Wage Posting and Business Cycles

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The canonical framework of Burdett and Mortensen (1998) derives wage dispersion as the unique equilibrium outcome in a stationary environment with meeting frictions and random search. Firms derive monopsony power from search frictions and commit to wage offers. Workers earn rents: wages are not compressed to the opportunity cost of work, so the Diamond (1971) paradox is broken. Key to this result is the ability of employed workers to receive additional offers and quit directly from one job into another, without experiencing unemployment.

In previous work (Moscarini and Postel-Vinay, 2013, 2016), we explored the implications of this job ladder for the aggregate dynamics of unemployment, wages, and the firm size distribution at business cycle frequencies. The model establishes a natural connection between the average wage growth in the economy and the pace of Employer-to-Employer (EE) transitions, through two channels. First, a composition effect: workers typically quit a job when they receive a better offer, hence the faster these transitions the higher the pace of reallocation towards high wages, and the higher average wage growth. Second, a strategic effect: the more opportunities workers have to quit, the more aggressive are their employers with their wage responses, to try and retain them. The first effect benefits only job movers, the second both movers and stayers. Therefore, we expect wage growth to be positively related to the pace of EE reallocation for all workers, but especially for stayers. We verify this empirically with longitudinal micro data from the Survey of Income and Program Participation (SIPP).

More generally, this successful labor market paradigm severs any direct link between unemployment and wages, and relates wage growth directly to EE reallocation. Any correlation between real (and, with some price stickiness, nominal) wage growth and unemployment, the core of the Phillips curve, is purely spurious. Unemployment is low when the job-finding rate from unemployment is high. In this wage-posting model with random search, employed workers also benefit from more job opportunities, leading to wage growth through the mechanism described above. We argue that monetary authorities concerned with inflationary wage pressure should pay more attention directly to the EE rate and less to the unemployment rate. The post-Great Recession experience, characterized by full unemployment recovery but anemic recovery in both wages and the EE rate, is an important case in point.

I. An equilibrium wage-posting model

A. *The environment*

We work with the heterogeneous firm version of Burdett and Mortensen (1998)'s wage posting model. Time is continuous, and the economy is in steady state. The labor market is populated by a unit mass of workers, who can be either employed or unemployed, and by a unit measure of firms. Workers are risk neutral, infinitely lived, and maximize payoffs discounted at rate ρ. Firms operate constant-return technologies with labor as the only input and with productivity scale ωp, where ω is an aggregate component, common to all firms, and p is a firm-specific component, distributed across firms according to a c.d.f. Γ over some positive interval $[\underline{p}, \overline{p}]$, with density $\gamma = \Gamma'$. Both ω and p are assumed constant over time.[1]

A firm can be inactive when its productivity is too low to profitably operate (see below), so

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[1] In Moscarini and Postel-Vinay (2013, 2016), we analyze the stochastic dynamics of this model, where the impulse is given by random shocks to ω. While equilibrium can be characterized in that case, the dynamic model is intractable and must be solved numerically. Here, we focus on tractable comparative statics to gain intuition about the complex effects of aggregate productivity shocks on labor market equilibrium.

the unit measure of firms includes all potential producers, active and inactive. We denote the lower support of active firm types by $p_m \geq \underline{p}$ (determined momentarily). The measure of active firms is therefore $\overline{\Gamma}(p_m) := 1 - \Gamma(p_m)$.[2]

The labor market is affected by search frictions in that unemployed workers can only sample job offers at Poisson rate λ_0. While searching, they enjoy a value of leisure b. Employed workers earn a wage, lose their job at rate δ, and also sample job offers at rate λ_1. For simplicity, we keep all three rates λ_0, λ_1 and δ exogenous in this paper, and will analyze the economy's response to changes in those rates.[3] We denote by $L(p)$ the equilibrium size of a firm of type p, and $N(p) = \int_{p_m}^{p} L(x) d\Gamma(x)$ the cumulated measure of employment at firms of productivity *at most* p. Thus, $N(\overline{p})$ is total employment and $u = 1 - N(\overline{p})$ the unemployment rate.

B. Workers

A firm of type p commits to a constant wage $w(p)$ for the duration of any match, and is subjected to an *equal treatment constraint*, whereby it must pay the same wage to all of its workers. Letting $F(w) = \int_{p_m}^{\overline{p}} I\{w(p) \leq w\} d\Gamma(p)/\overline{\Gamma}(p_m)$, where $I(\cdot)$ is the indicator function, denote the c.d.f. of wages posted by all firms (i.e. $F(\cdot)$ is the distribution from which job searchers draw wages), the value $V(w)$ of working at a firm offering wage w solves:

$$\rho V(w) = w + \delta [U - V(w)] + \lambda_1 \int_w^{+\infty} [V(x) - V(w)] dF(x)$$

where U denotes the value of unemployed search. The worker collects a wage w and, loses her job with flow probability δ (which yields a capital loss of $V(w) - U$), or draws an alternate job offer with chance λ_1 that she accepts if its wage (drawn from $F(\cdot)$) exceeds that in her current job, w.[4] Following a similar logic, the value of unemployed search solves:

$$\rho U = b + \lambda_0 \int_R^{+\infty} [V(x) - U] dF(x)$$

where R is the unemployed workers' reservation wage, defined by $U = V(R)$. Because no worker will accept a lower wage than R, the lower support of the wage offer distribution $F(\cdot)$ equals the greater of R and any institutional minimum wage $w_{\min}$.

C. Firms

A firm posting any wage $w \geq R$ loses workers to unemployment at rate δ, and to other more valuable firms at rate $\lambda_1 \overline{F}(w)$. Simultaneously, the firm hires a number of new workers equal to:

$$h(w) := \frac{1}{\overline{\Gamma}(p_m)} \left[\lambda_0 (1 - N(\overline{p})) + \lambda_1 \int_{p_m}^{\overline{p}} I\{w(p) \leq w\} dN(p) \right]$$

where $\lambda_0/\overline{\Gamma}(p_m)$ is an unemployed worker's flow probability of receiving a job offer from that particular firm, $\lambda_1/\overline{\Gamma}(p_m)$ is the same for an employed worker, and $\int_{p_m}^{\overline{p}} I\{w(p) \leq w\} dN(p)$ is the measure of employed job seekers that would earn less than w by staying where they are. Balancing the flows in and out of that firm's workforce, which is constant in steady states, yields the size of a firm posting wage w, $\mathcal{L}(w) = h(w)/\left[\delta + \lambda_1 \overline{F}(w)\right]$.

Firms maximize steady-state flow profits:[5]

$$\pi(p) = \max_{w \geq \max\langle R, w_{\min} \rangle} (\omega p - w) \mathcal{L}(w). \tag{1}$$

This program gives rise to an optimal policy $w(p)$ and implied firm size $L(p) = \mathcal{L}(w(p))$. Standard monotone comparative statics arguments establish that $w(p)$ is increasing in p: more productive firms offer higher wages. As a consequence, the equilibrium offer distribution is such that $F(w(p)) = \Gamma(p)/\overline{\Gamma}(p_m)$. This can

[2] Throughout this paper, a bar over a cdf is used to denote survival functions, so that $\overline{\Gamma}(\cdot) = 1 - \Gamma(\cdot)$.

[3] In Moscarini and Postel-Vinay (2016) we endogenize hiring behavior and have job-contact probabilities determined by a matching function.

[4] What workers care about are job values, rather than wages. Showing that workers optimally accept jobs offering a higher *wage* than what they currently earn requires the small step that consists of checking that $V(w)$ is increasing in w.

[5] Maximization of steady-state profit flows coincides with full dynamic maximization of the PDV of future profits when firms are infinitely patient. If not, the two problems yield solutions that produce the same steady-state allocation. See Moscarini and Postel-Vinay (2013) for a detailed comparison.

be shown to imply a wage policy defined by

$$w(p) = -\frac{\pi(p_m)}{L(p)} + \omega\left[p - \int_{p_m}^{p}\left(\frac{\overline{\Gamma}(p_m)+\frac{\lambda_1}{\delta}\overline{\Gamma}(p)}{\overline{\Gamma}(p_m)+\frac{\lambda_1}{\delta}\overline{\Gamma}(x)}\right)^2 dx\right] \tag{2}$$

where $\pi(p_m) = L(p_m)(\omega p_m - w(p_m))$ is the profit earned by the least productive active firm. This marginal firm's type is either $\underline{p}$ (the least productive type in existence), or the type that achieves zero profit given the lower support of the wage distribution, i.e. R/ω or $w_{\min}/\omega$, whichever is larger. The marginal firm's profit $\pi(p_m)$ is therefore zero unless neither the reservation wage R nor the statutory minimum wage bind, in which case the least productive firm is active: $p_m = \underline{p}$. Intuitively, the firm's mark-up comprises two terms: the integral in (2) captures market power due to frictions, while the other term compensates the firm for the minimum rent it can earn in the market, $\pi(p_m) \geq 0$.

In what follows, we focus on cases with an active entry margin, i.e. where $\pi(p_m) = 0$ and $p_m = \max\langle R/\omega, w_{\min}/\omega\rangle$. The wage function is then given by (2) with $\pi(p_m) = 0$ and R defined by $V(R) = U$. The latter implies:

$$R = b + (\lambda_0 - \lambda_1)\int_R^{+\infty}\frac{\overline{F}(x)}{\rho+\delta+\lambda_1\overline{F}(x)}dx. \tag{3}$$

D. Comparative statics

We now investigate the comparative response of wages to changes in aggregate productivity ω. Wages depend on ω directly, and also through the measure of active firms, $\overline{\Gamma}(p_m)$. Moreover, even though contact rates are exogenous in this model, we further consider the possibility that ω directly impacts firms' labor demand, therefore affecting the job contact rates λ_0 and λ_1. We can then decompose the response as follows:

$$\frac{dw(p)}{d\omega} = \underbrace{\frac{\partial w(p)}{\partial\omega}}_{\substack{\text{Opportunity}\\ \text{Cost}}} + \underbrace{\frac{\partial w(p)}{\partial p_m}\frac{dp_m}{d\omega}}_{\text{Entry/Exit}} + \underbrace{\frac{\partial w(p)}{\partial\lambda_0}\frac{d\lambda_0}{d\omega} + \frac{\partial w(p)}{\partial\lambda_1}\frac{d\lambda_1}{d\omega}}_{\text{Competition}} \tag{4}$$

We study the three pieces of $dw(p)/d\omega$ in turn.

The first *Opportunity Cost* effect is the direct impact of the productivity scale ω, which reflects the higher opportunity cost (due to a loss of output) of not hiring/retaining workers that a firm pays when ω increases. Suppose all firms keep their wage offers fixed as ω rises to $\omega' > \omega$. Then firm p will go from productivity ωp to $\omega' p$. Given the strategy of other firms, value of leisure, and arrival rates, this firm will optimize by mimicking firm $p' = p\omega'/\omega$: whether the firm is more productive for idiosyncratic or aggregate reasons is immaterial to its choice, given a wage offer distribution and arrival rates. So firm p will raise its wage offer to $w(p') > w(p)$, and, in equilibrium, all firms will raise their wages.

Inspection of (2) when $\pi(p_m) = 0$ reveals that the elasticity of the wage function with respect to aggregate productivity ω is one in this model, so that, if this direct effect were the only one at play, all wages would rise proportionally to aggregate productivity.[6]

The second *Entry and Exit* effect is the impact of aggregate productivity on the set of active firms. The model allows for entry and exit "at the bottom": as ω changes, so will the entry threshold p_m. In general, an increase in ω will pull some relatively unproductive firms into the market, thus lowering wages: $dp_m/d\omega < 0$ and $\partial w(p)/\partial p_m > 0$.

The (positive) response of wages to p_m is exactly one-for-one at the bottom and changes along the productivity scale in a complex way that depends on $\Gamma(\cdot)$. The negative response of p_m to ω depends on whether the reservation wage R or the minimum wage is binding. In the latter case, $p_m = w_{\min}/\omega$ so that $dp_m/d\omega$ is simply equal to $-p_m/\omega$ (negative unit elasticity). Things are more complex when R is binding, as then $p_m = R/\omega$ is defined implicitly by (3) and $dp_m/d\omega$ depends, inter alia, on the responses to ω of the job contact rates λ_0 and λ_1.

The third *Competition* effect is the direct impact of aggregate productivity on wage competition through the response of the arrival rates of offers λ_0 and λ_1, given the set of active firms. Here we can make the following key remark:

[6] In Moscarini and Postel-Vinay (2016), we show that, with endogenous hiring, this direct effect is dampened by hiring costs, so that the $w(p)$ with respect to ω can be less than one.

given the reservation wage R (or given a binding minimum wage), the wage function (2) only depends on λ_1, and not on λ_0, i.e.:

$$\frac{\partial w(p)}{\partial \lambda_0} = 0 \quad \text{and} \quad \frac{\partial w(p)}{\partial \lambda_1} \geq 0.$$

This implies that a change in the arrival rate λ_0 of offers to the *unemployed* has no direct effect on equilibrium wages, and will work only through the reservation wage R, whenever it is binding. What matters for wage competition above R is the arrival rate of offers to *employed workers* λ_1, which is the true index of competition. If R is fixed, or if a binding minimum wage makes it irrelevant, firm commitment will insulate wages from a direct influence of cyclical fluctuations in the value of unemployed search, as in Hall and Milgrom (2008)'s credible bargaining, but for very different reasons.

II. Empirical Evidence

In Moscarini and Postel-Vinay (2016) we analyze the quantitative bite of each of the effects highlighted above using a fully stochastic dynamic version of the steady-state model presented here, including endogenous and costly hiring by firms. Here, we focus on one important prediction of the model, namely that when the minimum wage binds, the unemployment exit rate does not have any impact on wages, only the job-finding rate from employment does.

Suggestive evidence is provided by Faberman and Justiniano (2015), who notice that the aggregate Employment Cost Index (ECI) is strongly correlated over the business cycle with the aggregate job-switching rate (the fraction of employed workers who change employers without going through unemployment — a proxy for λ_1 in our model). In this paper, we investigate the data further on this question.

Table 1 shows the results from a regression of the quarterly growth rate of the ECI on the (quarterly averages of the) job finding rate of the unemployed (UE rate, the empirical counterpart of the model's λ_0) and employment-to-employment job switching rate (EE rate). The latter two variables were constructed (and regularly updated) by Fallick and Fleischman (2004) from the Current Population Survey (CPS).[7] We include the quarterly change in the unemployment rate as an additional control to capture the *Opportunity Cost* and *Entry/Exit* effects of ω — see (4).[8] In the first column of Table 1, we regress the ECI growth rate on the UE rate alone, and obtain, as expected, a positive and significant correlation. Yet in the second column, we include the EE rate as an additional regressor, and see that, not only does the coefficient on the EE rate come out positive and significant (as most theories would predict), but also that the effect of the UE rate all but disappears and loses its statistical significance. This result provides support for the model's prediction that only λ_1 puts substantial pressure on wage growth.

We next complement this aggregate evidence with a brief analysis of micro data. One advantage of individual-level data is that they allow us to separately estimate the effects of UE and EE rates on the wage growth of job movers and job stayers. The model predicts that neither should be influenced by the UE rate, and both should be influenced positively (although with different magnitudes) by the EE rate.

We extract a panel of workers aged 18-60 from the last four panels (1996, 2001, 2004 and 2008) of the SIPP. One advantage of the SIPP is that it allows us to measure job spells fairly precisely: in particular, we can identify job-to-job switchers and job stayers. A significant drawback of the SIPP is that the wage data are very noisy, particularly in earlier panels. Bearing that in mind, we merge the SIPP panel with the aggregate UE and EE rates from Fallick and Fleischman (2004), and regress individual monthly wage growth on backward-looking six-month moving averages of those two rates, either on their own or interacted with job stayer/switcher indicators, plus a set of controls.[9]

Table 2 shows the results, which broadly con-

[7] The ECI series is available from 2001 onwards on the Bureau of Labor Statistics (BLS) web site.

[8] All of the results presented in this section are robust to omitting the change in unemployment which, interestingly, is not estimated to have a statistically significant effect on wage growth in any of the regressions shown below.

[9] We define a job stayer as someone staying with the same employer in two consecutive months. We attempt to capture "voluntary" job switchers by defining those as people changing employers with less than 29 days' unemployment in between jobs, excluding transitions by dual job holders caused by the loss of the main job (the second job becoming the main one, creating an apparent employer-to-employer transition). The residual category are thus dual job holders losing their main job.

TABLE 1—THE CYCLICALITY OF EMPLOYMENT COST INDEX GROWTH

Dependent variable: ECI growth		
UE rate	0.146***	0.039
EE rate	—	0.120**
Unemployment rate change	−0.205	−0.215

Note: Quarterly data, 2001Q1-2015Q3. All rates are normalized for comparability.

Source: CPS compiled by Fallick and Fleischman (2004), BLS, and authors' calculations.

TABLE 2—THE CYCLICALITY OF WAGE GROWTH.

Dependent variable: monthly log wage growth				
UE rate	0.269***	−0.165	—	—
EE rate	—	0.520***	—	—
(UE rate)*switcher	—	—	0.941***	−0.678
(UE rate)*stayer	—	—	0.226***	−0.082
(EE rate)*switcher	—	—	—	1.766*
(EE rate)*stayer	—	—	—	0.387***
Unemployment rate change	−3.263	1.120	−3.375	0.973

Note: Monthly data, 1996m1-2013m7 (with gaps). All rates are normalized for comparability. Controls include gender, race, age, marital status, education, industry, occupation, mover/stayer status, and establishment size. Standard errors are clustered by individual.
Source: CPS compiled by Fallick and Fleischman (2004), SIPP, and authors' calculations.

firm the aggregate results from Table 1. First looking at the first two columns of Table 2, which mirror the regressions in Table 1, we see that the positive correlation between the UE rate and wage growth disappears when the EE rate is included as a regressor. Breaking down the effects of the UE and EE rates between job switchers and job stayers (columns 3 and 4) yields similar results for both worker categories, although less precisely estimated for job switchers.

Taken together, those descriptive results support the prediction obtained from the Burdett and Mortensen (1998) model that wages are primarily responsive to the job contact rate of employed workers, rather than to the unemployment exit rate. Beyond the model, and as pointed out before by Faberman and Justiniano (2015), this evidence suggests that the EE job switching rate is a strong predictor of future wage growth and, ultimately, of inflation.

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