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Abstract

I conduct an empirical investigation of the cyclicality of the price of labor. Firms employ workers up to the point where workers' marginal revenue product equals the price of labor. If the labor market is a spot market, then the price of labor is the wage. But often workers are contracted for more than one period. The price of labor captures both the wage at the time of hiring and the impact of labor market conditions at the time of hiring on future wages. The price of labor and not wage is allocational for employment. Because it is not directly observed in the data, I construct the price of labor based on the behavior of individual wages and turnover. I find that a one percentage point increase in unemployment generates more than a 4.5% decrease in the price of labor. This cyclicality is three times higher than the cyclicality of individual wages and also noticeably higher than the cyclicality of the wages of newly hired workers. I conclude that the price of labor is very procyclical. Key words: Price of labor. User cost of labor. Cyclicality. Cyclicality of wages. JEL Codes: E32, E24, J31.

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1 Introduction

Macroeconomists have long been interested in the cyclicality of real marginal costs of labor as means of understanding the dynamics of business cycles.[1] Early literature considered aggregate wages to be a measure of real marginal cost and documented almost acyclical wages (Mankiw, Rotemberg and Summers 1985). Starting with Bils (1985), the literature turned to examining individual wages, free of composition bias.[2] Bils analyzes the cyclicality of individual wages,an distinguishing wages of newly hired workers from wages of workers employed for longer periods. He documents a significant difference between the cyclicality of wages of workers who stay with their employers (job stayers) and the cyclicality of wages of workers who change employers (job changers). The wages of job stayers on average decrease by less than 1% if the unemployment rate increases by one percentage point, whereas the wages of job changers decrease by as much as 3%.[3]

These findings suggest that wages within an existing employment relationship do not respond to labor market conditions as readily as do wages of newly hired workers. Such a wage payment arrangement can arise, for example, in the presence of the implicit contracts between a worker and a firm, by which a risk-neutral firm insures a risk-averse worker against fluctuations in productivity. If this is the case – if wages are smoothed within employment relationships – then neither average individual wage nor the wage of newly hired workers reflects a marginal cost of a worker.

In this paper, I propose a measure of the marginal cost of a worker to a firm – the price of labor – and estimate its cyclicality. The price of labor takes into account both the wage at the time of hiring as well as the effect of the economic conditions from the time of hiring on future wage payments within the employment relationship. Formally, I define the price of labor as the difference between the expected present discounted value of wages paid to a worker hired in the current year and the expected present discounted value of wages to be paid to an identical worker hired next year. Hence, the price of labor is the wage at the time of hiring plus the expected present discounted value of the differences between the wages from the next year and onward that are paid in the relationship that starts in the current year and in the relationship that starts in the next year.

[1] The procyclicality of the real marginal cost of labor is an important feature of the real business cycle model. See, for example, a discussion of the real business cycle theory and procyclicality of wages in Mankiw (1989). See Rotemberg and Woodford (1999) for an extensive review.

[2] The argument about the composition bias is first mentioned in Stockman (1983).

[3] In a recent review, Pissarides (2007) reports these numbers as a consensus of the empirical literature on the cyclicality of wages.

The paper's main finding is that the constructed price of labor is more than three times as cyclical as individual wages and noticeably more cyclical than the wages of newly hired workers. I find that the price of labor decreases by more than 4.5% in response to a one percentage point increase in the unemployment rate.

To understand the main empirical result of the paper, consider, for example, an environment where wages are smoothed as a result of optimal contracts between risk-neutral firms and risk-averse workers. When unemployment is high, hiring wages are low. In addition, the wages in all subsequent periods in the contract are relatively lower than wages in contracts initiated under more favorable economic conditions. If the unemployment rate is expected to return to lower levels, hiring wages in the future are expected to rise. By hiring currently as opposed to hiring the following year, a firm "locks in" a worker to a relatively lower stream of wages. In this case, the wage at the time of hiring overstates the price of labor. The price of labor is lower by the expected difference between the values of wages to be paid starting in the following year to a worker hired in the following year and the identical worker hired currently. Thus, when unemployment is high, the hiring wage is low, but the price of labor is even lower. This implies that labor's price is more responsive to changes in unemployment than the hiring wages are.

I conduct an empirical investigation of the cyclicality of the price of labor using the National Longitudinal Survey of Youth. Because the price of labor is not directly observed in the data, I construct the empirical counterpart based on the behavior of individual wages and turnover. First, I estimate an empirical model of the response of individual wages to the history of unemployment rates from the time of hiring. As in Beaudry and DiNardo (1991), I consider the initial unemployment rate, the minimum unemployment rate from the start of employment relationship, and the contemporaneous unemployment rate. Next, using the estimated empirical model for wages, the empirical separation rate, I construct a series for the price of labor. In the construction, future payments are discounted to take into account anticipated separation rates and the real interest rates. Finally, I project (the logarithm of) the constructed series of the price of labor on the contemporaneous unemployment rate.

The main idea of the paper builds on ideas of Barro (1977) and Hall (1980) who argue that what matters to a firm is the value of wages to be paid during the course of a firm–worker relationship.[4] Barro calls sticky wages just a "façade" of the implication of the long-term

[4] In the words of Hall (1980), "to see what is happening today in the labor market, one should look at the implicit asset prices of labor contracts recently negotiated, not at the average rate of compensation paid to all workers."

labor contracts to short-term macro fluctuations. Kydland and Prescott (1980) note that the weak procyclicality of real wages can suffer from "cyclical measurement bias" because, with implicit contracts, wage payments are not perfectly associated with labor services provided each period. The concept of the price of labor defined here is analogous to the rental price of capital and can be thought of as the user cost of labor.

This paper, to my knowledge, is the first attempt to measure the cyclicality of the price of labor taking into account the effect of economic conditions at the time of hiring on future wages. Studies on cyclicality have evolved from examining the cyclicality of aggregate wages to examining the cyclicality of individual wages of job stayers and job changers, documenting each of these wage statistics as more cyclical than the preceding one. But, if economists accept that wage is not allocational in the presence of implicit contracts, then the cyclicality of individual wages or wages of newly hired workers may not equal the cyclicality of the labor's user cost. I find that although the data show that individual wages are smoothed within the employment relationship, a wedge between the cyclicality of wages of job stayers and job changers conceals a substantial procyclicality of the price of labor a firm incurs.

The paper is organized as follows. Section 2 derives the expression for the price of labor. Section 3 analyzes the behavior of individual wages over the business cycle. Section 4 estimates the cyclicality of the price of labor and section 5 concludes.

2 The Price of Labor

Consider an economy populated by infinitely lived firms and infinitely lived workers. Assume that if a firm decides to hire, a worker is always available for hire. The only costs associated with hiring a worker are wage payments. A firm pays according to the wage schedule agreed on when the worker is hired. Every period, a nonzero probability exists that a worker and a firm will exogenously separate.[5]

The price of labor can be thought of as the user cost of labor, i.e., the per period cost of a worker to a firm. If workers are hired in a spot market, the price of labor is the wage. However, workers are often contracted for more than one period. In that case, economic conditions at the time of hiring may have an effect on future wage payments. To capture the effect of economic conditions on future wages, the price of labor is defined by analogously with the implicit rental price of capital. The rental price of capital is the difference between the

[5] In what follows I use the terms "job" and "firm" interchangeably.

purchase price and the expected price that can be recovered from selling the un-depreciated part of the factor after utilization.

Let $w_{t,t+\tau}$ denote the wage paid in period $t+\tau$ to a worker hired in period t, let λ_t denote the separation rate at which a worker separates from the firm in period t, and let β denote a discount factor, where $0 < \beta < 1$. The expected present discounted value of wages to be paid to a worker hired in period t is given by

$$C_t = w_{t,t} + E_t \sum_{\tau=1}^{\infty} \left(\beta^\tau \prod_{k=0}^{\tau-1} (1 - \lambda_{t+k}) \right) w_{t,t+\tau}, \tag{1}$$

where $E_t = E(.|I_t)$ and I_t is the information set at time t.

Equation (1) states that a worker hired in period t is paid a wage $w_{t,t}$. With probability $1 - \lambda_t$, the employment relationship survives until period $t + 1$ and the worker is paid wage $w_{t,t+1}$. With probability λ_t, the relationship is terminated and the firm pays nothing.

The implicit asset price of labor in period t is the difference between the expected present discounted value of wages paid to a worker hired in t and the expected present discounted value of wages paid to a worker hired in $t + 1$:

$$P_t = E_t \left[C_t - \beta(1 - \lambda_t) C_{t+1} \right]. \tag{2}$$

Hence, the price of labor is the expected difference in cost between two alternatives: hiring a worker this period, or hiring a worker next period with probability $(1 - \lambda_t)$. These two options differ only in how many workers the firm employs this period; they give the same expected employment levels in all future periods. Therefore, the difference between them is the implicit price of the services of one worker this period.

Substituting from (1), I obtain the following expression for the price of labor[6]:

$$P_t = E_t \left[w_{t,t} + \sum_{\tau=1}^{\infty} \left(\beta^\tau \prod_{k=0}^{\tau-1} (1 - \lambda_{t+k}) \right) (w_{t,t+\tau} - w_{t+1,t+\tau}) \right]. \tag{3}$$

Equation (3) implies that the price of labor in period t is the sum of the hiring wage in period t and the expected present discounted value of the differences between wages paid from the next period onward in the employment relationship that starts in period t and the employment relationship that starts in period $t + 1$. If wages are renegotiated every period

[6] See Appendix A for the proof that $E_t|w_{t,t} + \sum_{\tau=1}^{\infty} \left(\beta^\tau \prod_{k=0}^{\tau-1} (1 - \lambda_{t+k}) \right) (w_{t,t+\tau} - w_{t+1,t+\tau}) | < \infty$.

and depend only on contemporaneous labor market conditions, i.e., $w_{t,t+\tau} = w_{t+1,t+\tau}$ for all $\tau \geq 1$, then the second term in expression (3) vanishes. Otherwise, the price of labor takes into account the expected value of the total stream of payments associated with the employment relationships that start in period t and in period $t+1$, respectively, conditional on information available at time t.

Following the empirical literature on the cyclicality of wages (Bils 1985), the cyclicality of the price of labor is the expected proportional change in the price of labor, P_t, in response to a unit change in the unemployment rate, U_t. Hence, it is the projection of $\ln P_t$ on U_t, which can be measured as the regression coefficient of $\ln P_t$ on U_t:

$$CI = \frac{cov(\ln P_t, U_t)}{var(U_t)}. \tag{4}$$

Define P_t^R to be the realized, ex post value of the price of labor. Then

$$P_t = E_t(P_t^R). \tag{5}$$

Next, define the random variable ε_t according to the following equation:

$$P_t^R = P_t \varepsilon_t,$$

where ε_t is independent of the variables in the information set I_t. Then the covariance of $\ln P_t^R$ with the unemployment rate, U_t, is

$$cov(\ln P_t^R, U_t) = cov(\ln P_t, U_t) + cov(\ln \varepsilon_t, U_t). \tag{6}$$

Because information set I_t contains the contemporaneous unemployment rate, U_t, and ε_t is independent of I_t, the last term in (6) is 0. Then, the following equality obtains:

$$cov(\ln P_t^R, U_t) = cov(\ln P_t, U_t).$$

This yields the following expression for the cyclicality of the price of labor:

$$CI = \frac{cov(\ln P_t^R, U_t)}{var(U_t)}. \tag{7}$$

Now the task is to construct an empirical counterpart of (5) and to estimate the cyclicality indicator in (7). The price of labor is not directly observed in the data. To construct the empirical counterpart of the realized price of labor, P_t^R, I need the series of individual wages and the separation rates, indexed by the period when a worker is hired and the contemporaneous period. In section 4, I describe how to obtain an estimate of the realized price of labor and the cyclicality indicator.

3 Evidence of Wage Smoothing Within Employment Relationships

The goal of this section is two-fold. First, I provide empirical evidence from individual wages that motivates the price of labor as opposed to the wage as a measure of the (wage component of the) user cost of labor.[7] From (3), note that if the wage in the employment relationship depends only on the contemporaneous economic conditions, then the price of labor is the wage. However, if wages exhibit history dependence on the economic conditions from the start of the job, in general the price of labor does not equal the wage. In this section, I present empirical evidence that wages depend on the history. Second, I present evidence that wages of newly hired workers are more procyclical than wages of workers who do not change jobs. This evidence provides an intuition behind the main empirical result of the paper, presented in the next section, that the price of labor is considerably more procyclical than individual wages.

3.1 Data

I use the National Longitudinal Survey of Youth (henceforth NLSY), 1978 - 2004. The survey collects information on work history of a nationally representative sample of young individuals who were between 14 and 21 years of age in 1979 when the first interview was taken.

I focus on the cross-sectional sample that represents the non-institutionalized civilian population and further restrict my analysis to males. This restriction is typical in other empirical studies of wage cyclicality (see, for example, Beaudry and DiNardo 1991; Solon

[7] The user cost of labor includes all costs associated with adding a worker to a firm: wage payments, training costs, hiring costs. In this paper, the price of labor refers to the wage component of the user cost of labor.

For example, in Kudlyak (2009) the user cost of labor is derived in a search and matching model. There, the user cost of labor consists of the wage component of the user cost of labor and the hiring cost component of the user cost of labor. The latter arises in a search and matching model due to vacancy posting costs.

and Shin 2007). Hence, I work with the following sub-samples, as defined in NLSY: 1 = cross-sectional white males, 3 = cross-sectional black males, 4 = cross-sectional Hispanic males, 5 = cross-sectional white females, 7 = cross-sectional black females, and 8 = cross-sectional Hispanic females. The following sub-samples are not included in the analysis: cross-sectional poor white males (2), cross sectional poor white females (6), all supplemental (9-14), and military sub-samples (15-20).

The data set is suited for the purposes of this study because it separately records wages and other job characteristics for up to five jobs that an individual might hold between two consecutive interviews. By tracking individuals over the years, I can isolate the individual-specific fixed effects. In addition, if a worker simultaneously held more than one job, the NLSY79 kept a separate record for each job, as opposed to PSID data that report the average wage in such cases.

On the other hand, the data contain information on individuals at the early stages of their labor market experience. Because jobs taken at the early stages of an individual's labor experience may be predominantly seasonal or temporary, these job changers may disproportionately affect the wage cyclicality. To alleviate this problem, I restrict the observations included in the wage equation to the observations of individuals who started a job at age 16 and older, were 20 and older at the time of the observation, and reported being out of school. When I use workers' fixed effects in the estimation, the sample is restricted to the workers having more than one observation. The details on the sample restrictions are provided in Appendix B.

Wage is an hourly pay variable constructed by NLSY. I deflate wages using the annual CPI index of the year the observation refers to. *Unemployment rate* is the annual, national, civilian unemployment rate for ages 16+ obtained from the Bureau of Labor Statistics. *Contemporaneous unemployment rate* is the annual unemployment rate of the calendar year when the respondent reported last working at the job. *Minimum* and *maximum* unemployment rates are minimum and maximum, respectively, of the unemployment rates of the calendar years from the start year to a contemporaneous year.

3.2 Individual Wages Over the Business Cycle

3.2.1 Dependence of Wages on Past Unemployment Rates

The price of labor differs from an ongoing hiring wage if wages exhibit dependence on the history of labor market conditions. I examine the response of individual wages to the history of labor market conditions that a worker experiences from the time of hiring. Labor market conditions are captured by the national unemployment rate.

The empirical model for wages is similar to Beaudry and DiNardo (1991) and is specified as follows:

$$\begin{aligned} \ln(w_{j,t_0,t}) &= \Omega\Phi_{j,t_0,t} + \gamma_{start}U_{t_0} + \gamma_c U_t + \gamma_{\min} \min\{U_\tau\}_{\tau=t_0}^{t} + \gamma_{\max} \max\{U_\tau\}_{\tau=t_0}^{t} + \\ &\quad \mu_j + \varepsilon_{j,t_0,t}, \qquad (8) \\ \varepsilon_{j,t_0,t} &= \nu_{t_0}^1 + \nu_t^2 + \eta_{j,t}, \qquad (9) \end{aligned}$$

where $w_{j,t_0,t}$ is the hourly wage of a worker j in year t who was hired in year t_0; $\Phi_{j,t_0,t}$ is the vector of the individual and job-specific characteristics of worker j in year t hired in year t_0; U_τ is the unemployment rate in year τ; μ_j is the individual-specific, time-invariant effect; and $\eta_{j,t}$ is the individual- and time-varying error term. $\eta_{j,t+\tau}$ is assumed to be serially uncorrelated as well as uncorrelated across individuals, with mean 0 and constant variance σ_η^2.

Error terms ν_{1,t_0} and $\nu_{2,t}$ are year-specific and reflect the effect on wages of the aggregate labor market conditions during the year a worker was hired, t_0, and at the time the observation was taken, t, respectively. Clustering is necessitated by the inclusion of the aggregate unemployment rates to explain individual separations. Moulton (1990) describes the downward bias in the standard errors that results from the possible correlation of the unobserved aggregate time effect in the error term with aggregate explanatory variables used to explain changes in individual variables. Wooldridge (2003) provides a good case for clustering standard errors as a possible remedy to the problem. Cameron, Gelbach, and Miller (2006) propose a parsimonious way to account for a two- (or multi-) way random effects errors and clustered regressors. In particular, they allow for the two-way clustered heteroscedastic errors, where ν_{1,t_0} and $\nu_{2,t}$ are correlated.

To estimate standard errors in (8) I employ the Cameron, Gelbach, and Miller (2006) two-way cluster-robust method. In particular, the variance–covariance matrix of their estimator is an adjusted sum of the variance–covariance estimates from the clustering by each dimension, t_0 and t, separately minus the variance covariance estimate from clustering by the two variables simultaneously, that is, by each $\{t_0, t\}$ pair. Equation (8) is estimated using OLS, controlling for the individual fixed effect. The vector of individual- and job-specific characteristics, $\Phi_{j,t_0,t}$, includes grade, a quadratic in potential experience, a quadratic in tenure, a dummy for union status, a dummy for missing union information, and four measures of unemployment rates.[8]

Specification in (8) is similar to Beaudry and DiNardo (1991), except I add a worker's maximum unemployment rate as in Grant (2003). This rate allows the capture of a possible downward adjustment in wages when unemployment rates are high. Beaudry and DiNardo interpret the specification as nesting three different contract models of the effect of labor market conditions on wages. If wages are influenced only by contemporaneous labor market conditions and are set in a spot market, the effect of past unemployment rates on wages is expected to be insignificant. The coefficient on the contemporaneous unemployment rate, γ_c, is expected to be negative. If wages are set according to contracts with full commitment and mobility is costly, then wages are expected to be influenced by initial labor market conditions at the time the job starts. In this case, the coefficient on the unemployment rate at the start of the job, γ_{start}, is expected to have a significant negative impact. If wages are set by contracts and mobility is costless, then whenever market conditions improve, the wage is expected to rise. In this case, the coefficient on the minimum unemployment rate since the start of the employment relationship is expected to be negative. Finally, inclusion of the maximum unemployment rates allows for the possibility of firms adjusting wages downward when labor market conditions worsen.

Equation (8) can also accommodate the model where a worker receives job offers while employed, and the ongoing wage is adjusted to reflect those offers if the firm wants to retain the worker. The goal in this section is to establish the dependence of wages on the history of unemployment rates in the data without necessarily establishing the source of the dependence.

In Table 1, I present results of estimating equation (8) with only one measure of unemployment rate—contemporaneous unemployment. In Column 1, the equation is estimated on the whole sample with the sample restrictions described in section 3.1. The coefficient on unemployment indicates that as the contemporaneous unemployment rate increases by one percentage point, wages on average tend to decrease by 1.51%. Because data contain information on up to five jobs between interviews, the sample that is not restricted to the current

[8] The regressions are estimated using annual measures of the unemployment rates. The estimated standard errors are two-way clustered: by the year the job starts and by the contemporaneous year. In most specifications it amounts to 28 and 30 clusters, respectively. From the Monte Carlo simulations in Cameron, Gelbach, and Miller (2006), this number of clusters delivers satisfactory results, provided there are a sufficient number of observations in each cluster. As a robustness check, I reestimate the regressions using monthly measures of unemployment rates and, consequently, clustering by the start and the contemporaneous unemployment months. This increases the number of clusters to approximately 300 in each dimension. The conclusions about the significance of the coefficients do not change or change only marginally (statistical significance of the coefficients increases) in most of the cases. The estimation results are available in Appendix D.

or most recent job at the time of the interview (henceforth, CPS jobs[9]) may oversample workers who tend to change jobs more often. Given more procyclical wages of job changers (Bils 1985; Devereux 2001, among others), one would expect the cyclicality of wages in the restricted sample to be lower. Results for the CPS sample show that the response of wages to the unemployment rate decreases to statistically insignificant 1.24%. The coefficient is also somewhat lower when I restrict the whole sample to observations with 30 hours worked per week or more.

Next, I add the past unemployment rates to the explanatory variables. Table 2 contains results from estimation wage regression (8) with three measures of unemployment rates: the unemployment rate from the time a worker is hired, the minimum unemployment rate experienced by a worker while on the job, and the contemporaneous unemployment rate. This specification is analogous to the original specification of Beaudry and DiNardo (1991) with the exception of an added quadratic in tenure and dummy for missing union status. Column 1 contains the coefficient estimates and columns 2 – 5 contain standard errors obtained using different corrections for standard errors. As compared with the results in Table 1, once the effect of the minimum unemployment rate is not restricted to zero, the effect of the contemporaneous unemployment rate decreases substantially. This result is consistent with the findings in Beaudry and DiNardo (1991). In particular, a one percentage point decrease in the unemployment rate experienced during a worker's tenure leads to more than a 3% increase in wages. At the same time, the effect of the contemporaneous unemployment rate is close to zero. Once the standard errors are clustered, the contemporaneous unemployment rate's significance drops from marginally significant to highly insignificant. The coefficient on the unemployment rate at the start of the job indicates that workers hired when the unemployment rate is high on average receive lower wages: for every percentage point increase in unemployment rate at the time of hiring, wages drop by approximately 1.75%.

Standard errors in columns 2 – 5 demonstrate the pitfalls of using aggregate variables to explain individual variables described in Moulton (1990): standard errors are substantially lower in column 1 where no measures are taken to remedy the possible correlation of the time effect in the error term with the aggregate explanatory variables. In column 3, I cluster standard errors by a contemporaneous year; that is, correlation of the error term is restricted to be the same for the observations taken in the same year. Column 4 presents standard errors clustered by each $\{t_0, t\}$ pair in the sample. Finally, column 5 presents the two-way clustered standard errors of Cameron, Gelbach, and Miller (2006). Because standard errors corrected

[9] These jobs are labelled "CPS jobs" in NLSY79.

by two-way clustering are close to the standard errors clustered by a contemporaneous year, I employ this one-way clustering in the wage regressions that follow. Estimation on the CPS sample and the sample with weekly hours restriction delivers a similar conclusion about the importance of the minimum unemployment rate.

From the estimation, I conclude that wages are affected by the history of unemployment rates experienced from the time of hiring by a worker. Once the history is considered, the effect of the contemporaneous unemployment rate is comparatively, small both statistically and economically.

Table 3 contains results of estimating equation (8) with four measures of unemployment: the unemployment rate at the time of hiring, the minimum and maximum unemployment rate, and the contemporaneous unemployment rate. Column 1 shows results of the estimation based on the whole sample. Estimation delivers a statistically significant coefficient of -1.28% on the maximum unemployment rate, a coefficient on the minimum unemployment rate of -2.75%, and a coefficient on the start unemployment of -1.21%.

In the sample, the effects of the four different unemployment rates are identified by those individuals for whom at least two of those rates are different. That is, for the observations associated with the same calendar start year and contemporaneous year, all four measures of unemployment are the same annual unemployment rate. Those observations constitute approximately 20% of the sample. I restrict the sample to the observations for which the calendar start and contemporaneous year do not coincide. The results of this estimation are presented in column 2 of Table 3. The coefficient on the maximum unemployment rate drops to -0.83% with standard error 0.73%. The effect of minimum unemployment becomes even more pronounced at -3.28%. Column 3 presents results for the same restricted sample but without the maximum unemployment rate. Clearly, the conclusions from Table 2 are reinforced here.

In the regressions above, I include a parsimonious set of the explanatory variables. When in addition to education, experience, tenure and union variables I add industry dummies, marital status, and region of residence, the coefficients on the minimum, initial, and contemporaneous unemployment rates decrease only slightly in magnitude. The conclusion about the importance of the history of the unemployment rates for the individual wages endures.

3.2.2 Wages of Newly Hired Workers and the Unemployment Rate

To examine the possible different response of wages of newly hired workers to the current labor market conditions, I restrict the sample to 1) the observations on individuals with less than one year of tenure, and 2) the observations on individuals with at least two years of tenure. The results of the estimation are presented in columns 2 and 3 in Table 1, respectively. In the sample of newly hired workers (tenure less than a year), the coefficient on the contemporaneous unemployment rate is -3.10%. In the sample of workers who stay at the job for two years and longer, the coefficient on the contemporaneous unemployment rate is 0.29% and is not statistically significant. It follows that wages of newly hired workers respond substantially more to changes in the contemporaneous unemployment rate than do wages of all workers. This conclusion is supported in the earlier literature (see summary in Pissarides 2009).

3.3 Implication of Wage Smoothing for the Cyclicality of the Price of Labor

The empirical results above go in-line with the findings in the literature on the cyclicality of individual wages. I find that (1) wages exhibit dependence on the past history of unemployment, and (2) wages of newly hired workers are substantially more procyclical than wages of workers who remain on the job for some time. In turn, the results imply that wage alone does not summarize the wage commitment a firm makes upon hiring a worker. The relevant measure of a cost of a worker to a firm should take into account both the wage at the time of hiring and the effect of the economic conditions at the time of hiring on future wages.

The empirical facts established on the cyclicality of wages of all workers and of newly hired workers give an intuitive prediction about the cyclicality of the price of labor. Business cycles can be described by high unemployment rates in recessions and low unemployment rates in booms. Consider a firm that hires a worker toward the end of a recession, when the unemployment rate is high, as opposed to hiring later, when the unemployment rate is expected to return to its lower level. In the previous section, I show that wages of newly hired workers are procyclical. Hence, when hiring currently, a firm pays a comparatively lower hiring wage. The low hiring wage may reflect the low bargaining power of workers given the high unemployment rate. In addition, it has been also established that wages of workers who remain at the same job for some time (those with longer tenure) are also procyclical but respond much less to the changes in the contemporaneous unemployment rate than do wages of newly hired workers. Once workers are hired, their wages are shielded from the effect of contemporaneous labor market conditions and bear the effect of the past unemployment rates. Thus, by hiring currently, a firm locks in a worker to a stream of wages that is expected to be lower than the stream of wages to be paid to an identically productive worker hired under the more favorable economic conditions. As a result, a per period cost of a worker to a firm, the price of labor, is even lower than the already low hiring wage because the price of labor also reflects comparatively low future expected wages. The opposite is true when a worker is hired at the peak of the cycle, when the unemployment rate is low but is expected to rise. Then the price of labor is higher than the hiring wage. Thus, the procyclical hiring wage and the "lock in" cause the price of labor to be more procyclical than the hiring wage.

Support for the conjecture that the price of labor is more procyclical than the wages of newly hired workers in the model where wages are smoothed within employment relationships can be found in Kudlyak (2009), where I consider the implicit self enforcing contracts of Thomas and Worrall (1988) in a search and matching model of Mortensen and Pissarides (1994).[10] The implicit contracts arise because risk-averse firms insure risk-neutral workers against fluctuations in productivity absent other means for smoothing consumption for workers. Three types of contracts are distinguished depending on the commitment assumption: full commitment contracts, one-sided lack of commitment from the worker and full commitment from the firm, and two-sided lack of commitment from both the worker and firm side. In the models, two identical workers who were hired in different periods may have different wages in the same period due to insurance considerations and the loss in the worker's value associated with becoming unemployed. The simulations of the series of wages of all workers, wages of newly hired workers and the price of labor (wage component of the user cost of labor) reveal that the model generates the price of labor that is substantially more procyclical than the wages of newly hired workers, which in turn are more procyclical than wages of all workers pooled together. The results remain true for all three type of contracts.

4 Cyclicality of the Price of Labor

In this section, I describe the estimation of the cyclicality of the price of labor introduced in section 2. First, I start with describing how the series of the realized price of labor is constructed from the data on individual wages and turnover. Second, I present the main empirical result.

[10] See Rudanko (2009) for an excellent analysis of the implicit contracts in a search and matching model.

4.1 Construction of the Price of Labor

The price of labor is not directly observed in the data. Hence, I construct the (realized) price of labor from the individual wage and turnover data. From section 2, the realized price of labor, P_t^R, is

$$P_t^R = w_{t,t} + \sum_{\tau=1}^{\infty} \left(\beta^\tau \prod_{k=0}^{\tau-1} (1 - \lambda_{t+k}) \right) (w_{t,t+\tau} - w_{t+1,t+\tau}). \tag{10}$$

The construction of the empirical counterpart of P_t^R, $\widehat{P_t^R}$, involves a few challenges. First, calculations of the price of labor requires two series of wages for each t in the sample period — a series of wages to be paid to a worker hired starting in time t and a series of wages to be paid to an identical worker hired the next period. Second, the calculation of the price of labor requires a series of separation rates. Finally, the expression for the price of labor assumes infinitely lived firms and workers; thus the calculations involve infinite sums. I deal with the last issue by truncating the calculations of the sum at different time horizons and checking the sensitivity of the calculated cyclicality indicator to its truncation horizon.

To obtain the series of the price of labor, I proceed as follows.

Step 1.

First, I specify the following model for wages in year t of worker j hired in period t_0:

$$\ln w_{j,t_0,t} = c + \sum_{\tau=1979}^{2004} \gamma_\tau^S D_{\tau,t_0}^S + \sum_{\tau=1979}^{2004} \gamma_\tau^C D_{\tau,t}^C + \rho \cdot t + \Psi X_{j,t} + \alpha_j + \varepsilon_{j,t}, \tag{11}$$

where D^S and D^C are two sets of time dummy variables that assume values as follows: for the job that starts in t_0 and is observed in t, $D_{\tau,t_0}^S = I(\tau = t_0)$ and $D_{\tau,t}^C = I(\tau = t)$, where $I(\cdot)$ is an indicator function. The data spans the sample period from 1978 to 2004; thus, there are 26 time dummies in each set, excluding the omitted base categories. $X_{j,t}$ is a quadratic in experience; α_j is a worker-specific individual fixed effect and $\varepsilon_{j,t}\tilde{}N(0, \sigma_\varepsilon^2)$.

The specification in (11) is similar to wage equation (8). Except here each dummy contains the time-specific effect of all economic conditions, including the effect of the unemployment rate. The task here is to obtain the expected wage for each $\{t_0, t\}$ pair in the sample period, conditional on worker characteristics.

I estimate equation (11) using fixed effects OLS weighting each observation by sampling weights.

Step 2.

Second, using the coefficient estimates from (11), I calculate the fitted values for wages,

$\widehat{w_{t_0,t}}$, for all t_0 and $t : t_0, t = \{1979, 2004\}, t_0 \leq t$:

$$\widehat{w_{t_0,t}} = \exp\left(\widehat{const_w} + \widehat{\rho}\bar{t} + \widehat{\Psi}\overline{X} + \widehat{\gamma^S_{t_0}} + \widehat{\gamma^C_t}\right),$$

where $\bar{t}$ and $\overline{X}$ are sample means. Note that $E_t(\widehat{w_{t_0,t}}) = w_{t_0,t}/\exp\frac{\sigma^2_\xi}{2}$. Assuming that $\sigma^2_\xi = const$ and $\overline{X}$ are uncorrelated with the contemporaneous unemployment rate, the cyclicality indicator does not depend on the actual values of $\bar{t}$, $\overline{X}$ and σ^2_ξ.

Step 3.

To obtain the series of separation rates, I proceed in two steps: first, I detrend the monthly separation rates; second, I estimate a linear probability model of the detrended monthly separation rates with a set of contemporaneous time dummies as explanatory variables. In the first step, I estimate the linear probability model with the dependant variable taking value 1 if a worker does not work for the same job in the next month and 0 otherwise. The explanatory variables are the quartic in monthly trend. I subtract the value of a quartic in trend multiplied by the estimated coefficients from the dependent variable and add the value of a quartic of a trend calculated at the mean multiplied by the estimated coefficients. In the second step, I run the constructed series on a set of contemporaneous time dummies. Then, using the coefficient estimates on the set of contemporaneous dummies, I obtain fitted projections, $\widehat{\lambda_t}$, for all $t : t = \{1, 324\}$. For the robustness check, I have also repeated this procedure with the probit in the first step instead of a linear probability model.[11] The results on the cyclicality remain the same. Alternatively, I also obtain the series of the separation rates without detrending. In this case, I estimate the probit regression with the monthly separation rate as a dependent variable and a set of contemporaneous dummies as explanatory variables. I present the results on the estimated cyclicality of the price of labor for detrended and non-detrended series of separation rates.

Finally, I use monthly fitted projections to obtain annual separation rates, $\widehat{\lambda^A_t}$. For all $t : t = \{1978, 2004\}$:

$$\widehat{\lambda^A_t} = 1 - \prod_{\tau=1}^{12}(1 - \widehat{\lambda_{\tau^t}}), \tag{12}$$

where $\widehat{\lambda_{\tau^t}}$ is a fitted monthly separation rate in a calendar month τ of year t.

Step 4.

I set a truncation horizon in calculating the second component of the realized price of labor in (10), τ_{tr} to 7 years. Truncation of the time horizon for calculating the price of

[11] In the second step, the probit regression is not applicable.

labor can be justified by two considerations. First, the discount factor, which includes the turnover rate and the real interest rate, increases. This in turn decreases the weight of the terms far in the future. Second, if the model behind the dependence of wages on the history of unemployment rates is that of Thomas and Worrall (1991) and the unemployment rate follows the mean-reverting process, then wages in the employment relationships that started in different years but that have lasted long enough to experience the periods of minimum and maximum unemployment rates will be the same. In that case, the terms in brackets in (10) will be equal for some high enough τ.

Later I examine the sensitivity of the estimated cyclicality of the price of labor to different truncations of the horizon, setting τ_{tr} equal to 5, 7 and 9 years. Increasing the truncation period, τ_{tr}, decreases the number of periods for which the price of labor can be calculated, given the finite length of the sample period. For example, given the truncation period of 7 years and the sample period from 1978 to 2004, the price of labor can be calculated for 20 years, from 1978 to 1997.[12]

Step 5.

Finally, I calculate the empirical counterpart of the realized price of labor using the constructed series $\widehat{w_{t_1,t_2}}$ and $\widehat{\lambda_t^A}$ and the truncation horizon τ_{tr}. I set a discount factor, β, to correspond to the real annual interest rate of 4.5%.

To obtain the cyclicality of the constructed price of labor, I run the following OLS regression bootstrapping standard errors:

$$\ln \widehat{UC_t^{RW}} = const + \gamma U_t + \chi t + \eta_t,$$

where U_t is the actual annual separation rate. The reported cyclicality coefficient is the coefficient on the unemployment rate multiplied by 100%:

$$\widehat{CI} = \frac{cov(\ln \widehat{P_t^{RC}}, U_t)}{var(U_t)} \cdot 100\% = \widehat{\gamma},$$

which is the semielasticity of the price of labor with respect to unemployment.

Before proceeding to the main empirical result, a discussion is in order. By definition, the price of labor is the difference between the two expected present discounted values of wages: (1) the expected present discounted value of wages paid to a worker hired in t and (2) the

[12] This number of observations is typical in papers on the cyclicality of wages that employ a two-step estimation procedure as in Solon, Barsky and Parker (1994) or Devereux (2001). For example, Devereux (2001) reports 22 observations in the second-stage regression.

expected present discounted value of wages paid to an identical worker hired in $t+1$. Suppose instead that a worker hired in $t+1$ has, for example, higher productivity, which is reflected in higher wages, in some periods from $t+1$ and onward as compared to a worker hired in t. Then the price of labor constructed as described above will also reflect the differences in future productivity in addition to the (wage component of the) user cost of labor at time t.

Two considerations may render the difference between the two expected present discounted values of wages specified above to also reflect the differences in productivity. First, an observationally equivalent worker hired in $t+1$ may have a different individual specific effect that is reflected in wages as compared to a worker hired in t. In the construction of the price of labor, I control for this effect by estimating the fixed effects regression for wages.

Second, if the quality of the match depends on economic conditions at the time of hiring, the productivity of a firm-worker pair may change as a consequence. Bowlus (1995) finds the evidence that the unemployment rate at the time of hiring has a positive impact on separation rates. In Appendix C, I present the results of the cyclicality of the price of labor that allow separation rates to depend on the history of unemployment rates from the start of the job. I find that accounting for the separation rate that depends on the history of the unemployment rate from the time of hiring does not change the main empirical result on the cyclicality of the price of labor.

In Appendix C, I first estimate the response of the separation rates to the unemployment rate at the time of hiring and to the contemporaneous unemployment rate. I find that the unemployment rate at the start of the job has a slight positive impact on the probability of future separation. Second, I construct the price of labor that allow separation rates to depend both on the contemporaneous and the hiring time period. Finally, I estimate the cyclicality. Because the effect of the initial unemployment rate is small and changes in unemployment from period to period are also small, the results on the cyclicality of the price of labor do not change.

4.2 Main Empirical Result

The main results are presented in Table 6. In the first row, I present estimates of the cyclicality of the price of labor constructed using a constant separation rate. The constant annual separation rate is constructed using equation (12) with $\widehat{\lambda}_t = 0.029$, the weighted average non-detrended monthly separation rate. In this case the constructed price of labor depends on the hiring wage and the difference between wages paid to the worker hired in the current year and the following year. In the next rows I present the cyclicality of the price of labor constructed using the separation rates that depend on the contemporaneous period using the procedure described in the Step 3 above for the detrended and non-detrended series of the separation rates, respectively. The cyclicality of the price of labor in Table 6 is calculated for the period 1978 - 1997.

The results of the estimation indicate that the cyclicality of the price of labor is much higher than the cyclicality of individual wages. In particular, the cyclicality of the price of labor calculated using a non-detrended series is -4.92%, which implies that as the unemployment rate increases by one percentage point, the constructed price of labor on average decreases by 4.92%.

In Table 7, I present the cyclicality results for the constructed price of labor truncated at 5, 7 and 9 periods, respectively. For comparison purposes, for all truncation horizons the cyclicality is calculated for 18 periods for which the data on the price of labor in all the cases is available. As shown in the table, as the truncation horizon increases, the cyclicality increases. For example, if the horizon is truncated at 5 years, the cyclicality of the price of labor constructed using non-detrended separation rates is -4.59%. It increases to -4.96% if the horizon is truncated at 9 years. From the estimation results, I conclude that the cyclicality of the price of labor is more than -4.5%, which is substantially higher than the cyclicality of individual wages of all workers and also noticeably higher than the cyclicality of wages of newly hired workers.

5 Conclusion

If labor is purchased in a spot market, then the wage is the price of labor. However, when wages depend on the history of the labor market conditions from the start of the job, the price of labor for the firm is the sum of the wage at the time of hiring and the expected effect of the economic conditions at the time of hiring on future wages. In this paper, I construct the price of labor and examine its cyclicality with respect to unemployment.

I find that a one percentage point decrease in the unemployment rate is associated with more than a 4.5% increase in the constructed price of labor. Consequently, the price of labor is much more procyclical than individual wages and also noticeably more procyclical than the wages of newly hired workers.

This paper is an attempt to measure the cyclicality of the price of labor explicitly accounting for the dependence of individual wages in the data on the past economic conditions from the start of the job. The importance of accounting for this history-dependence in wages, like that generated by implicit contracts between a worker and a firm, has been mentioned in the earlier literature by Hall (1980) and Rotemberg and Woodward (1999). However, to my knowledge, this paper is the first attempt to measure the cyclicality of the price of labor taking into account wage smoothing within the employment relationship.

I find that the price of labor is very procyclical. This result contrasts with the literature that uses aggregate wage or individual wages as a measure of the price of labor. Uncovering a noticeable cyclicality of the price of labor is important for both qualitative performance and for quantitative predictions of the models of business cycles.

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Table 1: Wages and Contemporaneous Unemployment

	Full sample 1	Tenure < 1 y. 2	Tenure ≥ 2 y. 3
U_t	-1.507**	-3.101***	0.292
	(0.705)	(0.716)	(0.733)
Grade	5.710***	4.003***	6.070***
	(0.457)	(0.600)	(1.361)
Experience	0.329***	0.258***	0.376***
	(0.038)	(0.032)	(0.036)
Experience^2	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Tenure	3.642***	1.721	2.114***
	(0.244)	(4.292)	(0.247)
Tenure^2	-0.124***	5.007	-0.077***
	(0.014)	(3.729)	(0.012)
Union	19.565***	20.439***	13.277***
	(1.018)	(1.248)	(1.529)
Union missing	3.288	5.555*	0.602
	(2.095)	(2.770)	(1.213)
Constant	-19.697*	10.729	-29.394
	(9.805)	(7.965)	(20.092)
R^2	0.6324	0.550	0.709
Observations	40850	14576	18546
N of ind	2627	2161	2186

Notes: NLSY79, 1978 - 2004, men only. Column 1 includes all observations in the sample with the sample restrictions as described in the text. Column 2 includes observations as in column 1 but is restricted to observations with tenure of less than 1 year. Column 3 includes observations as in column 1 but is restricted to observations with tenure of 2 years and longer. Estimated standard errors are in parentheses, clustered by time. The reported coefficients and standard errors are multiplied by 100. P-values: ***p<0.01, ** p<0.05, * p<0.1. Dependent variable: the natural logarithm of the real hourly wage. All regressions are estimated with fixed effects using sampling weights. The unemployment rate is an annual unemployment rate of the calendar year to which the wage observation corresponds.

Table 2: Wages and Initial, Minimum and Contemporaneous Unemployment

	Coefficient 1	Robust S.E. 2	S.E. clust. by t 3	S.E. clust. by $t_0 \cdot t$ 4	S.E. clust. by t_0 & t 5
U_t	0.505	(0.251)**	(0.770)	(0.372)	(0.760)
U_{t_0}	-1.745	(0.304)***	(0.390)***	(0.384)***	(0.561)***
$\min U$	-3.013	(0.465)***	(0.835)***	(0.627)***	(1.103)***
Grade	5.183	(0.492)***	(0.507)***	(0.484)***	(0.567)***
Experience	0.311	(0.012)***	(0.032)***	(0.018)***	(0.036)***
Experience^2	-0.001	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Tenure	3.331	(0.172)***	(0.224)***	(0.236)***	(0.356)***
Tenure^2	-0.102	(0.008)***	(0.012)***	(0.010)***	(0.014)***
Union	19.150	(0.705)***	(0.961)***	(0.777)***	(1.049)***
Union miss.	3.903	(1.158)***	(1.747)**	(1.238)***	(1.721)*
Constant	7.094	(6.744)	(11.232)	(7.732)	(12.271)
R^2	0.635				
N of obs.	40850				
N of ind.	2627				

Notes: NLSY79, 1978 - 2004, men only, includes all observation in the sample as described in the text. Dependent variable: the natural logarithm of the real hourly wage. All regressions are estimated with fixed effects using sampling weights. Column 1 contains coefficient estimates. Columns 2 - 5 contain estimated standard errors (in parentheses) from the alternative estimations. Coefficients and standard errors are multiplied by 100. The number of clusters by a current year is 28, by a year of the start of the job, 30. The reported coefficients and standard errors are multiplied by 100. P-values of the coefficients associated with standard errors: *** p<0.01, ** p<0.05, * p<0.1. Unemployment coefficients are the corresponding annual unemployment rates.

Table 3: Wages and Initial, Min, Max and Contemporaneous Unemployment

	All sample	$t = t_0$ excluded	$t = t_0$ excluded
	1	2	3
U_t	1.019	0.839	0.544
	(0.903)	(0.872)	(0.763)
U_{t_0}	-1.212**	-1.439***	-1.743***
	(0.567)	(0.500)	(0.381)
$\min U$	-2.750***	-3.276***	-3.547***
	(0.818)	(0.927)	(0.917)
$\max U$	-1.282*	-0.832	x
	(0.717)	(0.726)	
Grade	5.147***	4.981***	5.018***
	(0.500)	(0.674)	(0.687)
Experience	0.309***	0.330***	0.332***
	(0.032)	(0.033)	(0.034)
Experience^2	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Tenure	3.737***	3.253***	17.681***
	(0.333)	(0.312)	(1.131)
Tenure^2	-0.112***	-0.099***	3.059*
	(0.014)	(0.013)	(1.567)
Union	19.164***	17.689***	2.996***
	(0.961)	(1.131)	(0.235)
Union missing	3.894**	3.054*	-0.093**
	(1.711)	(1.557)	(0.012)
Constant	7.912	14.253	13.485
	(10.932)	(14.204)	(14.560)
R^2	0.675	0.700	0.700
Observations	40850	32735	29523

Notes: NLSY79, 1978 - 2004, men only, and includes all observation in the sample as described in the text. Dependent variable: natural logarithm of real hourly wage. Estimated standard errors in parentheses. The reported coefficients and standard errors are multiplied by 100. P-values: *** p<0.01, ** p<0.05, * p<0.1 Standard errors are clustered by a contemporaneous year. Column 1 includes all observations. Columns 2 and 3 exclude observations for which the contemporaneous calendar year equals the start year. Unemployment measures are annual unemployment rates.

Table 4: Individual Separations and Unemployment

	No FE	FE	No FE	FE
	1	2	3	4
U_t	-0.010	0.040	-0.055	0.002
	(0.090)	(0.094)	(0.081)	(0.079)
U_{t_0}	x	x	0.130**	0.119
			(0.054)	(0.094)
Grade	-0.108***	-0.450***	-0.111***	-0.455***
	(0.018)	(0.169)	(0.017)	(0.168)
Age	-0.046***	-0.048***	-0.047***	-0.049***
	(0.011)	(0.008)	(0.011)	(0.008)
Age^2	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Tenure	-0.051***	-0.012***	-0.052***	-0.013***
	(0.002)	(0.001)	(0.002)	(0.002)
$Tenure^2$	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Biannual	yes	yes	yes	yes
Seasonals	yes	yes	yes	yes
Constant	16.195***	19946***	15.715***	19.511***
	(2.496)	(3.551)	(2.566)	(3.701)
F st. (df1,df2)	102.26 (18;324)	15.61 (18;324)	99.57 (19;324)	14.87 (19;324)
% yhat<0	7.363	4.885	7.258	5.009
Observations	539,801	539,801	539,801	539,801

Notes: NLSY79, 1978 - 2004, men only, tenure at least 4 weeks, workers of private companies only. Dependent variable: 1 if a worker reports not working at the same job the following month; 0 if a worker stays at the same job the following month. Standard errors are clustered by a contemporaneous month. Linear probability model; estimation uses sampling weights. Columns 1 and 3 – estimation without fixed effects; columns 2 and 4 – estimation with worker-specific fixed effects. When standard errors are two-way clustered: by the contemporaneous month and by the month when the job started; standard errors remain almost unchanged. A biannul dummy is one that indicates the observation is taken from the post-1994 interviews when interviews were conducted on a biannual basis. The reported coefficients and standard errors are multiplied by 100.

Table 5: Individual Separations and Unemployment, no FE

	LPM 1	Probit 2	Logit 3
U_t	-0.056	-0.027	-0.016
	(0.090)	(0.053)	(0.046)
U_{t_0}	0.145***	0.100***	0.086***
	(0.051)	(0.034)	(0.031)
Grade	-0.111***	-0.102***	-0.090***
	(0.018)	(0.016)	(0.016)
Age	-0.042***	-0.014***	-0.011**
	(0.010)	(0.005)	(0.005)
Age^2	0.000***	(0.000)	0.000
	(0.000)	(0.000)	(0.000)
Tenure	-0.051***	-0.052***	-0.049***
	(0.002)	(0.002)	(0.002)
Tenure^2	0.000***	0.000***	0.00***
	(0.000)	(0.000)	(0.000)
Biannual dummy	yes	yes	yes
Seasonal dummies	yes	yes	yes
Hours per week dummies	yes	yes	yes
Trend, trend sq., constant	yes	yes	yes
Log pseudoL	x	-67193.557	-67121.88
F statistics (df1,df2)	78.55 (25,324)	x	x
Observations	539801	539801	539801

Notes: NLSY79, 1978 - 2004, men only, tenure at least 4 weeks. Dependent variable: 1 if a worker reports not working at the same job the following month; 0 if a worker stays at the same job the following month. Standard errors are clustered by the contemporaneous month. All regressions estimated without fixed effects. For probit and logit, marginal effects are reported calculated at sample means, except for dummy variables. When standard errors are two_way clustered: by the contemporaneous month and by the month when the job started – standard errors remain almost unchanged. A biannul dummy is one that indicates the observation is taken from the post-1994 interviews when interviews were conducted on a biannual basis. Hours-worked-per-week dummies: a set of 5 dummies indicating whether a worker worked less than 10 hours per week, between 10 and 20, between 20 and 30, between 30 and 40 and above 40 hours per week. The reported coefficients and standard errors are multiplied by 100. P-values: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 6: Cyclicality of the Price of Labor

	Coefficient on $U_t \cdot 100\%$
Price of labor, $\lambda_t = const$	-5.29
	(0.97)
Price of labor, λ_t	-5.11
	(0.84)
Price of labor, λ_t not detrended	-4.92
	(0.81)

Notes: The results are from the regression of the natural logarithm of the constructed price of labor on the annual unemployment rate and a time trend (annual). There are 20 observations in each regression – from 1978 to 1997. The time trend is negative and statistically significant. R squared is around 0.90. Bootsrapped standard errors are in parentheses (1,000 replications).

Table 7: Cyclicality of the Price of Labor, Robustness

	Coefficient on $U_t \cdot 100\%$		
	$\tau_{tr.} = 5$	$\tau_{tr.} = 7$	$\tau_{tr.} = 9$
Price of labor, $\lambda_t = const$	-4.87	-5.12	-5.23
	(0.89)	(0.97)	(0.98)
Price of labor, λ_t	-4.72	-4.95	-5.05
	(0.80)	(0.81)	(0.90)
Price of labor, λ_t not detrended	-4.58	-4.82	-4.95
	(0.77)	(0.88)	(0.92)
Price of labor, $\lambda_{t_0,t}$	-4.59	-4.83	-4.96
	(0.68)	(0.78)	(0.78)

Notes: The results are from the regression of the natural logarithm of the constructed price of labor on the annual unemployment rate and a time trend (annual). There are 18 observations in each regression – from 1978 to 1995. The time trend is negative and statistically significant. R squared is around 0.90. Bootsrapped standard errors are in parentheses (1000 replications).

A Proof that the Price of Labor Is Well-Defined

Claim: $E_t|w_{t,t} + \sum_{\tau=1}^{\infty}\left(\beta^{\tau}\prod_{k=0}^{\tau-1}(1-\lambda_{t+k})\right)(w_{t,t+\tau} - w_{t+1,t+\tau})| < \infty$.

Proof.

Notice that $0 \leq 1-\lambda_t \leq 1\ \forall t$. Let $1-\lambda \equiv \sup_t(1-\lambda_t)$. Then $\beta^{\tau}\prod_{k=0}^{\tau-1}(1-\lambda_{t+k}) \leq (\beta(1-\lambda))^{\tau}$.

Suppose that $\exists\rho < \beta(1-\lambda)$ and $\overline{w} < \infty$ s.t. $\forall\tau\ w_{t,t+\tau} \leq \overline{w}\rho^{\tau}$, $w_{t+1,t+\tau} \leq \overline{w}\rho^{\tau}$. In other words, wages do not grow faster than $\beta(1-\lambda)$. Then,

$$
\begin{aligned}
&|w_{t,t} + \sum_{\tau=1}^{\infty}\left(\beta^{\tau}\prod_{k=0}^{\tau-1}(1-\lambda_{t+k})\right)(w_{t,t+\tau} - w_{t+1,t+\tau})| \leq \\
&\qquad |\sum_{\tau=1}^{\infty}\left(\beta^{\tau}\prod_{k=0}^{\tau-1}(1-\lambda_{t+k})\right)(w_{t,t+\tau} - w_{t+1,t+\tau})| \leq \\
&\qquad \sum_{\tau=1}^{\infty}\left(\beta^{\tau}\prod_{k=0}^{\tau-1}(1-\lambda_{t+k})\right)|(w_{t,t+\tau} - w_{t+1,t+\tau})| \leq \\
&\qquad\qquad \sum_{\tau=1}^{\infty}(\beta(1-\lambda))^{\tau}\max\{w_{t,t+\tau}, w_{t+1,t+\tau}\}.
\end{aligned}
$$

Then

$$
\begin{aligned}
E_t|w_{t,t} + \sum_{\tau=1}^{\infty}\left(\beta^{\tau}\prod_{k=0}^{\tau-1}(1-\lambda_{t+k})\right)(w_{t,t+\tau} - w_{t+1,t+\tau})| &\leq \\
E\left(\beta(1-\lambda)\right)^{\tau}\overline{w}\rho^{\tau} &= \\
\frac{\overline{w}}{1-\beta(1-\lambda)\rho} &< \infty. \blacksquare
\end{aligned}
$$

B Description of Working with the Data

Wage is an hourly pay variable constructed by NLSY, "*Hourly Rate of Pay Job #1–5*" and "*Hourly Rate of Pay at current/most recent job*". These variables contain hourly rate of pay for those respondents who were paid hourly. For those who report other than hourly rate of pay, the average hourly pay was constructed using information on usual earnings and usual hours worked. Usual earnings include tips, overtime and bonuses before deductions. I deflate nominal wages using the annual CPI index (All Urban Consumers, all items) from the Bureau of Labor Statistics (base period 1967). I use the deflator of the year when the respondent last worked for the job as reported at the time of the interview. In the sample, real wages below 0.10 and above 50.00 in 1967 dollars are dropped, which constitutes less than 1% of the sample.

To identify hours worked up to the 1993 interview (except for year 1979), I combine variables "*Hours per week usually worked at current/most recent job*" (from the CPS section) and "*Hours per week usually worked at Job #1/5*" (from the "Job Information" section). After 1993, all information is contained in "*Hours worked at Job #1/5*" variables. After the 1987 interview, the Questionnaire explicitly asked respondents whether reported hours worked included hours worked at home, and if not, a separate variable was created with information on combined hours worked. Before the 1988 interview, the question did not specify whether reported hours included hours worked at home. As explained in the User's Guide, the variable "Hourly Rate of Pay" was created factoring in all hours worked. I have examined the data with hours worked corrected for hours worked at home and without this correction. The results do not depend on the correction. To correct for hours worked at home, I use variables "*Hours per week usually worked include hours worked at home? Job#1/5*"and "*Hours per week usually worked (includes hours worked at home), Job#1/5*". I report the results for the sample with hours worked corrected for the hours worked at home.

I investigate only those workers who report as working for private companies, thus dropping government employees, self-employed and those working without pay. The information on the class of worker is available for an employed respondent's current/most recent job, as well as for each job held since the last interview in which s/he worked for more than 20 hours a week (10 hours in pre-1988 interviews) and for more than nine weeks since the last interview. The coding of the class of worker changed after 1993. Thus I re-record the class of worker according to the pre-1994 scheme.

Date of birth is collected in the 1979 interview and clarified in the 1981. Thus, I use the 1981 variable to infer the date of birth. For those respondents who did not participate in 1981 interview, I infer the age from 1979 variable.

To identify the year respondent started working at the job, I subtract the tenure in weeks calculated by NLSY from the week the respondent reported as the last week working for the job and add 1. Then I identify a corresponding calendar year (or month and quarter) associated with that week.

To construct potential experience, I subtract the number of years at school plus 6 from the current age. Current age for each job observation is constructed as the year the respondent reported "stopped working" at the time of the interview minus the birth year. The age at the start of the job is calculated as the difference between the year of the start of the job and the year of birth. The start of the job is recovered as the difference between the week the job ended and the tenure at the job in weeks. The tenure variable is the tenure constructed by NLSY.

All observations with non-positive hours worked per week or grade completed were dropped from the sample. Observations for jobs that started before 1976 were dropped. If the respondent reports as enrolled in school, the observations were dropped. The observations for jobs that started when the respondent was under 16 years old or the observations for respondents younger than 20 years were dropped. In all regressions estimated with the individual fixed effect, the individuals for whom only one observation was available in the sample were dropped.

C The Cyclicality of the Price of Labor When Separation Rates Depend on the History of Unemployment Rates

In this section I present the results of the cyclicality of the price of labor allowing separation rates to depend on the history of the unemployment rates from the start of the job. I find that accounting for separation rate that depends on the history of the unemployment rate from the time of hiring does not change the main empirical result on the cyclicality of the price of labor.

First, I estimate the response of the separation rates to the unemployment rate at the time of hiring and the contemporaneous unemployment rate. Second, I construct the price of labor allowing separations rates to depend both on the contemporaneous and the hiring time period. Finally, I estimate the cyclicality of the constructed price of labor.

C.1 Individual Separations Over the Business Cycle

The discussion in section 3.3 provides intuition for the price of labor being more procyclical than wages on newly hired workers if the wages during employment relationships are smoothed. One of the ideas behind the intuition is that the firm locks in a worker to the economic conditions from the time of hiring. If the separation rate of workers hired in two consecutive periods exhibit considerable systematic differences, this may weaken the lock-in effect.

Suppose that the separation rates depend positively on the unemployment rate at the time of hiring. Then, the workers who are hired when the unemployment rate is high tend to have higher separation rates, which lead to shorter tenures. Once a worker is separated, a firm must hire a new one to fill the position. But, given that the labor market conditions have improved, a new worker is offered a new value of wages that is expected to be higher than the value paid to the previous employee. Thus, higher separation rates weaken the lock-in to the initial labor market conditions.

In this subsection, I estimate the response of the separation rates to the unemployment rate at the time of hiring and to the contemporaneous unemployment rate. Bowlus (1995) finds that worker-firm matches created when unemployment rates are high tend to have lower tenure as compared with matches created when the unemployment rate is low.

In Table 4, I present the results of estimating the linear probability model of monthly separation rates. The dependent variable takes the value 0 if a worker is with the job and 1 if a worker reports not working at the job the following month. The separations include job-to-job transitions and transitions to unemployment. The explanatory variables used in columns 1 and 2 include education, a quadratic in age, a quadratic in tenure, a quadratic in time trend, seasonal dummies, dummy for biannual interviews, and contemporaneous unemployment rate. The unemployment rate at the time of hiring is added in the regressions reported in columns 3 and 4. The reported standard errors are clustered by the contemporaneous year. Clustering by two dimensions — contemporaneous year and start year — has a very small impact on standard errors. Hence, I report standard errors clustered in one dimension only.

As seen from columns 1 and 2, which show the results with and without fixed effects, the effect of the contemporaneous unemployment rate is both numerically and statistically insignificant. As seen from columns 3 and 4, the effect of the initial unemployment rate on the subsequent probability of separation is positive and substantial. In particular, as the unemployment rate at the time of hiring increases by one percentage point, the separation rate increases by 0.13%, which constitutes about 4.3% of the average monthly separation rate of 3%. The value of the coefficient decreases only slightly when I control for workers' fixed effects, from 0.13% to 0.12%. However, the standard error increases substantially when the fixed effects are estimated. In what follows, I present the results of the estimation without fixed effects.

The purpose of estimating the separation equation is to examine the effect of the current and initial unemployment rate on the separations. Given a large sample size, a linear probability model serves this purpose well despite that it may not generate sensible predictions for the probabilities. The model generates between 7% and 10% of predicted probabilities below 0. Thus in Table 5, I present results of the estimation without fixed effects of both linear and nonlinear models of separations.

The separation rate may differ across full- and part-time workers. To control for the hours worked per week, I construct a set of five dummy variables that correspond to the hours worked per week: less than 10, between 10 and 20, between 20 and 30, between 30 and 40, and above 40. The results of the estimation are analogous to those reported in Table 5. The effect of the contemporaneous unemployment rate is negligible and statistically insignificant. The coefficient on the initial unemployment rate in all three models is positive and statistically significant. The largest effect is estimated by the linear probability model: as the initial unemployment rate increases by one percentage point, the separation rate is expected to increase by approximately 0.145%, which is 4.5% of the monthly average separation rate. Probit and logit estimates are somewhat smaller but comparable with the linear probability model estimates: estimated on the sample averages, when the initial unemployment rate increases by one percentage point from its mean, the separation rate increases by approximately 0.086% – 0.100% which constitutes approximately 2.5% – 3% of the average monthly separation rate.

As a result of the estimation, I conclude that the unemployment rate at the start of the job has a small positive impact on the probability of future separation. In the next subsection, I incorporate this finding in the construction of the price of labor.

C.2 The Price of Labor with History-Dependent Separations

In this subsection, I define the price of labor allowing for the probability of separation to depend on the history of economic conditions from the start of the job.

C.2.1 Expression for the Price of Labor

An economic environment is as described in section 2. Consider the following thought experiment. A firm hires a worker in period t. Assume that a worker is always available for hire, and the only costs associated with hiring a worker are wage payments. A firm pays according to the wage schedule agreed upon when the worker is hired. Every period, a nonzero probability exists that a worker will exogenously separate from the position. Separation probability, $\lambda_{t,\tau}$, may depend on the history of labor market conditions a worker experiences from the time of hiring. After separation, a firm hires a new worker to replace the separated one. A new firm–worker relationship is likely to start with a new wage agreement. In this thought experiment if the firm hires a worker in some period t, it maintains the number of workers at 1 from that period on by re-hiring in case the worker hired in τ separates. Thus, hiring a worker in t can be thought of as creating a position in period t that will be filled with probability 1 onward. Then the expected present discounted value of wages paid to create a position in t onward is given by

$$\begin{gathered} C_t = E_t(w_{t,t} + \beta((1-\lambda_{t,t})w_{t,t+1} + \lambda_{t,t}w_{t+1,t+1})+ \\ \beta^2(1-\lambda_{t,t})(1-\lambda_{t,t+1})w_{t,t+2} + \lambda_{t,t}(1-\lambda_{t+1,t+1})w_{t+1,t+2}+ \\ ((1-\lambda_{t,t})\lambda_{t,t+1} + \lambda_{t,t}(1-\lambda_{t+1,t+1}))w_{t+2,t+2} + ...) = \\ E_t(w_{t,t} + \sum_{\tau=t+1}^{\infty} \beta^{\tau-t} \sum_{k=t}^{\tau-1}(\Lambda_{t,k,\tau-1}w_{k+1,\tau})), \end{gathered} \tag{13}$$

where w_{t_1,t_2} is a wage paid in t_2 to a worker hired in t_1; λ_{t_1,t_2} is a separation rate at the end of t_2 for a worker hired in t_1, conditional that there is no separation between $t_1$and t_2; $\Lambda_{t,k,\tau}$ is a probability that a separation takes place at the end of period k at the position that a firm opened in t and a new worker is hired in $k+1$ and continues working on that position in τ; and $E_t = E(.|I_t)$, where I_t is the firm's information set at time t. Both wage payments and separation rates are allowed to depend on the history of labor market conditions from the period a worker is hired.

Equation (13) states that a worker hired in period t is paid a wage $w_{t,t}$. With probability $1-\lambda_{t,t}$, the firm-worker relationship survives until the period $t+1$ and the worker is paid wage $w_{t,t+1}$. With probability $\lambda_{t,t}$, the relationship is terminated and the firm hires a new worker at wage $w_{t+1,t+1}$ to fill the position. By analogy, in period $t+2$ a firm retains a worker hired in period t with probability $(1-\lambda_{t,t})(1-\lambda_{t,t+1})$ and pays a wage $w_{t,t+2}$. With probability $(1-\lambda_{t,t})\lambda_{t,t+1}$, that worker is separated and the firm replaces the worker with another at wage $w_{t+2,t+2}$. Also, in period $t+2$ a worker hired in $t+1$ is retained with probability $\lambda_{t,t}(1-\lambda_{t+1,t+1})$ and receives wage $w_{t+1,t+2}$. In the case of separation, with probability $\lambda_{t,t}\lambda_{t,t+1}$ this worker is replaced with a new one at wage $w_{t+2,t+2}$.

The implicit asset price of labor in period t is the difference between the expected present discounted value of wages paid at the position opened in period t and $t+1$:

$$P_t = E_t\left[C_t - \beta C_{t+1}\right].$$

The price of labor is the expected difference in cost between two alternatives: hiring a worker in the current period or hiring a worker in the following period. These two options give the same expected employment levels – one – in all future periods. Therefore, the difference between them gives the implicit price of the services of one worker this period.

Substituting from (13), I obtain the following expression for the price of labor:

$$P_t = E_t(w_{t,t} + \sum_{\tau=t+1}^{\infty} \beta^{\tau-t}(w_{t,\tau} \prod_{k=t}^{\tau-1}(1-\lambda_{t,k}) - w_{t+1,\tau}(1-\lambda_{t,t}) \prod_{k=t+1}^{\tau-1}(1-\lambda_{t+1,k}))+ \sum_{\tau=t+1}^{\infty} \beta^{\tau-t}(\sum_{k=t}^{\tau-1}(\Lambda_{t,k,\tau-1} - (1-\lambda_{t,t})\Lambda_{t+1,k,\tau-1})w_{k,\tau})). \tag{14}$$

If separation depends only on the current labor market condition, $\lambda_{t_0,t} = \lambda_t$ for all t and t_0, then (14) simplifies to the following expression, which is analogous to equation (3) in section 2:

$$P_t = E_t\left(w_{t,t} + \sum_{\tau=t+1}^{\infty} \beta^{\tau-t}(\prod_{k=t}^{\tau-1}(1-\lambda_k))(w_{t,\tau} - w_{t+1,\tau})\right).$$

If the separation rate is constant, $\lambda_{t_0,t} = \lambda$, equation (14) simplifies to

$$P_t = E_t\left(w_{t,t} + \sum_{\tau=t+1}^{\infty} (\beta(1-\lambda))^{\tau-t}(w_{t,\tau} - w_{t+1,\tau})\right).$$

C.2.2 Construction of the Price of Labor

To estimate the cyclicality of the price of labor with separation rate that depends on the history, I construct the realized price of labor using the procedure similar to the one described in section 4. The difference is in *Step 3* above. In *Step 3,* I obtain a projection of the series of monthly separation rates on two sets of dummies instead of one. In particular, one set of time dummies corresponds to the year the job starts and another set of dummies corresponds to the contemporaneous year. Finally, I use monthly fitted projections to obtain annual separation rates, $\widehat{\lambda^A_{t_1,t_2}}$. For all t_1 and t_2 : $t_1, t_2 = \{1978, 2004\}, t_1 < t_2$:

$$\widehat{\lambda^A_{t_1,t_2}} = 1 - \frac{\sum_{\tau^{t1}=1}^{12}\left(\prod_{k^{t2}=1}^{12}(1-\widehat{\lambda_{\tau^{t1},k^{t2}}})\right)}{12},$$

where $\widehat{\lambda_{\tau^{t1},k^{t2}}}$ is a fitted monthly separation rate in a calendar month k of year t_2 at the job that started in a calendar month τ of year t_1. In a similar manner, I calculate annual separation rates $\widehat{\lambda^A_{t_1,t_2}}$ for $t_1 = t_2$, annualizing monthly separations.

I proceed to estimate the cyclicality indicator as described in section 4. The results of the estimation are presented in Table 7. As shown in the table, allowing the separation rate to depend on the history of economic conditions from the time of hiring does not change the main result on the cyclicality of the price of labor. The constructed price of labor is very procyclical.

D Robustness Results

Table 8: Wages and Contemporaneous Unemployment

	Hours worked per week ≥ 30		
	All	Tenure < 1 y.	Tenure ≥ 2 y.
	1	2	3
U_t	-1.427*	-2.716***	0.132
	(0.725)	(0.712)	(0.683)
Grade	5.724***	4.299***	6.091***
	(0.536)	(0.713)	(1.220)
Experience	0.340***	0.282***	0.389***
	(0.037)	(0.032)	(0.034)
Experience^2	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Tenure	3.283***	0.650	1.787***
	(0.248)	(4.632)	(0.202)
Tenure^2	-0.114***	4.798	-0.068***
	(0.015)	(3.875)	(0.011)
Union	19.022***	20.002***	12.804***
	(1.080)	(1.208)	(1.510)
Union missing	2.369	3.817	-0.027
	(1.987)	(2.833)	(1.094)
Constant	-18.692*	4.778	-26.614
	(10.685)	(9.033)	(17.955)
R^2	0.668	0.584	0.744
Observations	37831	12997	17633
N of ind	2586	2062	2135

Notes: NLSY79, 1978 - 2004, men only. Column 1 includes all observations in the sample with the sample restrictions as described in the text and hours worked per week restricted to 30 and above. Column 2 includes observations as in column 1 but is restricted to observations with tenure of less than 1 year. Column 3 includes observations as in column 1 but restricted to observations with tenure of 2 years and longer. Estimated standard errors are in parentheses, clustered by time. The reported coefficients and standard errors are multiplied by 100. P-values: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dependent variable: the natural logarithm of the real hourly wage. All regressions are estimated with fixed effects using sampling weights. The unemployment rate is an annual unemployment rate of the calendar year to which the wage observation corresponds.

Table 9: Wages and Contemporaneous Unemployment

	All	CPS jobs only Tenure < 1 y.	Tenure ≥ 2 y.
	1	2	3
U_t	-1.236	-2.406***	-0.101
	(0.730)	(0.856)	(0.645)
Grade	6.120***	4.969***	5.981***
	(0.485)	(0.606)	(1.146)
Experience	0.347***	0.301***	0.364***
	(0.040)	(0.039)	(0.034)
Experience^2	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Tenure	3.043***	8.973	1.346***
	(0.273)	(5.300)	(0.215)
Tenure^2	-0.110***	-0.872	-0.052***
	(0.018)	(5.560)	(0.011)
Union	17.038***	20.944***	9.107***
	(1.166)	(1.414)	(1.294)
Union missing	1.987	4.812	0.622
	(1.813)	(2.892)	(1.610)
Constant	-22.976**	-8.373	-17.607
	(10.568)	(9.637)	(18.069)
R^2	0.685	0.617	0.751
Observations	29466	8987	15120
N of ind	2536	1956	2004

Notes: NLSY79, 1978 - 2004, men only. Column 1 includes all observations in the sample with the sample restrictions as described in the text and restricted to CPS jobs (as defined by NLSY). Column 2 includes observations as in column 1 but is restricted to observations with tenure of less than 1 year. Column 3 includes observations as in column 1 but is restricted to observations with tenure of 2 years and longer. Estimated standard errors are in parentheses, clustered by time. The reported coefficients and standard errors are multiplied by 100. P-values: *** p<0.01, ** p<0.05, * p<0.1. Dependent variable: the natural logarithm of the real hourly wage. All regressions are estimated with fixed effects using sampling weights. The unemployment rate is an annual unemployment rate of the calendar year to which the wage observation corresponds.

Table 10: WAGES AND CONTEMPORANEOUS UNEMPLOYMENT, MONTHLY

	All sample 1	Tenure < 1 y. 2	Tenure ≥ 2 y. 3
U_t	-1.487***	-3.108***	0.345
	(0.307)	(0.360)	(0.400)
Grade	5.714***	4.039***	6.082***
	(0.453)	(0.748)	(0.920)
Experience	0.330***	0.260***	0.377***
	(0.017)	(0.022)	(0.021)
Experience^2	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Tenure	3.648***	1.191	2.112***
	(0.156)	(5.508)	(0.222)
Tenure^2	-0.125***	5.497	-0.077***
	(0.009)	(5.308)	(0.010)
Union	19.551***	20.382***	13.278***
	(0.797)	(1.240)	(1.099)
Union missing	3.254**	5.443***	0.593
	(1.561)	(2.080)	(1.337)
Constant	-19.958***	10.282	-30.016**
	(6.755)	(10.010)	(12.785)
R^2	632	0.551	0.709
Observations	40850	14576	18546
N of ind	2627	2161	2186

Notes: NLSY79, 1978 - 2004, men only. Column 1 includes all observations in the sample with the sample restrictions as described in the text. Column 2 includes observations as in column 1 but is restricted to observations with tenure of less than 1 year. Column 3 includes observations as in column 1 but is restricted to observations with tenure of 2 years and longer. Estimated standard errors are in parentheses, clustered by time (323,323, 305 clusters, respectively). The reported coefficients and standard errors are multiplied by 100. P-values: *** p<0.01, ** p<0.05, * p<0.1. Dependent variable: the natural logarithm of the real hourly wage. All regressions are estimated with fixed effects using sampling weights. The unemployment rate is a monthly unemployment rate of the calendar month to which the wage observation corresponds.

Table 11: Wages and Contemporaneous Unemployment, Monthly

	Hours worked per week $\geq$ 30		
	All	Tenure < 1 y.	Tenure $\geq$ 2 y.
	1	2	3
U_t	-1.384***	-2.730***	0.222
	(0.303)	(0.391)	(0.368)
Grade	5.733***	4.327***	6.106***
	(0.477)	(0.760)	(0.821)
Experience	0.341***	0.284***	0.391***
	(0.016)	(0.023)	(0.020)
Experience^2	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Tenure	3.290***	0.171	1.786***
	(0.144)	(5.774)	(0.202)
Tenure^2	-0.115***	5.260	-0.068***
	(0.008)	(5.497)	(0.009)
Union	19.013***	19.959***	12.805***
	(0.785)	(1.244)	(1.071)
Union missing	2.327*	3.704**	-0.046
	(1.332)	(1.694)	(1.045)
Constant	-19.202***	4.470	-27.591**
	(7.158)	(10.125)	(11.416)
R^2	0.668	0.584	0.745
Observations	37831	12997	17633
N of ind	2568	2062	2135

Note: NLSY79, 1978 - 2004, men only. Column 1 includes all observations in the sample with the sample restrictions as described in the text and hours worked per week restricted to 30 and above. Column 2 includes observations as in column 1 but is restricted to observations with tenure of less than 1 year. Column 3 includes observations as in column 1 but is restricted to observations with tenure of 2 years and longer. Estimated standard errors are in parentheses, clustered by time (323, 323, 305 clusters, respectively). The reported coefficients and standard errors are multiplied by 100. P-values: *** p<0.01, ** p<0.05, * p<0.1. Dependent variable: the natural logarithm of the real hourly wage. All regressions are estimated with fixed effects using sampling weights. The unemployment rate is a monthly unemployment rate of the calendar month to which the wage observation corresponds.

Table 12: WAGES AND CONTEMPORANEOUS UNEMPLOYMENT, MONTHLY

	CPS jobs only		
	All	Tenure < 1 y.	Tenure $\geq$ 2 y.
	1	2	3
U_t	-1.375***	-2.644***	-0.101
	(0.318)	(0.468)	(0.336)
Grade	6.107***	4.976***	5.980***
	(0.494)	(0.841)	(0.950)
Experience	0.345***	0.300***	0.364***
	(0.021)	(0.030)	(0.022)
Experience^2	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Tenure	3.052***	8.574	1.347***
	(0.171)	(6.522)	(0.233)
Tenure^2	-0.110***	-0.508	-0.052***
	(0.010)	(6.499)	(0.011)
Union	17.009***	20.859***	9.106***
	(0.932)	(1.484)	(1.058)
Union missing	1.951	4.639*	0.619
	(1.709	(2.619)	(1.323)
Constant	-21.674***	-6.542	-17.586
	(7.688)	(11.745)	(13.359)
R^2	0.686	0.617	0.751
Observations	29466	8987	15120
N of ind	2536	1956	2004

Notes: NLSY79, 1978 - 2004, men only. Column 1 includes all observations in the sample with the sample restrictions as described in the text and restricted to CPS jobs (as defined by NLSY). Column 2 includes observations as in column 1 but is restricted to the observations with tenure of less than 1 year. Column 3 includes observations as in column 1 but is restricted to the observations with tenure of 2 years and longer. Estimated standard errors are in parentheses, clustered by time (299, 276, 258 clusters, respectively). The reported coefficients and standard errors are multiplied by 100. P-values: *** p<0.01, ** p<0.05, * p<0.1. Dependent variable: the natural logarithm of the real hourly wage. All regressions are estimated with fixed effects using sampling weights. The unemployment rate is a monthly unemployment rate of the calendar month to which the wage observation corresponds.

Table 13: Wages and Initial, Minimum and Contemporaneous Unemployment, CPS jobs only

	Coefficient 1	Robust S.E. 2	S.E. clustered by t 3	S.E. clustered by $t_0 \cdot t$ 4	S.E. clustered by t_0 & t 5
U_t	0.776	(0.257)***	(0.702)	(0.358)***	(0.689)
U_{t_0}	-0.921	(0.329)***	(0.431)**	(0.410)**	(0.565)*
$\min U$	-4.008	(0.496)***	(0.859)***	(0.663)***	(1.151)***
Grade	5.488	(0.613)***	(0.666)***	(0.569)***	(0.742)***
Experience	4.088	(0.163)***	(0.366)***	(0.239)***	(0.428)***
Experience^2	-0.091	(0.005)***	(0.013)***	(0.007)***	(0.014)***
Tenure	2.295	(0.177)***	(0.267)***	(0.237)***	(0.379)***
Tenure^2	-0.077	(0.008)***	(0.014)***	(0.010)***	(0.016)***
Union	15.987	(0.807)***	(1.061)***	(0.832)***	(1.119)***
Union missing	1.892	(1.154)	(1.219)	(1.173)	(1.105)
Constant	7.126	(8.484)	(12.946)	(9.103)	(14.011)
R^2	0.7071	0.7071	0.7071	0.7071	-
Observations	27350	27350	27350	27350	27350

Notes: NLSY79, 1978 - 2004, men only, includes only CPS jobs; hours-worked-per-week restricted to 35 and above. Dependent variable: the natural logarithm of the real hourly wage. All regressions are estimated with fixed effects using sampling weights. Column 1 contains coefficient estimates. Columns 2 - 5 contain estimated standard errors (in parentheses) from the alternative estimations. The reported coefficients and standard errors are multiplied by 100. P-values of the coefficients associated with standard errors are denoted as follows: *** p<0.01, ** p<0.05, * p<0.1. Unemployment coefficients are the corresponding annual unemployment rates.

Table 14: Wages and Monthly Initial, Min, Max and Contemporaneous Unemployment

	All sample 1	$t = t_0$ excluded 2	$t = t_0$ excluded 3
U_t	0.958**	0.817*	0.699*
	(0.421)	(0.426)	(0.383)
U_{t_0}	-0.986***	-1.212***	-1.300***
	(0.334)	(0.335)	(0.315)
$\min U$	-3.317***	-3.642***	-3.879***
	(0.588)	(0.603)	(0.588)
$\max U$	-0.694*	-0.370	x
	(0.381)	(0.386)	
Grade	5.181***	5.008***	5.017***
	(0.462)	(0.533)	(0.534)
Experience	0.313***	0.334***	0.335***
	(0.015)	(0.017)	(0.017)
Experience^2	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Tenure	3.381***	2.942***	2.766***
	(0.254)	(0.252)	(0.195)
Tenure^2	-0.102***	-0.091***	-0.086***
	(0.010)	(0.010	(0.010)
Union	19.121***	17.691***	17.695***
	(0.769)	(0.810)	(0.812)
Union missing	4.039***	3.141**	3.181**
	(1.448)	(1.398)	(1.402)
Constant	5.398	11.027	11.129
	(7.162)	(8.410)	(8.407)
R^2	0.635	0.635	0.635
Observations	40850	32735	32735

Notes: NLSY79, 1978 - 2004, men only, includes all observations in the sample as described in the text. Dependent variable: the natural logarithm of the real hourly wage. Estimated standard errors in parentheses. The reported coefficients and standard errors are multiplied by 100. P-values: *** p<0.01, ** p<0.05, * p<0.1 Standard errors are clustered by a contemporaneous month. Column 1 includes all observations. Columns 2 and 3 exclude observations for which the contemporaneous calendar year equals the start year. Unemployment measures are monthly unemployment rates.

Table 15: Wages and Initial, Min, and Contemporaneous Unemployment, 1978 - 2002

	Industry dummies incl. 1	Industry dummies not incl. 2
U_t	-0.035	-0.085
	(0.954)	(0.992)
U_{t_0}	-1.445***	-1.485***
	(0.368)	(0.395)
$\min U$	-2.821***	-2.987***
	(0.998)	(1.022)
Grade	4.791***	4.750***
	(0.464)	(0.463)
Experience	0.318***	0.343***
	(0.026)	(0.028)
Experience^2	-0.001***	-0.001***
	(0.000)	(0.000)
Tenure	3.464***	3.411***
	(0.360)	(0.336)
Tenure^2	-0.112***	-0.113***
	(0.021)	(0.020)
Union	16.623***	18.872***
	(0.734)	(0.956)
Union missing	3.151**	3.375**
	(1.418)	(1.384)
Constant	18.036*	13.475
	(10.508)	(10.579)
R^2	0.641	0.626
Observations	39132	39132
N of ind.	2623	2623

Notea: NLSY79, 1978 - 2002, men only, includes all observations in the sample as described in the text. Dependent variable: the natural logarithm of the real hourly wage. Standard errors are in parentheses. The reported coefficients and standard errors are multiplied by 100. P-values: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by a contemporaneous year.