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ABSTRACT

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We construct a simple equilibrium search model in which workers accumulate information about previously met employment contacts. We term the latter search capital. Here search capital (partially) insures workers against adverse shocks. The model provides a theory of job-to-job transitions that are associated with voluntary or involuntary mobility and with wage rises or wage cuts. It also shows why low wage and younger workers are associated with a higher probability of becoming unemployed.

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1 Introduction

Models of on-the-job search provide a useful framework for analysing job and wage mobility as well as wage dispersion. (See Burdett and Mortensen, 1998, and Postel-Vinay and Robin, 2002, for leading examples.) In these models, workers move up the earnings distribution as they repeatedly search and find better employment. When displaced, however, these workers do not recall the information from employment contacts accumulated during this process.

Amnesia is unappealing. Information recalled from prior contacts is potentially a valuable asset for avoiding unemployment when a worker separates from the current job. Recent empirical work in the networks literature points out the importance that employment contacts have in significantly increasing the job finding rates of non-employed workers (see Capellari and Tatsiramos, 2011, and references therein).

This paper formalises these ideas in a simple equilibrium model in which past search experiences become capital that (partially) insures workers against adverse shocks. Here on-the-job search not only enables workers to increase their wage, but to also build employment contacts. If displaced, workers can use previous employment contacts to fall back on. This simple and intuitive mechanism provides a plausible structural interpretation for the exogenous reallocation shock process added to estimated job search models. Without this type of ad hoc addition, on-the-job search models fail to account for the high proportion of job-to-job transitions that involve a wage cut or for the prevalence of immediate job re-accessions found in many OECD countries (see Jolivet, Postel-Vinay and Robin, 2006). Remembering contact histories directly builds in this feature. Moreover, with recall possible, the high turnover rates of young and low paid workers might not be due solely to the instability of their jobs, but to the relatively small size of their employment network as well.

2 Economic Environment

The model is based on the framework developed by Postel-Vinay and Robin (2002) and Carrillo-Tudela, Menzio and Smith (2011). Time is continuous and goes on forever. There is a unit mass of risk neutral workers and firms with a common discount rate $r > 0$. Workers maximize the discounted expected sum of their lifetime consumption. Firms operate using a constant return to scale technology and maximize the discounted expected sum of their profits.

Employment status along with the amount of capital accumulated from prior search characterise a worker. During unemployment, this worker consumes $z > 0$ units of output. While employed at wage w, the worker produces $x > z$ and consumes w. The worker's search capital, n, represents the number of available prior employment contacts, excluding the current employer or any firm that the worker might have just met. To keep the analysis

as straightforward as possible, let $n = 0, 1$. Further, a worker loses a contact at Poisson rate of $\phi \geq 0$ which can be interpreted as the rate at which search capital depreciates.

Unemployed workers meet a firm at rate $\lambda \geq 0$. Employed workers meet a firm at rate $s\lambda$, where $s \geq 0$ denotes the worker's search intensity. Any meeting triggers off a complete information auction for the worker's services among the just met firm and, if available, from the worker's other contact or employer. Each firm bids a wage knowing whether or not a competitor exists. If the worker accepts a bid, the wage remains constant until either the match separates or until another meeting which would trigger a new auction. If all bids are rejected, the worker becomes unemployed.

We emphasize that this fallback into unemployment assumption is made only to ease the notational burden. Allowing an employed worker who meets another firm thereby triggering a new auction with two bidders to reject both bids and then revert to the previous wage does not alter the equilibrium outcome. The possibility of reverting to the old wage expands the strategies for firms such that these strategies could depend on the existing wage and employment relationship. However, because a firm in a single bidder auction offers a wage that makes the worker indifferent between unemployment and employment ($U_1 = E_0(w)$ below), there is no difference in the value of reversion between employment and unemployment.

Regardless of the acceptance decision, a worker with no previous contacts adds the newly met firm to the contact list.[1] If the worker transits from unemployment to employment, however, the newly met firm becomes the employer and does not count as a contact in n.

At rate $\delta \geq 0$, an employed worker is exogenously displaced from the current job. When this happens, the current employer receives a payoff of zero and the worker receives a take-it-or-leave-it offer from the firm that is still in contact with him (if any). If the displaced worker accepts the fallback offer, the worker moves from one employer to the other without an intervening spell of unemployment. If the worker rejects the offer (or if the worker did not have a contact), the worker becomes unemployed.

3 Equilibrium

We focus on stationary symmetric pure strategies. Let $\sigma_f = (w_1, w_2)$ denote the strategy of a firm, where the first element denotes the wage the firm offers to a worker in an auction with one bidder and the second element the wage the firm offers to a worker in an auction with two bidders. Let U_n denote the lifetime utility of a worker who is unemployed and has n contacts. Let $E_n(w)$ denote the lifetime utility of a worker who is employed at the wage w and has n contacts. Let M_{n+1} denote the value to the firm of participating in an

[1] We assume that a worker who does not accept a job offer is not in bad terms with the potential employer later on.

auction with $n+1$ bidders. Let C^u denote the value to the firm of being in contact with an unemployed worker who has no other contact. Similarly, let C^e denote the value to the firm of being in contact with an employed worker who has no other contact. Finally, let $J_n(w)$ denote the value to a firm from employing a worker who has n contacts at wage w.

The expected value of an unemployed worker satisfies

$$rU_n = z + \lambda[\max\{E_n(w_{n+1}), U_1\} - U_n] + n\phi[U_0 - U_1].$$

Given that an employed worker stops searching after obtaining a contact (the capital gains from doing so are zero), the expected value of employment at wage w satisfies

$$rE_0(w) = w + s\lambda[\max\{E_1(w_2), U_1)\} - E_0(w)] + \delta[U_0 - E_0(w)],$$

$$rE_1(w) = w + \delta[\max\{E_0(w_1), U_1\} - E_1(w)] + \phi[E_0(w) - E_1(w)].$$

Since $E_n(w)$ is strictly increasing in w, the worker's acceptance strategy in an auction with $n+1$ bidders has the reservation property. Let $\sigma_w = (R_1, R_2)$ denote the strategy of a worker, where R_n denotes the reservation wage in an auction with n bidders.

The firm's expected value from meeting a worker with no other contacts

$$M_1 = \max_w\{I[w \geq R_1](J_0(w) - C^u)\} + C^u,$$

where I is an indicator function that takes the value of one if $w \geq R_1$ and zero otherwise. The firm's expected value from meeting a worker who is either employed or who is unemployed with one contact is

$$M_2 = \max_w \left\{ I[w > w_2](J_1(w) - C^e) + I[w = w_2] \left(\frac{J_1(w) - C^e}{2} \right) \right\} + C^e,$$

where the firm offers the wage w to the worker and the other contact (or current employer) offers him the wage w_2 and we have conjectured that $w_2 \geq R_2$. We also assume that a worker with two acceptable and equal offers chooses one randomly.

Definition: *A Symmetric Equilibrium is a worker's strategy $\sigma_w = (R_1, R_2)$ and a firm's strategy $\sigma_f = (w_1, w_2)$ such that:*
(i) For $n = 0, 1$, $E_n(w) \geq U_1$ if and only if $w \geq R_{n+1}$;
(ii)For $n = 0, 1$, w_n solves the firm's maximization problem describe by M_n.

4 Characterisation

The wage offered in a one bidder auction equals the workers reservation wage ($w_1 = R_1$) and the wage offered in a two bidder auction makes the firm indifferent about hiring

the worker (w_2 solves $J_1(w_2) = C^e$). Hence, the firm's strategies $\sigma_f = (w_1, w_2)$ imply $M_1 = J_0(w_1)$ and $M_2 = J_1(w_2) = C^e$, where $J_n(w_{n+1})$, C^e and C^u are given by

$$rJ_0(w_1) = x - w_1 + s\lambda[J_1(w_2) - J_0(w_1)] - \delta J_0(w_1),$$

$$rJ_1(w_2) = x - w_2 - \delta J_1(w_2),$$

$$rC^e = \delta(M_1 - C^e) - \phi C^e,$$

$$rC^u = \lambda(M_2 - C^u) - \phi C^u.$$

The following result describes the indifference condition faced by firms in an auction with two bidders.

Lemma 1: *Given* $w_2 \geq R_2$,

$$w_2 = \frac{(r+\phi)(r+\delta+s\lambda)}{(r+\phi)(r+\delta+s\lambda)+\delta(r+\delta)}x + \frac{\delta(r+\delta)}{(r+\phi)(r+\delta+s\lambda)+\delta(r+\delta)}w_1.$$

An unemployed worker with no contacts gets offered a wage $w_1 = R_1$ such that he is indifferent from accepting the job; i.e. $E_0(w_1) = U_1$.

Lemma 2: *Given* $w_2 \geq R_2$,

$$w_1 = \varphi w_2 + (1-\varphi)z,$$

where

$$\varphi = \frac{\lambda[(r+\lambda+\delta) - s(r+\lambda+\phi)]}{(r+\delta+\phi)(r+\lambda+\phi)+\lambda(r+\lambda))} < 1.$$

Note that φ is decreasing with search intensity as unemployed workers are prepared to accept a lower wage today as an investment for future wage growth (see Postel-Vinay and Robin, 2002). This effect is tempered, however, by the possibility of accumulating employment contacts. Given that an unemployed worker has the option to continue searching and increasing the wage when meeting another contact, a firm must compensate the worker for giving up this option. The relative importance of these channels then pins down the sign of φ.

Proposition 1: *The wages offered in equilibrium satisfy:*

$$w_2 = \alpha x + (1-\alpha)z \quad \textit{and} \quad w_1 = \beta x + (1-\beta)z,$$

where

$$\alpha = \frac{(r+\phi)(r+\delta+s\lambda)}{(r+\phi)(r+\delta+s\lambda)+(1-\varphi)\delta(r+\delta)},$$

$\beta = \varphi\alpha$ *and* $w_2 > w_1$.

To complete the characterisation of equilibrium we need to derive workers' reservation wages $\sigma_w = \{R_1, R_2\}$. The above arguments show that $w_1 = R_1$. The reservation wage of workers in a two bidder auction are derived by solving $E_1(R_2) = U_1$. It is straightforward

to verify that $w_2 \geq R_2$ is indeed satisfied.[2] Further, $J_0(w_1) > C^u > 0$ implies firms strictly prefer to hire an unemployed worker at the first meeting rather than keeping the worker as a contact. In a competitive auction, $J_1(w_2) = C^e > 0$ implies firms are indifferent between hiring the worker and keeping the worker as an employed contact and hence there is no profitable deviation. These arguments establish existence. Uniqueness can be established by showing that there is no equilibrium where firms offer a wage $w_{n+1} < R_{n+1}$.

Theorem 1: *The reservation strategies* $\sigma_w = (R_1, R_2)$ *and the offer strategies* $\sigma_f = (w_1, w_2)$ *describe the unique symmetric equilibrium with on-the-job search.*

5 Implications

This simple model is consistent with two observed properties of wage and employment dynamics that traditional search model have a difficult time in explaining. In particular, the model generates voluntary job-to-job transitions that are associated with wage rises and involuntary job-to-job transitions that are associated with wage cuts, both prominent features of modern labour markets (see Jolivet, Postel-Vinay and Robin, 2006). If an employed worker meets another firm, he chooses an employer with equal probability and keeps the other firm as an additional contact (a voluntary job-to-job transition with a wage rise). If subsequently his job is destroyed, the worker takes employment with his contact (if still available) at a lower wage, experiencing an involuntary job-to-job transition with a wage cut.

The mechanism inducing wage cuts is very different from that explored in other papers (see e.g. Postel-Vinay and Robin, 2002), in which workers accept voluntary wage cuts when changing to a job in a more productive firm that offers higher wage growth prospects. Adding firm heterogeneity also generates this type of job-to-job transition. Connolly and Gottshack (2008) present evidence showing that an important proportion of job transitions that involve a wage cut do not lead to faster wage growth in subsequent employment as implied by Postel-Vinay and Robin (2002). Indeed, the latter find that firm heterogeneity alone cannot generate the amount of wage cuts observed in the data. Furthermore, the importance of involuntary transitions is stressed by Nagypal (2005) who report that although job-to-job movements are approximately twice as large as employment-to-unemployment changes in the US, only a small fraction (less than 5%) of employed workers are actively searching. Jolivet, Postel-Vinay and Robin (2006) also find that involuntary job mobility that lead to immediate re-accessions (reallocation shocks and layoffs) are more frequent that voluntary mobility. It is then important to have a theory of job mobility that is consistent with this evidence.

Given that the amount of search capital is correlated with a worker's wage the model

[2]This follows as the solutions of w_2 and w_1 described in Proposition 1 imply that $E_1(w_2) > E_0(w_1) = U_1 = E_1(R_2)$. Since E_1 is increasing in w, we get that $w_2 > R_2$.

also implies that low wage workers have a higher probability of experiencing unemployment that high wage workers. Since worker's search capital is correlated with time spent in employment, younger workers also have a higher probability of becoming unemployed. These two implications are again consistent with empirical evidence. In particular, Stewart (2007) finds strong evidence showing that low wage jobs significantly increase the worker's probability of experiencing unemployment. This evidence is normally attributed to "unstable" jobs that exhibit a high separation rate. We argue that the accumulation of contacts over time and the possibility of recall is a plausible competing as well as complementary explanation.

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