firms facing this scenario capture total net surplus. Nonetheless, we assume here that commited wage contracts can be made enforceable by courts once production takes place, whereas any other arrangement cannot be verified at a reasonable cost. Thus, firms have no incentives in opening an ex-post competition among applicants. However, it will be shown in Section 2.3 that firms will ex-ante commit in equilibrium to wages that assign no positive wage to the event in which two or more identical workers are subject to the tie-breaking rule.

as in (1). Given the state variable u, the permutation is thus bijective.[11] We will refer to $s \equiv \sigma(\tau; u)$ as the position in the queue of the representative agent of age τ. Although a job offer consists of a pair (w, σ), they will be named by their wage contract for notational simplicity due to our posterior focus on equilibria with ranking by unemployment duration.

Workers of same age use identical mixed-application strategies, which is a natural assumption when looking at symmetric equilibrium with a continuum of agents. In other words, by ruling out coordinating strategies, coordination frictions arise and guarantee the coexistence of unemployment and vacancies. To be more specific, the matching process relies on the urn-ball scheme. Meetings are multilateral: some urns (i.e. posted offers) may receive many balls (i.e. applications), whereas some other will receive no one. Finally, it can only be selected one ball per urn. As a result, some workers and firms are matched, and the remaining seekers stay unemployed and vacant, respectively.

Let $v(w)$ be the measure of vacant firms offering job w. Then, as applications are submitted independently over time and across individuals, each of those firms expects $q_s(w) \equiv \frac{\sum_i \lambda_i u_i(\sigma^{-1}(s))}{v(w)}$ type $\sigma^{-1}(s)$ workers. Moreover $q^s(w) \equiv (q_1(w), q_2(w), ..., q_s(w))$. The probability that no worker better placed than a s candidate either applies to a firm offering ω or, if applied, performs correctly in the test is[12]

$$P_s(q^{s-1}(w)) = e^{-\sum\limits_{s'<s} q_{s'}(w)} \tag{3}$$

The probability of filling a job with a type s worker a firm posting wage ω faces is

$$\eta_s(q^s(w)) = P_s(q^{s-1}(w)) \left(1 - e^{-q_s(w)}\right) \tag{4}$$

Note that this expression captures both the firms' ranking strategy and the fact that unskilled workers are never hired. Since it must be the case that the measure of matched workers and firms coincide, we have

$$\nu_s(q^s(w))q_s(w) = \eta_s(q^s(w))$$

[11] Let $\sigma^{-1}(\cdot;\, u)$ denote the inverse function of $\sigma(\cdot; u)$.

[12] This comes out from taking the limit to the below expression to the large game, where $\rho_{(s',i)}(w)$ is the probability assigned to contract w by type i workers of age $\sigma^{-1}(s')$.

$$\lim \prod_{s'<s} \left(1 - \rho_{(s',h)}(w)\right)^{u_h(\sigma^{-1}(s'))} \left(1 - \lambda\rho_{(s',l)}(w)\right)^{u_l(\sigma^{-1}(s'))} = P_s(w)$$

Therefore, the job-finding probability for a given type s worker conditional on applying to job ω and passing the test is[13]

$$\nu_s(q^s(w)) = P_s(q^{s-1}(w))\frac{1-e^{-q_s(w)}}{q_s(w)} \tag{5}$$

Value Functions Let us proceed with the value functions of workers and firms. As employment is an absorbing state, an employed worker derives utility from wages till retirement:

$$E_\tau(w) = w_\tau \frac{1-\beta^{T-\tau+1}}{1-\beta} \tag{6}$$

An unemployed worker of age τ in turn will apply costlessly to any posted job offer that maximizes her utility. The applicant gets employed with probability $\nu_{\sigma(\tau;u)}(q^{\sigma(\tau;u)}(w))$ conditional on succeeding in the test, remaining unemployed one more period otherwise. Thus, her value function is:

$$U_\tau(u) = b + \max_w \left\{ p_\tau(u)\nu_{\sigma(\tau;u)}(q^{\sigma(\tau;u)}(w))\left(E_\tau(w) - b - \beta U_{\tau+1}(u)\right)\right\} + \beta U_{\tau+1}(u), \tag{7}$$

where $p_\tau(u) = \lambda + \frac{u_h(\tau)}{u_h(\tau)+u_l(\tau)}(1-\lambda)$ is the probability of passing the test conditional on age τ. Notice that this last expression requires to take into account the state variable u, or, equivalently, we are assuming that job-seekers keep records of the economy's history from their birth.

Now, a firm that has offered contract w and has filled its vacancy with a type τ worker receives worker's productivity net of wages till worker retires:

$$J_\tau(w;u) = (\overline{y}_\tau(u) - w_\tau)\frac{1-\beta^{T-\tau+1}}{1-\beta} \tag{8}$$

Like workers, also firms need to know the state variable u in order to compute the applicants' expected productivity, $\bar{y}_\tau(u)$. The corresponding value function of a vacancy can be written as:

$$V(w;u) = -k + \sum_{s=1}^{T} \eta_s(q^s(w))J_{\sigma^{-1}(s)}(w;u) \tag{9}$$

A firm posting a vacancy for one period incurs a recruitment cost k, and gets the job filled in with a type s candidate with probability $\eta_s(q^s(w))$. That is, they start testing the candidates with the largest expected profitability, and continue testing until they find a successful applicant.

[13] Notice that if $y_l > b$, then firms would randomize among candidates provided no one passed the test. We rule out this case for tractability reasons, and hence test-failing candidates are not employable.

2.2 Equilibrium

Now, we define the symmetric recursive equilibrium in the steady state. Notice that the aggregate state is endogenous: it is a result of the history of agents' equilibrium decisions.

Definition 1 *A steady state symmetric recursive equilibrium consists of value functions* $V(\cdot;u)$*,* $J_\tau(\cdot;u)$*,* $E_\tau(\cdot)$*:* $[0,y_h]^T \to \mathcal{R}_+$*, and* $U(u) \in \mathcal{R}_+^T$*, a distribution for each type* i *of workers over durations* $u_i : \{1,...,T\} \to [0,1]$*, and, given* u*, a hiring rule* $\sigma : \{1,...,T\} \to \{1,...,T\}$*, a menu of contracts* $\omega \in [0,y_h]^T$*, and expected queue lengths* $Q : [0,y_h]^T \to \mathcal{R}_+{}^T$ *such that:*

i) The value functions satisfy the above Bellman equations.

ii) Profit maximization and zero-profit condition:

- *Given* u *and* ω*, the hiring rule* σ *satisfies condition (2).*
- *Given* U*,* Q*,* u*, and* σ*,* ω *is the profit-maximizing contract, and profits become null.*

$$V(w;u) \leq 0, \text{ with equality for } w = \omega \tag{10}$$

iii) Workers direct their search:

$$U_\tau(u) \geq b + p_\tau(u)\nu_{\sigma(\tau;u)}(Q^{\sigma(\tau;u)}(w))\left(E_\tau(w) - b - \beta U_{\tau+1}(u)\right) + \beta U_{\tau+1}(u) \tag{11}$$

and $Q_{\sigma(\tau;u)}(w) \geq 0 \; \forall w \in [0,y_h]^T$*, with complementary slackness.*

iv) Recursivity condition*: The distribution of workers recursively satisfies:*

$$u_i(\tau+1) = u_i(\tau)\left(1 - \lambda_i \nu_{\sigma(\tau;u)}(q^{\sigma(\tau;u)}(\omega))\right) \text{ for } i \in \{l,h\} \tag{12}$$

v) Vacancies condition*:*

$$Q_{\sigma(\tau;u)}(\omega) = Q_1(\omega)\frac{u_h(\tau) + u_l(\tau)\lambda}{\mu + (1-\mu)\lambda} \tag{13}$$

Firms maximize profits, which drop down to zero in equilibrium because of free entry. The third equilibrium condition is required to pin down rational expectations on queue lengths out of the equilibrium. The Law of Large Numbers ensures that if the job-finding probability of a skilled worker is $\nu(q)$, then $u\nu(q)$ skilled workers will leave unemployment at the end of the period. Thus, the fourth condition determines the law of motion of the state variable. Finally, the *Vacancies condition* implies that the ratio of effective job-seekers to the queue length does not change across cohorts. This must be the case since the measure of vacancies is not contingent on workers' observables. It may be worth emphasizing that a deviation of firms targetting a particular subset of job-seekers is not profitable. By definition, such contracts are available, and yield non-positive expected profits once expected queue lenghts are computed.

2.3 Equilibrium with Ranking by Unemployment Duration

Now, we focus on a particular subset of the equilibria just defined: we are to characterize the symmetric recursive equilibria consistent with $\sigma(\tau; u) = \tau$. That is, firms optimally discriminate against candidates with longer unemployment duration.

The following proposition is the generalization of a standard result in the literature.:The equilibrium allocation can be expressed as a fixed point of a correspondence f. Let $f : [0,1]^{2T} \times \mathbb{R}_+^T \to [0,1]^{2T} \times \mathbb{R}_+^T$ be defined as the composite correspondence $f \equiv \phi \circ \psi$, where ϕ and ψ are defined as follows. First, given u and U', $\psi(u, U')$ is defined as the set of triples (U, ω, q) that satisfy the *Vacancies condition* and solve the dual to the firm's profit maximization program:

$$\begin{aligned} \max_{w,q^T} \quad & \nu_1(q)\left(E_1(w_1) - b - \beta U_2'\right) \\ \text{s. to} \quad & \textstyle\sum_\tau \eta_\tau(q^\tau) J_\tau(w_\tau) = k \\ & b + p_\tau(u)\nu_\tau(q^\tau)\left(E_\tau(w_\tau) - b - \beta U_{\tau+1}'\right) + \beta U_{\tau+1}' \geq U_\tau, \quad \forall \tau \end{aligned} \tag{14}$$

It can be shown that the firm's maximization problem has a unique solution. Secondly, let ϕ be a function defined as $\phi(U, \omega, q) \equiv (\tilde{u}, \tilde{U})$, where $\tilde{u}$ is uniquely determined by the equilibrium *Recursivity condition* and $\tilde{U} = U$. The next proposition characterizes the equilibrium.

Proposition 2.1 *Any equilibrium allocation (u, ω, U, q) is a fixed point of correspondence f; and conversely, a fixed point of f is an equilibrium allocation.*

Furthermore, it can be shown that f is indeed a continuous function. Notice that the finite lifetime of workers implies that the domain of f is of finite dimension. Hence Brower's Fixed Point Theorem applies to show existence of a fixed point and thereby existence of equilibrium.

Corollary 2.2 *There exists a symmetric steady state equilibrium, which is characterized by the Recursivity and Vacancies conditions along with the following set of conditions:*

$$\sum_{\tau=1}^{T}\left(\beta(\tau)\bar{y}_{\tau}(u)-b-\beta U_{\tau+1}\right)e^{-\sum_{\tau'=1}^{\tau-1}q_{\tau'}}\left(e^{-q_{\tau}}(1+\sum_{\tau'=1}^{\tau}q_{\tau'})-1-\sum_{\tau'=1}^{\tau-1}q_{\tau'}\right)=-k \tag{15}$$

For $\tau\in\{1,...,T\}$,

$$U_{\tau}=b+\beta U_{\tau+1}+\frac{p_{\tau}(u)}{e^{\sum_{\tau'=1}^{\tau}q_{\tau'}}}\left(\beta(\tau)\bar{y}_{\tau}(u)-b-\beta U_{\tau+1}-\sum_{\tau'=\tau+1}^{T}e^{-\sum_{\tau''=\tau+1}^{\tau'-1}q_{\tau''}}(1-e^{-q_{\tau'}})\left(\beta(\tau')\bar{y}_{\tau'}(u)-b-\beta U_{\tau'+1}\right)\right) \tag{16}$$

$$\beta(\tau)w_{\tau}=\frac{q_{\tau}e^{-q_{\tau}}}{1-e^{-q_{\tau}}}\left(\beta(\tau)\bar{y}_{\tau}(u)-b\text{-}\beta U_{\tau+1}-\sum_{\tau'=\tau+1}^{T}e^{-\sum_{\tau''=\tau+1}^{\tau'-1}q_{\tau''}}(1-e^{-q_{\tau'}})\left(\beta(\tau')\bar{y}_{\tau'}(u)-b-\beta U_{\tau'+1}\right)\right)+b+\beta U_{\tau+1} \tag{17}$$

Uniqueness of equilibrium is not guaranteed. The second equilibrium condition corresponds to the first order condition with respect to the queue lengths in the firms' problem. By plugging (16) into the zero-profit condition (10) and the unemployed workers' value function (11), the first equilibrium condition and the equilibrium wages are derived, respectively. The equilibrium wages condition (17) deserves some comments. The fraction in the first term is the elasticity of the job-filling probability as usual. Because of the multilateral meetings, it has here one more appealing interpretation: it is the probability of being her the only type τ applicant conditional on the firm receiving at least one application of that type. It multiplies the output obtained from hiring this worker net both of his unemployment value and the net expected output derived from any other potential match. In other words, workers are rewarded according to their marginal value. Notice that if there were another type τ applicant, the marginal value of the worker would be zero.

2.4 Properties of Equilibrium

First, it is worth highlighting the information externality. Period t firms form rational expectations on applicants' productivity from their unemployment duration. Long unemployment spells are indicative of several failures at past screening processes.[14] The following lemma states that the

[14] Notice that if multiple employment spells were allowed, recruiting firms would take into account the whole unemployment history. Further, if firm-initiated layoffs were considered, then the entire employment history would

expected productivity falls with unemployment duration regardless of what recruiting strategies (other than testing) firms choose. The underlying intuition is that, for any given cohort, the pool of job-seekers deteriorates over time as better candidates are more likely to be hired. However, this result is not inmediate, and relies on the focus on the steady state.[15]

Lemma 2.3 *Given a distribution u, $\overline{y}_\tau(u)$ is a decreasing function of τ provided that $\lambda_l < \lambda_h$, and passing the test is required for the job.*

Given the OLG structure of the economy, this result suggests that employers end up discriminating against applicants with longer unemployment spells and hence ranking candidates by duration. Precisely, Lemma 2.4 states that ranking recruiting strategies are optimal in equilibrium by showing that the most productive applicant is indeed the most profitable one. In other words, ranking by duration is an optimal hiring rule. A result that, as we commented in the Introduction, is supported by the empirical evidence, particularly from Oberholzer-Gee (2008) work.

Lemma 2.4 *The value of an active firm $J_\tau(\omega)$ declines with duration in equilibrium. Therefore, $\sigma(\tau) = \tau$ in the steady state equilibrium.*

Rational stigma is expected to make worker-related equilibrium variables decrease with unemployment duration as well. We show that the unemployment asset value does decline with age leading to the deterioration of workers' well-being over time. Furthermore, hazard rates show the same declining pattern, consistently with the empirical evidence on negative duration dependence. Indeed, the ranking recruiting strategies is the state dependence component of the negative duration dependence on hazard rates.[16]

Lemma 2.5 *The equilibrium expected returns from unemployment U_τ and the (conditional and unconditional) job-finding rates fall with duration.*

be informative. These extensions, although natural and supported by the empirical evidence (see e.g. Gibbons and Katz (1991)), complicate the algebra without adding much to our story.

[15] It is easy to come up with an economic environment in which a two state aggregate productivity follows a Markov process, and the expected productivity is not monotonic in unemployment duration.

[16] Notice that if firms were not discriminating according to unemployment duration, then negative duration dependence would be fully caused by unobserved heterogeneity: Each type of workers would face a constant hazard rate over their lifetime, being higher for skilled ones.

However, we cannot extend this general falling pattern to equilibrium wages. In his one period economy with two-sided heterogeneity, Shimer (2005) points out that wages need not decline given any exogenous declining productivity distribution. It is clear from the equilibrium wage condition (17) that if, for example, there were two consecutive types, τ and $\tau + 1$, with an ϵ productivity difference (with the type $\tau + 2$ much less productive) and of equal measure, then the ϵ less productive worker would be promised a higher wage because of his greater marginal value. Unlike in Shimer (2005), here the expected productivity distribution is endogenously determined. Recall that equilibrium wages are determined by two components: a conditional probability and a net expected productivity. Notice that the former is indeed an increasing function in τ, hence so are wages holding everything else equal.[17] Despite that, we can prove that wages fall with duration in the limit case as T grows large if that distribution shows some degree of convexity. Notewithstanding, we have not been able to show that such suffficient condition holds in equilibrium.

The simulated work instead does support the falling wages result. Figure ??? shows the hazard rate and wage distributions for parameter values ????. After a large number of simulations, we have faced two possible scenarios regarding wages: either they continuously fall with duration or they fall steadily up to some age, from which on wages increase. The intuition for the second case is clear: the marginal value of the very last worker is high as that candidate is the last resource for the firm. Looking backwards, the candidate's value may smoothly decrease up to some point. However, the smoothness of the increase with age suggests that this is a second order effect. This interpretation is backed by the comparative statics exercise depicted in Figure ????: for the same set of parameter values, as the lifetime horizon is increased, the duration at which the minimum wage is attained increases.

2.5 Calibration

To be included.....

2.6 Simulated Comparative Statics

To be included....

[17]The continuous time version of the model would be valuable as such conditional probability would equal 1 if the equilibrium equation replicated equation (17). Nonetheless, frictions disappear in continuous time, unless some ad hoc assumptions are made (see e.g. Blanchard and Diamond (1994)).

2.7 Efficiency Properties of Equilibrium

A number of public policies have been implemented worldwide to help the long term unemployed. Policies are of two types: redistributive and market failure-targetting. In this section we claim that a benevolent social planner could improve upon the decentralized equilibrium, and thus public intervention is needed to maximize social welfare.

The centralized economy is set in the Appendix. As is standard in the literature with risk neutrality, a benevolent dictator posts a number of vacancies to maximize total output net of recruitment costs. The planner is also subject to the same constraints specified above for the decentralized economy: namely, the anonymity constraint and the imperfect λ-testing technology. The latter constraint ensures that the planner has no access to better screening technologies than firms do in the decentralized economy. The former in turn limits the ability of the planner to assign workers to jobs: Each vacancy receives a number of applications, identified by the age of the applicants, and the planner is free to choose any among them.

Proposition 2.6 *The steady state equilibrium is not constrained efficient provided the test is informative. A tax on firms' profits or on the vacancy-posting activity leads the equilibrium to attain efficiency.*

We think the $T = 2$ case provides the insights for the inefficiency result. For simplicity, we will drop the leisure value, $b = 0$. In the decentralized economy, after substituting wages out, the private returns of a period t vacancy are

$$\Pi_t = \sum_{\tau=1}^{2} \eta_\tau(q_t^\tau)\bar{y}_t(\tau)\beta_\tau - k - q_{1,t}\left(\sum_{\tau=1}^{2} \frac{\partial \eta_\tau(q_t^\tau)}{\partial q_{1,t}}\bar{y}_t(\tau)\beta_\tau + \frac{q_{2,t}}{q_{1,t}}\frac{\partial \eta_2(q_t^2)}{\partial q_{2,t}}\bar{y}_t(2)\right) + \beta\bar{y}_t(2)q_{1,t}^2\frac{d\nu_1(q_t^1)}{dq_{1,t}}\frac{\partial \eta_2(q_t^2)}{\partial q_{2,t}}p_t(2) \tag{18}$$

-

The interpretation of (18) is straigthforward. The first two terms are the expected output produced by the firm net of the vacancy cost, whereas the last two are the wage costs the firm faces. The firms entry condition becomes $\Pi_t = 0$. Let us turn now to the centralized economy. The social planner opens extra vacancies provided their returns are positive. Let $\tilde{\Pi}_t$ denote the social returns of a period t vacancy. Then, from the social planner problem we obtain:

$$\tilde{\Pi}_t = \sum_{\tau=1}^{2} \eta_\tau(q_t^\tau)\bar{y}_t(\tau)\beta_\tau - k - q_{1,t}\left(\sum_{\tau=1}^{2}\frac{\partial \eta_\tau(q_t^\tau)}{\partial q_{1,t}}\bar{y}_t(\tau)\beta_\tau + \frac{q_{2,t}}{q_{1,t}}\frac{\partial\eta_2(q_t^2)}{\partial q_{2,t}}\bar{y}_t(2)\right) - q_{1,t}\beta\left(\frac{\partial \eta_2(q_{t+1}^2)}{\partial q_{1,t}}\bar{y}_{t+1}(2) + \eta_2(q_{t+1}^2)\frac{\partial \bar{y}_{t+}}{\partial q}\right. \tag{19}$$

Once again, the first two terms stand for the expected production net of vacancy costs. The third term is the standard negative externality on other period t firms as they are less likely to fill their vacancies. Notice that this effect is internalized in equilibrium as usual. The last term is new, and corresponds to the discounted period $t+1$ costs as period t firms reduce the expected returns from period $t+1$ firms. This intertemporal effect occurs through two channels that are pointed out by the two objects in this last term. Let us see first the externsive margin: the extra period t firm reduces the mass of period $t+1$ job-seekers, hence making filling period $t+1$ jobs more difficult. Now, the intensive margin: it negatively affects the composition of the period $t+1$ pool of unemployed and hence reduces this period expected utility.

Now, for the constrained efficiency analysis, we want to compare the social and private returns of a vacancy. Let their difference at any given allocation be denoted by $\Delta_t \equiv \Pi_t - \tilde{\Pi}_t$. Then, we have

$$\Delta_t \equiv \beta q_{1,t}\left(\eta_2(q_{t+1}^2)\frac{\partial \bar{y}_{t+1}(2)}{\partial q_{1,t}} + \frac{\partial \eta_2(q_{t+1}^2)}{\partial q_{1,t}}\bar{y}_{t+1}(2) + q_{1,t}\bar{y}_t(2)\frac{\partial \eta_2(q_t^2)}{\partial q_{2,t}}\frac{d\nu_1(q_t^1)}{dq_{1,t}}p_t(2)\right) =$$

$$= \frac{-d\nu_1(q_t^1)}{dq_{1,t}}\beta q_{1,t}\mu(1-\mu)(1-\lambda)\left(\eta_2(q_{t+1}^2)\frac{\lambda y_h}{(u_{ht}+\lambda u_{lt})^2} + q_{1,t}\bar{y}_{t+1}(2)\frac{\partial \eta_2(q_{t+1}^2)}{\partial q_{2,t+1}}\frac{1-\lambda}{p_t(1)(u_{h,t}+u_{l,t})}\right) > 0 \tag{20}$$

This difference in returns is strictly positive provided that the test is informative, and the two types of workers coexist. That is, decentralized firms do not internalize the next period output reduction they lead to, and hence there is excessive firms' entry in equilibrium. Therefore, a tax on the entry cost, or equivalently on firms' profits, would lead the decentralized economy to the social planner's allocation. For extra insights it is worth looking at the two extreme cases: namely, $\lambda = 1$ and $\lambda = 0$. In the former, if the test is not informative, then the equilibrium is constrained efficient. Indeed, the setup does not differ from the standard directed search model: All workers are identical, firms do not test and make decisions according to expected productivity, the actual productivity does not depend on past decisions and is realized at the matching time. That is, not only $\frac{\partial \bar{y}_{t+1}(2)}{\partial q_{1,t}} = 0$ as in the standard directed search model with constant labor productivity, but also the welfare cost of marginally increasing the mass of vacancies in period t (decreasing the mass of unemployed workers) coincides with the increase in total output in period $t+1$ due to more available candidates.

The second case is a bit more striking, and corresponds to an asymmetric information scenario as firms have perfect information on applicants' skills, whereas they do not. If $\lambda = 0$, then the equilibrium is not constrained efficient, and there is excessive firms' entry despite $\frac{\partial \bar{y}_{t+1}(2)}{\partial q_{1,t}} = 0$. The social planner perfectly discriminates among workers' types, and decides the mass of vacancies according to the right mass of type h candidates for each τ. The equivalent decentralized economy would be populated only by skilled workers. Instead, although firms also perfectly distinguish types in our setup, they are constrained to promise a market value which is below the one in this other decentralized economy because of the workers' uncertainty about their own type. In other words, the forgone output in period $t+1$ is larger than the welfare gains of increasing marginally the mass of vacancies in period t. For intermediate values of λ, the inefficiency source is twofold. First, the second term in (20) is always positive suggesting again a less stringent market value condition than necessary to attain efficiency. Second, now $\frac{\partial \bar{y}_{t+1}(2)}{\partial q_{1,t}} > 0$ an externality which is not captured by period t agents in equilibrium.

3 Data

This section looks at data to confront the testable implications from the model. Appendix 6.3 contains further descriptive details of the data set. The data source is the Current Population Survey (CPS), a monthly US survey published by the Bureau Labor Statistics. Its suitability relies on the two variables we pay attention to: namely, hazard rates and exit wages by unemployment duration. Sampled individuals are in the survey for four consecutive months, then eight out, and again four in. This short longitudinal element allows us to keep track of the employment status of the interviewed agents as well as to learn what the exit wage is. The sample period under analysis is 1994-2008.

The final pool of observations is obtained after applying several filters to the original sample. Briefly speaking, we focus on non-farming and non-public-sector individuals of age 20 to 60 who were unemployed and actively seeking a job at the previous month. Eventually we work with 52576 observations of individuals' employment status and 10103 observations for hourly wages. Dealing with two different data sets is justified by the fact that earnings-related questions are only asked at the fourth and eigth individual's interviews, the so-called outgoing rotation group. Unemployment spells are reported in weeks.

First, we describe the hazard rate analysis. We take the 1994-2008 observations conditional on being unemployed on the previous period, and, using the final weights, produce one time series of newly employed and another one of total job-seekers for any unemployment duration. We use the US Census Bureau's software X-12-ARIMA to seasonally adjust these two series. Finally, we add up all the observations for any given duration to calculate the empirical hazard rate, $h(\tau)$. That is,

$$h(\tau) \equiv \frac{\sum_t e(t,\tau)}{\sum_t s(t,\tau)}$$

where $e(t,\tau)$ and $s(t,\tau)$ refer to the weighted and seasonally adjusted mass of newly employed and job-seekers who had been unemployed for τ weeks at time t.[18] Figure ¿1a? shows the empirical hazard rate distribution. It steadily declines as unemployment progresses, although the decline is fairly smooth after four months indicating that the reemployment prospects deteriorate fairly soon.[19]

Regarding earnings, CPS has historically distinguished between hourly wages and weekly earnings. The former refers to before-tax-and-deductions earnings, whereas the latter also includes overtime pay, tips, and commisions and has both working time and potential multi-job components. Due to working-time-related issues, we focus on hourly wages.[20] After deflating wages by monthly CPI, we adopt a log-linear specfication using the outgoing rotation weights. To standardize, we regress log hourly wages on a number of observables: monthly dummies to seasonally adjust, the age and its square, and other dummies related to education, sex, race, marital status, state and major industry and occupation. The coefficient of determination R2 is 0.4226, meaning that the workers-related observables explain slightly above one third of total earnings variation in line with the literature. We compute the distribution of average wages upon exiting unemployment as the average of the regression residuals by duration. The correlation between unemployment duration and the average accepted wages is -0.4562 as Table 1 indicates implying that wages decline fairly more

[18] See e.g. Shimer (2008) for a similar approach.

[19] The correlation with unemployment duration goes from -0.9433 during the first fifteen weeks down to 0 for the remaining spells.

[20] See Appendix 6.3 for firther details.

Table 1: Correlation with Unemployment Duration

Correlation	Overall	Boom	Bust
Hazard rate	-0.8289 (0.0000)	-0.8489 (0.0000)	-0.8487 (0.0000)
Log hourly wage	-0.4562 (0.0000)	-0.5067 (0.0000)	-0.0512 (0.0143)

The significance level is reported within parenthesis.

slowly than hazard rates, yet real wages show netheir a convexity nor a concavity clear pattern.[21]

Furthermore, recall that one other testable implication of the model was that accepted wages decline faster during booms than during recessions. Pissarides (2009) recalls that "the cyclical indicator variable used in the panel studies is usually national unemployment, following the lead of Bils (1985)." In this line, we sort observations out according to whether unemployment experienced quite a low or high rate at their month and year. More specifically, the recession set is formed by observations that correspond to months with national unemployment rate above the 75% percentile (i.e. a rate above 5.7%), and the boom set by those linked to rates below the first quartile (i.e. 4.5%). Each group is formed by over 1700 observations. Robustness checks have been undertaken using GDP growth as an alternative business cycle indicator as well as for the 10 and 90 percentiles to define the subsampes. See Appendix 6.3.

We observe no appreciable slope difference in the empirical job-finding rate distributions, although it is easier to find a job during booms than busts as Figure 1 shows. Regarding wages, their correlation with unemployment duration is ten times bigger during booms than during recessions. In this regard, we take one other approach. We perform one more linear regression including two cycle-and-duration-related variables, and a cubic ploynomial of the unemployment rate to control for the cycle effects other than those related to those associated to unemployment duration. The boom-related variable coincides with the actual unemployment duration if the observation falls into the boom subsample, and is 0 otherwise. Analogously for the recession-related variable. Therefore, we read those coefficients as relative to the overall effect of unemployment duration and subject to the cycle effects. The estimate for the recession period is not statistically significant, whereas the one for the boom is -0.002 and statistically different from 0 at 1%. More importantly, we test the null hypothesis of whether those coefficients coincide with one another, and we can reject it at 5% in favor of the recession coefficient being larger than the boom one. Nonetheless, this result does

[21]Upon regressing the exit wages against the mentioned variables along with unemployment duration, the estimate of the latter is -0.0010268, and statistically significant at 1%.

not always hold for different specifications in the robustness check exercicse of Appendix 6.3.

A final note regarding the cyclicality of real wages is worthwhile. Abraham and Haltiwanger (1995) summarizes the literature based both on aggregated and panel data concluding that real wages are slightly procyclical, at least for the mid 1960s to 1980s period analyzed. They also estimate that the composition effect that could bias earlier studies using aggregate data may not be quantitatively relevant. Studies using longitudinal data sets mostly use either PSID or NLS. Further, as Pissarides (2009) comments, the estimate of unemployment rate in the wage regression for job-changers is near to -0.03, whereas for job-stayers is about -0.01 or even below. However, wages linked to job-to-job transitions may be more procyclical than those associated to unemployment to employment transitions. Indeed, in his table II, Carneiro and Portugal's (2007) estimate is cited to be -2.08, using Portuguese data. Using monthly CPS data for newly employed workers, we also find that real hourly wages are procyclical, with a statistically significant coefficient around -0.015 for the 1994-2008 period. That is, one percentage point increase in the unemployment rate leads about to a 1.5 percent drop in real hourly wages.

4 Discussion on Public Policy

Despite the wide set of public policies implemented in most OECD countries targetting long term unemployed workers, little normative work has been carried out. Although this is not our goal here either, we want to comment on the effects of several public policies on labor market outcomes. The main insight in this section is that most public policies targetting long term unemployment have very little returns if firms rank candidates by duration.

Unemployment Benefits We undertake a comparative statics analysis with respect to the home production parameter, b: the higher b, the fewer vacancies posted. As firms compete for workers by posting wage contracts, a higher home production obliges firms to raise their wage offers reducing the returns to posting. Thus, job prospects deteriorate. Job-finding rates for long term unemployed reduce not only because there are fewer vacancies to apply to, but also because the event of those fewer vacancies not being filled in by short term unemployed is of lower probability. In other words, firms' ranking strategies make the unemployment benefits effects on job prospects be increasingly stronger with duration. This demand-side-driven mechanism is complementary to Ljungqvist and Sargent (1998) story for the long term unemployment differences between the US and Europe. In their case, the European higher rates are explained from the supply side: the larger the benefits, the less intensely job-seekers search, with human capital depreciation working as an amplification mechanism.

Minimum Wage A binding minimum wage legislation have a well-known effect: it makes unemployed become unemployable after a certain unemployment duration as it is associated here with low expected productivity. There is a secondary effect. By conditioning hiring of low productive workers, the minimum wage policy restrains firms' entry as it reduces the expected profits of a given vacancy. Thus, skilled workers turn out to be affected as well. The empirical relevance of this effect remains to be estimated.

Job-search Assistance Programs Long term unemployed are usually helped to write their applications and resumes, and prepare their interviews (see Heckman et al.). In our model, these programs can be modeled by raising the parameter λ for long-term unemployed. Notice that this policy is inefficient by definition: it reduces the level of information as the testing device becomes less informative. Thus, firms update their beliefs on the imperfectness of the screening technology, and the expected productivity of long term unemployed would fall down reducing firms' entry.

Hiring Subsidies Subsidizing job creation is a policy widely used across countries. Its usefulness mainly relies on the assumption of human capital deterioration while unemployed, and skill acquisition on the job. However, if the informational stigma mechanism is of some empirical importance, this policy introduces important distortions in the economy. It modifies firms' hiring incentives: the subsidy makes job-seekers with longer unemployment spells more attractive to firms even though they are less skilled than others in expected terms.

Centralized Screening Systems There is an obvious information-wasting problem in this economy as a negative result at testing is only observable to firms, untradable and imperfectly captured by job-seekers' unemployment duration. Efficiency gains would be obtained by centralizing testing. Two empirical counterparts of centralized screening are worthwhile mentioning: namely, the US Temporary Help Supply industry and the Japanese school-based hiring system. Regarding the former, Autor (2001) reports that THS firms grew systematically in the 1990s accounting for 10 percent of employment growth in that decade. Autor (2003) estimates the effects of the changes to the employment-at-will doctrine on the growth of the THS industry at 20% from 1973 to 1995. In addition to training and labor supply, the THS industry offers screening services. In particular, screening is relevant for one fourth of THS services clients, who aim at filling in permanent positions. Japanese high-schools in turn play an active role in the job-asignment of the newly-graduated students, and firms benefit from the bulk of information accumulated by teachers over the education years.

5 Conclusions

The empirical evidence shows that hazard rates and exit wages fall as unemployment progresses. Two non-mutually exclusive factors have been considered: a genuine and a spurious duration dependence. The latter component is based on heterogeneity of workers that is observable to economic agents, but unobservable to the econometrician. Over the course of unemployment the composition of workers changes in favor of those with lower hazard rates. Genuine duration dependence in contrast results from characteristics, such as loss of skills, search discouragement or stigmatization that can change during unemployment.

This paper builds a theory of ranking by unemployment duration based on informational stigma, in which both factors take place. Firms form rational expectations on the expected productivity of job applicants according to the observables. Provided that skilled workers are more likely to pass the interviews, unemployment duration is a signal of the expected productivity of applicants as it conveys information on past rejections. The informational externality leads firms to optimally rank candidates by duration, what points to the state dependent component of the negative duration dependence referred to above. In addition to the consistency with these well-known facts, we positively test with CPS data the implication that wages decline more over duration during booms than during recessions.

Time is modeled as discrete. The reason for this assumption is twofold: first, there would be no coordination frictions with continuous time (footnote on Moen, and Blanchard and Diamond); second, discrete time enables us to show existence of equilibria. Notice that this may have an effect on the difficulties to analytically show that wages decrease with unemployment duration. It is worth recalling that equilibrium wages are determined by two components; the first one is the probability of being the only applicant from her cohort conditional on the firm receiving at least one application from it. In this setup, this conditional probability increases with duration as noted above, whereas in a continuous time setting it would be always 1. Therefore, this is a valuable extension.

References

Abraham, K., and J. Haltiwanger (1995): "Real wages and the business cycle," *Journal of Economic Literature*, 33(3), 1215–1264.

Abraham, K., J. Spletzer, and J. Stewart (1999): "Why do different wage series tell different stories?," *American Economic Review*, 89(2), 34–39.

Arvey, R., and J. Campion (1982): "THE EMPLOYMENT INTERVIEW: A SUMMARY AND REVIEW OF RECENT RESEARCH1," *personnel psychology*, 35(2), 281–322.

Autor, D. (2001): "Why do Temporary Help Firms Provide Free General Skills Training?*," *Quarterly Journal of Economics*, 116(4), 1409–1448.

——— (2003): "Outsourcing at will: the contribution of unjust dismissal doctrine to the growth of employment outsourcing," *Journal of Labor Economics*, 21(1), 1–42.

Blanchard, O. J., and P. Diamond (1994): "Ranking, Unemployment Duration, and Wages," *The Review of Economic Studies*, 61(3), 417–434.

Genda, Y., A. Kondo, and S. Ohta (2010): "Long-Term Effects of a Recession at Labor Market Entry in Japan and the United States," *forthcoming in Journal of Human Resources*.

Gibbons, R., and L. Katz (1991): "Layoffs and lemons," *Journal of labor Economics*, pp. 351–380.

Gonzalez, F., and S. Shi (2009): "An equilibrium theory of learning, search and wages," *Mimeo U. of Toronto*.

Greenwald, B. (1986): "Adverse selection in the labour market," *The Review of Economic Studies*, 53(3), 325–347.

Haefke, C., M. Sonntag, and T. Van Rens (2007): "Wage rigidity and job creation," *mimeo*.

Heckman, J., R. LaLonde, and J. Smith (1999): "The economics and econometrics of active labor market programs," *Handbook of labor economics*, 3, 1865–2097.

Jaeger, D. (1997): “Reconciling the old and new census bureau education questions: Recommendations for researchers,” *Journal of Business & Economic Statistics*, 15(3), 300–309.

Katz, L., and B. Meyer (1990): “Unemployment insurance, recall expectations, and unemployment outcomes,” *The Quarterly Journal of Economics*, pp. 973–1002.

Ljungqvist, L., and T. Sargent (1998): “The European unemployment dilemma,” *Journal of Political Economy*, 106(3), 514–550.

Lockwood (1991): “Information Externalities in the Labour Market and the Duration of Unemployment,” *The Review of Economic Studies*, 58(4), 733–753.

Machin, S., and A. Manning (1999): “THE CAUSES AND CONSEQUENCES OF LONGTERM UNEMPLOYMENT IN EUROPE,” *Handbook of Labor Economics*.

Moen, E. (1999): “Education, ranking, and competition for jobs,” *Journal of Labor Economics*, 17(4), 694–723.

Oberholzer-Gee, F. (2008): “Nonemployment stigma as rational herding: A field experiment,” *Journal of Economic Behavior and Organization*, 65(1), 30–40.

Pissarides, C. (2009): *Econometrica*.

Pissarides, C. A. (1992): “Loss of Skill During Unemployment and the Persistence of Employment Shocks,” *The Quarterly Journal of Economics*, 107(4), 1371–1391.

Polivka, A. (1996): “Data watch: The redesigned current population survey,” *The Journal of Economic Perspectives*, 10(3), 169–180.

Shimer, R. (2005): “The Assignment of Workers to Jobs in an Economy with Coordination Frictions,” *Journal of Political Economy*, 113(5), 996–1025.

Shimer, R. (2008): “The probability of finding a job,” *American Economic Review*, 98(2), 268.

US-Census-Bureau (2006): “Design and Methodology. Current Population Survey,” .

Vishwanath, T. (1989): “Job search, stigma effect, and escape rate from unemployment,” *Journal of Labor Economics*, pp. 487–502.

6 Appendix

6.1 Model with Skill Attrition

As van der Berg and van Ours (1996) state, unobserved heterogeneity and true state dependence appear to yield very similar hazard rate distributions, what leads to an identification problem of difficult solution. We show here that indeed, two mechanisms that may be responsible for each of those two components of negative duration dependence are observationally equivalent. In this section we consider a more general model in which human capital depreciates while unemployed. We model it as a expected productivity drop, which may vary over unemployment, $\delta(\tau)$. Therefore, the expected productivity distribution becomes $y(\tau) = \bar{y}(\tau) - \delta(\tau)$. Clearly, this is an additional reason for recruiting firms to rank candidates by unemployment duration.

First, we show that the stigma mechanism presented above and a mechanism based mainly on human capital depreciation may be observationally equivalent. That is, for a given skill attrition distribution over duration, the two mechanisms support the same equilibrium outcome. The identification problem is thus of major interest, first, to understand the relevance of each channel on the unemployment distribution, and, second, to recommend adequate public policies.

Second, we calibrate the extended model to the US economy, and undertake some counterfactual policy experiments.

6.1.1 Identification Problem

Let us consider a slightly different physical environment, where the differential features are:

1. Workers are ex-ante identical. Thus, testing is useless. [22]

2. Unemployed workers' productivity depreciates every period according to the exogenous distribution $y(\tau)$.

3. Search discouragement: workers apply with an exogenous intensity, $s(\tau)$, to jobs as unemployment progresses.

The following proposition claims that the equilibrium allocation characterized by the fixed point condition of function f may be also obtained in this environment. Two requirements must hold:

[22] Alternatively, we might consider that firms disregard screening candidates because of too a high testing cost.

First, workers' productivity depreciates as unemployment elapses according to the stigma equilibrium expected productivity distribution $\bar{\mathbf{y}}_\tau$. Second, the exogenous search intensity declines with duration according to $p(\tau; \mathbf{u})$. These two conditions make the equilibrium characterization problem formally equivalent to the above one.

Proposition 6.1 *Any equilibrium allocation* $(\mathbf{u}, \omega, \mathbf{U}, \mathbf{q})$ *derived from the stigma scenario is also an equilibrium outcome in this environment provided that* $y(\tau) = \bar{\mathbf{y}}_\tau$, *and* $s(\tau) = p(\tau; \mathbf{u})$.

Two issues are worth highlighting in the comparison. First, despite the equivalence in equilibrium outcomes, the efficiency properties differ. This is not surprising as the physical world must also differ in the centralized economies. Recall that the stigma equilibrium was shown to be constrained inefficient because agents could not internalize the effects of testing on future new born agents. When making productivity and search intensity exogenously decline with duration, the planner cannot improve upon the decentralized outcome under certain assumptions: namely, the productivity distribution is concave. It is easy to come up with examples in which ranking workers by duration is individually optimal, but not socially. For instance, for T=2, and with an ϵ skill deterioration, the planner may prefer to hire the "long term" unemployed workers if the discounting parameter is low enough.

Second, despite the steady state equivalence, the two propagation mechanisms behave differently when the economy faces a sudden temporary shock. Let us consider an aggregate negative and temporary productivity shock. The flow of vacancies instantaneously reduces due to lower expected returns to posting. With exogenous decline in productivity and search intensity, a temporary unemployment rise would have long effects over time. In contrast, in the benchmark environment the propagation mechanism is affected by the demand side's reaction to the negative shock. The more loose the labor market is, the less information on the expected productivy of the pool of remaining applicants is conveyed to the future because of less testing. As a result, for any given duration τ, the average productivity of the unemployed pool declines at a lower rate than before the shock. Therefore the transition back to the steady state must be shorter and showing lower unemployment rates in the stigma scenario. (simulation). This is consistent with Lazear's (1986) results. In his model, stigma is also more of an issue during booms than during recessions.

Despite the obvious interest in disentagling the two channels, no much can be said as even if the human capital depreciation rates are disproportionally high, that may be caused by a not well-pinned down search discouragement effect. There is little work devoted on isolating the causes of negative duration dependence whereas a number of public policies have been implemented worldwide to help the long term unemployed.

The two mechanisms of duration dependence in this paper, however, have been shown to have quite different implications.

6.2 Proofs

Proof of Lemma 2.3

Let $P(i|\tau, p)$ denote the probability that a worker of age τ is of type i conditional on having passed the test (event p). We need to show that $P(h|\tau, p)$ is decreasing in τ. Then, by using Bayes' rule,

$$P(h|\tau,p) > P(h|\tau+1,p) \Leftrightarrow \frac{P(h)P(\tau,p|h)}{P(h)P(\tau,p|h)+(1-P(h))P(\tau,p|l)} > \frac{P(h)P(\tau+1,p|h)}{P(h)P(\tau+1,p|h)+(1-P(h))P(\tau+1,p|l)}$$

Now, after some manipulations, this inequality is true if and only if

$$\frac{P(\tau|l)}{P(\tau|h)} < \frac{P(\tau+1|l)}{P(\tau+1|h)} = \frac{P(\tau|l)(1-\lambda_l+\lambda_l P(\tau+1|\tau))}{P(\tau|h)(1-\lambda_h+\lambda_h P(\tau+1|\tau))} \Leftrightarrow \lambda_h > \lambda_l$$

where $P(\tau+1|\tau)$ stands for the probability of staying unemployed one more period conditional on passing the test. Thus, the expected productivity $\overline{y}_\tau$ falls with τ provided that type l workers are less successful in passing the test than type h job-seekers are.$\|$

Proof of Proposition 2.2 Let $f : K \to K$ defined as the composition $\phi \circ \psi$. We just need to show that f is a continuous function, and $K \subset \Re^{3T}$ is a compact set. Then, Brower's Fixed Point Theorem applies, and ensures the existence of a fixed point of function f.

Let us first define K. $K \equiv \{z = (u, U') \in [0,1]^{2T} \times [0, y_h\beta(1)]^T | \frac{u_h(\tau+1)}{u_l(\tau+1)} \leq \frac{u_h(\tau)}{u_l(\tau)}, U'_{\tau+2} \geq U'_{\tau+1} + \frac{\beta(\tau)\overline{y}(\tau;u)-\beta(\tau+1)\overline{y}(\tau+1;u)}{\beta}\}$, where $\beta(\tau) = \frac{1-\beta^{T-\tau+1}}{1-\beta}$. In words, K is the nonempty set of pairs formed by worker distributions in the two dimensional age-productivity space and today's expectations on unemployment value functions. The reasons for the defining constraints will be seen in short. Obviously, the set in question is compact.

We turn now to show that $\psi(z)$ is a continuous function. After substituting out the wages from the complementary slackness conditions, the firm's problem can be rewritten as

$$max_q F(q) \equiv \sum_{\tau=1}^{T} \left(\eta_\tau(q^\tau)\Delta(\tau) - q_\tau \frac{U_\tau - b - \beta U'_{\tau+1}}{p_\lambda(\tau)} \right)$$

where $\Delta(\tau) \equiv \bar{y}_\lambda(\tau)\beta(\tau) - b - \beta U'_{\tau+1}$. Wages were replaced out because unemployed workers strictly prefer employment to unemployment. Then, the complementary slackness condition implies that low wages are penalized with zero queue lengths. In other words, $U_\tau > b + \beta U'_{\tau+1}$. First, we will show that the firm's problem has a unique solution, which is characterized by the first order conditions. The Hessian of function F is $D^2F = (h_{ij})_{i,j}$, where for any given pair (i,j), with $i \leq j$,

$$h_{ij} = \sum_{\tau \geq j} \frac{\partial^2 \eta_\tau(q^\tau)}{\partial q_i \partial q_j} \Delta(\tau) = -\frac{U_j - b - \beta U'_{j+1}}{p_\lambda(j)}$$

The last expression for $h_{i,j}$ is only true at the critical values of F. Therefore, $h_{i,j} < 0$ at the critical values for all i, j. Now, we will show that the Hessian is negative definite at all critical values. That is the case if and only if $v' D^2 F v < 0$, where v is a nonzero vector of dimension T. Notice that $v' D^2 F v = \sum_{i=1}^T h_{ij} \left(\sum_{\ell=i}^T v_\ell \right)^2$, which is strictly negative since: first, all hessian components are so, and are multiplied by nonnegative numbers; and second, $\sum_{\ell=\iota}^T v_\ell \neq 0$, where $\iota$is the subindex of the last nonzero component of vector v. As a result, all critical values must be local maximums, i.e. there is a unique global maximum, and the FOC are also sufficient..

Let $z \in K$. Then, $\psi(z)$ is defined by the solution set of the following system:

$$q_\tau = q_1 \alpha(\tau) \text{ for all } \tau < T \tag{21}$$

$$q_T = q_1 \alpha(T)$$

$$\sum_{\tau=1}^T \left(\beta(\tau)\overline{y}(\tau; u) - b - \beta U'_{\tau+1} \right) \sum_{j=1}^\tau q_j q_\tau \frac{\partial \nu_\tau(q)}{\partial q_j} = -k \tag{22}$$

where $\alpha(\tau) = \frac{u_h(\tau) + u_l(\tau)\lambda}{\mu + (1-\mu)\lambda}$. The third condition comes from rearranging terms in the zero-profit condition by using the FOC of the firms' maximization problem, whereas the remaining equations are the *Vacancies condition* (13).

It must be shown that the solution set is singleton. For that, the variables q_τ are replaced out from the last condition imposing the first equalities. Thus, it remains a two equation system with two unknowns q_1 and q_T. The equation (**??**) establishes a positive relationship between the two variables. Finally, after taking derivatives on the equation (22) with respect to q_1, we obtain

$$\overline{y}(T;u)e^{-(q_1\sum_i^{T-1}\alpha(i)+q_T)}\left(q_1\sum_i^{T-1}\alpha(i)+q_T\right)\frac{dq_T}{dq_1}=$$

$$-\sum_\tau^{T-1}(\beta(\tau)\overline{y}(\tau)-\beta U'_{\tau+1}-\beta(\tau+1)\overline{y}_{\tau+1}+\beta U'_{\tau+2})q_1e^{-q_1\sum_i^\tau\alpha(i)}\left(\sum_i^\tau\alpha(i)\right)^2$$

$$-\overline{y}(T)\sum_i^{T-1}\alpha(i)e^{-q_1\sum_i^{T-1}\alpha(i)-q_T}\left(q_1\sum_i^{T-1}\alpha(i)+q_T\right)$$

From what it follows $\frac{dq_T}{dq_1}<0$ in K as the second defining restriction implies that the first term of the right hand side is negative. Hence ψ is a function on K. Indeed, it is a continuous one. Since ϕ is obviously a continuous function, so is the composed f. Finally, the first defining constraint of the set K guarantees that the equilibrium is characterized by a declining expected productivity over the lifetime.‖

Proof of Lemma 2.4

The proof follows closely Shimer (2005), so omitted. ‖

Proof of Lemma 2.5

Let us first show that $U(\tau)$ decreases in τ. For simplicity, $b=0$. We can rewrite the first order condition of the firm's program (14) with respect to $q_{\tau'}$ as

$$U(\tau)=\beta U(\tau+1)+p_{\tau'}e^{-\sum_1^\tau q_{\tau'}}\sum_\tau^T e^{-\sum_{\tau+1}^{\tau'}q_{\tau''}}(\Delta(\tau')-\Delta(\tau'+1)) \tag{23}$$

Now, we proceed by backward induction. The first inequality in the two following cases comes from $p_\tau>p_{\tau+1}$ for all τ

Case T-1:

$U(T-1)-U(T)>\beta U(T)+p_Te^{-\sum_1^{T-1}q_{\tau'}}(\Delta(T-1)-\Delta(T))=\beta U(T)(1-p_Te^{-\sum_1^{-1}q_{\tau'}})+p_Te^{-\sum_1^{T-1}q_{\tau'}}(\bar{y}_{T-1}(1+\beta))-\bar{y}_T)>0$

Case τ:

$U(\tau)-U(\tau+1)>\beta(U(\tau+1)-U(\tau+2))+p_{\tau+1}e^{-\sum_1^\tau q_{\tau'}}(\sum_\tau^T e^{-\sum_{\tau+1}^{\tau'}q_{\tau''}}(\Delta(\tau')-\Delta(\tau'+1))-e^{q_{\tau+1}}\sum_{\tau+1}^T e^{-\sum_{\tau+2}^{\tau'}q_{\tau''}}(\Delta(\tau')-\Delta(\tau'+1)))=$
$=\beta(U(\tau+1)-U(\tau+2))+p_{\tau+1}e^{-\sum_1^\tau q_{\tau'}}(\Delta(\tau)-\Delta(\tau+1))=\beta(U(\tau+1)-U(\tau+2))(1-p_{\tau+1}e^{-\sum_1^\tau q_{\tau'}})+p_{\tau+1}e^{-\sum_1^\tau q_{\tau'}}(\bar{y}_\tau\beta(\tau)-\bar{y}_{\tau+1}\beta(\tau+1))>0$

The last inequality derives from the induction step, and the falling expected productivity.

Regarding the second part, to show that the job-finding rate conditional on passing the test it must be shown that for any τ,

$$\frac{1-e^{-q_\tau}}{q_\tau} > e^{-q_\tau}\frac{1-e^{-q_{\tau+1}}}{q_{\tau+1}} \tag{24}$$

or, rearranging terms

$$e^{q_\tau}\frac{1-e^{-q_\tau}}{q_\tau} > \frac{1-e^{-q_{\tau+1}}}{q_{\tau+1}} \tag{25}$$

Notice that the left hand side is an increasing function of q_τ. Thus, the inequality holds provided that $q_\tau > q_{\tau+1} > 0$. In equilibrium this condition is satisfied due to the *Vacancies condition*. Now, to show that unconditional job-finding probabilities also decline with τ, we need to prove that

$$(p(h|\tau+1)+\lambda(1-p(h|\tau+1))\nu_{\tau+1}(q_{\tau+1}) \leq (p(h|\tau)+\lambda(1-p(h|\tau))\nu_{\tau+1}(q_\tau) \tag{26}$$

We just proved that $\nu_{\tau+1}(q_{\tau+1}) \leq \nu_\tau(q_\tau)$. As the passing the test probability also decreases with τ (26) holds.$\|$

Proof of Lemma **??**

Let us consider the equilibrium allocation of Section 3. Now, let us consider the Inada conditions on the cost function c. Consider an ϵ measure of firms deviating to pay for $\lambda-\delta$-screening services. That is, unskilled applicants will pass the test with probability $\lambda-\delta$ if applying to this offer, and these firms will pay $c(\delta)$ to some unmodelled intermediaries with screening expertise. To see whether such a deviation may be profitable, let us consider the simple case in which, despite the more stringent screening technology, firms sufficiently compensate workers to make them indifferent to the equilibrium allocation of Section 3. This requires:

$$p(\tau;u)(E_\tau(w)-b-\beta U_{\tau+1}(u)) = p_\delta(\tau;u)(E_\tau(w_\delta)-b-\beta U_{\tau+1}(u))$$

Now, the asset value of the vacancy of such deviating firms becomes

$$V_\delta(w_\delta;u) = -k-c(\delta)+\sum_\tau \eta_\tau(q^\tau(w_\delta))(\bar{y}_\delta(\tau;u)-w_\delta)\beta(\tau)$$

Obviously, for $\delta = 0$, that value is 0. We have to show that for positive and sufficiently small values of δ, it is indeed strictly positive. Since the deviation is set for $q^{\tau}(w_{\delta})$ to coincide with the equilibrium queue length, the derivative of the asset value with respect to δ is $\frac{dV_{\delta}}{d\delta} = -c'(\delta) + \sum_{\tau} \eta_{\tau}(q^{\tau}(w_{\delta}))\frac{d(\bar{y}_{\delta}(\tau;u)-w_{\delta})}{d\delta}\beta(\tau)$. Given that $c'(0) = 0$, and $\frac{d(\bar{y}_{\delta}(\tau;u)-w_{\delta})}{d\delta}\beta(\tau) = \frac{u_l(\tau)}{u_h(\tau)+(\lambda-\delta)u_l(\tau)}(\bar{y}_{\delta}(\tau;u)\beta(\tau) - w_{\delta}\beta(\tau) + \beta U_{\tau+1}(u))$, the derivative evaluated at $\delta = 0$ is strictly positive.

Proof of Proposition ??

The equilibrium does not need a fixed point problem to be characterized in the environment with skill attrition as the productivity and the search discouragement distributions are exogenous. Notwithstanding, given any pair of such distributions, the equilibrium allocation must be a fixed point of function f, defined in Section (2.3). We will show that the equilibrium allocation derived from the informational stigma scenario is also an equilibrium with skill attrition and exogenous search discouragement. Let $(\mathbf{u}, \omega, \mathbf{U}, \mathbf{q})$ be an equilibrium allocation in the benchmark scenario.

Let $u(\tau) \equiv \mathbf{u}_h(\tau) + \mathbf{u}_l(\tau)$ denote the unemployment measure conditional on duration. Given $(\mathbf{u}, U')$, and the exogenous productivity and search effort distributions, the equilibrium allocation must also solve the (dual of the) firm's problem, and the vacancies condition. The firm's problem does not present any difficulty. The vacancies condition must be written in terms of efficient units of search as it is defined from the expected queue lenghts. Thus,

$$q_{\tau} = q_1 \frac{s(\tau)u(\tau)}{s(1)u(1)}$$

It is easy to see that this expression coincides exactly with condition 13 provided that the search intensities are defined by $p(\tau; \mathbf{u})$. Then, it only remains to show that the unemployement distribution by duration is equally determined as in function f. Given the definition of $u(\tau)$, the condition $s(\tau) = p(\tau; \mathbf{u})$ suffices to show that the dynamics (by duration) of unemployment are obtained by adding the two *Recursivity conditions* 12 $u(\tau + 1) = u(\tau)(1 - s(\tau)\nu_{\tau}(q^{\tau}))$.$\|$

6.2.1 Appendix B. Social Planner Problem

The centralized economy is ruled by a social planner, who maximizes the discounted expected utility of the representative worker subject to a number of constraints. As usual in the literature, that is equivalent to maximizing output net of recruitment costs. Those restrictions are: the benevolent dictator faces the same symmetric incomplete information problem as agents do in the decentralized environment. Likewise, it has access to the same imperfect screening technology. However, the results from testing cannot be centralized. That is, the planner gathers information only from unemployment duration. Finally, the planner must asign vacancies to observables, i.e. τ, but not to individuals.

The benevolent dictator has four decisions to make. First, how many labor submarkets to create. Second, how many vacancies in each submarket. Third, it must tell workers to which labor market to apply. And, finally, the hiring strategy must be determined as a function of observables.

It is straightforward to give an answer to some of these questions. Within any submarket, if randomizing among candidates to fill a given vacancy, the matching technology is CRS, and the job-finding probability is concave in $\frac{1}{q}$, where q stands for the ratio of job-seekers to vacancies. Thus, it is optimal to create a single labor market, and indicate all unemployed to send an application to that market although some workers may be discriminated against. That is an optimal decision provided that there are no crowding-out effects. Now, notice that low-skilled workers are as productive at home as at work. As a result, the planner will make passing the test a necessary qualifying condition. Finally, the planner does not have superior information than agents have in the decentralized economy with respect to candidates' productivity. Unemployment duration is informative to discriminate against those workers who are equally productive at home than in the market. Therefore, the planner will use unemployment duration to

6.3 Data

The Bureau of Labor Statistics (BLS) compiles data on employment- and earnings-related issues since 1940 by means of the Current Population Survey (CPS). Individuals stay in the survey for two sets of four consecutive months with a eight month period in between. The fourth and eight interviews constitute the so-called outgoing rotation groups, and earnings-related questions are only asked at these times. Due to these structural difference, hazard rate observations outnumber newly employed workers' wages by about four to one. We construct two different datasets for the period 1994-2008.[23] In either case, observations correspond to individuals in the survey who were unemployed at the previous month. Furthermore, the earnings data set reduces to individuals

[23]Surverys from June to September 1995 are excluded due to methodological changes that difficult tracing individuals over time.

additionaly reporting to be employed at the interviewing month. To keep track of individuals over two consecutive months, we control for household identifier, person line number, month-in-sample, sex, race and age.

The final dataset is the result of a number of filters. First, age is restricted to be 20 to 60. Second, individuals reporting either not to be actively seeking for a job or expecting a recall in the previous month are excluded as their seeking behavior and the resulting outcomes from the searching activity differ from the regular unemployed job-seekers'.[24] Third, farming-, army- and public-administration-related employment are removed from the pool. Fourth, observations linked to unemployment spells longer than one year are not considered. Finally, imputed observations are excluded, i.e. only are reported earnings considered (see the allocated earnings-related problem below). Eventually, we have 52576 observations of hazard rates and 10103 of hourly wages.[25]

Hourly Wages. CPS has undergone a number of modifications since 1940. In particular, an important redesign took place in 1994 both on the question wording and the data processing, which particularly affected the earnings variable (see US-Census-Bureau (2006) and Polivka (1996)). These changes arise inconsistency of hours worked and hourly wage before and after 1994, and motivate our choice of the time period. Prior to this methodological change, individuals were asked to report their earnings on a weekly basis, including overtime, tips and commisions. In addition, they were asked to report their usual working hours at all jobs. After 1994, more information were obtained in these respects. More specifically, interviewees were allowed to choose to report their earnings on different time basis, being formally labeled 'hourly' and 'non-hourly' workers.[26] Hourly workers are asked to report their hourly rate at their main job, excluding overtime, tips and commissions. These perks are also reported at the weekly basis. Remaining interviewess report total earnings (including perks) in the prefered time basis, amounts which are converted to weekly rates in later data-processing.

Our focus is on the hourly wage of hourly workers at their main job. This may have some caveats, particularly if there is a selection effect when excluding non-hourly workers, and if the

[24] Reemployment wages upon recall are strongly linked to their priot-to-temporary-layoff earnings. Katz and Meyer (1990) estimate the mean weekly income loss at 14.44% upon a job switch, and at 5.73% after a recall.

[25] Although unemployment benefits surely affect job-seeking behavior, and hence the two outcomes of the seeking activity (probability of finding a job and accepted wage), unfortunately CPS does not ask for benefits eligibility.

[26] To be precise, those individuals who preferred to report in a non-hourly-basis, but declared to be paid hourly are also labeled as 'hourly workers'.

perks are a substantial component of earnings. An alternative is to analyze weekly earnings (perks included) divided by usual hours (see Schmitt (2003) for a discussion). A couple of points justify our choice: first, the ratio of hourly to non-hourly workers is above five, and, for hourly workers, weekly earnings obtain from multiplying the hourly wage and the usual number of working hours (adding the overtime, tips and commissions, if reported).[27] There are very few observations on perks for hourly workers, and the summary statistics (particularly the mean) of adjusted hourly rates from weekly earnings do not differ much from hourly wages. Second, as opposed to working time "at all jobs", since 1994 usual working time at the main job has been directly addressed, and double checked. Further, 'hours vary' was introduced as a new answer in the working time question. Although imputation strategies may be undertaken given that such a response accounts for 6 to 7% of the total employment (see Schmitt (2003)), the percentage rises over 14% in our subsample of newly employed indicating that the working time may be more volatile at the start of employment spells. Furthermore, Abraham, Spletzer, and Stewart (1999) emphasize the problem of workers' overreporting their working time. In any case, we do robustness checks for hourly workers' weekly earnings controlling for working time to adjust for perks. See Table ???.

There are some usual issues related to earnings-data processing. Looking at weekly earnings, less than 0.2% of the observations are topcoded. Regarding trimming, i.e. how best to deal with implausibly low or implausibly high hourly wages, we follow Schmitt's (2003) suggestion and keep hourly rates between $1 and $100. Due to the above comments on topcoding, removing hourly wages above 100 is irrelevant. Finally, another potential issue is the allocated earnings. BLS uses the "cell hot decking" procedure to impute earnings to those missing responses.[28] The allocated responses account for over 30% of the outgoing rotation group after 1994, and about 21% in our subsample of newly employed workers.[29] We have performed the analysis excluding those imputed earnings, and robustness checks including them are in Table ???.

Hourly wages are deflated by the US city average CPI. In the Mincerian log wage regression, the set of regressors is formed by a time variable, age and its square, along with sex, race, month, marital status, industry, occupation, state, education and union-membership dummies. Additionally, a dummy to control for the potential effects of unemployment benefits exhaustion at the 26th week

[27] Using CPS recoding variables, we would have: Prernwly = Prernhly x Peernhr0 + Peern.

[28] According to the US-Census-Bureau (2006, 9-2), "the weekly earnings hot deck is defined by age, race, sex, usual hours, occupation, and educational attainment."

[29] For methodological reasons, there are no imputed earnings from January 1994 to August 1995.

is included, although it is not statistically significant. Although experience is usually considered, it must be noticed that basic monthly CPS does not include experience reports. Haefke, Sonntag, and Van Rens (2007), for instance, impute experience from substracting schooling years from age, and considering Jaeger (1997) estimation of years of schooling from CPS coding. We prefer to use directly age and educational attaintment as regressors, capturing all information from such imputation. We find no appretiable difference otherwise. Finally, we use the outgoing rotation weights.

Hazard Rates. To estimate the empirical hazard rate at any given unemployment duration, two time series are constructed: one for newly employed and another one of job-seekers. Those observations are multiplied by the CPS final weights. For seasonal adjustment, we use the US Census Bureau's software X-12-ARIMA. The way X-12-ARIMA deals with missing values is by treating them as outliers. Thus, we replace the missing values by the outlier-identifying code, -99999. Unfortunately, for many months the seasonal adjustment is not possible due to too many missing values. That is the reason why Figure ¿? plots hazard rates for up to 26 weeks.

Finally, we add up all the observations for any given duration to calculate the empirical hazard rate, $h(\tau)$. That is,

$$h(\tau) \equiv \frac{\sum_t e(t,\tau)}{\sum_t s(t,\tau)}$$

where $e(t,\tau)$ and $s(t,\tau)$ refer to the weighted and seasonally adjusted mass of newly employed and job-seekers who had been unemployed for τ weeks at time t.