Skill and Luck in the Theory of Turnover*

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Abstract

This paper investigates the joint implications of search and matching frictions in labor markets for wage inequality, and quantifies the average amount and the distribution of specific job-matching capital, vulnerable to exogenous job destruction. Workers differ both *ex-ante* in their average individual productivity (skill) and *ex-post* in their luck when matching with employers, learn over time the quality of the match, bargain on a wage, and search on and off the job for new employers. Conditional on skills, learning and selection map gaussian output noise into an equilibrium stationary and ergodic wage distribution which is unimodal and right-skewed, with a Paretian right tail. When parameterized to match observed aggregate worker flows, the model accurately predicts the observed wage loss following job destruction and hazard rates of separation as a function of tenure. The average amount of matching capital, vulnerable to job destruction, is then quantified at over a year worth of wages. Across skills, more able workers are more willing to tolerate mismatch to avoid unemployment; hence on average they experience a longer tenure, a more pronounced within-skill wage dispersion, a lower relative wage and welfare loss from displacement, a lower entry rate into unemployment and unemployment rate, higher job-to-job quitting rates with associated larger wage raises. Less skilled workers are dismissed earlier and then need to try more jobs or to get luckier to stay employed.

Keywords: wage distribution, job matching, job stability, specific human capital, worker flows, unemployment, Bayesian learning, ergodic analysis.

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1. Introduction

Different workers typically experience very different labor market outcomes on a variety of dimensions, well beyond the wages that they earn. Low-skill workers have relatively high incidence of unemployment and entry rates into unemployment, and relatively low exit rates from unemployment,[1] job tenure, propensity to search on the job (Blau and Robins 1990, Pissarides and Wadsworth 1994, Belzil 1996), and within-skill wage dispersion (Postel-Vinay and Robin 2002).

In this paper we show that a simple assumption about labor supply elasticity, combined with job matching frictions, goes a long way towards explaining all of these facts, *without* running into counterfactual predictions on other important dimensions. Suppose that the gap between individual productivity and opportunity cost of working time is higher for high-skill workers; in other words, across workers, the elasticity of labor supply is decreasing in skills. Then, high-skill workers are *more willing to tolerate mismatch* with their employers, because their mismatch with joblessness is relatively more severe. When a lackluster performance reveals a poor match, they are less willing to quit to unemployment, and rather search on the job to upgrade their match. They enter unemployment less often and accept higher within-skill wage dispersion. When jobless, they "compress" their wages relative to their productivities, so as to beat the competition of less skilled but also cheaper job applicants and leave unemployment faster. In contrast, less skilled workers turn over much more frequently and give the (false) impression of impatience when shopping for jobs, due to their relative comparative disadvantage in market activities. Fewer of the unskilled work, but those who do are matched better on average with their employers; they need to get luckier to stay employed. Their wages are similar.

To formalize and evaluate quantitatively this view, we adopt an equilibrium model of

[1] At any point in time, even within industry or sector, "primary" workers experience from 5% to 45% higher labor participation rates, from 3% to 20% lower unemployment rates and from two to ten times lower entry rates into unemployment, as well as midly higher exit rates from unemployment and from 1.2 to two times as many weekly hours worked. See Moscarini (1996) for the sources of this well established empirical evidence.

the labor market, which nests a version of Jovanovic (1979, 1984)'s canonical job matching model of worker turnover into Mortensen and Pissarides (1994)'s canonical model of equilibrium unemployment. The baseline model, introduced in Moscarini (2003) and assuming *ex ante* homogenous workers and firms, addresses stylized facts relating to worker turnover and within-skill wage inequality. In this paper, we extend the model to incorporate observable *ex ante* worker heterogeneity, and we evaluate quantitatively its predictions for the cross-sectional patterns that we mentioned at the onset and that motivate this study.

The literature offers a variety of equilibrium models of the labor market, that allow for worker heterogeneity of some sort, to address these same issues. However, each of these frameworks appears inadequate on at least one of the dimensions that we focus on. The canonical Mortensen and Pissarides (1994) model of unemployment and job flows, extended by the same authors (1999) to encompass skill heterogeneity just like in this paper, does not fare well in terms of implied wage dynamics on the job and shape of the wage distribution.[2] Partial equilibrium job matching models à la Jovanovic (1979, 1984) have little to say about job creation and again the wage distribution. Wage-posting models of equilibrium wage dispersion (e.g., Burdett and Mortensen 1998) have counterfactual predictions for within-job wage dynamics and tenure effects. Competitive Roy models of self-selection in terms of *ex ante* heterogeneous characteristics, designed to explain the wage distribution (Heckman and Sedlacek 1995), miss worker turnover and unemployment.

Our model interacts *ex ante* worker heterogeneity in terms of general human capital with *ex post* match selection−resulting in accumulation of specific human capital−to reconcile the observed dynamics *and* cross-sectional distributions of labor market quantities *and* prices. In equilibrium, the two forms of human capital are correlated positively, in the sense that more skilled workers accumulate more knowledge about a match before rejecting it, but also negatively, as skilled workers mismatch more in *ex post* terms, so the

[2]Equilibrium search models that allow for skill inequality have focused exclusively on low-frequency events, such as the rise in the skill premium (Acemoglu 1998) or the persistent inequality of employment rates (Mortensen and Pissarides 1999), rather than on short-term labor market dynamics.

overall productivity distribution is more compressed than that of general skills.[3]

There are two main reasons to focus on job matching and learning as a source of specific human capital accumulation. First, ample empirical evidence supports this choice.[4] Second, from a theoretical viewpoint, learning guides the modeler in the formalization of idiosyncratic productivity uncertainty. This source of risk has attracted increasing attention in the incomplete-market macroeconomic literature, but is hard to measure empirically. In this respect, learning imposes some general restrictions that are independent of the productivity process − most notably, posterior beliefs about match quality are martingales − and thus have robust implications for the correlation between tenure, wages, on-the-job search, and other observables.

We present a calibration of the model that exhibits substantial "over-identification" power: few unobservable parameters can be calibrated to match closely many more empirical moments. In other words, the reduced-form statistical model of labor market transitions and wages implied by our structural model is parsimonious and empirically accurate. One advantage of deriving it from an equilibrium model is the possibility of performing quantitative welfare analysis. In particular, we are interested in the size and in the distribution of job matching capital, the accumulated knowledge about specific productivity, which is vulnerable to an exogenous job separation. We find that the average value of this capital across productive matches exceeds one year of wages, and is larger for less skilled individuals, for the reasons explained earlier. That is, *albeit low-skill workers enter unemployment more often, they have more to lose when this is caused by exogenous events.* We abstract from other (orthogonal) potential sources of welfare loss from displacement,

[3]Neal (1998) assumes a technological complementarity between general skills and specific training, which leads more educated workers to accumulate more training and to move less across jobs.

[4]A good example of the established applied literature using survey data is Flinn (1986). More recently, Lane and Parkin (1998) find strong support for the Jovanovic matching model in the turnover patterns of a major accounting firm. Nagypal (2000) finds in French matched employer-employee data that learning about match quality vastly dominates learning-by-doing as a source of specific human capital accumulation. Altonji and Pierret (2001) go back to the the NLSY79 to find evidence of "statistical discrimination": firms hire workers based on easily observable characteristics − such as education − and then base their wage and promotion policies increasingly on what they learn from each employee's performance.

such as unemployment stigma, aversion to uninsurable income risk, and specific training: hence, here we consider just one side of the coin − better, of the die. Our estimate thus provides lower bounds both to the implied productivity decline that causes a privately efficient separation, and to the potential deadweight welfare loss in terms of matching capital from an inefficient separation.

In principle, the average welfare loss from a layoff may be computed directly from empirical observations, as the present discounted value of the persistent wage losses following a layoff. These empirical estimates, even if taken at face value and assuming them free from residual unobserved worker heterogeneity, tell us nothing about the loss to the firm, and therefore about the amount of idiosyncratic risk in labor markets and the total social loss. Different assumptions about the sharing between firms and workers of the loss from job separation feed back in general equilibrium on the accumulation of specific human capital and on the total loss itself. The larger the share of the cost sustained by firms, the lower job creation, the higher the cost of unemployment, the more pervasive mismatch in employment, and the lower the average amount of specific human capital in the economy. For this very reason, we deem necessary to rely on an equilibrium model, calibrated to match quantity and price data.

Another interesting magnitude with no observable counterpart is the average surplus (over idleness) of an employment relationship when the parties involved are not allowed to act on the information that output provides about match quality, and must stay together. The difference between the equilibrium surplus of a new match and this magnitude measures the returns from acting on information, and provides another measure of matching human capital. We estimate this magnitude at just over two months of wages. This is about the same as that found by Jovanovic and Moffitt (1990), using rather different methods applied to a simplified 2-OLG version of the original Jovanovic (1979) job matching model. Our estimate should be larger than theirs because we attribute all moves to job matching, as opposed to changes in sectorial wages as they do; but also smaller, because the search frictions and unemployment that we introduce reduce the value of learning. In the limit, if it were impossible to find a new match, no one would separate endogenously. Again, this return from information is larger for low-skilled workers, who use turnover more intensively to improve their match quality, and pay the price in terms of unemployment.

Section 2 illustrates the model, Section 3 its equilibrium, Section 4 its quantitative implications, Section 5 concludes.

2. The Economy

A consumption good is produced in continuous time by pairwise firm-worker matches (*jobs*). The average productivity of each match $\mu(a, \theta)$ is an increasing function of two time-invariant factors: a worker-specific component a (*ability, skill*), transferable across jobs and observable *ex ante* by both parties, and a match-specific component θ (*match quality*), which is *ex ante* uncertain and captures the experience good nature of a job. Without loss in generality, a and θ are independent. Upon matching, the firm and the worker share a common prior belief on θ, independent of their past histories and concentrated on two points, $p_0 = \Pr(\theta = \theta_H) = 1 - \Pr(\theta = \theta_L) \in (0, 1)$, where θ_L denotes a "bad" match and $\theta_H (> \theta_L)$ a "good" match.

The performance of the match is also subject to two additional and orthogonal sources of idiosyncratic noise. First, cumulative output in the time interval $[0, t]$ is a normal random variable, a Brownian Motion with drift $\mu(a, \theta)$ and known variance σ^2:

$$X_t = \mu(a, \theta)t + \sigma Z_t \sim N\left(\mu(a, \theta)t, \sigma^2 t\right).$$

Here Z_t is a Wiener process, a continuous additive noise that keeps θ hidden and creates an inference problem. Over time, parties observe output realizations $\langle X_t \rangle$, generating a filtration $\{\mathcal{F}_t^X\}$, and update in a Bayesian fashion their belief from the prior p_0 to the posterior $p_t \equiv \Pr(\theta = \theta_H \mid \mathcal{F}_t^X)$. The second, more drastic source of idiosyncratic shocks is a Poisson jump process, forcing jobs out of business at rate $\delta > 0$. This shock captures many important idiosyncratic sources of match dissolution; a few examples are, on the labor demand side, technological obsolence, natural disasters, changes in specific tax code provisions, idiosyncratic product demand shocks; on the labor supply side, human capital shocks such as worker disability, retirement, death, or other events like spousal relocation.

The economy is populated by a continuum of *ex ante* identical firms, of mass large enough to ensure free entry, and by a continuum of *ex ante* heterogeneous workers, with ordered skill types $a \in \mathbb{A} \subset \Re$ distributed by a given and known density. A jobless worker a enjoys a flow value of leisure $b(a)$, while idle firms get zero flow returns. Workers and firms are risk-neutral optimizers and discount future payoffs at rate $r > 0$.

We impose two cross-restrictions between productivity and value of leisure, one to avoid trivialities, the other substantive.

Assumption 1. *For every skill* $a \in \mathbb{A}$*:* $\mu(a, \theta_L) < b(a) < \mu(a, \theta_H)$.

Assumption 2. *For every match outcome* $\theta \in \{\theta_L, \theta_H\}$*:* $\mu(a, \theta) - b(a)$ *is increasing in* a.

By Assumption 1, the matching choice is non trivial: a match should be dissolved if and only if $\theta = \theta_L$, when it produces less than the joint value of inactivity $b(a)$. *De facto*, parties perform a sequential probability ratio test of simple hypotheses on the viability of the match. By Assumption 2, more skilled workers have a comparative advantage in market activities; a skill-inelastic value of leisure $b(a) = b$ would trivially satisfy it.

A worker of skill a is hired at finite Poisson rate $\lambda(a)$ when unemployed, and at rate $\psi\lambda(a)$ when searching on the job. In both cases job search is costless, except for its time-consuming aspect and for discounting. Here ψ is the chance at every point in time that an employed worker who wants a new job has the opportunity to actively search for one. There is no recall of past offers. The firm must pay a flow sunk cost κ to keep a vacancy open and attract applications from workers, unemployed and employed alike. Every new match, whether the worker joins from unemployment or from another job, restarts from a common prior chance p_0 of success. For the sake of simplicity, there is no initial "screening" phase as in Jovanovic (1984), nor choice of search intensity. Search frictions create rents that the parties split according to a generalized Nash bargaining rule.

The natural state variable of the bargaining game is the posterior belief p_t of match success. Conditional on the output process X, the posterior probability that a match was successful evolves from any prior $p_0 \in (0,1)$ as a martingale diffusion solving:

$$dp_t = p_t(1-p_t)s(a)d\bar{Z}_t \tag{2.1}$$

where

$$s(a) \equiv \frac{\mu(a,\theta_H) - \mu(a,\theta_L)}{\sigma}$$

is the *signal/noise ratio* of output produced by skill a, and

$$d\overline{Z}_t \equiv \frac{1}{\sigma}\left[dX_t - p_t\mu(a,\theta_H)dt - (1-p_t)\mu(a,\theta_L)dt\right]$$

is the *innovation* process, the normalized difference between realized and unconditionally expected flow output. This is independent of skills, and a standard Wiener process w.r. to the filtration $\{\mathcal{F}_t^X\}$. Intuitively, beliefs move faster the more uncertain match quality (the term $p(1-p)$ peaks at $p = 1/2$), and the more informative production, as measured by $s(a)$.

3. Equilibrium

We analyze the steady state general equilibrium of this economy, where aggregate variables (including the wage distribution) do not change over time, while worker turnover and job churning are continuously driven by purely idiosyncratic uncertainty. We first analyze the employment relationship conditional on *ex ante* worker heterogeneity, which is reintroduced in Section 4. For notational simplicity, until then we omit skill a and set $\mu(a,\theta_i) = \mu_i$ for $i = L, H$, $\lambda(a) = \lambda$. The results of this section draw from Moscarini (2003).

3.1. Wages and Job Separation

Let $W(p)$ denote the discounted total payoffs that a worker receives in the equilibrium of the bargaining-and-search game, when employed in a match that is successful with current posterior chance p. Similarly, let U denote the worker's value of unemployment, independent of p because of the match-specific nature of θ, $J(p)$ the rents of the firms, V the value to the firm of holding an open vacancy, and $S(p) = W(p) + J(p) - U - V$ the total surplus of this match. By free entry, $V = 0$. We may then write Bellman equations for worker and firm given an arbitrary wage function $w(p)$ of the belief p; the equilibrium wage is pinned down by a generalized Nash bargaining solution, giving the worker a fraction $\beta \in [0, 1]$ of total match surplus: $W(p) - U = \beta S(p)$, $J(p) = (1 - \beta)S(p)$, implying

$$\beta J(p) = (1 - \beta)[W(p) - U]. \tag{3.1}$$

Before solving for the wage from (3.1), by backward induction we first address the subgame following an outside offer to a worker, who is searching on the job, to match at a renewed prior p_0. This situation describes a symmetric information game between two buyers (the firms) competing for a worker, under common knowledge of the total gains from either trade, $S(p) + U$ with the current employer and $S(p_0) + U$ with the new perspective one. We assume that the two firms play an ascending auction for the worker, or *ex post* Bertrand competition with offers and counteroffers. However, we also impose a backward induction refinement, which implies that to no bids are made in equilibrium. The key is symmetric information: all players know in advance which firm will win the auction. For the losing firm, bidding is weakly dominated, and strictly dominated for any arbitrarily small cost of bidding. It is common knowledge that the winning firm can always respond successfully to any hostile bid. Firms' bids only redistribute rents to the worker.[5] The firm's *ex post* temptation to respond to outside offers creates *ex ante* incentives for the worker to generate offers via on-the-job search. In turn, the worker rent-seeking behavior reduces all firms' payoffs.

As a result of this backward induction equilibrium, when a worker matched with a firm at posterior belief p receives an outside offer by another firm to re-match at p_0, the

[5] Moscarini (2003) discusses various alternative specifications of this subgame, including those already adopted in the literature, and shows that they are all vulnerable to backward induction as long as information about match values is symmetric.

following events ensue. If $W(p) < W(p_0)$, the current employer does not respond, the worker quits, restarts bi-lateral renegotiation with the new firm, and earns rents $W(p_0)$; otherwise the worker and his employer disregard the outside offer. Therefore, the employed worker keeps searching for another job if and only if $W(p) < W(p_0)$, no outside offers are matched by employers, and no lump-sum transfers between firms and workers take place.

When no outside offer is on the table, firm and worker face a bilateral renegotiation problem. We solve for the equilibrium wage that guarantees (3.1). The worker's values of being (respectively) unemployed and matched well with probability p solve the Hamilton-Jacobi-Bellman (HJB) equations:

$$\begin{aligned} rU &= b + \lambda[W(p_0) - U] \\ rW(p) &= w(p) + \Sigma(p)W''(p) - \delta[W(p) - U] + \psi\lambda \max\langle W(p_0) - W(p), 0\rangle \end{aligned} \quad (3.2)$$

where

$$\Sigma(p) \equiv \frac{1}{2}s^2p^2(1-p)^2$$

is half the *ex ante* variance of the change in posterior beliefs, roughly speaking "the speed of learning" about match quality. The opportunity cost of unemployment, rU, equals its flow benefit b plus the capital gain $W(p_0) - U$ from a new match, which has prior belief p_0 of being successful, accruing at rate λ. Similarly, the opportunity cost $rW(p)$ of working in a job that is successful with posterior chance p equals the flow wage $w(p)$, plus a diffusion-learning term $\Sigma(p)W''(p)$, minus the capital loss following exogenous separation at rate δ, plus the capital gain following a profitable quit to another job, which resets the prior to p_0. The learning speed $\Sigma(p)$ is converted into payoff units by the convexity of the Bellman value $W''(p)$, because information (here in the form of output) spreads posterior beliefs and empowers more informed decisions by the worker.

The worker optimally quits to unemployment at every belief $\underline{p}_W \in [0,1]$ such that $W(\underline{p}_W) = U$ (*value matching*) and $W'(\underline{p}_W) = 0$ (*smooth pasting*), and keeps searching on the job whenever $W(p)$ falls short of the value $W(p_0)$ that he can obtain from a fresh start at a new firm.

The problem of the firm is similar. A free entry condition sets the value of the vacancy to zero. The value to the employer $J(p)$ of an active match that is successful with posterior chance p solves the HJB equation

$$rJ(p) = \bar{\mu}(p) - w(p) + \Sigma(p)J''(p) - \delta J(p) - \psi\lambda J(p)\mathbb{I}\{W(p) < W(p_0)\} \tag{3.3}$$

with $\mathbb{I}\{\cdot\}$ an indicator function, so $\mathbb{I}\{W(p) < W(p_0)\} = 1$ if and only if the worker seeks outside offers. The opportunity cost of production $rJ(p)$ equals expected flow output

$$\bar{\mu}(p) \equiv p\mu_H + (1-p)\mu_L$$

minus the wage $w(p)$, plus the return from learning the quality of the match $\Sigma(p)J''(p)$, minus expected capital losses due to exogenous separation ($\delta J(p)$) and to a quit by the worker to another job ($\psi\lambda J(p)$ when $W(p) < W(p_0)$ and the worker keeps searching). The firm optimally fires the worker at every $\underline{p}_J \in [0,1]$ such that $J(\underline{p}_J) = 0$ and $J'(\underline{p}_J) = 0$.

By (3.1), worker and firm agree to separate and to become idle when the posterior belief hits the same threshold(s) $\underline{p}= \underline{p}_W = \underline{p}_J$. When the worker quits to another job, he forfeits positive rents $W(p) - U > 0$ for even larger ones $W(p_0) - U$ in the new match, while his employer suffers an unrecoverable loss $J(p) \propto W(p) - U > 0$. Observe that (3.1) implies $\mathbb{I}\{W(p) < W(p_0)\} = \mathbb{I}\{J(p) < J(p_0)\}$ and $\beta J''(p) = (1-\beta)W''(p)$. Using these facts and (3.1) into the HJB equations (3.2) and (3.3), plus some (omitted) algebra, yield a simple and intuitive expression for the equilibrium wage:

$$w(p) = b + \beta\left[\bar{\mu}(p) - b + \lambda J(p_0)(1 - \psi\mathbb{I}\{J(p) < J(p_0)\}\right]. \tag{3.4}$$

This expression is self-explanatory: b is the worker's opportunity cost of time, β his bargaining share β, $\bar{\mu}(p)$ flow expected output, $\lambda\beta J(p_0)$ his endogenous outside option from unemployed job search, reduced by a fraction ψ when the match looks unpromising and the worker searches on the job, $W(p) < W(p_0)$ or $J(p) < J(p_0)$, in order to compensate the firm for the potential loss of a valuable employee. The wage is affine and increasing in the posterior belief, and jumps up at p_0 as the worker ceases on-the-job search and the firm no longer faces the potential quit of its employee. Employed search improves the worker's outside option, at the expense of joint match surplus.

Replacing the wage function (3.4) into the worker's and the firm's HJB equations transforms their bargaining-separation game into two separate optimal stopping problems. Using (3.1), (3.4) and boundaries turns the firm's HJB equation (3.3) into:

$$J(p) = \frac{(1-\beta)[\bar{\mu}(p) - b] + \Sigma(p)J''(p) - \beta\lambda J(p_0)(1 - \psi\mathbb{I}\{J(p) < J(p_0)\})}{r + \delta + \psi\lambda\mathbb{I}\{J(p) < J(p_0)\}}$$

subject to value matching and smooth pasting at $\underline{p}$. An additional boundary condition is

$$J(1) = (1-\beta)\frac{\mu_H - b}{r+\delta} - \frac{\beta\lambda}{r+\delta}J(p_0),$$

because the worker would never quit a "perfect" match $(W(1) > W(p_0))$ due to the absorbing property of the extreme belief $p = 1$. This allows to solve for the value function, which equals the sum of the present discounted value of flow returns and of the option value of separating should things go wrong, including a direct quit for $p < p_0$:

$$\begin{aligned} J(p) \;=\; & \left[c_{0J}p^{1-\alpha_0}(1-p)^{\alpha_0} + k_{0J}p^{\alpha_0}(1-p)^{1-\alpha_0}\right]\mathbb{I}\{\underline{p} \le p < p_0\} + c_{1J}p^{1-\alpha_1}(1-p)^{\alpha_1}\mathbb{I}\{p_0 \le p \le 1\}, \\ & + \frac{(1-\beta)[\bar{\mu}(p) - b] - \beta\lambda J(p_0)(1 - \psi\mathbb{I}\{\underline{p} \le p < p_0\})}{r + \delta + \psi\lambda\mathbb{I}\{\underline{p} \le p < p_0\}} \end{aligned}$$

where

$$\alpha_0 \equiv \frac{1}{2} + \sqrt{\frac{1}{4} + \frac{2(r+\delta+\psi\lambda)}{s^2}}; \quad \alpha_1 \equiv \frac{1}{2} + \sqrt{\frac{1}{4} + \frac{2(r+\delta)}{s^2}}.$$

and the coefficients c_{0J}, k_{0J}, c_{1J} and the optimal stopping point $\underline{p} \in (0, p_0)$ uniquely solve the system of four algebraic equations:

$$J(\underline{p}) = 0, \qquad J'(\underline{p}+) = 0, \qquad J(p_0-) = J(p_0+), \qquad J'(p_0-) = J'(p_0+).$$

3.2. Turnover

This model is more tractable than the original Gaussian job matching model of Jovanovic (1979), but preserves all of its implications for turnover and tenure effects. The bargaining/separation equilibrium implies a stochastic process for the worker's employment status and, conditional on employment, for the posterior belief of a good match p_t. The belief starts from p_0, evolves as the diffusion (2.1) following output realizations, is "killed" at rate δ by exogenous destruction and is absorbed into unemployment for a random duration of mean $1/\lambda$. The same happens if dismal output drives the belief down to $\underline{p}$ and leads parties to separate and to restart search. If $p_t < p_0$ the worker also seeks outside job offers, and finds one at rate $\psi\lambda$, resetting the belief to p_0.

In the absence of endogenous separation at $\underline{p}$, the expected tenure $\mathcal{T}(p)$ starting from a posterior p should equal $1/\delta$ for $p > p_0$ when outside offers are rejected, and $1/(\delta + \psi\lambda)$ for $p < p_0$ when they are accepted. But the match also terminates endogenously, when the belief falls to $\underline{p}$. Overall, $\mathcal{T}(p)$ solves:

$$\Sigma(p)\mathcal{T}''(p) - (\delta + \psi\lambda\mathbb{I}\{\underline{p} \leq p < p_0\})\mathcal{T}(p) = -1$$

subject to standard boundary conditions $\mathcal{T}(\underline{p}) = 0$, $\mathcal{T}(p_0-) = \mathcal{T}(p_0+)$, $\mathcal{T}'(p_0-) = \mathcal{T}'(p_0+)$. By direct verification

$$\begin{aligned}
\mathcal{T}(p) &= \mathbb{I}\{p_0 \leq p \leq 1\}\frac{1}{\delta}\left\{1 + c_{1\mathcal{T}}p^{1-\alpha_1}(1-p)^{\alpha_1}\right\} \\
+\mathbb{I}\{\underline{p} &\leq p < p_0\}\frac{1}{\delta + \psi\lambda}\left\{1 + c_{0\mathcal{T}}p^{1-\alpha_0}(1-p)^{\alpha_0} + k_{0\mathcal{T}}p^{\alpha_0}(1-p)^{1-\alpha_0}\right\}
\end{aligned}$$

an increasing and convex function of the current belief that the match is productive.

The martingale property of posterior beliefs and optimal separations imply that, conditional on match continuation, the posterior belief is a strict *sub*martingale, that is it drifts upward. Since the value functions W and J are convex in p, and the wage w is affine in p, these are submartingale too and are expected to rise conditional on match continuation.

Finally, the hazard rate of separation is also decreasing in p. Unconditionally on match quality, starting from a current belief p_t, the probability of separating endogenously ($p = \underline{p}$) before finding out that the match is good for sure ($p = 1$) equals $(p_t - \underline{p})/(1 - \underline{p})$; therefore, the probability of endogenous separation to unemployment is decreasing in p_t. The hazard rate of a quit $\psi\lambda\mathbb{I}\{\underline{p} \leq p_t < p_0\}$ is also decreasing in p_t. The hazard rate of exogenous separation, δ, is independent of p_t. Overall, separation is less likely the larger the expected productivity of the match, and thus the longer the worker's tenure. The only exception is at the beginning of a match, when instantaneous endogenous separation is impossible by continuity of the belief process' sample paths. Thus, on average, the hazard rate of separation initially increase and then decrease with tenure.

3.3. The Ergodic Wage Distribution

The stochastic process describing the equilibrium evolution of the posterior belief of a good match is clearly Markovian and strongly recurrent. Therefore, the stationary density is also ergodic: from any non-degenerate prior $p_0 \in (0,1)$, the posterior belief converges a.s. to a random variable p_∞ with support $[\underline{p}, 1]$ and total probability mass equal to total employment, plus an atom of unemployment. If p_∞ has a density, say f, then in a large population of workers f can be interpreted also as the ergodic and stationary cross-sectional distribution of employed workers (matches, posterior beliefs). Imposing stationarity in the Fokker-Planck (Kolmogorov forward) equation of the process, which describes the dynamics of the transition density, we obtain the following equation for the stationary and ergodic density f of the belief process:

$$\frac{d^2}{dp^2}[\Sigma(p)f(p)] - (\delta + \psi\lambda\mathbb{I}\{\underline{p} \leq p < p_0\})f(p) = 0, \tag{3.5}$$

subject to the following three boundary conditions:

1. no time spent at the separation boundary $\underline{p} > 0$: $\Sigma(\underline{p})f(\underline{p}+) = 0$, thus by $\Sigma(\underline{p}) > 0$,

   $$f(\underline{p}+) = 0;$$

   this is a standard condition for "attainable" boundaries, which can be hit in finite time with positive probability and are either absorbing or reflecting;

2. balance of total flows (respectively) in and out of employment:

   $$\Sigma(p_0)[f'(p_0-) - f'(p_0+)] = \psi\lambda \int_{\underline{p}}^{p_0} f(p)dp + \delta \int_{\underline{p}}^{1} f(p)dp + \Sigma(\underline{p})f'(\underline{p}+),$$

equating the total inflow into employment on the LHS to the total outflow on the RHS, due to (resp.) quits to other jobs, exogenous job destructions, and quits to unemployment at $\underline{p}$.

3. balance of total flows (respectively) in and out of unemployment:

$$\delta \int_{\underline{p}}^{1} f(p)dp + \Sigma(\underline{p})f'(\underline{p}+) = \lambda(1 - \int_{\underline{p}}^{1} f(p)dp),$$

equating the inflow into unemployment, both involuntary due to job dissolution at rate δ and voluntary through the separation boundary $\Sigma(\underline{p})f'(\underline{p}+)$, to the outflow, exit rate λ times unemployment. This is a standard restriction in search models, which gives rise to a Beveridge curve.

The total flow in or out of employment exceeds that in or out of unemployment by an amount equal to job-to-job quits, because these are the only separations that do not entail an unemployment spell.

By direct verification, the solution to (3.5) is, for $p \in [\underline{p}, 1]$:

$$f(p) = c_{0f}p^{-1-\gamma_0}(1-p)^{\gamma_0-2}\left[\left(\frac{1-\underline{p}}{\underline{p}}\frac{p}{1-p}\right)^{2\gamma_0-1} - 1\right]\mathbb{I}\{\underline{p} \le p < p_0\} + c_{1f}p^{-1-\gamma_1}(1-p)^{\gamma_1-2}\mathbb{I}\{p_0 \le p \le 1\}$$

where

$$\gamma_0 \equiv \frac{1}{2} + \sqrt{\frac{1}{4} + \frac{2(\delta + \psi\lambda)}{s^2}}; \qquad \gamma_1 \equiv \frac{1}{2} + \sqrt{\frac{1}{4} + \frac{2\delta}{s^2}}$$

and the scaling coefficients c_{0f} and c_{1f} are the unique and positive solution of a linear algebraic system derived from the boundary conditions. f is globally continuous, with a kink at p_0. In $[\underline{p}, p_0]$, f is always increasing; in $[p_0, 1]$, f is decreasing if $\gamma_1 \geq 2$, namely if the rate of attrition exceeds the squared signal/noise ratio of output $\delta \geq s^2$, U-shaped if $\min\{3p_0 - 1, 1\} < \gamma_1 < 2$, and increasing if $1 < \gamma_1 \leq \min\{3p_0 - 1, 1\}$.

Rational (Bayesian) learning and optimal match selection map Gaussian output X_t into a piece-wise Lévy-stable distribution f of posterior beliefs p_t, of the Lévy-Pareto *type*. The interpretation of f is empirically more meaningful in wage space. Without loss in generality, we can normalize the scale of output so that $\beta\sigma s = \beta(\mu_H - \mu_L) = 1$. Then, the equilibrium wage function (3.4) becomes a pure location transformation $w(p) = \mathfrak{w}_{\mathbb{I}\{\underline{p} \le p < p_0\}} + p$ where:

$$\mathfrak{w}_{\mathbb{I}\{\underline{p} \le p < p_0\}} \equiv b + \beta \left[\mu_L - b + \lambda J(p_0)(1 - \psi \mathbb{I}\{\underline{p} \le p < p_0\} \right].$$

For $w \geq \underline{w} \equiv \mathfrak{w}_1 + \underline{p}$, and given $w_0 \equiv \mathfrak{w}_0 + p_0$, the wage density is:

$$\phi(w) = f\left(w - \mathfrak{w}_{\mathbb{I}\{w < w_0\}}\right).$$

Therefore, ϕ also belongs to the Pareto type. In fact, both f and ϕ have a *fat right tail, which is decaying generically (for $\delta \geq s^2$) but always at slower rate than a Gaussian.*

The theoretical equilibrium wage distribution $\phi(w)$ replicates remarkably well the typical shape of an empirical wage distribution, including its well-known Paretian right tail. Quits to other jobs and to unemployment weed out disproportionately bad matches, censor the left tail, and skew the distribution. Optimal turnover is so powerful to map Gaussian output into polynomially decaying wages.

4. Quantitative Implications

4.1. Data Sources and Parameter Calibration

The description of the economy can be completed by a matching function, and the equilibrium is closed by a free entry condition that determines job-finding rates $\lambda(a)$, so far treated parametrically. However, the main goal of this paper is a quantitative exercise. Therefore, we just choose values for the exit rates $\lambda(a)$ from empirical evidence on unemployment duration, and we do not need to delve into the details of the matching process.

We study a version of the model with two types of skills, Low and High (a_L and a_H), that we interpret as representing, respectively, workers who hold at most a High School degree or more. The production function is additive, $f(a, \theta) = a + \theta$, with little loss in generality − we can always define a worker skill to be her ex ante expected productivity, and treat the rest as additive orthogonal zero-mean noise. This version of the model is parameterized at a monthly frequency, so that its aggregate predictions match some broad empirical facts about worker stocks and flows and wage inequality in the US in the last three decades.

The parameters to be chosen are described in Table 1. Some are simple normalizations: the labor force is 100, skills $a_L = 0.4$ and $a_H = 0.6$, match outcomes $\theta_H = -\theta_L = 0.5$. Normalizing the inter-skill productivity difference to 0.2 is equivalent to pin down the productivity scale, while its location depends on the value of leisure b. Since the prior belief will be set to $p_0 = 0.5$, match outcomes must sum up to zero by definition, so that their prior expectation is zero; their size can be chosen freely because only the ratio of $\theta_H - \theta_L$ to the standard deviation of output σ matters for decisions and outcomes.

Three parameters can be directly estimated. The discount rate is set at $r = 0.004$, implying a 5% annual real interest rate, roughly the historical average yield on risky assets. Although in the model agents are risk-neutral and capital markets are perfect, we try to capture some of the real costs of delay through this choice for the interest rate. The proportion of low skills in the population equals 70%, the average proportion of the US labor force holding a High School degree or less in the last three decades, based on the 1971-2000 Annual Demographic March files of the Current Population Survey (our computation). The average exit rates from unemployment of low and high skill workers are set to 0.3 and 0.33, respectively. These imply an economy-average unemployment duration of about one quarter. The inequality between groups is conservative, but consistent with most of the available evidence.

The remaining six parameters in Table 1 are truly free and directly unobservable, and therefore offer six degrees of freedom. We choose their values to match a variety of facts illustrated in Table 2, concerning worker stocks and flows and wages, and in Figure A.1, referring to the evolution of the hazard rate of separation as tenure progresses. Before discussing the results, we describe the data sources.

We draw monthly worker flows between Employment (E), Unemployment (U) and Not in the labor force (N) from Blanchard and Diamond (1990) [BD90], based on the 1968-1986 Annual Demographic March files of the Current Population Survey. Two corrections are necessary to make the model comparable with BD90's data. First, the distinction between U and N is not made here while it is crucial to BD90. They document that the UE (U to E) flow is approximately equal to the NE flow, and that a subset of N not much smaller than total unemployment U, say $\hat{N}$, declare to "want a job", Hence we add $\hat{N}$ to formal unemployment U to form a "Jobless" category, calibrated at 9.5% of the labor force, which is also extended to include $\hat{N}$. This group of people $\hat{N}$ is also assumed to produce the entire NE flow reported by BD90; summed to the UE flow, this yields a total flow out of joblessness equal to 2.1% of the labor force. In steady state, this is also the total flow out of employment. A caveat is that the evidence of BD90, based on the CPS and the Longitudinal Research Database (manufacturing only), does not describe a steady state, because employment rose over the period. The LRD allows BD90 to distinguish also between layoffs, about 1.3% of employment and therefore (by extrapolation to the economy as a whole) about 1.2% of the labor force, while total quits are roughly 1.8%, giving an overall 3% average separation rate. Of quits, direct and indirect evidence in BD90 points to an educated guess of a 50-50 split between quits to unemployment (0.9%) and direct quits to other jobs (EE flow, 0.9%).

These facts are supplemented by the more recent, reliable and detailed evidence presented by Fallick and Fleischman (2001) [FF01]. FF01 exploit the "dependent interview" techniques adopted for the CPS since 1994, and document worker flows in 1994-2000. They find a monthly flow of workers from employer to employer (EE flow) of the order of 2.7% of employment, therefore about 2.55% of the labor force. This number overstates the average magnitude of direct job-to-job quits that we use for calibration, for several reasons. First, some transitions entail an intervening spell of unemployment shorter than a month (hence unobserved); about 40% of new unemployed usually find a job in the first month. Second, as FF01 point out, some EE movements occur when a multiple job holder separates from his/her main employer and keeps the other job. These should not be counted as quits. Finally, 1994-2000 were years of strong expansion, when direct quits are know to exceed the overall time average. Since the measurement of EE flows in FF01 is direct, while those in BD90 are just an indirect and noisy imputation, we raise the target quit rate to 1.1% of the labor force. The figures for quits to unemployment and layoffs in FF01 are comparable to BD90's, after aggregating U and $\hat{\text{N}}$ into the relevant jobless pool.

FF01 also find that 5% of employees report searching on the job at every point in time, in line with evidence from the UK in Pissarides and Wadsworth (1994). In the model, we interpret this proportion as representing the "effective employed job searchers", namely the fraction ψ of potential employed job searchers (of mismatched workers) who have an actual opportunity to search at each point in time. Once the opportunity is there, these job searchers face the same job-finding rate λ as the unemployed of equal skills, as found by Blau and Robins (1990).

To assess wage inequality and skewness, we choose the statistics (Average wage − median wage)/Stdev(wages) because invariant to affine transformation in wages. A standard quantile difference in the wage distribution would not capture its skewness. The shape of the wage distribution and the (mean-median)/stdev statistics are obtained from the March CPS files, the latter taking an average over 1985-2000.

The average short-run wage loss from job displacement is drawn from Stevens (1997). She finds that the wage loss at impact is roughly the same whether or not the job loss involved a plant closure, an event that necessarily implies a job destruction.

The empirical hazard rate of separation is computed as the rate of decrement of the empirical tenure frequency distribution. The tenure data are from Diebold, Neumark, and Polsky (1997) [DNP97], drawn from the 1987 CPS Tenure Supplement and adjusted for "heaping". This methodology to compute the hazard rate is valid under the assumption that the tenure distribution is stable; see DNP97 for the issues involved in this computation and for corroborating evidence of such stability.

We input values for the six free parameters into the analytic equilibrium solution of the model, and we iterate to minimize the sum of squared distances of the model output from the corresponding empirical observation. Only for the equilibrium hazard rate of separation as a function of tenure, the model yields no analytic expression. Therefore, *after* choosing the six parameter values to match the eight numbers in the last column of Table 2, we run a 10^7-step simulation of a discrete-time version of the same model, where the step Δt is one day. The belief is replaced by a $\Delta t-$discrete time Markov process constructed so as to converge in distribution to the true belief diffusion as $\Delta t \to 0$. From this simulation, we compute the implied hazard rate of separation as a function of tenure.

4.2. Results: Aggregate Patterns

Compare the empirical observations in the fourth column of Table 2 to the corresponding model predictions in the third column. The six calibrated parameters allow to match almost perfectly the eight facts in Table 2. Among the implied parameter values, in Table 1 notice in particular the exogenous attrition rate $\delta = 0.0129$ (a job is expected to last 77.5 months or 6.45 years unless the worker quits earlier); $\psi = 0.24$ (an employed worker who would like to switch jobs has an opportunity to search on average a quarter of the time, compared to a jobless individual); and $b = 0.32$, implying that wedge between general human capital a and value of leisure b is 3.5 times larger for highly skilled workers ($a_H - b = 0.28$) than for low skills ($a_L - b = 0.08$).

Figure A.3 reports the ergodic belief distribution for low-skilled workers (the wage distribution is just an affine rescaling). The total mass of the distribution is the employment rate. For comparison, Figure A.4 reports the belief distribution from the same simulation of the model used to predict the hazard rate of separations in Figure A.1. In both cases it emerges that the distribution is right-skewed and has a fat and leveling right tail: in fact the chosen parameters imply $\gamma_1 = 1.96$, close to the critical value of 2. From Table 2, the median wage is always below the mean wage. All these properties are characteristic of the US empirical wage distribution, both conditional and unconditional on observable worker skills.

The predicted average hazard rate of separations in Figure A.1 (solid line) is declining in tenure for two reasons. First, the duration dependence induced by optimal match selection; second, the composition effect of the selection of the two classes of skills. The predicted hazard rate is quite close to the observed one (dashed line). The former tends to tends to modestly overestimate the latter, the more so the higher tenure. The reason is that agents in the model have an infinite time horizon to experiment with new jobs, or retire/die at constant exponential rate; in real life, as tenure proceeds and retirement approaches, the incentive to switch job decline, and the hazard rate of separation with it.

The calibration provides also quantitative implications for some moments of our model economy that have no empirically observed counterpart. In the absence of job upgrading and selection through quits to other jobs and to unemployment, the employed population would be split evenly above and below $p_0 = .5$. Notice *the strength of selection*: of the 90.32 workers employed at any point in time, only about 21% (=18.88/90.32) stick to their job although prior expectations have been disappointed, while the remaining 79% appear more productive than when they started, hence earn a wage above the initial value $w(p_0)$. Of the 18.88 "disappointed" workers, about one fourth can search for a job upgrading at every point in time, hence "Effective on-the-job searchers" are correctly predicted to about 5% of employment. As a consequence, the average paid wage (weighted across skills by employments) is roughly 16% larger than the average initial wage $w(p_0)$ (weighted across skills by new hires). Though the worker receives only a 40% share in bargaining, the starting wage is almost equal to initial expected flow output, just like in an economy without search frictions (Jovanovic 1979), because of the forward-looking returns to remain matched. The average relative wage gain from a direct quit is $1-\mathbb{E}[w(p_0)/w(p)|\underline{p} \leq p \leq p_0]$, because only workers employed at $p \leq p_0$ search on the job and, when successful, restart from $w(p_0)$. This is estimated at a much more modest number than the wage loss from displacement; the model allows only for limited gains from a quit, while job destruction can hit even the most established of matches.

Average match surplus among active jobs is about four times bigger than the initial one. This value represents the expected *welfare loss from exogenous job destruction* for firm and worker, and far exceeds on average one year worth of wages. This is a large number, if we consider that it includes only the permanent income loss, and abstracts from additional sources of welfare loss, such as risk aversion and unemployment stigma.

4.3. Results: Cross-Sectional Patterns

We now turn to examine the additional predictions of this calibration for cross-sectional patterns and welfare consequences of job mobility, also reported in Table 2.

Figure A.2 illustrates the implied value function of a firm employing a low-skill worker, which is strikingly steep: the maximum present profits $J(1|a_L)$ are about 10 times bigger than the initial value $J(p_0|a_L)$. In contrast, flow output may only roughly double from a prior expectation of $a_L = 0.4$ to a theoretical maximum of $a_L + \theta_H = 0.9$.

The key Assumption 2 implies that *more skilled workers are more willing to mismatch*, as they have more to lose from not working. Thus, their stopping belief $\underline{p}$ is lower than the one chosen by the low skilled. A larger proportion of skilled workers (21.40% vs. 17.80% of the labor force) prefer to remain on a job that pays below going starting wages, and to search on the job rather than to become unemployed. The lower unemployment rate of skilled workers reflects this attitude, because the inequality of entry rates across worker skills (in the model as well as in the data) swamps that of exit rates from unemployment. In fact, skilled workers quit 50% less frequently to unemployment, and quit to other jobs almost 80% more often.

Cross-skill wage inequality is compressed, relative to skill inequality, by the different attitudes to mismatch. The cross-skill differential in either the starting or the average wage is smaller than the $a_H - a_L = 0.2$ skill difference. Within-skill wage dispersion is larger for skilled workers, and this is due entirely to their higher propensity to mismatch, not to technological reasons, as skill a and luck θ are additive in technology. Unskilled workers are matched better on average if employed; hence they lose more of their wage from a displacement and gain slightly less from a direct quit to another job. Finally, the welfare loss from a displacement is a much bigger multiple of average monthly wages for unskilled workers, as they accumulate more learning conditional on being employed.

Finally, following Jovanovic and Moffitt (1990), we ask what would be the surplus (over idleness) of a match were parties forced to stay together, i.e. if they were prohibited from acting on their accumulated knowledge. It is easy to see that this is a present discounted value not containing any learning term, and precisely $(a-b)/(r+\delta+\lambda)$. The difference between the initial surplus $S(p_0|a)$ and this magnitude, still in units of monthly wages, is reported in Table 2 as "Value of acting on match information". We estimate this magnitude at just over two months of wages. We mentioned in the Introduction the relationship between our findings and those in Jovanovic and Moffitt (1990). Again, low-skilled workers turn over more often and benefit more from learning opportunities. Without job matching, wage inequality would be even higher than observed.

To recap, the most pronounced inequality across skills is observed in unemployment rates, quits, both to unemployment and to other jobs (in opposite directions), and the relative welfare loss following job destruction. Most wage measures are instead compressed across skills. More skilled workers choose to protect themselves from unemployment by paying a price in terms of matching quality. Unskilled workers need to get lucky to stay employed, search more from unemployment, hence when employed they must be matched better.

5. Conclusions and Directions for Future Research

This paper introduces a frictional equilibrium model of the labor market which explains and helps to organize our thoughts about a host of cross-sectional patterns observed in labor markets. The model allows for *ex ante* worker heterogeneity in terms of general human capital and for *ex post* specific human capital in the sense of Jovanovic (1979), and for both employed and unemployed job search. The model provides an accurate description of labor market dynamics, both in terms of quantities and prices. The model is calibrated to aggregate worker flows, and yields empirically correct predictions for the shape of the wage distribution implied by turnover and learning, measures of wage inequality, the impact wage loss following a layoff, and the relationship between hazard rate of job separations and tenure. A single and plausible assumption about preferences for leisure − high-skill workers have a larger wedge between their productivity and opportunity cost of time than low-skill workers − reconciles a number of cross-sectional patterns observed in labor markets. These include the higher propensity of high skill workers to search from employment, their lower incidence of unemployment and unexplained residual wage dispersion. Intuitively, highly skilled workers are more prone to mismatch with their employers in ex post terms, in order to avoid joblessness.

The calibrated structural model is used to evaluate the deadweight welfare loss from job destruction, which is found to exceed on average one year worth of wages, and to decline in a worker's general human capital, relative to her average wages. The results warn against the standard practice of using wage changes associated to job changes as measures of specific human capital, as the correspondence between wages and welfare is loose, due to the complicated dynamics of work careers.

The model suggests many different applications and extensions. An important one that is worth mentioning here is the possibility of structural estimation. The decomposition of worker productivity in skill and luck is directly inspired by the standard econometric specification of wage equations. This model provides a novel structural specification. Consider the wage equation inclusive of skills a:

$$w(p|a) = \beta p\mu(a,\theta_H) + \beta(1-p)\mu(a,\theta_L) + (1-\beta)b\,(a) + \beta\lambda\,(a)\,J(p_0|a)(1-\psi\mathbb{I}\left\{\underline{p} \leq p \leq p_0\right\}).$$

When bringing this equation to the data, a summarizes worker observables (easily extended to a vector) and p is the residual. We detect fixed effects not only through the mean (value of leisure $b\,(a)$ and value of search $\beta\lambda(a)J(p_0|a)$), but more generally via the whole error distribution $f(p|a)$. At the very least, errors are heteroskedastic. The deep parameters of the model may be estimated directly by maximizing the closed-form likelihood function f.

From a theoretical viewpoint, the natural next step is the introduction of firm heterogeneity. The possibility that more productive firms employ more skilled workers appears quite consistent with microeconometric evidence on factor substitution, and gives rise to assortative matching as a mechanism for wage compression alternative to Assumption 2. The interaction between this type of *ex ante* sorting and *ex post* matching is central to the growing literature on empirical wage equations with matched employer-employee data, but we know near nothing about its equilibrium implications.

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A. Appendix. Tables and Figures.

Table 1. Parameterization of the Model

Technology	$f(a, \theta) = a + \theta$
NORMALIZATIONS	
Low skill a_L	0.4
High skill a_H	0.6
Good match outcome θ_H	0.5
Bad match outcome θ_L	-0.5
Labor force	100
ESTIMATED PARAMETERS	
Rate of time preference (monthly)	0.004
Proportion of low skills	0.7
Job-finding rates: low-skill $\lambda(a_L)$	0.3
high-skill $\lambda(a_H)$	0.33
CALIBRATED PARAMETERS	
Exogenous job destruction rate δ (monthly)	0.0129
Opportunity rate for employed search ψ	0.24
Output noise σ	8.5
Value of leisure b	0.32
Prior belief p_0	0.5
Worker bargaining share β	0.4

Table 2. Results.

	MODEL			DATA
	Low skill $a_L = 0.4$	High skill $a_H = 0.6$	Economy	Economy
Stopping belief $\underline{p}$	0.39	0.36		
WORKER STOCKS				
Jobless	7.91	1.77	9.68	
Employed below starting wage $w(p_0)$	12.46	6.42	18.88	
Employed above starting wage $w(p_0)$	49.63	21.81	71.44	
Total	70	30	100	
WORKER STOCKS (% OF LABOR FORCE)				
Jobless	11.3	5.90	9.68	9.5
Employed below starting wage $w(p_0)$	17.80	21.40	18.88	
Employed above starting wage $w(p_0)$	70.90	72.70	71.44	
"Effective" on-the-job searchers (% of empl.)	3.36	1.65	5.01	5
MONTHLY WORKER FLOWS (% OF LF)				
Quits to joblessness	1.09	0.53	0.91	0.9
Exogenous displacements	1.15	1.22	1.17	1.2
Job-to-job quits	0.86	1.54	1.07	1.1
Hires from joblessness	2.24	1.75	2.08	2.1
MONTHLY WAGES				
Skewed distribution, Paretian right tail	yes	yes	yes	yes
Starting wage $w(p_0)$	0.41	0.56	0.46	
Average wage $\mathbb{E}[w(p) \mid p \geq \underline{p}]$	0.478	0.660	0.534	
Median wage	0.463	0.646	0.519	
Standard deviation of wages	0.06	0.07	0.068	
(Aver. wage − Median wage)/Stdev(wages)			0.22	0.19
% wage loss from displacement	14.6	13.9	14.3	13.8
% wage gain from job-to-job quit	3.5	3.6	3.5	
VALUES AND WELFARE (AS MULTIPLES OF AVERAGE WAGES)				
Total surplus from a new job	3.36	3.76	3.47	
Average match surplus	15.33	12.75	14.50	
Average returns from learning	12	9		
Value of acting on match information	2.78	2.54		

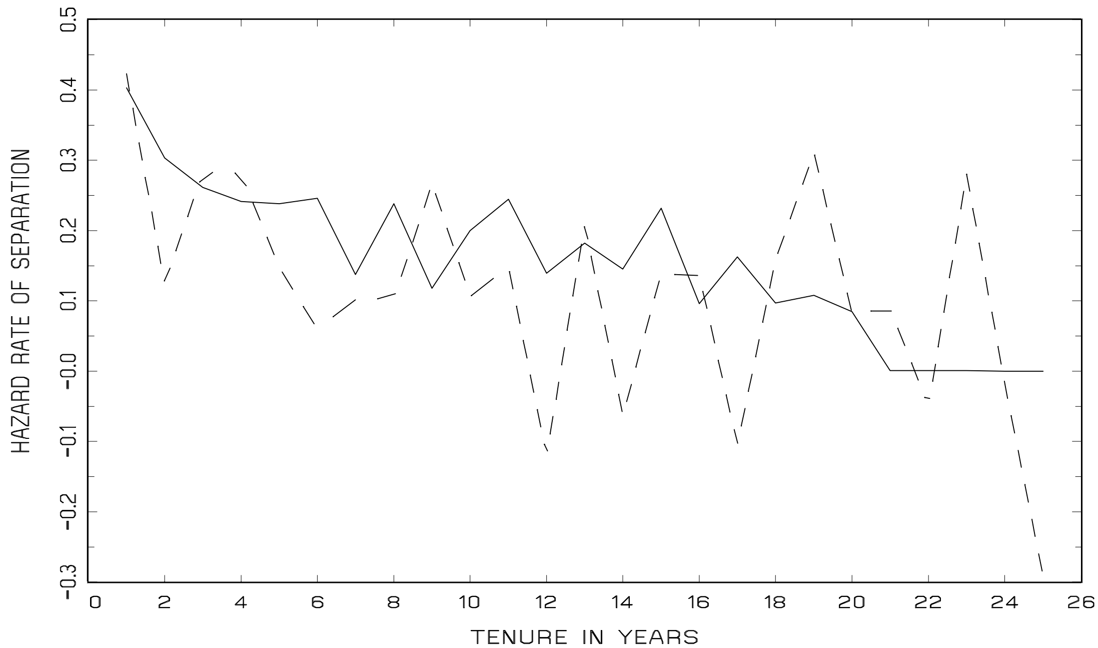

Figure A.1: Hazard rate of separation: model (solid line) and data (dashed line).

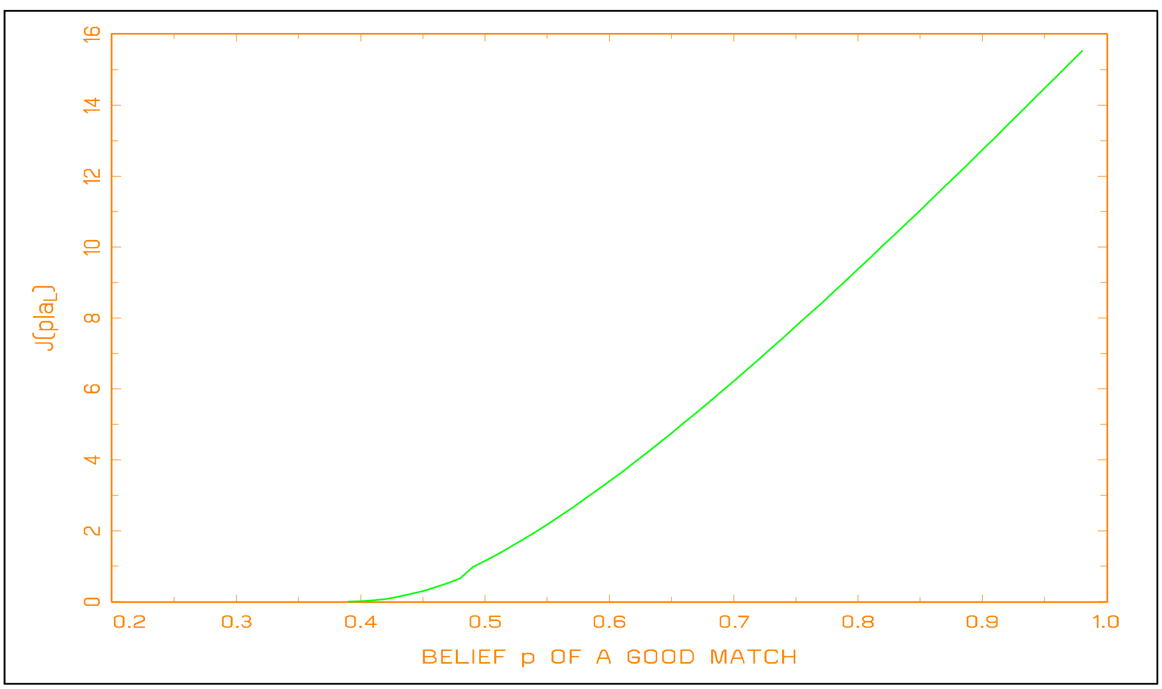

Figure A.2: The value function of a firm employing a low-skill worker.

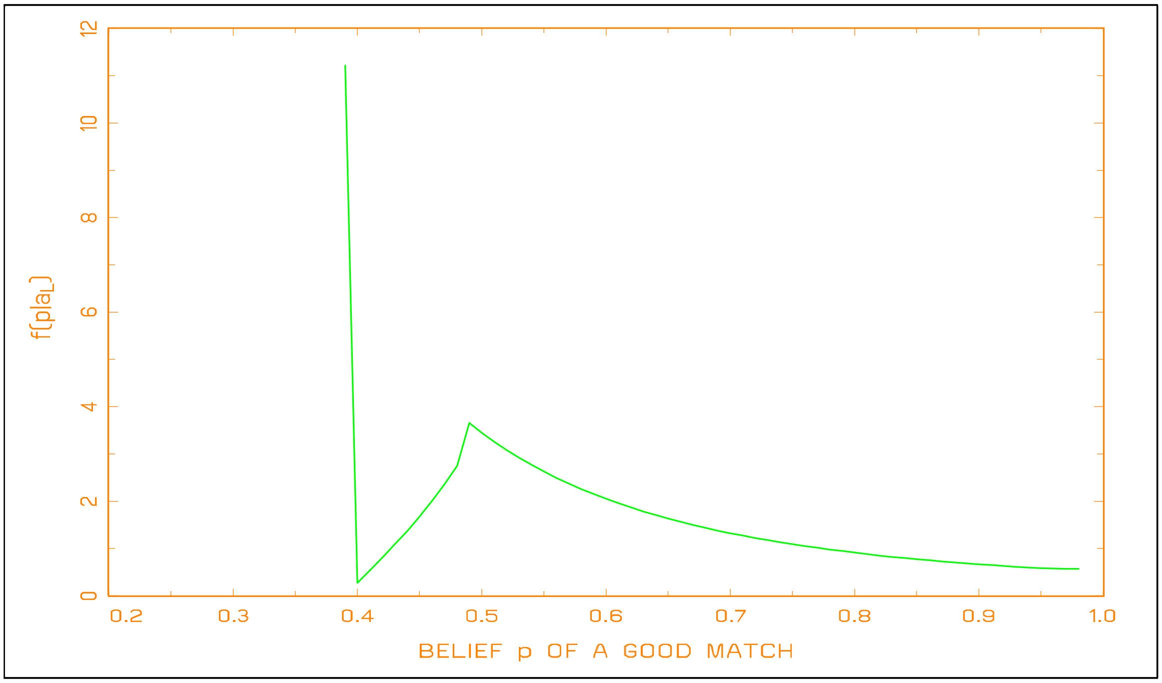

Figure A.3: The ergodic and stationary density of beliefs on match quality for low-skill workers. The atom at the lower bound is the stationary measure of low-skill jobless workers.

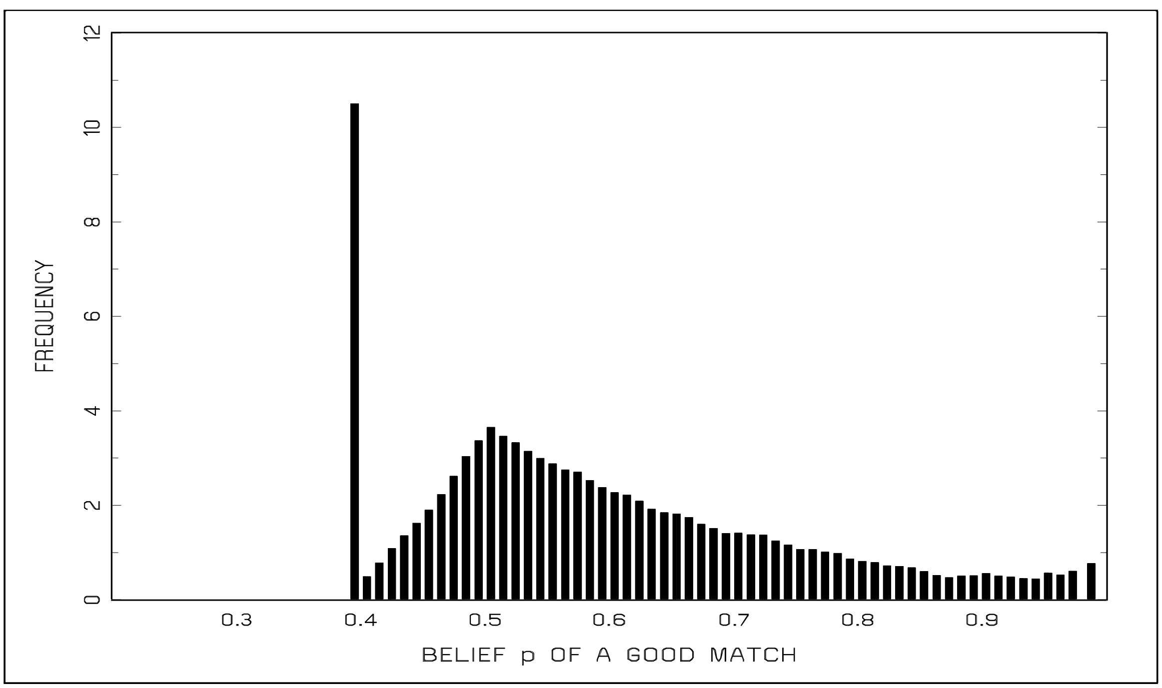

Figure A.4: Frequency distribution of simulated belief process for low-skill workers.