The Subjective User Cost of Labor*

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Abstract

The user cost of labor, the difference in the expected present value of wages between two matches formed one period apart, governs hiring in search models. Under full-information rational expectations (FIRE) it is procyclical, challenging wage-rigidity explanations of unemployment volatility. I measure it under subjective wage expectations reported in surveys of workers and firms. Subjectively expected wage growth barely moves over the business cycle, even as realized wage growth falls with unemployment. Because subjectively expected wage growth does not rise in recessions, the perceived user cost stays high, hiring stays costly, and firms cut vacancies by more. In a search model with these subjective expectations, tightness and unemployment are twice as volatile as under FIRE and half as volatile as in the data. A payroll subsidy indexed to the cycle costs half as much per unit of employment created.

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I Introduction

Wage rigidity is central to leading explanations of why unemployment is so volatile over the business cycle. In the canonical search-and-matching model, small movements in the surplus a firm earns from a match translate into large movements in job creation, so how wages respond to the cycle largely determines how much unemployment fluctuates (Shimer, 2005; Hall, 2005). Yet the object that matters for hiring is not the flow wage paid in any given period but the *user cost of labor*, the difference in the expected present value of wages between two matches formed one period apart (Kudlyak, 2014). Because wages in ongoing relationships partly reflect conditions at the time of hire, a firm deciding whether to open a vacancy today weighs the entire expected path of wages, not just today's wage.

Measuring this user cost requires taking a stand on how firms and workers form expectations about future wages. The existing literature measures it under full-information rational expectations (FIRE) and finds the user cost of labor *more* cyclical than the flow wage, because workers hired in recessions earn lower wages not only at the moment of hire but for years afterward (Kudlyak, 2014; Bils et al., 2023). A procyclical user cost undercuts the wage-rigidity channel. If the effective price of labor falls in recessions, the firm's surplus is cushioned just when the rigidity mechanism requires it to collapse.

This paper measures the user cost of labor under the expectations agents report. In the search model the user cost depends on beliefs through the expected path of wages within a match, and a firm and a worker who share a belief about that path agree on its price. The belief can therefore be read from the people whose wages are being forecast. Each month the Survey of Consumer Expectations (SCE) asks workers how much they expect their earnings to change over the next twelve months if they remain "in the exact same job at the same place" and work "the exact same number of hours." The Wage Growth Tracker of the Federal Reserve Bank of Atlanta measures, from the Current Population Survey, the wage growth that workers who stay in their jobs realize over twelve months. Both series refer to the wage growth of workers who stay in their jobs over the same twelve-month horizon, so the gap between them is a forecast gap for that wage.

Workers expect wage growth to move with labor-market tightness at one quarter to one third of the rate at which it moves. In the SCE Labor Market Survey, which interviews the

same workers four months apart, a one-unit increase in the ratio of vacancies to unemployed workers is associated with a rise in the real earnings growth that workers expect in their current job by 0.85 percentage points at an annual rate and the real growth the same workers realize over the following four months by 2.57 points, so their forecast errors rise with tightness at the date of the forecast. A percentage point of the quits rate is associated with a rise in expected growth of 1.12 points and in realized growth of 4.44 points. Nationally over 2013–2025, the median one-year expectation rises with the vacancy-unemployment ratio by 0.54 percentage points, one third of the 1.65 points by which the realized wage growth of job stayers rises. In the Livingston record over 1961–2022, realized manufacturing wage growth falls when unemployment rises, while the forecasts of the same growth do not move with it.

These expectations enter the user cost directly. The user cost is the new-hire wage less the capitalized expected growth of wages, so expected wage growth that moves little with the cycle gives a user cost that moves with the new-hire wage. Applied to three surveys and the pension disclosures, each paired with the wage growth realized over the year it forecasts, the user-cost formula gives a FIRE user cost that falls with unemployment in every case and a subjective user cost, built from the survey expectations with the same wage, that does not; the FIRE user cost is 1.9 to 3.4 times as volatile.

Firms' pension disclosures, the firm-side record closest to the expected pay path of existing employees, show the same stability. Under Accounting Standards Codification Topic 715 (ASC 715), firms that sponsor defined-benefit plans disclose the rate of compensation increase they assume in projecting their obligations. Its median is 3.0 percent in every year from 2013 to 2023, while the discount rate the same firms disclose moves with bond yields.

In the search-and-matching model, the rigidity of the perceived user cost is quantitatively important. Because firms create jobs against the price of labor they perceive, and that price falls much less in downturns, the same productivity shock generates substantially larger unemployment fluctuations under subjective beliefs than under FIRE. Under alternating-offer bargaining in the manner of Hall and Milgrom (2008), whose wage splits the current gains from trade and so carries no forecast of the future, the model reproduces both the cyclical new-hire wage and the muted expectations. At the perceived persistence that workers' expectations imply and with wages renegotiated about once a year, market tightness and unemployment are about twice as volatile as under FIRE and about half as volatile as in the

data; taking the whole expected wage path as given raises the factor to about 3.8. A payroll subsidy indexed to the cycle costs 1.9 years of output per worker for each job-year created under the measured beliefs, against 3.7 under FIRE, because firms that expect a downturn to persist value support tied to the cycle more.

These results have a direct implication for models of unemployment fluctuations. Because subjectively expected wage growth does not rise in recessions, the perceived user cost stays high even as demand weakens, suppressing job creation exactly when the wage-rigidity mechanism requires it. Measured under subjective expectations, the user cost of labor is far less procyclical than under FIRE, providing an expectations-based microfoundation for the reduced-form wage rigidity assumed in Shimer (2005), Hall (2005), and Christiano et al. (2016), and consistent with recent work that builds rigidity from perceptions rather than from bargaining frictions (Menzio, 2023). This rigidity does not require the spot wage to be sticky. It lives in the *expected present value* of wages and arises from how agents form expectations, so the mechanism operates even when the flow wage is fully flexible. More broadly, the persistence of subjective wage expectations is difficult to reconcile with models in which the timing of wage payments is irrelevant (Barro, 1977), and is naturally captured by models in which expectations respond too little to persistent shocks (Mankiw and Reis, 2002; Coibion and Gorodnichenko, 2015; Angeletos et al., 2021).

The paper makes three contributions. First, it measures the user cost of labor of Kudlyak (2014) under the expectations agents report, and shows that in the wage process that underlies the user cost the belief is summarized by a single ratio: the response of expected to realized wage growth to labor-market conditions, for the same wage and horizon. Second, it measures that ratio at about one third in workers' expectations of their own wage growth and near zero in professional forecasts of manufacturing wages, so that the subjective user cost moves with the new-hire wage rather than with the FIRE user cost. Third, it shows that the measured belief, shared by firms and workers and carried through the free-entry condition of a search model with alternating-offer bargaining, raises the volatility of market tightness by a factor of about two at the workers' ratio, to about half of its volatility in the data, with a flexible new-hire wage.

The remainder of the paper proceeds as follows. Section II places the paper in the literature. Section III sets up the free-entry condition and defines the user cost of labor

under subjective expectations. Section IV describes the survey and macroeconomic data. Section V presents the time-series and worker-level evidence on the cyclicality of subjective wages. Section VI embeds the measured rigidity in the search-and-matching model and shows that it amplifies unemployment volatility. Section VII discusses the broader implications for macroeconomic models, and Section VIII concludes. The appendices document the data construction (Appendix A), derive the joint surplus (Appendix B), set out the model and its global solution (Appendices C and D), show that realized wages mean-revert toward productivity (Appendix E), derive the average compensation that firms expect in the model (Appendix F), report the estimates behind Figures 3 and 4 (Appendix G), and plot the user cost of labor for each survey (Appendix H).

II Related Literature

The user cost of labor. Kudlyak (2014) shows that the price of labor relevant for hiring is the user cost, the difference in the expected present value of wages across matches formed one period apart, and that under FIRE it is far more procyclical than the flow wage. Basu and House (2016) distinguish such allocative wages from the remitted wages that workers are paid, Bils et al. (2023) adjust the measured user cost for worker quality, and Kudlyak (2024) reviews the evidence. This literature imputes the expected wage path from realized wages. I measure the same object from reported expectations and find it far less cyclical.

Unemployment volatility and wage rigidity. With flexible wages the search model generates too little unemployment volatility (Shimer, 2005). Rigid wages (Hall, 2005; Hall and Milgrom, 2008; Gertler and Trigari, 2009; Christiano et al., 2016), a small surplus (Hagedorn and Manovskii, 2008; Ljungqvist and Sargent, 2017), and time-varying discount rates (Hall, 2017; Borovičková and Borovička, 2017; Kehoe et al., 2023) raise it, and Pissarides (2009) shows that the rigidity that matters is in the wages of new hires. The procyclical user cost of Kudlyak (2014) challenges the rigid-wage resolutions. Here the rigidity is in the expected wage path, so the flow wage, including the new-hire wage, can remain flexible, and discount rates stay at their FIRE values.

New-hire wages and downward rigidity. New-hire wages are more cyclical than the wages of incumbents (Bils, 1985; Haefke et al., 2013), a difference that Gertler et al. (2020)

trace to job changers and the procyclical quality of their matches. Nominal wages rarely fall (Dickens et al., 2007; Elsby and Solon, 2019; Grigsby et al., 2021), and the share of workers with no nominal wage change is more countercyclical than the share with cuts, a pattern that downward nominal wage rigidity best explains (Jo, 2025). The wages of new hires are rigid downward and flexible upward (Hazell and Taska, 2025), and downward nominal rigidity amplifies unemployment in models of the open economy (Schmitt-Grohé and Uribe, 2016). The mechanism here differs, since the flow wage is flexible in the model and the rigidity is in expected wage growth, and the evidence is complementary: if new-hire wages fall little in recessions, the subjective user cost falls even less. The expected gain from changing jobs, unlike the realized gain, does not rise with tightness (Section V).

Beliefs in labor markets. Job seekers overestimate their job-finding prospects and revise them slowly (Mueller et al., 2021), workers underestimate their outside options (Jäger et al., 2024), and workers' search and offer expectations respond to the offers they receive (Conlon et al., 2018; Faberman et al., 2022). Menzio (2023) shows that stubborn beliefs about the value of a match can substitute for wage rigidity in search equilibrium. I measure the beliefs about the wage path that enter the user cost, in the expectations of workers, firms, and forecasters, and carry them through the free-entry condition.

Subjective expectations. Survey forecasts underreact to news in the aggregate (Mankiw and Reis, 2002; Coibion and Gorodnichenko, 2015) and overreact at the level of the individual forecaster (Bordalo et al., 2020), patterns that models of imperfect information, asymmetric attention, and diagnostic expectations account for (Angeletos et al., 2021; Kohlhas and Walther, 2021; Bianchi et al., 2024). Firms' expectations depart from FIRE in similar ways (Coibion et al., 2018; Candia et al., 2023; Born et al., 2023; Barrero, 2022; Bloom et al., 2025). I treat agents as internally rational given a common perceived law of motion (Adam et al., 2016).

Beliefs and business cycles. Distorted beliefs about tail risk, about the state of the economy, and about asset payoffs shape aggregate fluctuations (Kozlowski et al., 2020; Bhandari et al., 2025; Bianchi et al., 2025). In Lee (2026), firms' distorted forecasts of their own cash flows move asset valuations and hiring; here the distortion is in expected wages, and it operates through the user cost of labor with discount rates at their FIRE values.

III A Subjective User Cost of Labor

In the search and matching model, the user cost of labor is the difference in the expected present value of wages between two firm-worker matches that are formed in two consecutive periods. Because wages in a match depend on the economic conditions at the start of the job, this difference depends on the expected path of wages, and I measure it under the beliefs that survey respondents report.

Consider the free-entry condition in the search and matching model:

$$\frac{\kappa}{q_t} = J_{t,t}$$

where a firm must pay a per-vacancy cost of κ and vacancies are filled with probability q_t. $J_{t,t}$ is the value of a newly created match at its hiring period t:

$$J_{t,t} \equiv z_t - w_{t,t} + \sum_{\tau=t+1}^{\infty} (\beta(1-\delta))^{\tau-t} \mathbb{F}_t[z_\tau - w_{t,\tau}]$$

where $\mathbb{F}_t[\cdot]$ denotes subjective expectations based on survey data. $\beta = 0.9569$ is the annual discount factor and $\delta = 0.295$ the annual separation rate (implied by a monthly rate of 0.029), both from Kudlyak (2014). Each period τ, a firm-worker match produces a per-period output of z_τ and an employed worker receives wage $w_{t,\tau}$ where t is the period when the worker is hired. $w_{t,t}$ is the new-hire wage. The expected difference between the firm's value of a newly created match in time t and the discounted value of a newly created match in period $t+1$ is

$$\begin{aligned} J_{t,t} - \beta(1-\delta)\mathbb{F}_t[J_{t+1,t+1}] = z_t - w_{t,t} + \sum_{\tau=t+1}^{\infty} (\beta(1-\delta))^{\tau-t} \mathbb{F}_t[z_\tau - w_{t,\tau}] \\ - \beta(1-\delta)\mathbb{F}_t \left[z_{t+1} - w_{t+1,t+1} + \sum_{\tau=t+2}^{\infty} (\beta(1-\delta))^{\tau-(t+1)} \mathbb{F}_{t+1}[z_\tau - w_{t+1,\tau}] \right] \end{aligned}$$

Assuming the Law of Iterated Expectations holds under the common subjective measure, as it does for the internally rational beliefs of Adam et al. (2016):

$$J_{t,t} - \beta(1-\delta)\mathbb{F}_t[J_{t+1,t+1}] = z_t - w_{t,t} - \sum_{\tau=t+1}^{\infty} (\beta(1-\delta))^{\tau-t} \mathbb{F}_t[w_{t,\tau} - w_{t+1,\tau}]$$

Substituting the free-entry condition into the left-hand side gives

$$\underbrace{\frac{\kappa}{q_t} - \beta(1-\delta)\mathbb{F}_t\left[\frac{\kappa}{q_{t+1}}\right]}_{\text{Non-wage component of user cost } UC_t^V} = \underbrace{z_t}_{\text{Benefit}} - \underbrace{\left[w_{t,t} + \sum_{\tau=t+1}^{\infty}(\beta(1-\delta))^{\tau-t}\mathbb{F}_t[w_{t,\tau} - w_{t+1,\tau}]\right]}_{\text{Wage component of user cost } UC_t^W}$$

The equation shows that the firm faces two sources of costs from a match: wage payments to a worker UC_t^W and vacancy opening costs UC_t^V. The firm creates jobs as long as the marginal benefit from adding a worker exceeds the user cost of labor. The wage component of the user cost of labor UC_t^W, not the wage $w_{t,t}$, is the allocative price of labor.

A firm hiring today commits to a wage path, not to a single wage. The wage component UC_t^W is the difference between the present value of wages promised to a worker hired now and one hired a period later. It is the marginal cost of moving a hire forward in time, and it is this cost, not the spot wage, that the firm weighs against the marginal benefit of a filled job. Two features make expectations central. First, UC_t^W is forward-looking. It depends on the entire expected path of wages within the match, $\{\mathbb{F}_t[w_{t,\tau}]\}_{\tau \geq t}$, so how the firm forecasts future wages, not only what it pays today, determines the perceived price of labor. Second, because wages in ongoing relationships depend on conditions at the start of the job, the user cost embeds the expected cyclical behavior of wages. If the firm expects wages to rise as a recession ends, hiring now locks in a low wage, the user cost is low, and hiring is cheap; if it expects wages to stay where they are, the user cost stays at the new-hire wage and hiring is more expensive. The cyclicality of the user cost is therefore a statement about expectations, and it is where the FIRE and subjective measures diverge.

Section V measures UC_t^W with survey expectations of wage growth. Under the wage process of Section VI, the wage component equals the new-hire wage less the capitalized expected growth of the new-hire wage (equation (8)), so the one-year expectations that the surveys report determine its cyclicality.

IV Data

To assess the cyclicality of subjective wage expectations, I use publicly available survey and macroeconomic data to construct measures of actual real wage growth, subjective wage expectations, and unemployment rate changes. The expectations come from the Livingston

Survey (semiannual, 1961–2023), the CFO Survey (quarterly, 2001Q4–2023Q4), the Survey of Consumer Expectations (SCE) (monthly, 2013M6–2025M1), and the pension disclosures of firms under ASC 715 (annual, 2011–2023). Appendix A lists the sample of each exhibit.

I derive subjective wage growth expectations from consensus forecasts of nominal wage growth in these surveys. The Livingston forecast is the median annualized growth of average weekly earnings in manufacturing between the six- and twelve-month horizons, deflated by the survey's own median forecast of Consumer Price Index (CPI) inflation over the same horizons. The CFO forecast is the expected growth of wages and salaries at the respondent's firm over the next twelve months through 2020Q1, and the expected growth of the firm's wage bill over the next calendar year from 2020Q2. The SCE forecast is the median expected earnings growth over the next twelve months. The CFO and SCE forecasts are deflated by the median CPI inflation forecast of the Survey of Professional Forecasters (SPF) for the next four quarters, taken from the latest survey released at each date.

I measure actual real wage growth using two wage series. For the Livingston Survey, realized growth is the annual log growth of the survey's base-period values of average weekly earnings in manufacturing, the last values known when the questionnaire is mailed. For the CFO Survey, the SCE, and the ASC 715 assumption, it is the four-quarter log growth of average monthly earnings of stable new hires in the national Quarterly Workforce Indicators of the Longitudinal Employer-Household Dynamics program (LEHD QWI). Realized and expected nominal wage growth are deflated by the same one-year CPI inflation forecast: the Livingston median forecast for the Livingston Survey and the SPF median forecast for the next four quarters otherwise. Figures 1 and 2 use the same series and the same deflation.

For unemployment rates used to assess the cyclicality of wages, I use both actual data and subjective forecasts. Realized changes are twelve-month changes in the U.S. unemployment rate from the Current Population Survey (CPS), in percentage points, with quarterly averages for the quarterly series. Expected changes are the SPF median forecast of the unemployment rate four quarters ahead less its forecast for the current quarter, from the latest survey released at each date; for the Livingston Survey, twice the difference between its median forecasts of the unemployment rate twelve and six months ahead.

The worker-level analysis uses the individual responses of the SCE Labor Market Survey, a rotating panel fielded in March, July, and November in which each respondent is interviewed

up to three times over a year. For each interview I observe current annual earnings, the start date of the current job, and expected own annual earnings four months ahead ("What do you believe your annual earnings will be in 4 months?"). Employed respondents also report the first-year salary they expect from the best job offer of the coming four months. Worker-level growth rates are deflated by the SPF median forecast of CPI inflation over the next calendar year, interpolated between surveys.

The national comparison of expected and realized wage growth in continuing matches uses the SCE median point prediction of the percent change in earnings over the next twelve months in the respondent's current job, at the same place and the same number of hours (monthly, 2013M6–2025M1), and the twelve-month wage growth of job stayers from the Wage Growth Tracker of the Federal Reserve Bank of Atlanta. Labor-market tightness is the number of job openings in the Job Openings and Labor Turnover Survey per unemployed person.

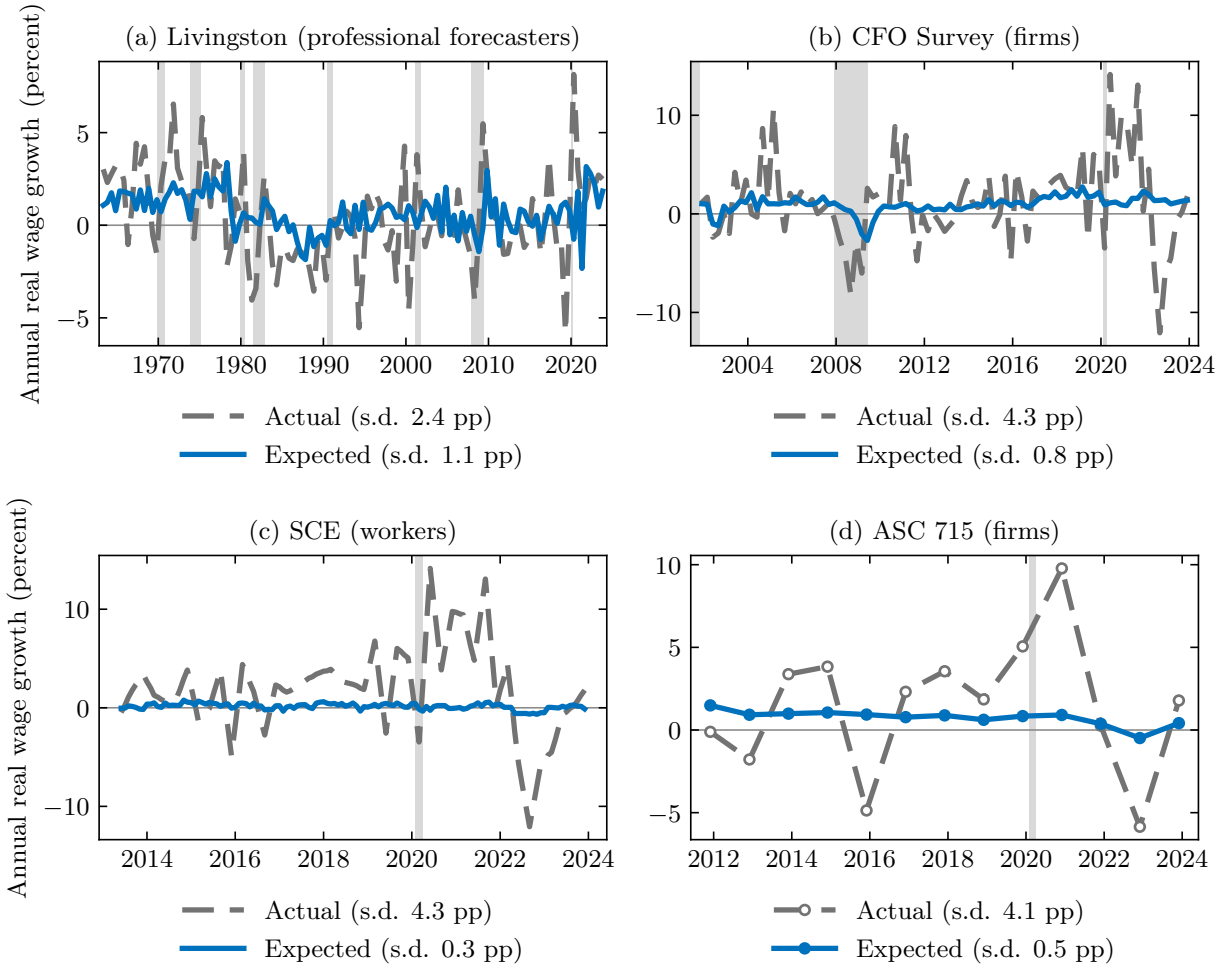
Appendix A gives the details of data construction.

V The Cyclicality of Subjective Wages

Figure 1 compares, survey by survey, the real wage growth that respondents expect over the next year with the real wage growth realized over the same year: the Livingston Survey, paired with average weekly earnings in manufacturing over six decades, and the CFO Survey, the Survey of Consumer Expectations (SCE), and the rate of compensation increase that firms sponsoring defined-benefit pension plans assume under ASC 715, discussed below, each paired with the earnings of stable new hires. Realized wage growth moves widely with the cycle; the expectations are far more stable. Even during the 2008 financial crisis and the COVID-19 recession, respondents anticipated only modest wage adjustments. Realized wage growth is two to fourteen times as volatile as the expectations meant to predict it (standard deviations of 2.4 against 1.1 percentage points for Livingston, 4.3 against 0.8 for the CFO Survey, 4.3 against 0.3 for the SCE, and 4.1 against 0.5 for the ASC 715 assumption), so most of the movement in wages is absent from what agents anticipate.

Figure 2 carries these expectations into the user cost of labor. Under the wage process of Section VI, the user cost is the new-hire wage less the capitalized expected growth of the

Figure 1: Real Wage Growth: Actual vs. Subjective Expectations

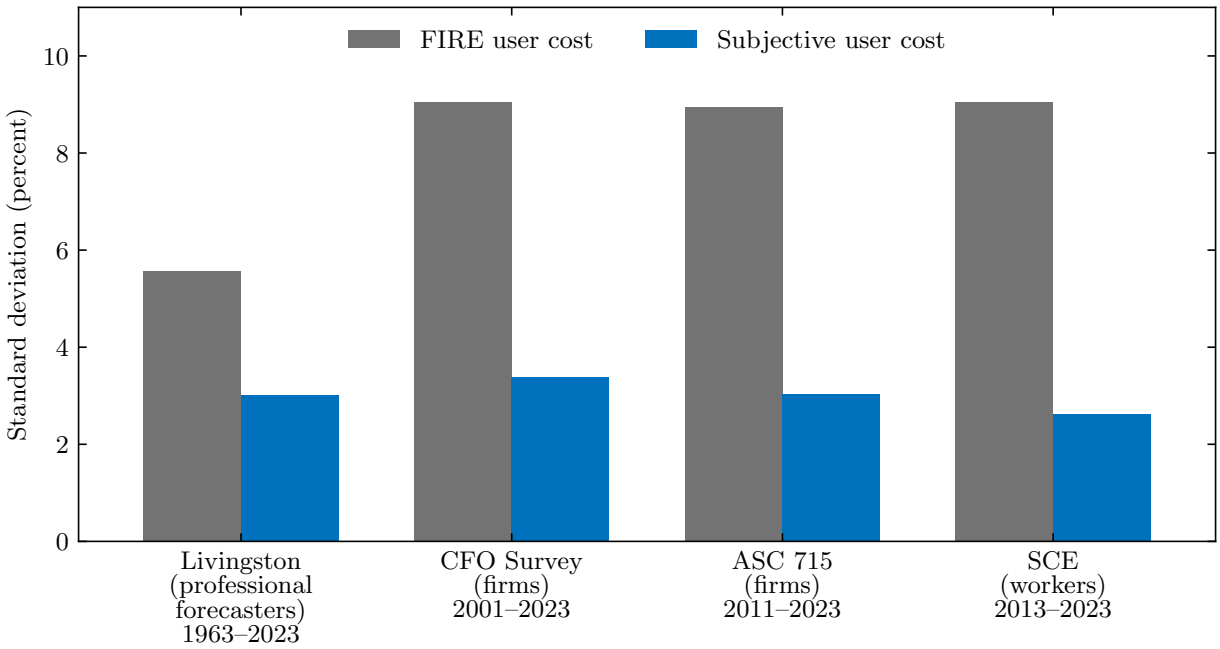


Notes: Realized real wage growth from each survey date t to $t+1$ year (dashed) and the survey expectation of the same growth. Panel (a), professional forecasters: Livingston Survey median forecast, semiannual, 1963–2023. Panel (b), firms: CFO Survey expected growth of wages and salaries at the respondent's firm over the next twelve months (from 2020Q2, of the firm's wage bill over the next calendar year), quarterly, 2001Q4–2023Q4. Panel (c), workers: SCE median expected earnings growth over the next twelve months, monthly, 2013M6–2023M12. Panel (d), firms: median across defined-benefit plan sponsors with a December fiscal year-end of the assumed rate of compensation increase disclosed under ASC 715, December of each year, 2011–2023 (371 firms, 1,912 firm-years). Panel (a): average weekly earnings of production and nonsupervisory employees in manufacturing. Panels (b) to (d): earnings of stable new hires (LEHD QWI). Realized and expected nominal wage growth are deflated by the same one-year CPI inflation forecast (the Livingston median forecast in panel (a); the SPF median forecast for the next four quarters, from the latest survey released at each date, in panels (b) to (d)). Standard deviations in the legends are of the plotted series, in percentage points. Recessions dated by the National Bureau of Economic Research (NBER) are shown with gray shaded bars.

new-hire wage, $UC_t^W = w_{t,t} - \frac{\varphi}{1-\varphi}\frac{b}{\eta}\mathbb{F}_t[w_{t+1,t+1} - w_{t,t}]$, with $\varphi = \beta(1-\delta)$ at the values of Kudlyak (2014) and the history-dependence share $b/\eta = 0.87$ of the model calibration. For each survey the FIRE user cost uses the realized wage growth of Figure 1 and the subjective user cost uses the survey expectation of the same growth, with the same wage level. The FIRE user cost falls with unemployment for every survey (Appendix Figure 8): controlling

for a cubic time trend, its slope is -0.79 percent per percentage point of unemployment for Livingston ($t = -1.8$), -1.57 for the CFO Survey ($t = -2.9$), -1.74 for the SCE ($t = -2.5$), and -4.18 for ASC 715 ($t = -2.6$). The subjective user costs are acyclical, with slopes between -0.15 and 0.48 and no t-statistic above 0.8 in absolute value, and the FIRE user cost is 1.9, 2.7, 3.4, and 2.9 times as volatile as the subjective one for the four surveys (Figure 2). In match-level data, Bils et al. (2023) find a FIRE user cost about 2.5 times as volatile as the new-hire wage. This is the pattern the model implies for a belief that treats shocks as persistent: the subjective user cost stays close to the wage and moves far less than the FIRE user cost.

Figure 2: Volatility of the User Cost of Labor under FIRE and Subjective Expectations



Notes: Standard deviations, in percent, of the FIRE user cost $w_t - \frac{\varphi}{1-\varphi}\frac{b}{\eta}(g_t - \bar{g})$ and the subjective user cost $w_t - \frac{\varphi}{1-\varphi}\frac{b}{\eta}(\mathbb{F}_t[g] - \overline{\mathbb{F}[g]})$ for each survey, from the series plotted in Figure 8 (Appendix H), with the respondents of each survey in parentheses.

To formally assess the cyclicality of real wage growth, Figure 3 compares the relationship between changes in the unemployment rate and real wage growth across FIRE and subjective expectations. As a FIRE benchmark, I use historical data on actual real wage growth to estimate the following regression, as in the literature (e.g., Bils, 1985; Solon et al., 1994; Gertler et al., 2020):

$$\Delta \log w_t = \beta_0 + \beta_1 \Delta u_t + \varepsilon_t, \tag{1}$$

where $\Delta \log w_t$ represents the actual annual log growth rate of real wages, Δu_t is the change in the unemployment rate over the same twelve months, in percentage points, and ε_t is the error term. β_1 is the coefficient of interest and captures the cyclicality of real wage growth.

Under subjective expectations, I use survey data on expected real wage growth to estimate:

$$\mathbb{F}_{t-1}[\Delta \log w_t] = \beta_0 + \beta_1 \mathbb{F}_{t-1}[\Delta u_t] + \varepsilon_t, \tag{2}$$

where $\mathbb{F}_{t-1}[\Delta \log w_t]$ is the median survey forecast for the annual log growth rate of real wages, from the Livingston, CFO, or SCE surveys, or the ASC 715 assumption, which is in nominal terms. $\mathbb{F}_{t-1}[\Delta u_t]$ is the median survey forecast of the change in the unemployment rate over the next year, from the Livingston Survey for the Livingston forecasts and from the SPF for the other three series. The coefficient of interest β_1 measures the cyclicality of expected real wage growth as perceived by survey respondents.

Figure 3 plots the estimates, and Appendix Table 5 reports them. Over 1961–2022, realized real manufacturing wage growth falls significantly when unemployment rises, by 0.0068 per percentage point ($t = -6.7$), while the Livingston forecast of the same growth has a coefficient of -0.0004 ($t = -0.2$). Realized real earnings growth of stable new hires falls by 0.0096 per percentage point ($t = -2.3$) in the CFO sample (2001–2022) and by 0.0082 ($t = -2.0$) in the SCE sample (2015–2022). In each of these three pairs the actual and survey slopes differ significantly ($t = -2.53$, -2.00, and -2.05). Subjective wage-growth expectations are acyclical, with coefficients that are small and statistically insignificant across all three surveys: -0.0004 for Livingston, -0.0013 for the CFO Survey, and -0.0001 for the SCE. In nominal terms, realized new-hire earnings growth over 2011Q4–2023Q4 has a slope of -0.0074 ($t = -1.7$), and the median pension assumption a slope of -0.0002 ($t = -0.5$). Firms' and workers' expected slopes are similarly small. The slopes for the two firm series (CFO Survey and ASC 715), the worker series (SCE), and the professional forecasts (Livingston) are 1 to 14 percent of the matching realized slopes, with t-statistics between -0.82 and -0.20, and the subjective user costs built from them have standard deviations of 3.4 percent (CFO Survey), 3.0 (ASC 715), 2.6 (SCE), and 3.0 (Livingston) (Figure 2). The data therefore do not distinguish firms' from workers' wage expectations in their cyclicality, which supports the common belief of the model; Section VI shows which of

the two beliefs matters for amplification.

The three surveys have very different respondents and sample periods: the Livingston Survey polls professional forecasters over six decades, the CFO Survey polls financial officers close to hiring decisions, and the SCE polls households about their own jobs. None shows significant cyclicality in expected wage growth. The rigidity is a feature of how agents in the labor market perceive the future path of wages, and it is this feature, carried through the free-entry condition, that makes the perceived user cost rigid.

This rigidity is a distortion in beliefs, not a sign that wages are unforecastable. Real manufacturing wages mean-revert toward productivity: the wage–productivity gap predicts subsequent wage growth ($R^2 = 0.29$; Appendix E), while the survey expectations stay flat. The model requires only that expectations overstate persistence relative to the mean-reverting wage process, $\hat{\rho} > \rho$, and the contrast between realized mean reversion and rigid reported expectations delivers that directly.

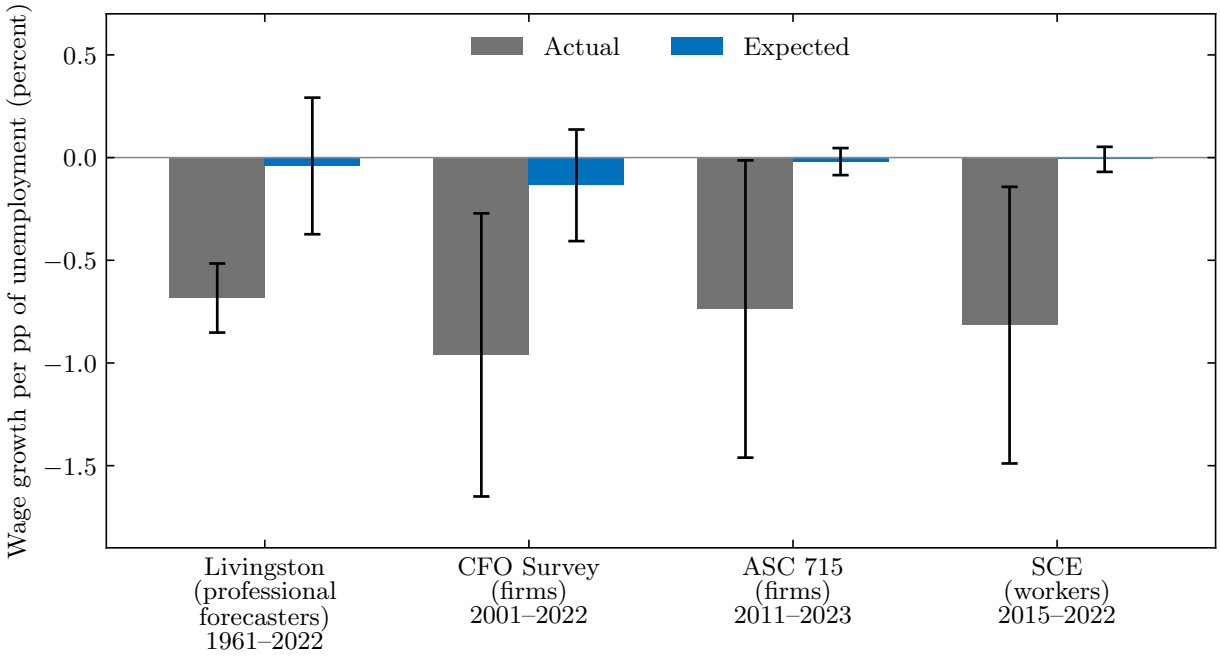
Expected and realized earnings growth of the same workers. The SCE Labor Market Survey makes it possible to compare each worker's expectation with the outcome for the same worker. For workers interviewed in two consecutive waves whose job at the second interview began in or before the month of the first interview, I estimate

$$\Delta \log w_{i,t} = \alpha_m + \beta X_{t-1} + \varepsilon_{i,t}, \tag{3}$$

$$\mathbb{F}_{t-1}[\Delta \log w_{i,t}] = \alpha_m + \beta X_{t-1} + \varepsilon_{i,t}, \tag{4}$$

where $\Delta \log w_{i,t}$ is the log change in worker i's reported annual earnings between the two interviews, $\mathbb{F}_{t-1}[\Delta \log w_{i,t}]$ is the log ratio of the annual earnings the worker expects four months ahead to current annual earnings at the first interview, both at an annual rate and deflated by the SPF forecast of CPI inflation over the next calendar year, so that their difference is the worker's own forecast error; X_{t-1} is labor-market tightness in the month of the first interview, the vacancy-unemployment ratio or the quits rate; and α_m are survey-month fixed effects. Figure 4 plots the slopes and Appendix Table 6 reports them. On the vacancy-unemployment ratio, the slope of expected earnings growth is 0.85 ($t = 1.4$), about one third of the realized slope of 2.57 (a ratio of 0.33 with a standard error of 0.20), and the

Figure 3: Cyclicality of Actual and Expected Wage Growth

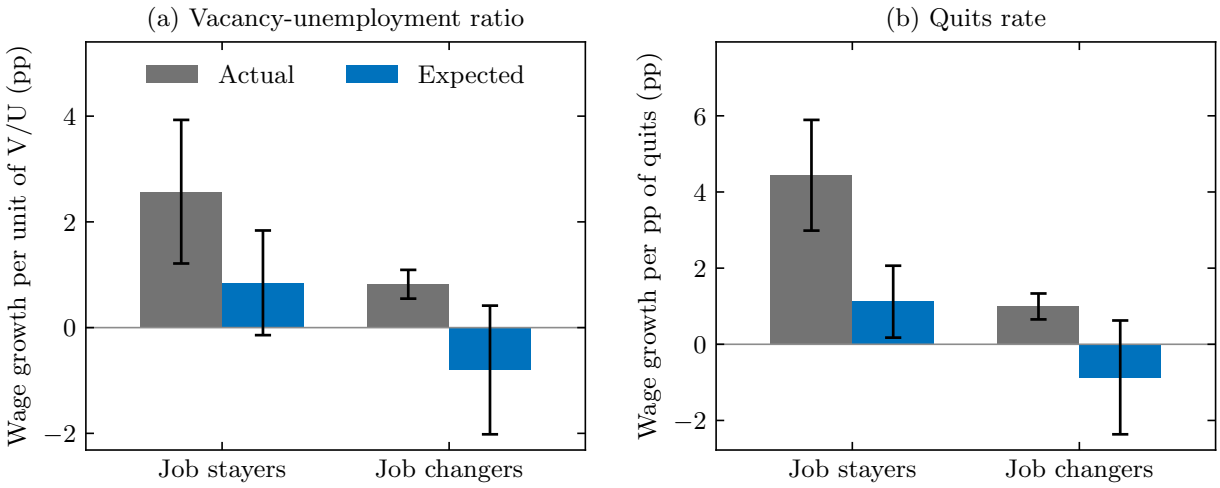


Notes: Slopes β_1 of equations (1) and (2), time-series regressions of annual log wage growth on the change in the unemployment rate over the same twelve months, in percentage points: actual growth on the realized change (gray), and the median survey forecast of growth on the forecast change (blue), in percent per percentage point; whiskers are 90 percent confidence intervals based on Newey–West standard errors (2 semiannual, 4 quarterly, 12 monthly, 1 annual lags). Livingston, 1961–2022, semiannual: average weekly earnings of production and nonsupervisory employees in manufacturing and the Livingston median forecast of its growth. CFO Survey, 2001–2022, quarterly; SCE, 2015–2022, monthly forecasts; ASC 715, 2011–2023, annual forecasts: four-quarter growth of average monthly earnings of stable new hires (LEHD Quarterly Workforce Indicators, private employers) and, respectively, the CFO Survey expected growth of wages and salaries at the respondent's firm (of the firm's wage bill from 2020Q2), the SCE median expected earnings growth, and the median assumed rate of compensation increase of defined-benefit plan sponsors under ASC 715. Realized and expected growth are deflated by the same expected CPI inflation (the Livingston forecast for Livingston, the SPF four-quarter forecast otherwise); the ASC 715 pair is nominal. The forecast change in unemployment is twice the difference between the Livingston forecasts twelve and six months ahead for Livingston, and the SPF forecast four quarters ahead less the current-quarter forecast otherwise. Appendix Table 5 reports the estimates.

equality of the two slopes is rejected with a p-value of 0.025. On the quits rate, the slopes are 1.12 and 4.44, a ratio of about one quarter (0.25, standard error 0.13), with a p-value of 0.001.

The right-hand groups of Figure 4 turn to the wages of job changers. Gertler et al. (2020) show that the greater cyclicality of new-hire wages documented since Bils (1985) is concentrated among workers who move directly from one job to another, whose wage gains rise in expansions because the quality of the matches they form is procyclical, while workers hired out of unemployment earn wages no more cyclical than those of incumbents. The

Figure 4: Actual and Expected Earnings Growth: Job Stayers and Job Changers



Notes: Slopes β on labor-market tightness, actual (gray) and expected (blue), in percentage points per unit of the vacancy-unemployment ratio (panel a) and per percentage point of the quits rate (panel b); whiskers are 90 percent confidence intervals. Job stayers: equations (3) and (4), SCE Labor Market Survey respondents interviewed in two consecutive waves who hold the same job at both, interviews 2015M3–2022M11, survey-month fixed effects, standard errors clustered by interview date. Job changers, actual: equation (5), median twelve-month wage growth of job switchers less that of job stayers in the Wage Growth Tracker of the Federal Reserve Bank of Atlanta, monthly, 2000M12–2026M9 except 2025M10, Newey–West standard errors with 12 lags. Job changers, expected: equation (6), the premium of the best expected job offer over current earnings among employed SCE respondents, interviews 2015M3–2022M11, survey-month fixed effects, standard errors clustered by interview date. Tightness: job openings per unemployed person and the quits rate (Job Openings and Labor Turnover Survey). Appendix Table 6 reports the estimates.

realized premium of a job change comes from

$$g_t^{\text{change}} - g_t^{\text{stay}} = \beta_0 + \beta X_t + \varepsilon_t, \tag{5}$$

where g_t^{change} and g_t^{stay} are the median twelve-month wage growth of job switchers and of job stayers in the Wage Growth Tracker, which is built from the Current Population Survey, and X_t is tightness at the end of the twelve-month window. Over 2000–2026 the premium rises by 0.82 percentage points per unit of the vacancy-unemployment ratio ($t = 5.0$, 309 months) and by 0.99 per percentage point of the quits rate ($t = 4.8$); at the 24 first-interview months of the SCE sample alone, the first slope is 0.75 ($t = 2.7$). The premium that employed SCE respondents expect comes from

$$\log \mathbb{F}_{t-1}[w_{i,t}^{\text{offer}}] - \log w_{i,t-1} = \alpha_m + \beta X_{t-1} + \varepsilon_{i,t}, \tag{6}$$

where $\mathbb{F}_{t-1}[w_{i,t}^{\text{offer}}]$ is the first-year salary that worker i expects from the best job offer of the

coming four months, $w_{i,t-1}$ is the worker's current annual earnings, and X_{t-1} is tightness at the interview. The slope is -0.80 ($t = -1.1$) on the vacancy-unemployment ratio and -0.87 ($t = -1.0$) on the quits rate. The gain realized by job changers rises with tightness, while the gain workers expect from changing jobs does not, so the procyclical match-quality component that Gertler et al. (2020) identify in job-to-job wage changes does not appear in workers' expected offer wages.

For job stayers under FIRE, the expected and realized slopes would coincide and the forecast gap would not be predictable from conditions at the date of the forecast. The data depart from this in the direction of expectations that move too little. In the reduced-form wage process of Section VI, expected stayer wage growth is a fixed fraction $\omega = (1 - \hat{\rho}^{\,h})/(1 - \rho^{\,h})$ of realized stayer wage growth at horizon h, for any indicator of the state observed at the date of the forecast. At the one-year horizon the national series give this ratio directly: over 2013–2025, the slope of the SCE median expectation of one-year wage growth in the current job on the vacancy-unemployment ratio is 0.537, against 1.655 for the twelve-month wage growth of job stayers in the Wage Growth Tracker, both in nominal terms, a ratio of 0.32 (standard error 0.09). The Livingston record gives a smaller ratio over a longer sample: over 1961–2022, the slopes of the forecast and of realized real manufacturing wage growth on the change in unemployment, -0.0004 and -0.0068 (Appendix Table 5, columns 1 and 2), give a ratio of 0.06. In both records expected wage growth captures a small part of the movement in realized wage growth.

Firms' wage expectations. The model gives firms and workers a common belief. The firm-side record closest to the object the user cost capitalizes, the expected pay path of the firm's existing employees, is the compensation-increase assumption in pension disclosures, discussed below. Surveys of businesses ask about a different object, the average compensation of the firm's whole workforce over the next three or six months. The National Federation of Independent Business (NFIB) asks small firms each month whether they plan to change average employee compensation during the next three months, and seven surveys of the Federal Reserve Banks of Richmond, Dallas, Kansas City, and New York ask firms whether their wages, or wages and benefits, will be higher or lower six months from now than in the current month; each reports the share of firms expecting an increase less the share expecting

a decrease. In standard-deviation units, the NFIB plans fall by 0.45 per percentage point of unemployment and the changes over the previous three months reported three months later by 0.46. In the regional surveys, the six-month outlook falls by 0.19 to 0.37, and the change from the previous month reported six months later falls by 0.10 to 0.20 in six of them and is +0.02 in the seventh. The model gives the same ordering under the subjective belief. The average compensation a firm pays adjusts toward current conditions as wages reset and new hires replace departing workers, and a firm that expects current conditions to persist expects that adjustment to continue: in a fixed-employment version of the model's wage recursion, the expected change in the average wage over the next two quarters rises with tightness while the realized change has a slope close to zero (Appendix F).

Firm-side evidence from pension disclosures. A more direct firm-side measure comes from pension accounting. Under ASC 715, every firm that sponsors a pay-related defined-benefit plan discloses each year the weighted-average *rate of compensation increase* it assumes when projecting the present value of its future wage-linked obligations, together with the *discount rate* it applies to them. The compensation-increase assumption is thus a mandatory, firm-level expectation of its own workforce's future wage growth, and it feeds a present-value object of the kind the user cost is. I collect it, and the discount-rate assumption, from the structured filings (eXtensible Business Reporting Language, XBRL) of the Securities and Exchange Commission (SEC) for every sponsor with a December fiscal year-end over 2011–2023: 371 firms (1,912 firm-years) report the compensation-increase assumption and 650 firms (3,427 firm-years) the discount rate. The median assumed rate of wage growth is 3.0 percent in every year from 2013 through 2023, moving by half a percentage point across the entire sample and not at all through the pandemic, even as the median assumed discount rate moves by 2.7 percentage points with corporate-bond yields. Within firms, the assumed wage growth is unchanged from the previous year in 63 percent of firm-years, and its within-firm standard deviation is 0.31 percentage points, against 0.70 for the discount rate. Changes in the assumed wage growth from a firm's previous report load an insignificant -0.006 percentage points on the change in the unemployment rate ($t = -0.4$), against -0.20 ($t = -2.3$) for the discount rate; in levels, the within-firm slope of the assumed nominal wage growth on the SPF expected change in log unemployment is positive, 0.006 ($t = 2.2$; 1,912

firm-years of 371 firms). The rigidity is specific to the wage, the cash-flow side of the present value, not to these firms' disclosure behavior in general.

VI A Search Model with a Rigid Subjective User Cost

This section places the measured rigidity in the search-and-matching model of Kudlyak (2014), in which the user cost of labor, not the flow wage, is the price that governs job creation. Unlike models in the tradition of Hall (2005), the flow wage here is flexible; the *expected present value* of wages is rigid because of how agents forecast. Appendix C sets out the full model and derives each equation below.

Free entry. Firms post vacancies at flow cost κ, and a vacancy is filled with probability $q(\theta_t)$, which falls with market tightness θ_t, the ratio of vacancies to unemployed workers. As in Kudlyak (2014), free entry can be written with the user cost of labor:

$$\frac{\kappa}{q(\theta_t)} = \hat{\mathbb{E}}_t \sum_{s\geq 0} \varphi^s \big(z_{t+s} - UC^W_{t+s}\big), \tag{7}$$

where z_t is match output, $\varphi \equiv \beta(1-\delta)$ combines discounting and separation, and $\hat{\mathbb{E}}_t$ is the belief firms use to value a hire. Tightness rises with the perceived present value of output net of the user cost.

The user cost of labor. The wage component of the user cost is the difference in the present value of wages between a hire today and a hire one period later:

$$UC^W_t = w_{t,t} + \sum_{s\geq 1} \varphi^s \, \hat{\mathbb{E}}_t\big[w_{t,t+s} - w_{t+1,t+s}\big] = w_{t,t} - \frac{\varphi}{1-\varphi}\frac{b}{\eta}\,\hat{\mathbb{E}}_t\big[w_{t+1,t+1} - w_{t,t}\big], \tag{8}$$

where $w_{t,\tau}$ is the wage at τ of a worker hired at t, and the second expression holds when a share b/η of the new-hire wage's response to conditions stays with the match (Appendix C). When the new-hire wage is expected to rise, hiring now locks in a lower wage than a hire one period later, so the user cost is low. Expected wage growth that does not move with the cycle keeps the user cost close to the new-hire wage.

Wage setting. Wages are set by alternating-offer bargaining in the manner of Hall and Milgrom (2008), with staggered renegotiation. In each period a match j resets its wage with probability λ, and every new hire starts at the reset wage:

$$w_{j,t} = \begin{cases} w^*(z_t) = \gamma + \xi\,(z_t - \gamma) & \text{at a reset or a new hire,} \\ w_{j,t-1} & \text{otherwise,} \end{cases} \tag{9}$$

where γ is the flow value of delay and ξ the weight on current productivity; with $\xi = 0.25$ the new-hire wage's elasticity to productivity is 0.28. The reset wage splits the current gains from agreement over delay, so it depends on current conditions and carries no forecast. Staggering makes wages history dependent, and $\lambda = 0.25$ gives an expected interval of one year between renegotiations (Gertler et al., 2020). Under Hall–Milgrom bargaining the new-hire wage's response to conditions is the same under either belief. Appendix D solves the model under this rule, and Appendix C sets out staggered Nash bargaining, flexible Nash bargaining, and posted wages, with amplifications of 1.4, 1.2, and 3.8.

Beliefs. Firms and workers share a belief that the driver of wages follows a first-order autoregressive process, AR(1), with persistence $\hat{\rho}$; its true persistence is ρ. The response of a continuing match's expected wage growth to the state is then a fraction

$$\omega = \frac{1 - \hat{\rho}^{\,h}}{1 - \rho^{\,h}} \tag{10}$$

of the response of its realized wage growth at horizon h (Appendix C). FIRE is $\omega = 1$, and expectations that do not respond are $\omega = 0$. Section V measures $\omega = 0.32$ at the one-year horizon, in nominal terms (0.537/1.655); with $\rho = 0.38$ at annual frequency, perceived persistence is 0.80 at annual frequency and 0.945 at quarterly frequency.

Amplification. The amplification is the volatility of market tightness under the measured belief relative to FIRE, with the same shocks and parameters:

$$\mathcal{A} = \frac{\mathrm{std}(\log \theta^{\mathrm{subj}})}{\mathrm{std}(\log \theta^{\mathrm{FIRE}})}. \tag{11}$$

Here std denotes the standard deviation. In the flow steady state, tightness maps into unemployment with the same coefficient under both beliefs, so $\mathcal{A}$ also measures the amplification of unemployment. In the log-linear model with the wage path taken as given, $\mathcal{A}$ is at least the persistence factor $(1-\varphi\rho)/(1-\varphi\hat{\rho})$, which exceeds one whenever $\hat{\rho} > \rho$ (Appendix C).

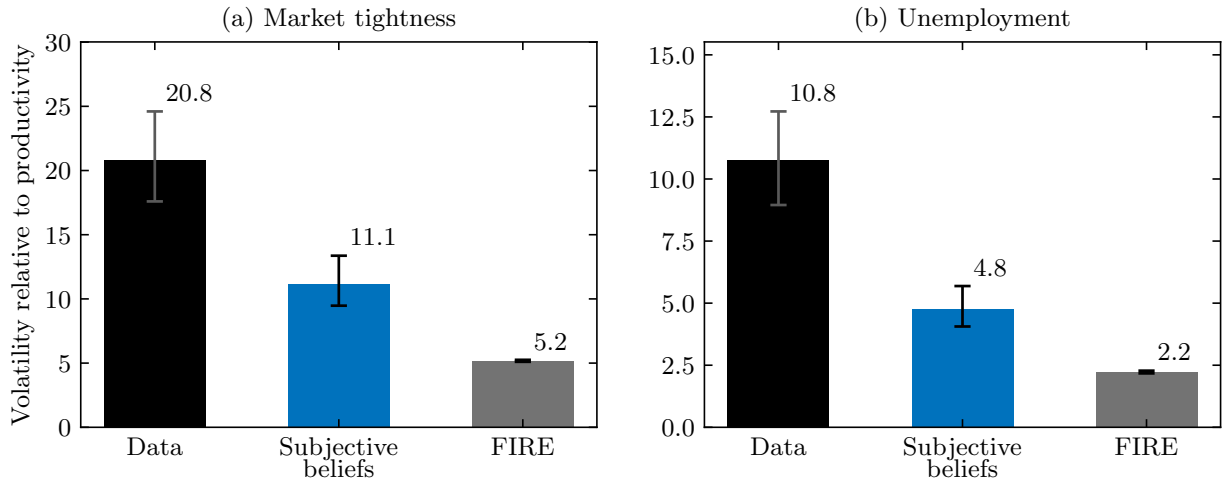
At the calibration below, $\mathcal{A} \approx 2.1$: market tightness is about twice as volatile under the measured beliefs as under FIRE. Relative to productivity, market tightness is 5.2 times as volatile under FIRE and 11.1 times under the measured beliefs, against 20.8 in the data, the gap Shimer (2005) documents; unemployment is 2.2 and 4.8 times as volatile, against 10.8 in the data (Figure 5).

Calibration. The model is quarterly, with the monthly job-finding and separation rates of Shimer (2005), the vacancy-filling rate of den Haan et al. (2000), and the vacancy cost of Hagedorn and Manovskii (2008) (Table 1). The new-hire pass-through matches the slope of new-hire wage growth on the change in unemployment in Figure 3, driver persistence $\rho \approx 0.79$ is that of the new-hire wage (Bils et al., 2023), the innovation standard deviation matches the volatility of filtered output per person, and $\hat{\rho} = 0.945$ comes from ω; Appendix C gives the details.

Counterfactual: the response of unemployment to shocks. Figure 6 plots the impulse response of unemployment to a one-percent decline in productivity under the two belief regimes, holding the shock, the matching function, and every other parameter fixed. Under FIRE the user cost falls with productivity, the surplus is cushioned, and unemployment rises by about 0.14 percentage points at its peak, one quarter after the shock. Under subjective beliefs the user cost falls much less, the surplus is more exposed, and unemployment rises by about 0.30 percentage points at its peak, also one quarter after the shock, about twice as much, with the gap closing as productivity recovers.

Model and data moments. Table 2 compares the two model economies with the data. The calibration targets the cyclicality of new-hire wages and the ratio ω in the subjective economy. The untargeted cyclicality of expected wages and the volatility of the FIRE user cost relative to the subjective one are close to the data under subjective beliefs and far from

Figure 5: Volatility of Market Tightness and Unemployment: FIRE versus Subjective Beliefs



Notes: Standard deviation of log market tightness (panel a) and of log unemployment (panel b) relative to the standard deviation of log productivity, all quarterly and detrended with a Hodrick–Prescott filter (smoothing parameter 10^5), as in Shimer (2005). Data, 1951Q1–2019Q4: vacancies from the composite help-wanted index of Barnichon (2010), unemployment and the unemployment rate from the Current Population Survey, quarterly averages of monthly values, and output per person in the nonfarm business sector, as in Shimer (2005, Table 1). Whiskers are 90 percent intervals: for the data, a moving-block bootstrap of the ratio (blocks of eight quarters, 1,000 draws); for the model, the 5th and 95th percentiles across simulated samples of the data's length, with the measured ratio ω drawn from its sampling distribution (standard error 0.087) for the subjective-belief economy. Model: the staggered Hall–Milgrom general equilibrium with renegotiation rate 0.25 per quarter, simulated under the true productivity process (2,000 samples of 276 quarters). The two economies share all primitives and differ only in beliefs: subjective agents perceive the driver as an AR(1) with persistence $\hat{\rho} = 0.945$, the value implied by the ratio of expected to realized wage growth in the SCE, and FIRE agents know the true process. Unemployment responds to tightness through the job-finding rate, with three monthly flows per quarter at the quarter's tightness, a steady-state monthly job-finding rate of 0.45, and a separation rate held fixed at 0.034 per month; model unemployment is the quarterly average of the monthly rates, as in the data. Table 1 lists the parameters.

it under FIRE, and the volatility of market tightness and unemployment doubles relative to FIRE and reaches about half of its value in the data.

Firm versus worker beliefs. Job creation depends on the firm's belief: free entry (7) values a hire under it, and the Hall–Milgrom reset wage does not depend on beliefs. Measured firm expectations are as rigid as workers' (Figure 3). With the belief implied by firms' pension assumptions, $\omega = 0$ and the amplification is about 3.2 (Appendix C).

Policy Implications

Figure 7 shows the reduction in unemployment after a 1 percent fall in productivity from a payroll subsidy paid for every employed worker and indexed to the cycle, so that it lapses as productivity recovers; in the model the subsidy is indexed to productivity. The subsidy costs 3.7 years of output per worker for each job-year created under FIRE and 1.9 under subjective

Table 1: Calibration

Parameter	Value	Source or target
β, discount factor (quarterly)	1/1.012	Shimer (2005); Kudlyak (2014)
f, s, job-finding and separation rates (monthly)	0.45, 0.034	Shimer (2005, pp. 31–32); three monthly flows per quarter
$q(\bar{\theta})$, vacancy-filling rate (quarterly)	0.71	den Haan et al. (2000); sets $\bar{\theta} = 1.17$ and $\chi = 0.77$
α, matching elasticity	0.5	Petrongolo and Pissarides (2001)
κ, vacancy cost (share of quarterly productivity)	0.584	Hagedorn and Manovskii (2008, Table 2)
ρ, productivity persistence (quarterly)	0.785	Persistence of the new-hire wage (0.38 annual; Bils et al., 2023)
σ_ε, innovation standard deviation	0.0135	Standard deviation of filtered output per person (0.019)
λ, wage reset rate (quarterly)	0.25	One renegotiation a year (Gertler et al., 2020)
ξ, weight of productivity in the reset wage	0.25	Slope of new-hire wage growth on the change in unemployment (-0.82; Figure 3)
γ, flow value of delay in the reset wage	0.8785	Free entry at the steady state
$\hat{\rho}$, perceived persistence (quarterly)	0.945	Ratio of expected to realized wage-growth slopes at a one-year horizon (0.32; SCE and Wage Growth Tracker)
η, new-hire pass-through (reduced form)	0.28	Implied by ξ
b/η, history dependence (reduced form)	0.87	FIRE user cost relative to the new-hire wage, ratio of standard deviations (2.5; Bils et al., 2023)
$\frac{\varphi}{1-\varphi}\frac{b}{\eta}$, user-cost multiplier (annual, measured user cost)	1.80	$\beta = 0.9569$, $\delta = 0.295$ annual (Kudlyak, 2014); $b/\eta = 0.87$

Notes: Values used in the baseline staggered Hall–Milgrom economy. The reduced-form parameters η and b/η enter the wage process (19) and the measured user cost of Figure 2.

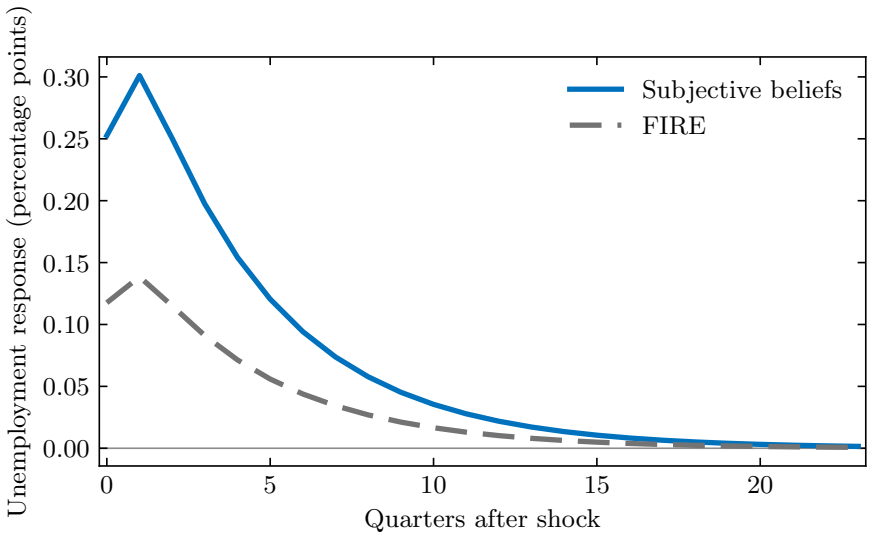
beliefs. Firms that perceive productivity as more persistent than it is expect support tied to the cycle to last longer, and the perceived present value of the subsidy is 1.9 times its value to FIRE firms. The over-extrapolation that amplifies the recession also amplifies the hiring response to state-contingent support. The same payroll subsidy paid on a schedule fixed at announcement costs 3.7 years of output per worker for each job-year created under FIRE and 3.6 under subjective beliefs, so the saving comes from indexing the subsidy to the cycle.

VII Implications for Macroeconomic Models

That the allocative price of labor is rigid because of how firms forecast wages bears on the sources of unemployment volatility and on policy.

A prominent alternative to wage rigidity attributes labor-market fluctuations to time-varying discount rates: recessions bring high risk premia that lower the present value of a

Figure 6: Impulse Response of Unemployment to a Productivity Shock



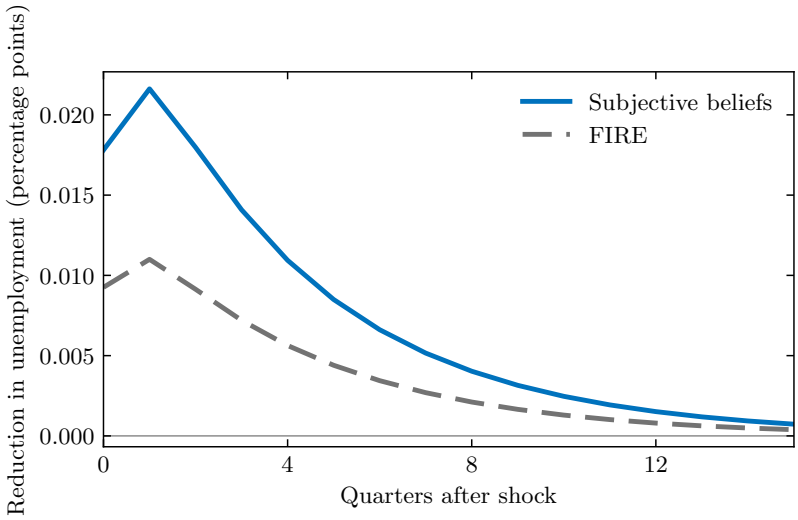
Notes: Response of the unemployment rate, in percentage points, to a one-percent decline in productivity, under FIRE (dashed) and under subjective beliefs (solid). The two economies share the same shock, matching function, and all other parameters, and differ only in how firms forecast the wage path that enters the user cost. The responses evaluate the market-tightness policy functions of the two staggered Hall–Milgrom economies of Figure 5 along the expected path of productivity, and update unemployment with three monthly flows per quarter at a steady-state monthly job-finding rate of 0.45 and separation rate of 0.034 (steady-state unemployment 7 percent); unemployment is the quarterly average of the monthly rates. The productivity process is the calibrated AR(1) with persistence $\rho \approx 0.79$.

Table 2: Moments: Data and Model

Moment	Data	FIRE	Subjective
Targeted			
New-hire wage cyclicality, $\beta(\Delta \log w_t^{\text{new}} \mid \Delta u_t)$	-0.82	-1.74	-0.79
Expected/actual ratio, ω	0.32	1.00	0.32
Not targeted			
Expected wage cyclicality, $\beta(\mathbb{F}_{t-1}[\Delta \log w_t] \mid \mathbb{F}_{t-1}[\Delta u_t])$	-0.13 to -0.01	-0.77	0.01
FIRE vs subjective user cost volatility, $\sigma(UC_t^{\text{FIRE}})/\sigma(UC_t^{\text{subj}})$	2.7 to 3.4	1.0	2.9
Tightness volatility, $\sigma(\log \theta_t)/\sigma(\log z_t)$	20.8	5.2	11.1
Unemployment volatility, $\sigma(\log u_t)/\sigma(\log z_t)$	10.8	2.2	4.8

Notes: $\beta(y \mid x)$ is the slope of a regression of y on x, in percent per percentage point: $\Delta \log w_t^{\text{new}}$ is four-quarter log growth of the new-hire wage and Δu_t the change in the unemployment rate over the same four quarters; $\mathbb{F}_{t-1}[\Delta \log w_t]$ is expected wage growth and $\mathbb{F}_{t-1}[\Delta u_t]$ the forecast change in unemployment. ω is the ratio of the responses of expected to actual wage growth to tightness. $\sigma(UC_t^{\text{FIRE}})/\sigma(UC_t^{\text{subj}})$ is the standard deviation of the FIRE user cost relative to that of the subjective user cost. The volatility rows are standard deviations of log market tightness and log unemployment relative to that of log productivity. Data: new-hire cyclicality for the SCE sample (LEHD QWI earnings of stable new hires); ω from SCE expected and Wage Growth Tracker realized stayer wage growth on the vacancy-unemployment ratio (Section V); expected wage cyclicality across the four surveys of Figure 3 (SCE -0.01, ASC 715 -0.02, Livingston -0.04, CFO Survey -0.13); user-cost volatility ratio for the three pairs of Figure 2 built on the new-hire wage (CFO Survey, SCE, ASC 715), net of a cubic trend; volatility ratios quarterly, 1951–2019, as in Figure 5. Model: the staggered Hall–Milgrom economy at the baseline ($\lambda = 0.25$, $\hat{\rho} = 0.945$), quarterly, simulated under the true productivity process, with stationary series; new-hire wage from equation (9); expected stayer wage growth under each economy's belief, regressed on the FIRE forecast of the change in unemployment; user costs built as in Figure 2 with the same new-hire wage; unemployment the quarterly average of three monthly flows. Appendix Table 4 reports further moments.

Figure 7: Payroll Subsidy Indexed to the Cycle



Notes: Reduction in the unemployment rate, in percentage points, from a payroll subsidy paid for every employed worker and indexed to productivity, 0.05 of output per worker per unit of the productivity shortfall, after a 1 percent fall in productivity that reverts at the true persistence, under FIRE (dashed) and under subjective beliefs (solid). Staggered Hall–Milgrom economy at the baseline calibration. The cost per job-year created is the cumulative subsidy outlay over the simulation, in units of output per worker, divided by the cumulative reduction in unemployment.

hire (Hall, 2017; Kehoe et al., 2023). The mechanism here operates on the cash-flow side of the present value. It requires that firms misperceive the cyclicality of wages, which the survey data document directly, and it holds discount rates at their FIRE values. Because the belief distortion is measured rather than inferred from asset prices, it can be taken to the data on its own terms, and it complements accounts based on discount rates.

The amplification carries a policy lesson. A subsidy raises the perceived surplus $z - UC^W$ one-for-one in the free-entry condition, so its effect on market tightness is inversely proportional to that surplus, $\partial \log \theta / \partial \tau \propto 1/(z - UC^W)$. Because the subjective surplus collapses in recessions while the FIRE surplus is cushioned, the same subsidy stimulates hiring far more under subjective beliefs, and it does so in the deep recessions the belief distortion creates. Firms perceive labor as expensive because the subjective user cost stays high even as the realized cost of a hire is falling, so the subsidy offsets a belief-driven overestimate of the cost of labor.

A second, distinctively belief-based lever follows from the source of the rigidity. Because the friction is a distortion in expectations rather than in wage-setting technology, policies or central-bank communication that lead firms to anticipate the wage declines that in fact accompany downturns would lower the perceived user cost and move employment even when

current wages and technology are unchanged. This channel has no counterpart in models in which wages are rigid by assumption.

VIII Conclusion

The user cost of labor, not the flow wage, is the allocative price of labor in search-and-matching models, and its cyclicality is what determines whether wage rigidity can account for unemployment volatility. Measured under FIRE, this user cost is strongly procyclical, which works against the wage-rigidity channel. This paper measures the user cost of labor instead from direct survey expectations of wages. Across the Livingston, CFO, and SCE surveys, expected real wage growth is statistically acyclical, while the realized manufacturing wage that the Livingston forecasters predict is procyclical over six decades. Workers in the SCE expect wage growth in their current job to move with labor-market tightness at one third of the rate at which the realized wage growth of job stayers moves, and the median wage-growth assumption in firms' pension disclosures is 3.0 percent in every year from 2013 to 2023. Built from these expectations with the same wage, the subjective user cost is acyclical while the FIRE user cost falls with unemployment. Because subjectively expected wage growth does not rise in recessions, the perceived user cost stays high when labor demand weakens. Relaxing FIRE thus turns the strongly procyclical user cost of the existing literature into a far less cyclical one, providing a direct, expectations-based microfoundation for the wage rigidity on which models of unemployment fluctuations rely.

Placed inside the standard search-and-matching model, this single change amplifies the response of unemployment to shocks. Because firms create jobs against the price of labor they perceive, and that price falls much less in downturns, the surplus from hiring is more exposed in recessions than it is under FIRE. Under alternating-offer wage-setting whose reset wage carries no forecast of the future, the change makes market tightness about twice as volatile, and about 3.8 times as volatile when the whole expected wage path is taken as given. In this calibration the economy with the measured beliefs produces about half of the observed volatility of market tightness relative to productivity, and the FIRE economy about a quarter of it. The price of labor that firms perceive is far less cyclical than the FIRE user cost, and that rigidity is what the standard model needs.

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A Data Construction

This appendix describes the sources of every series in the paper and how each figure and table is built from them. All growth rates are log differences; "percent" denotes 100 times a log difference, and changes in the unemployment rate are in percentage points. Monthly series are dated at the first day of the month. Quarterly series from the Quarterly Workforce Indicators (QWI) are dated at the last month of the quarter. All regressions are unweighted. Table 3 lists the sources.

Table 3: Data Sources

Series	Source and identifier	Frequency, period used
Expected wage, price and unemployment levels	Livingston Survey, Federal Reserve Bank of Philadelphia, median forecasts of WMFG, CPI, UNPR	Semiannual, June 1961–December 2023 surveys
Expected wage growth of firms	The CFO Survey (Duke University, Federal Reserve Banks of Richmond and Atlanta), historical data workbook	Quarterly, 2001Q4–2023Q4
Expected earnings growth of workers	Survey of Consumer Expectations (SCE), Federal Reserve Bank of New York: published median expected earnings growth and median point prediction	Monthly, 2013M6–2025M1
Individual earnings expectations and outcomes	SCE Labor Market Survey public microdata	March, July, November waves, 2014M3–2023M3
Firms' pension assumptions	SEC XBRL frames, us-gaap rate of compensation increase and discount rate used to determine the benefit obligation	Annual, fiscal years 2011–2023
Firms' compensation and wage plans	National Federation of Independent Business, Small Business Economic Trends (compensation plans and changes, net percent); Federal Reserve Banks of Richmond (manufacturing, services), Dallas (manufacturing, services, retail), Kansas City (services), and New York (services) business surveys, wages six months ahead and wages compared with a month earlier	Monthly, to 2026; from 1986 (NFIB), from 1997 to 2014 depending on the survey (regional)
Earnings of stable new hires	LEHD Quarterly Workforce Indicators, national, all private employers, EarnHirNS	Quarterly, 1994Q2–2025Q2
Wage growth of job stayers and switchers	Federal Reserve Bank of Atlanta Wage Growth Tracker, FRED FRBATLWGT3MMAUMHWGJMJST, FRBATLWGT3MMAUMHWGJMJSW	Monthly
Unemployment rate	BLS, Current Population Survey, FRED UNRATE (seasonally adjusted), UNRATENSA	Monthly
Job openings, unemployed, quits	BLS JOLTS, FRED JTSJOL, JTSQUR; CPS unemployed persons, FRED UNEMPLOY	Monthly, from 2000M12
Vacancies, 1951–2019	Composite help-wanted index of Barnichon (2010)	Monthly
Productivity and labor share	BLS Productivity and Costs, nonfarm business sector: output per person (FRED PRS85006163), output per hour (OPHNFB), labor share (PRS85006173)	Quarterly
Expected unemployment and inflation	Survey of Professional Forecasters (SPF), Federal Reserve Bank of Philadelphia, median forecasts of UNEMP and CPI	Quarterly
Consumer prices	BLS CPI-U, FRED CPIAUCSL	Monthly
User cost and new-hire wage	Bils et al. (2023), series of their Figure 2	Annual, 1980–2011

A.1 Livingston Survey

The Livingston Survey is conducted in June and December; its questionnaire is mailed in May and November. I date each survey at the month the questionnaire is mailed (May for the June survey, November for the December survey). For each variable the Livingston Survey reports a base-period value, the last historical value known when the questionnaire is mailed (April for a June survey and October for a December survey), and median forecasts of the level six and twelve months beyond the survey month (for a June survey, the following December and June). The wage variable is average weekly earnings in manufacturing (WMFG, dollars per week, not seasonally adjusted); the price variable is the CPI; the unemployment variable is the civilian unemployment rate (UNPR, seasonally adjusted), forecast since June 1961. For a survey dated t, let W_t^0 denote the base-period wage and W_t^6 and W_t^{12} the median wage forecasts six and twelve months ahead, and define P_t^6, P_t^{12} and U_t^6, U_t^{12} in the same way for the price level and the unemployment rate.

Expected growth. Expected nominal wage growth is the annualized growth between the two forecast horizons, $F_t^n = 2\left[\log W_t^{12} - \log W_t^6\right]$, and the survey's own inflation forecast over the same horizons is $\pi_t^L = 2\left[\log P_t^{12} - \log P_t^6\right]$. Expected real wage growth is $F_t = F_t^n - \pi_t^L$.

Realized growth. Realized nominal wage growth is the growth of the base-period value from survey t to the survey one year later, $g_t^n = \log W_{t+12m}^0 - \log W_t^0$, that is, from April to April or October to October. Realized real wage growth subtracts the same inflation forecast, $g_t = g_t^n - \pi_t^L$, so that realized and expected growth are deflated identically.

Unemployment. The expected change in unemployment is $2\left(U_t^{12} - U_t^6\right)$, in percentage points. The realized change is the twelve-month change in the CPS unemployment rate (not seasonally adjusted) from the survey month to twelve months later. In the user-cost slopes, the regressor is the seasonally adjusted rate in the survey month.

Wage level and samples. The wage level of the user cost is $w_t = \log W_t^0 - \log \mathrm{CPI}_t$, with the CPI-U of the survey month. The cyclicality regressions use the June 1961 to December 2022 surveys with both realized and expected growth available (124 surveys); Figure 1 and

the user cost use the June 1963 to December 2023 surveys (122 surveys).

A.2 CFO Survey

Through 2020Q1 the CFO Survey asks for the expected percent growth of wages and salaries at the respondent's firm over the next twelve months; from 2020Q2 it asks for expected growth of the firm's wage bill, and I use the median for the next calendar year. Both are medians across respondents. Expected nominal growth is $F_t^n = \log(1 + x_t/100)$, where x_t is the median in percent; an entry of exactly zero is treated as missing. No quarter between 2001Q4 and 2023Q4 is missing.

Timing. I date the survey of quarter q at the middle month of the quarter. The realized window runs from the last month of quarter q to the last month of quarter $q + 4$. Expected and realized nominal growth are deflated by the SPF four-quarter CPI inflation forecast of the same quarter's survey (Section A.8). The expected change in unemployment is taken from the same SPF survey; the realized change is the difference between the quarterly averages of the unemployment rate four quarters ahead and in quarter q.

Samples. The cyclicality regressions use 2001Q4–2022Q4 (85 quarters); Figure 1 and the user cost use 2001Q4–2023Q4 (89 quarters).

A.3 Survey of Consumer Expectations

Core survey, national series. The published SCE series "median expected earnings growth" is the median across respondents of expected growth in earnings over the next twelve months, monthly from 2013M6. Expected nominal growth is $\log(1 + x_t/100)$, and expected real growth subtracts the SPF four-quarter CPI forecast from the latest survey released by month t. The cyclicality regressions use 2015M5–2022M12 (92 months); Figure 1 and the user cost use 2013M6–2023M12 (127 months). The comparison of expected and realized wage growth in continuing matches in Section V uses the published "median point prediction" of the percent change in earnings in the current job, at the same place and the same number of hours, and the Wage Growth Tracker median twelve-month wage growth of job stayers (three-month moving average) read twelve months after the forecast month, both nominal

and in percent, over the 139 forecast months from 2013M6 to 2025M1 other than 2024M10, whose tracker value twelve months later (2025M10) is not available. Each is regressed on the vacancy-unemployment ratio of the forecast month with Newey–West standard errors (12 lags); the ratio of the two slopes has a delta-method standard error from their joint Newey–West covariance.

Labor Market Survey: interviews. The SCE Labor Market Survey is fielded in March, July, and November; a respondent can be interviewed up to three times over a year. I use the following items, with the question codes of the questionnaire[1]: L1, the month and year the current job started; L3, current annual earnings before taxes and deductions, including bonuses, overtime pay, tips and commissions, $y_{i,t}$; L4, the earnings bracket for respondents who skip L3; OO2e2, "What do you believe your annual earnings will be in 4 months?", $y^e_{i,t}$; and OO2a2, the expected first-year annual salary of the best job offer received within the coming four months ("the offer you would be most likely to accept"), $y^o_{i,t}$.

Expected and realized growth of the same workers. I pair each interview at month t with the same respondent's next interview when it takes place at $t+4$. Current earnings must be positive at both interviews and expected earnings positive at the first. Expected growth is $E_{i,t} = 300 \log(y^e_{i,t}/y_{i,t})$ and realized growth is $R_{i,t} = 300 \log(y_{i,t+4}/y_{i,t})$, both annualized percent over the same four months. A pair is a stayer pair when the start date of the job held at the second interview is reported at both interviews and falls in or before the month of the first interview. Both $E_{i,t}$ and $R_{i,t}$ are deflated by the same SPF CPI inflation forecast at the month of the first interview (Section A.8). Observations outside the 5th and 95th percentiles of $E_{i,t}$ are dropped, and then those outside the 5th and 95th percentiles of $R_{i,t}$ in the remaining sample. First interviews run from 2015M3 to 2022M11 (24 interview dates); there are 9,277 pairs with the three earnings reports, 8,877 stayer pairs, and 7,189 stayer pairs of 4,899 workers after trimming. Columns (1) and (2) of Table 6 are estimated jointly: E and R are regressed on the same regressor and on July and November indicators in the same sample, and the covariance of the two slopes is clustered by the date of the first interview, with the finite-sample factor $\frac{G}{G-1}\frac{n-1}{n-k}$. The test of equal slopes and the ratio of the slopes

[1] `https://www.newyorkfed.org/medialibrary/media/research/microeconomics/interactive/downloads/sce-labor-questionnaire.pdf`.

(delta method) use this joint covariance, with p-values from the t distribution with $G-1$ degrees of freedom.

Expected premium of the best offer. Column (4) of Table 6 uses every interview from 2015M3 to 2022M11 of a respondent with $y_{i,t} > 0$ and $y^o_{i,t} > 0$. The expected premium is $100 \log(y^o_{i,t}/y_{i,t})$, a ratio of two nominal amounts reported at the same interview. Observations outside its 5th and 95th percentiles are dropped (11,428 interviews remain). The regression includes July and November indicators, with standard errors clustered by interview date (24 dates).

A.4 ASC 715 Pension Disclosures

The disclosure. Accounting Standards Codification Topic 715 requires sponsors of defined-benefit pension and other postretirement benefit plans to disclose the weighted-average assumptions used to determine the benefit obligation at the measurement date, the end of the fiscal year. Two of them are the discount rate and, for pay-related plans, the rate of compensation increase, the sponsor's assumed growth of the pay of covered employees over the life of the obligation.

Source. I take both assumptions from the structured (XBRL) financial statements that filers submit to the Securities and Exchange Commission, through the SEC's XBRL frames interface (`data.sec.gov/api/xbrl/frames`), which returns, for a given reporting concept and calendar instant, one value per filer. I use the frames of the fourth-quarter instants of year $= 2011, \ldots, 2023$ for the two us-gaap concepts

- `DefinedBenefitPlanAssumptionsUsedCalculatingBenefitObligationRateOfCompensationIncrease`, "weighted average rate increase of compensation, used to determine benefit obligation of defined benefit plan"; and
- `DefinedBenefitPlanAssumptionsUsedCalculatingBenefitObligationDiscountRate`, "weighted average rate for present value of future retirement benefits cash flows, used to determine benefit obligation of defined benefit plan."

Values are decimal fractions. A frame contains, for each filer, the one fact of the requested calendar instant that applies to the entire filing entity, taken from the most recent filing that reports it. The frame therefore resolves duplicate reports of the same fact across filings, including amended filings and the prior-year comparatives of the next annual report, by keeping the latest filed value, and it gives one weighted-average value per sponsor rather than separate values for individual plans or plan groups. The instant frame for the fourth quarter of calendar year t collects balance-sheet dates close to the end of the calendar year; in the frames used here, every compensation-increase and discount-rate fact refers to a fiscal year ending within five weeks of 31 December, and 89 percent end on 31 December itself. I refer to these as December fiscal year-ends and to the fiscal year by its calendar year t.

Construction of the firm-year panel. The frames contain 1,920 compensation-increase facts and 3,437 discount-rate facts. Values below one are decimal fractions and are multiplied by 100; values of one or more are already in percent (five compensation-increase and four discount-rate facts). Values outside the range from 0 to 15 percent are dropped (8 and 10 facts). The panel is indexed by the filer's Central Index Key and the year t; because a frame holds one fact per filer, each firm-year has at most one value of each assumption. The panel has 695 firms and 3,683 firm-years. The compensation-increase assumption is reported for 1,912 firm-years of 371 firms, between 110 (in 2022) and 206 (in 2012) firms a year; the discount rate for 3,427 firm-years of 650 firms.

The aggregate series. The aggregate series is the cross-sectional median, unweighted, of the compensation-increase assumption across the firms reporting it in year t. It is 3.50 percent in 2011, 3.14 percent in 2012, and 3.00 percent in every year from 2013 to 2023. The expected growth series is $F_t^n = \log(1 + m_t/100)$, where m_t is the median in percent. The median discount rate is formed the same way from the firms reporting it.

Timing. The assumption disclosed at the fiscal year-end t determines the obligation measured at that date and so describes expected pay growth from t on. I date it in December of year t and compare it with realized growth from the fourth quarter of t to the fourth quarter of $t + 1$. The SPF forecasts paired with it, of unemployment and of CPI inflation, are those of the fourth-quarter survey of year t, the latest released by December.

Firm-level statistics. For the within-firm statistics of Section V, the change in an assumption is measured relative to the firm's previous reported year (1,541 changes for the compensation-increase assumption). The within-firm standard deviation is averaged across firms with at least two reports. The change-on-change regressions demean the change in each assumption, in percentage points, and the change in the annual average unemployment rate within firms, with standard errors clustered by year (12 years). The levels regression demeans $\log(1 + \text{rate}/100)$ and the SPF expected log change in unemployment from the fourth-quarter survey, $\log \hat{u}_t^{(4)} - \log u_{\text{Dec},t}$, within firms (1,912 firm-years of 371 firms, standard errors clustered by year, 13 years).

The ASC 715 user cost. The ASC 715 panels of Figures 1 and 8 deflate both the assumption and realized growth by the SPF four-quarter CPI forecast of the fourth-quarter survey of year t: $F_t = F_t^n - \pi_{\text{Dec},t}^{SPF}$ and $g_t = \log y_{t+1,Q4}^N - \log y_{t,Q4}^N - \pi_{\text{Dec},t}^{SPF}$, where y^N is the earnings of stable new hires (Section A.6). The wage level is $w_t = \log y_{t,Q4}^N - \log \text{CPI}_{\text{Dec},t}$, and the user costs follow Section A.9 over the 13 annual observations 2011–2023. In Table 5 and Figure 3 the ASC 715 pair is nominal: column (8) regresses F_t^n on the expected change in unemployment of the fourth-quarter SPF survey, $\hat{u}_t^{(4)} - \hat{u}_t^{(0)}$, over 2011–2023, and column (7) regresses nominal four-quarter growth of new-hire earnings on the realized four-quarter change in quarterly average unemployment over the 49 quarters 2011Q4–2023Q4.

A.5 Business Surveys of Compensation Plans

The NFIB series are the net percent of small firms planning to raise average employee compensation over the next three months and the net percent that raised it over the previous three months; the regional series are seasonally adjusted diffusion indexes of wages, or wages and benefits, six months ahead and compared with a month earlier. Each series is regressed on the unemployment rate of its survey month, with calendar-month indicators for the NFIB series, which are not seasonally adjusted, and the slope is divided by the standard deviation of the series. The realized counterpart of a plan dated t is the change reported three months later (NFIB) or six months later (regional surveys).

A.6 Realized Wage Series

Earnings of stable new hires (LEHD QWI). I use the national public-use Quarterly Workforce Indicators of the Longitudinal Employer-Household Dynamics program (U.S. Census Bureau, `https://lehd.ces.census.gov/data/`), the sex-by-age tabulation for all firm ages and sizes, all private ownership, not seasonally adjusted, and select the national tabulation for all industries, both sexes, and all ages. The series y_t^N (EarnHirNS) is the average monthly earnings of stable new hires: total quarterly earnings in quarter t at employer j of workers with positive earnings at j in quarters $t-1$, t and $t+1$ and none in $t-2$ to $t-5$ (workers newly hired in $t-1$ who stay for the full quarter t), divided by their number and by three. I seasonally adjust $\log y_t^N$ with fixed quarterly factors: the quarter-of-year means, normalized to sum to zero, of its deviation from a centered 2×4 moving average over 1994Q2–2025Q2. Because the factors are fixed, four-quarter growth rates are unaffected; the adjustment enters the wage level and the monthly values. Monthly values for the SCE dates interpolate the log level linearly between quarter-end months. Realized growth over a window starting at month t is the log level twelve months later less the log level at t.

Manufacturing earnings. Realized growth for the Livingston Survey is the growth of the survey's base-period values of average weekly earnings in manufacturing, the historical values known to the forecasters at each survey.

Atlanta Fed Wage Growth Tracker. The tracker is the median twelve-month percent change in hourly wages of individuals observed twelve months apart in the Current Population Survey. I use the three-month moving averages for job stayers and job switchers; job switchers are workers in a different occupation or industry than a year earlier or who changed employer or job duties in the past three months. Column (3) of Table 6 uses the difference between the two, in percentage points, monthly from 2000M12 (the first month of JOLTS) to 2026M9 other than 2025M10, for which neither the tracker nor the number of unemployed persons is available (309 months), regressed on the vacancy-unemployment ratio or the quits rate at the end month of the twelve-month window, with Newey–West standard errors (12 lags).

A.7 Labor-Market Regressors

Unemployment. The unemployment rate is the BLS CPS rate, seasonally adjusted, except for the realized change in the Livingston columns, which uses the rate not seasonally adjusted at the survey months. For quarterly series the rate is the quarterly average of the monthly rates. The realized change paired with a forecast dated t is the change from t to $t+12$ months (quarterly averages from quarter q to $q+4$ for quarterly series), in percentage points.

Survey forecasts of unemployment. The SPF reports median forecasts of the quarterly average unemployment rate for the current quarter, $\hat{u}_t^{(0)}$ (UNEMP2), and for each of the next four quarters, the last of which is $\hat{u}_t^{(4)}$ (UNEMP6). Its questionnaire is due, and its results released, in the middle month of the quarter, so I date the survey of quarter q at that month and carry it forward to the following months until the next survey. The expected change over the next year is $\hat{u}_t^{(4)} - \hat{u}_t^{(0)}$ in percentage points. The firm-level levels regression uses $\log \hat{u}_t^{(4)} - \log u_t$ from the same survey. For the Livingston Survey the expected change is $2\,(U_t^{12} - U_t^6)$.

Labor-market tightness and quits. The vacancy-unemployment ratio is JOLTS total nonfarm job openings divided by the number of unemployed persons, both monthly and seasonally adjusted. The quits rate is the JOLTS total nonfarm quits rate, in percent of employment. In columns (1), (2), and (4) of Table 6 they are measured in the month of the first interview or of the interview, and in column (3) at the end month of the twelve-month growth window.

A.8 Deflators

Livingston. Livingston forecasts and their realized counterparts are deflated by the survey's own median CPI forecast over the same horizons, π_t^L.

SPF four-quarter CPI forecast. The SPF reports median forecasts of headline CPI inflation for each quarter, at annualized quarter-over-quarter rates of the quarterly average price level, for the current quarter and for each of the next four quarters, $\hat{\pi}_t^{(k)}$ for $k = 1, \ldots, 4$ (CPI3 to CPI6). The four-quarter forecast is $\pi_t^{SPF} = \frac{1}{4}\sum_{k=1}^{4} \log(1 + \hat{\pi}_t^{(k)}/100)$, dated at

the middle month of the survey quarter and carried forward to the following months until the next survey, so that each date uses the latest survey released. It deflates both realized and expected growth for the CFO Survey, the SCE core series, and the ASC 715 series in Figures 1 and 8, and in columns (3) to (6) of Table 5.

SPF annual CPI forecast. For the Labor Market Survey analyses (Table 6), the deflator is $\log(1+\hat{\pi}_t^A/100)$, where $\hat{\pi}_t^A$ (CPIB) is the SPF median forecast of fourth-quarter-over-fourth-quarter CPI inflation in the year after the survey year. It is dated at the middle month of the survey quarter and interpolated linearly to the months between surveys.

Nominal comparisons. Columns (7) and (8) of Table 5, the ASC 715 firm-level statistics, the best-offer premium, and the national comparison of expected and realized stayer wage growth are in nominal terms. Wage levels in the user cost are deflated by the CPI-U of the dating month.

A.9 User Cost of Labor

Formula and parameters. For each survey panel, the FIRE and subjective user costs are

$$UC_t^{\text{FIRE}} = \tilde{w}_t - K\,(g_t - \bar{g}), \qquad UC_t^{\text{subj}} = \tilde{w}_t - K\,(F_t - \bar{F}), \qquad K = \frac{\varphi}{1-\varphi}\,\frac{b}{\eta},$$

where g_t and F_t are the realized and expected real wage growth of Figure 1, $\bar{g}$ and $\bar{F}$ their means over the panel sample, and $\tilde{w}_t$ the wage level net of a cubic time trend. The discount and separation parameters are the annual values of Kudlyak (2014), $\beta = 0.9569$ and $\delta = 0.295$, so $\varphi = \beta(1-\delta) = 0.6746$. The history-dependence share $b/\eta = 0.87$ is the model calibration of Section VI, at which the FIRE user cost is 2.5 times as volatile as the new-hire wage. Together, $K = 1.804$. Both user costs of a panel use the same $\tilde{w}_t$, K and dates.

Wage levels and detrending. The wage level is $\log W_t^0 - \log \text{CPI}_t$ for the Livingston panel and $\log y_t^N - \log \text{CPI}_t$ at the dating month (the last month of the survey quarter for the CFO Survey, the survey month for the SCE, December for ASC 715) for the other panels. $\tilde{w}_t$ is the residual from an OLS regression of w_t on a constant and a cubic polynomial in time (in decades from the sample mean date), estimated over each panel's own sample. The

plotted series are in percent (100 times the log deviation), and the standard deviations are those of the plotted series.

Cyclicality. The slope of each user cost on the unemployment rate is estimated by OLS of the series on the unemployment rate (the rate in the survey month for the Livingston Survey and the SCE, the quarterly average for the CFO Survey and ASC 715) and the three trend terms, with Newey–West standard errors and $\lfloor 4(n/100)^{2/9} \rfloor$ lags (four for the Livingston Survey and the SCE, three for the CFO Survey, two for ASC 715).

Bils, Kudlyak and Lins series. The comparison series are the log user cost and log new-hire wage of Bils et al. (2023), annual 1980–2011, as deviations from their sample means in the data of their Figure 2. Removing a cubic trend from each, the standard deviation of the user cost is 2.55 times that of the new-hire wage.

A.10 Construction of the Exhibits

Figure 1. Each panel plots $100\, g_t$ and $100\, F_t$ of one survey at the survey dates: Livingston June 1963–December 2023 (semiannual), CFO 2001Q4–2023Q4 (quarterly), SCE 2013M6–2023M12 (monthly), ASC 715 2011–2023 (annual). The legends report sample standard deviations in percentage points.

Figures 2 and 8. Figure 8 plots $100\, UC_t^{\text{FIRE}}$ and $100\, UC_t^{\text{subj}}$ for the same four panels and samples; Figure 2 reports their standard deviations.

Figure 3 and Table 5. Each column is an ordinary least squares regression of annual log wage growth on the change in the unemployment rate in percentage points. Columns (1) and (2) use the 124 Livingston surveys of June 1961–December 2022. Columns (3) and (4) use the CFO dates 2001Q4–2022Q4 (85 quarters): new-hire earnings growth from the last month of the survey quarter on the realized change in quarterly average unemployment, and the CFO forecast on $\hat{u}_t^{(4)} - \hat{u}_t^{(0)}$. Column (5) uses the quarter-end months 2015Q2–2022Q4 (31 quarters) and column (6) the SCE months 2015M5–2022M12 (92 months). Columns (7) and (8) are as described in Section A.4. Newey–West standard errors use 2 lags for semiannual, 4

for quarterly, 12 for monthly, and 1 for annual data, with the finite-sample factor $n/(n-2)$. Figure 3 plots 100 times the slopes with 90 percent confidence intervals, ± 1.645 standard errors. The tests of equal realized and expected slopes in Section V stack the two regressions on common dates and use the joint Newey–West covariance of their scores; for the SCE pair the common dates are the quarter-end months of the SCE sample, with 4 lags.

Table 6. Columns (1), (2), and (4) are described under the Labor Market Survey above and column (3) under the Wage Growth Tracker. R^2 is that of the specification with the vacancy-unemployment ratio.

Figure 5 and Tables 2 and 4. Market tightness is the composite help-wanted index of Barnichon (2010) divided by the number of unemployed persons, and productivity is output per person in the nonfarm business sector, as in Shimer (2005); all series are quarterly averages over 1951Q1–2019Q4, in logs, detrended with a Hodrick–Prescott filter with smoothing parameter 10^5. The standard deviation of filtered log market tightness is 0.392, against 0.0189 for output per person, a ratio of 20.8. Over 1951–2003 the same series give standard deviations of 0.385 and 0.020, against 0.382 and 0.020 in Shimer (2005, Table 1).

B Derivation of the Joint Surplus

This appendix derives the joint-surplus recursion used for the Nash specifications of Appendix C and shows that, under common beliefs and Nash bargaining, the bargained wage is a transfer that cancels from the surplus, so the wage split cannot amplify or dampen job creation on its own. Throughout, $\mathbb{F}_t$ is the common subjective measure, β the discount factor, δ the separation rate, and $f(\theta_t) = \theta_t q(\theta_t)$ the job-finding rate. Free entry implies that a firm with an unfilled or separated position has value zero.

Value functions. A filled match pays flow output z_t and wage w_t, survives with probability $1-\delta$, and is worth zero to the firm upon separation. The firm's value of a filled job is

$$J_t = z_t - w_t + \beta(1-\delta)\,\mathbb{F}_t[J_{t+1}]\,. \tag{12}$$

An employed worker earns w_t and, next period, remains employed with probability $1-\delta$ and separates into unemployment with probability δ:

$$W_t = w_t + \beta\,\mathbb{F}_t[(1-\delta)W_{t+1} + \delta\,U_{t+1}]\,. \tag{13}$$

An unemployed worker receives the flow value of nonemployment *ell* and finds a job with probability $f(\theta_t)$:

$$U_t = ell + \beta\,\mathbb{F}_t\big[f(\theta_t)\,W_{t+1} + \big(1-f(\theta_t)\big)U_{t+1}\big]\,. \tag{14}$$

Worker surplus. Subtracting (14) from (13) and collecting the continuation terms,

$$\begin{aligned} W_t - U_t &= w_t - ell + \beta\,\mathbb{F}_t\big[(1-\delta)W_{t+1} + \delta U_{t+1} - f(\theta_t)W_{t+1} - \big(1-f(\theta_t)\big)U_{t+1}\big] \\ &= w_t - ell + \beta\,\mathbb{F}_t\big[\big((1-\delta) - f(\theta_t)\big)W_{t+1} - \big((1-\delta) - f(\theta_t)\big)U_{t+1}\big]\,, \end{aligned}$$

where the second line uses $\delta - 1 + f(\theta_t) = -\big((1-\delta) - f(\theta_t)\big)$. Writing the worker surplus as $V_t \equiv W_t - U_t$,

$$V_t = w_t - ell + \beta\,\mathbb{F}_t\big[\big((1-\delta) - f(\theta_t)\big)V_{t+1}\big]\,. \tag{15}$$

Joint surplus. The firm's outside value is zero, so its surplus equals J_t. Adding (12) and (15), the wage w_t enters with opposite signs and cancels; it is a pure transfer between the two parties:

$$S_t \equiv J_t + V_t = z_t - ell + \beta\,\mathbb{F}_t\big[(1-\delta)J_{t+1} + \big((1-\delta) - f(\theta_t)\big)V_{t+1}\big]\,. \tag{16}$$

The Nash sharing rule splits the surplus in constant proportions, $J_t = (1-u)S_t$ and $V_t = uS_t$, with u the worker's bargaining weight. Substituting the continuation values $J_{t+1} = (1-u)S_{t+1}$ and $V_{t+1} = uS_{t+1}$ into (16),

$$\begin{aligned} (1-\delta)J_{t+1} + \big((1-\delta) - f(\theta_t)\big)V_{t+1} &= \Big[(1-\delta)(1-u) + \big((1-\delta) - f(\theta_t)\big)\,u\Big]S_{t+1} \\ &= \Big[(1-\delta) - uf(\theta_t)\Big]S_{t+1}, \end{aligned}$$

which yields the recursion used in the text:

$$S_t = z_t - ell + \beta\,\mathbb{F}_t\big[\big((1-\delta) - \ uf(\theta_t)\big)S_{t+1}\big]\,. \tag{17}$$

Free entry and wage-split neutrality. Free entry equates the vacancy cost to the perceived value of a new match, $\kappa/q(\theta_t) = \mathbb{F}_t[J_{t,t}] = (1 - \ u)S_t$, so market tightness is pinned by a *constant* share of the joint surplus. Two implications follow directly. First, the bargained wage cancels from (16), so it cannot independently raise or lower job creation: any belief that moves the wage moves the worker's and firm's sides in offsetting directions, leaving the surplus, and hence tightness, unchanged. A belief distortion affects hiring only insofar as it changes the *surplus* S_t, not the split. This neutrality is about the wage as a transfer, not about the bargaining weight: u still enters the surplus recursion and the free-entry condition, and a protocol in which the wage is not a constant share of the surplus is not neutral. When the wage is not a fixed share of the surplus, as under the Hall–Milgrom resets of Section VI, the firm value $J_{t,t}$ is no longer $(1 - \ u)S_t$ and its belief-sensitivity departs from the surplus's; that departure, not the Nash split, is what the amplification in Section VI turns on. Second, the belief operator $\mathbb{F}_t$ in (17) multiplies the continuation $\big[(1-\delta) - \ uf(\theta_t)\big]S_{t+1}$; the coefficient $(1-\delta) - \ uf(\theta_t)$ is the surplus's continuation share, which lies strictly below the job value's share $(1-\delta)$ whenever $\ uf(\theta_t) > 0$. The gap is the congestion (search) externality: a higher job-finding rate raises the worker's outside option and shrinks the surplus. This term attenuates the response of tightness to a belief shock, but, being multiplicative in the continuation, does not reverse its sign. It is present under FIRE ($\mathbb{F} = \mathbb{E}$) and is not itself a belief effect.

C Model Details

This appendix sets out the model of Section VI in full: the environment, timing and equilibrium, wage setting under each protocol, beliefs, the derivations of equations (7) to (11), the calibration, and the comparisons across protocols and beliefs. Appendix D describes the global solution.

Overview. The model is the search-and-matching model of Kudlyak (2014), whose free-entry condition is written in terms of the user cost of labor, with the wage expectations that enter the user cost formed under the belief measured in Section V. The flow wage is flexible; the *expected present value* of wages, the user cost UC_t^W of Section III, is rigid because of how agents forecast. The cyclicality of the user cost is the joint product of two ingredients: the bargaining protocol, which fixes how much hire-time conditions imprint on ongoing wages, and the belief, which fixes how that imprint is forecast. The same bargained wage process has a user cost that is procyclical under FIRE and rigid under the subjective belief the surveys document.

Environment. The labor market is the standard Diamond–Mortensen–Pissarides economy (Diamond, 1982; Mortensen, 1982; Pissarides, 2009). A unit measure of risk-neutral workers discount the future at β, and a fraction u_t are unemployed. Firms post v_t vacancies at flow cost κ, and new matches form through a constant-returns matching function $m(u_t, v_t) = \chi\, u_t^{\alpha} v_t^{1-\alpha}$. With market tightness $\theta_t \equiv v_t/u_t$, a vacancy is filled with probability $q(\theta_t) = \chi\theta_t^{-\alpha}$ and an unemployed worker finds work with probability $f(\theta_t) = \theta_t q(\theta_t) = \chi\theta_t^{1-\alpha}$, so $q' < 0$. Matches produce flow output z_t and separate exogenously at rate δ, and unemployment evolves as $u_{t+1} = u_t + \delta(1 - u_t) - f(\theta_t)u_t$. I write $\varphi \equiv \beta(1-\delta)$ for the effective discount factor that combines impatience and separation. Aggregate productivity is the only shock; its deviation from trend $x_t \equiv z_t - \bar{z}$ follows a first-order autoregressive process, AR(1),

$$x_t = \rho\, x_{t-1} + \varepsilon_t, \qquad 0 < \rho < 1, \tag{18}$$

with ε_t mean-zero and independent and identically distributed. The firm is the residual claimant on the match: the value $J_{t,\tau}$ of a job formed at t and evaluated at date τ is defined in Section III, and free entry drives the value of a vacancy to zero, so $\kappa/q(\theta_t) = J_{t,t}$. As Kudlyak (2014) shows and Section III rederives under subjective beliefs, this free-entry condition can be written in terms of the user cost of labor, equation (7) in the text,

$$\frac{\kappa}{q(\theta_t)} = \hat{\mathbb{E}}_t \sum_{s \geq 0} \varphi^s \big(z_{t+s} - UC_{t+s}^W\big),$$

where UC_t^W is the wage component of the user cost defined in Section III and $\hat{\mathbb{E}}_t$ is the belief firms use to value a hire. Market tightness, and hence unemployment, is governed by the perceived present value of the match surplus $z_t - UC_t^W$: the user cost, not the flow wage, is the allocative price.

Timing and equilibrium. Within a period, productivity z_t is realized, wages are set by the protocol in place, firms post vacancies given their belief, matches form, and a fraction of existing matches separates; unemployment follows three monthly flows per quarter, $u \leftarrow u + s(1-u) - f(\theta_t)u$, with monthly separation rate s. Given a belief $\hat{\mathbb{E}}_t$, an equilibrium is a tightness function of the state and a wage rule such that wages follow the protocol, free entry (7) holds in every state with match values computed under the belief, and unemployment follows the flow equation. Moments are computed under the true productivity process, an internally rational equilibrium in the sense of Adam et al. (2016). The FIRE economy is the special case in which the belief is the true process. Appendix D describes the global solution.

The mechanism. Equation (7) makes tightness the discounted sum of expected future surpluses $z - UC^W$. Under FIRE the user cost is strongly procyclical (Figure 2): in a recession it falls with output, so the surplus is cushioned and tightness barely moves. Under the subjective belief the user cost is far less cyclical: it falls much less, the decline in output passes through to the surplus, and tightness and vacancies drop sharply, because firms do not perceive labor becoming cheaper in the downturn. In the present-value identity that decomposes a price into expected cash flows and discount rates (Campbell and Shiller, 1988), the distortion sits on the cash-flow side, the expected wage path, while the discount rate is left at its FIRE value. Because it operates on the forward part of the path and not the spot wage, the new-hire wage can be flexible and cyclical while the allocative price stays rigid.

The wage process. To make the user cost explicit I adopt a transparent reduced form for the wage a match pays. A worker hired at t and still employed at $\tau \geq t$ earns

$$w_{t,\tau} = \bar{w} + a\, x_\tau + b\, x_t, \qquad a, b \geq 0, \tag{19}$$

so the wage responds to current conditions with loading a and carries a permanent imprint b of the state prevailing at the date of hire. The new-hire wage is $w_{t,t} = \bar{w} + \eta\, x_t$ with cyclical pass-through $\eta \equiv a + b$, and b/η is the degree of history dependence that Kudlyak (2014) emphasizes: the wages of incumbents are partly anchored to the conditions under which they were hired. The imprint is permanent. Equation (19) is a reduced form. The history dependence it encodes is a documented feature of wages (Bils et al., 2023) and arises naturally from optimal long-term wage-setting rather than from any nominal or Calvo friction: in a self-enforcing contract the wage persists as long as it lies within the bilateral bargaining set and is renegotiated only when it would leave (MacLeod and Malcomson, 1993; Thomas and Worrall, 1988), and under limited-commitment risk-sharing the new-hire wage reflects the outside option at the date of hire and is then smoothed within the match (Rudanko, 2009). What matters for the amplification is that the loadings a and b respond to realized conditions and not to the forecast of them; the comparison of protocols below shows how a wage bargained against the *perceived* surplus differs.

Wage setting under each protocol. The reduced form (19) takes the whole expected wage path as given, as under posted or rule-based wages, and delivers the closed-form amplification (23). Under staggered Hall–Milgrom bargaining, equation (9) in the text, a match keeps the reset wage $w^*(z_j)$ of the state z_j at its last renegotiation, so its wage carries the imprint of past conditions as in (19), and the reset wage itself contains no forecast. Under Nash bargaining the wage gives the worker a share ν of the perceived joint surplus (Appendix B), either at every date (flexible Nash) or at the dates of renegotiation (staggered Nash at rate λ). The paragraphs below compare the protocols.

FIRE and subjective beliefs. The firm and worker share a common belief $\hat{\mathbb{E}}_t$ about the driver and are internally rational given it (Adam et al., 2016). The two regimes differ in a single object, the persistence they attribute to the state: let $\hat{\rho}$ be perceived persistence, so $\hat{\mathbb{E}}_t x_{t+s} = \hat{\rho}^{\,s} x_t$. Under FIRE agents know the true law of motion (18), so $\hat{\rho} = \rho < 1$ and shocks are expected to mean-revert. Under the subjective belief agents overstate persistence, $\hat{\rho} > \rho$, and expect shocks to endure, with the random-walk case $\hat{\rho} \to 1$ as its limit. For a worker hired at t, expected wage growth to horizon τ is $\hat{\mathbb{E}}_t w_{t,\tau} - w_{t,t} = a\big(\hat{\rho}^{\,\tau-t} - 1\big)x_t$:

cyclical under FIRE, and vanishing as $\hat{\rho} \to 1$. In the wage process (19), the response of the expected wage growth of a continuing match to any indicator of the state is therefore the fraction ω of equation (10) in the text of the response of its realized wage growth at horizon h: one under FIRE and zero as $\hat{\rho} \to 1$. Section V measures $\omega = 0.32$ (0.537/1.655) in workers' one-year expectations of their own wage growth. With $\rho = 0.38$ at annual frequency, this ratio implies perceived persistence of 0.80 at annual frequency and 0.945 at quarterly frequency, the baseline value; the Livingston forecast slope, statistically indistinguishable from zero, points to a belief at least as persistent. In the one-shock model the driver stands in for the cyclical force that moves the surplus, and its true persistence ρ is identified from the wage data the model must reproduce. Perceived persistence $\hat{\rho}$ is the single belief parameter.

Foundations of the belief. Overstated persistence, $\hat{\rho} > \rho$, is the common prediction of the leading departures from full information. Under noisy or dispersed information agents cannot cleanly separate persistent from transitory movements and their forecasts underreact to the persistent component (Woodford, 2001; Coibion and Gorodnichenko, 2015); under rational inattention a noisy series like one's own future wage growth is optimally tracked only coarsely (Sims, 2003); parsimonious or "natural" forecasting fits a low-order model that captures short-run momentum but misses slow mean-reversion, overstating persistence for the hump-shaped dynamics wages and productivity display (Fuster et al., 2010); and constant-gain learning about a persistent series drives perceived persistence toward one (Marcet and Sargent, 1989; Malmendier and Nagel, 2016). Internal rationality (Adam et al., 2016) makes such a belief admissible in equilibrium. Each of these mechanisms delivers $\hat{\rho} > \rho$, and the data determine how far. The measured ratio of expected to realized wage growth pins $\hat{\rho} = 0.945$ at quarterly frequency, and the contrast between realized wages, which mean-revert (Appendix E), and expected wages, which do not, identifies a belief gap, $\hat{\rho} > \rho$, rather than a wage process that is itself rigid.

The user cost under each belief. Substituting the wage process (19) into the user cost of Section III, the history term telescopes: at every horizon $s \geq 1$ the wage gap between a worker hired at t and one hired at $t+1$ is $w_{t,t+s} - w_{t+1,t+s} = b\,(x_t - x_{t+1})$, independent of s,

so

$$UC_t^W = \bar{w} + \eta\, x_t + \frac{\varphi\, b}{1-\varphi}\big(x_t - \hat{\mathbb{E}}_t x_{t+1}\big). \tag{20}$$

With perceived persistence $\hat{\rho}$, the forward term is $x_t - \hat{\mathbb{E}}_t x_{t+1} = (1-\hat{\rho})x_t$, so

$$UC_t^W = \bar{w} + \Big[\eta + \tfrac{\varphi b(1-\hat{\rho})}{1-\varphi}\Big] x_t, \tag{21}$$

which specializes to the procyclical FIRE user cost at $\hat{\rho} = \rho$ and to the rigid one, $UC_t^W = \bar{w} + \eta\, x_t$, as $\hat{\rho} \to 1$. The cyclicality of the user cost is thus the *product* of two ingredients: the history dependence b that the wage-setting protocol builds into ongoing wages, and the belief gap $1-\hat{\rho}$ through which that history dependence is capitalized. Their product $\varphi b(1-\hat{\rho})/(1-\varphi)$ is the entire wedge between the user cost and the new-hire wage. Neither ingredient alone produces the contrast in Figure 2: with spot wages ($b = 0$) there is no cohort effect for beliefs to distort, and under FIRE ($\hat{\rho} = \rho$) the protocol's history dependence is fully priced, so deferring a hire saves a great deal in a boom and costs a great deal in a slump and the user cost is strongly procyclical, the Kudlyak (2014) pattern in Figure 2. As agents overstate persistence the belief gap $1-\hat{\rho}$ shrinks and the forward-looking part of the user cost flattens. At the measured $\hat{\rho} = 0.945$ the forward term keeps a quarter of its FIRE loading, $(1-\hat{\rho})/(1-\rho) = 0.25$, so the user cost stays close to the new-hire wage, which is what the subjective user cost in Figure 2 shows. Because the new-hire wage changes by $w_{t+1,t+1} - w_{t,t} = \eta\,(x_{t+1} - x_t)$, equation (20) equals the second expression in equation (8) of the text, $w_{t,t} - \frac{\varphi}{1-\varphi}\frac{b}{\eta}\hat{\mathbb{E}}_t[w_{t+1,t+1} - w_{t,t}]$.

Job creation and amplification. Write the match surplus as $z_t - UC_t^W = (\bar{z} - \bar{w}) + c\, x_t$, with loading $c^{\text{subj}} = 1 - \eta - \varphi b(1-\hat{\rho})/(1-\varphi)$ under the subjective belief and $c^{\text{FIRE}} = 1 - \eta - \varphi b(1-\rho)/(1-\varphi)$ under FIRE ($\hat{\rho} = \rho$); the FIRE user cost absorbs more of the productivity movement, so $c^{\text{subj}} > c^{\text{FIRE}}$ whenever $\hat{\rho} > \rho$. Log-linearizing the free-entry condition (7) around the deterministic steady state, with $\kappa/q(\theta_t) = (\kappa/\chi)\theta_t^{\alpha}$ on the left and the perceived present value of the surplus on the right, gives

$$\alpha\, \bar{S}\, \hat{\theta}_t = c\, \hat{\mathbb{E}}_t \sum_{s \geq 0} \varphi^s x_{t+s} = \frac{c}{1-\varphi\hat{\rho}}\, x_t, \tag{22}$$

where $\hat{\theta}_t$ is log tightness and $\bar{S} = \kappa/q(\bar{\theta})$ is the steady-state surplus; both the surplus loading c and the perceived discounting move with $\hat{\rho}$. Tightness loads on the state with coefficient $c/[\alpha\bar{S}(1-\varphi\hat{\rho})]$, so the amplification of tightness under the subjective belief relative to FIRE, holding the bargained wage's cyclical response fixed across the two regimes, is

$$\mathcal{A} \;=\; \frac{c^{\text{subj}}/(1-\varphi\hat{\rho})}{c^{\text{FIRE}}/(1-\varphi\rho)} \;=\; \underbrace{\frac{c^{\text{subj}}}{c^{\text{FIRE}}}}_{\geq 1} \cdot \underbrace{\frac{1-\varphi\rho}{1-\varphi\hat{\rho}}}_{\text{persistence} \geq 1} \;\geq\; \frac{1-\varphi\rho}{1-\varphi\hat{\rho}}. \tag{23}$$

Two features of (23) matter. First, the steady-state surplus $\bar{S}$ and the matching elasticity α enter the tightness loading of both economies identically and cancel from the ratio: for a given measured wage process, the amplification is *invariant* to the value of nonemployment and to the level of the fundamental surplus (Ljungqvist and Sargent, 2017), the very parameters behind the Shimer (2005) versus Hagedorn and Manovskii (2008) debate. These parameters change the wage's cyclicality, and hence the loadings a and b, only through the wage data the model already matches; holding that measured cyclicality fixed, they move the level of both economies' volatility and not the ratio. Second, the ratio is bounded below by the persistence factor $(1-\varphi\rho)/(1-\varphi\hat{\rho})$, which exceeds one whenever agents overstate persistence ($\hat{\rho} > \rho$): holding the contemporaneous surplus fixed, the subjective firm capitalizes a shock as more persistent than it is and therefore responds more. The discount factor φ is common to the two regimes: this is a difference in the perceived *persistence of the cash flow*, not in the rate at which it is discounted. The additional factor $c^{\text{subj}}/c^{\text{FIRE}} \geq 1$ reflects that the FIRE user cost also cushions the surplus. At this calibration the FIRE surplus stays procyclical ($c^{\text{FIRE}} > 0$) for a new-hire pass-through $\eta < 0.4$. In the log-linear model the ratio of tightness loadings in (23) is the ratio of standard deviations that defines $\mathcal{A}$ in equation (11) of the text.

Amplification: protocol and belief. Equation (23) makes the two ingredients explicit. The amplification equals one under FIRE ($\hat{\rho} = \rho$), where the two economies coincide, and rises monotonically in $\hat{\rho}$, to about 3.8 in the reduced form at the measured $\hat{\rho} = 0.945$. The bargaining protocol sets how steeply. Its history dependence b raises the first factor $c^{\text{subj}}/c^{\text{FIRE}}$ above one, adding the user-cost channel on top of the persistence factor; with spot wages ($b = 0$) the first factor collapses to one and only the persistence factor remains. The full effect therefore requires both a belief that moves $\hat{\rho}$ off ρ and a bargaining protocol that makes the

user cost history-dependent.

From tightness to unemployment. Equation (23) is stated for market tightness, but it carries directly to unemployment. In the flow steady state $u = \delta/[\delta + f(\theta)]$, so log unemployment responds to tightness as

$$\hat{u}_t = -(1-u)(1-\alpha)\,\hat{\theta}_t, \tag{24}$$

with the same coefficient under both beliefs, since it depends only on the matching technology and the steady-state unemployment rate. The ratio of unemployment volatilities across the two regimes is therefore also $\mathcal{A}$: whatever amplifies tightness amplifies unemployment one for one.

Steady state. The deterministic steady state sets $x_t = 0$, so output is $\bar{z}$, the user cost is $\bar{w}$ under either belief, and the flow surplus is $\bar{z} - \bar{w}$. Free entry equates the vacancy cost to the present value of that surplus,

$$\frac{\kappa}{q(\bar{\theta})} = \bar{S} \equiv \frac{\bar{z} - \bar{w}}{1 - \varphi}, \tag{25}$$

which pins tightness and, through the flow balance $\delta(1-\bar{u}) = f(\bar{\theta})\bar{u}$, unemployment. The steady state matches the monthly job-finding and separation rates of Shimer (2005), 0.45 and 0.034, applied in three monthly flows per quarter, and a quarterly vacancy-filling rate of 0.71 (den Haan et al., 2000), so that $\bar{\theta} = 1.17$, $\chi = 0.77$, and $\bar{u} \approx 0.07$; the vacancy cost is 0.584 of quarterly productivity (Hagedorn and Manovskii, 2008), and free entry sets the flow value of delay $\gamma = 0.8785$. The steady-state surplus $\bar{S}$ enters the tightness loading $c/[\alpha\bar{S}(1-\varphi\hat{\rho})]$ of both economies identically, so it drops out of the amplification (23).

Calibration. The model is calibrated at quarterly frequency (Table 1). The discount factor is $\beta = 1/1.012$ and the separation rate $\delta = 0.10$, standard values that give $\varphi = \beta(1-\delta) = 0.89$.[2] The matching function is Cobb–Douglas with elasticity $\alpha = 0.5$, the conventional midpoint of the empirical range; the matching efficiency χ and the vacancy cost κ normalize the steady-state job-finding rate and market tightness and affect only the level of the surplus $\bar{S}$, which

[2]These are the values Kudlyak (2014) uses for her quarterly model, the Shimer (2005) parametrization; the annual figures $\beta = 0.9569$, $\delta = 0.295$ in Section III are her values for the annual user-cost series.

cancels from the amplification (23). The persistence ρ is that of the wage-driving state, which I identify from the estimated persistence of the new-hire wage, about 0.38 at annual frequency (Bils et al., 2023), or $\rho \approx 0.79$ quarterly. This is lower than aggregate productivity persistence, because wages do not track productivity one for one; reproducing the volatility of the FIRE user cost relative to the new-hire wage with non-negative wage loadings requires ρ no higher than about 0.81. The history-dependence share b/η is set so that the FIRE user cost is 2.5 times as volatile as the new-hire wage, the ratio in the Bils et al. (2023) series, which given φ and ρ implies $b/\eta \approx 0.87$. The measured subjective user cost in Section V uses the same share. The new-hire pass-through is $\eta = 0.28$, set so that the slope of new-hire wage growth on the change in unemployment matches the -0.82 of Figure 3. Perceived persistence is set by the measured ratio ω through the wage process (19), which gives $\hat{\rho} = 0.945$ at quarterly frequency. The ratio compares nominal expected and realized wage growth, because expected inflation itself moves with tightness: over 2013–2025 the SPF one-year CPI inflation forecast rises by 0.81 percentage points per unit of the vacancy-unemployment ratio. Deflating both series by that forecast gives a ratio of -0.33, which places perceived persistence at its upper bound of one, where the Hall–Milgrom amplification is 3.2. The general-equilibrium solution of Appendix D replaces this reduced-form pass-through with an explicit Hall–Milgrom reset wage. I set the renegotiation rate to $\lambda = 0.25$, one renegotiation a year on average, as in Gertler et al. (2020). At this rate the model's FIRE user cost is 1.4 times as volatile as the new-hire wage, against about 2.5 in the Bils et al. (2023) series; matching that ratio requires renegotiation once every twenty years ($\lambda = 0.013$), at which the amplification is 3.4. The volatility of market tightness is not targeted; Figure 5 reports it.

Magnitude. With this calibration, equation (23) gives surplus loadings $c^{\text{FIRE}} \approx 0.31$ and $c^{\text{subj}} \approx 0.62$, a persistence factor $(1 - \varphi\rho)/(1 - \varphi\hat{\rho}) \approx 1.9$, and an amplification $\mathcal{A} \approx 3.8$: market tightness, and in the flow steady state unemployment, is about 3.8 times as volatile under subjective beliefs as under FIRE. This is the amplification when the whole expected wage path is taken as given, as under posted or rule-based wages, or a cohort wage that is never renegotiated. Appendix D solves the general equilibrium with a bargained wage; under staggered Hall–Milgrom bargaining the amplification is about 2.1.

The bargaining protocol and the new-hire wage. Once wages are bargained, the magnitude turns on how the new-hire wage responds to the belief, and a measured moment distinguishes the protocols. Under Nash bargaining the new-hire wage is a share of the *perceived* joint surplus. Because the subjective belief treats shocks as more persistent than they are, that perceived surplus is far more sensitive to current conditions than the true one, so the Nash wage turns *more* cyclical under the subjective belief than under FIRE: the elasticity of the new-hire wage to the state rises from about 0.3 to about 0.7. A belief that overstates persistence flattens expected wage *growth* under Nash as well, so the moment that separates the protocols is the cyclicality of the new-hire wage *level*, which Bils et al. (2023) and Kudlyak (2014) measure. In their series the user cost is 2.5 times as volatile as the new-hire wage, and its semi-elasticity to unemployment is -0.053, against -0.024 for the new-hire wage, controlling for a cubic trend. A belief-invariant wage preserves this ordering, while a Nash wage under the survey belief, twice as cyclical as under FIRE, narrows the gap to the user cost. Fully flexible Nash bargaining, with an amplification of about 1.2, narrows this ordering; a protocol whose wage carries no forecast of the future path preserves it.

Amplification under staggered Hall–Milgrom bargaining. A protocol whose wage carries no forecast of the future is alternating-offer bargaining in the manner of Hall and Milgrom (2008). There the wage splits the *current* gains from agreement over delay, and the flow threats that discipline it, the value of continued search for the worker and foregone output for the firm, are dated objects that contain no perceived persistence. The continuation of the match is common to settling now and settling one round later and so drops out of the split. The reset wage then loads on current conditions and a fixed delay value, never on $\hat{\rho}$, and so delivers a cyclical new-hire wage whose cyclicality does not depend on the belief, together with muted expected wage growth. The staggered economy is solved globally with Hall–Milgrom resets (Appendix D). Productivity follows the true process, the wage renegotiates at rate λ to the belief-invariant reset value, matches are valued under each belief, and moments are computed under the true process. The wage renegotiates once a year on average ($\lambda = 0.25$), and the measured ratio of expected to realized wage growth pins the belief at $\hat{\rho} = 0.945$. At that calibration the amplification is $\mathcal{A} \approx 2.1$: market tightness is about twice as volatile under the measured beliefs as under FIRE, holding the shock, the

separation rate of Shimer (2005), and every other parameter fixed. Setting the belief instead by the worker-level ratios of Table 6, 0.33 on the vacancy-unemployment ratio and 0.25 on the quits rate, mapped through $\omega = (1 - \hat{\rho}^h)/(1 - \rho^h)$ at their four-month horizon, gives $\hat{\rho} = 0.93$ and 0.95 at quarterly frequency and an amplification of 2.0 and 2.2. In the limit of acyclical expected wage growth, $\hat{\rho} \to 1$, which the professional forecasts approach, it is 3.2. Staggered Nash bargaining at $\lambda = 0.25$ gives 1.4, fully flexible Nash bargaining about 1.2, and a wage that is never renegotiated ($\lambda = 0$) 3.8. Where Hall (2005) *assumes* a rigid wage to resolve the volatility puzzle, here the rigidity that does the work sits in expectations and is measured.

Firm versus worker beliefs. Firms' and workers' wage expectations are equally rigid in Figure 3, which supports the common belief of the baseline. Job creation runs through the firm's perceived user cost: the free-entry condition (7) values a hire under the firm's belief, and workers' beliefs matter only through the wage. In the Hall–Milgrom economy the reset wage depends only on current productivity, so the worker's belief does not enter wage setting and the amplification depends only on the firm's belief; at the measured $\hat{\rho} = 0.945$ it is 2.1 whatever workers believe. Under Nash bargaining, with each side valuing the match surplus under its own belief, the worker's belief moves the wage, but the firm's belief still carries most of the amplification. At the renegotiation rate $\lambda = 0.25$, a firm holding the survey belief that bargains with a FIRE worker gives an amplification of 1.34, a FIRE firm that bargains with a worker holding the survey belief gives 1.03, and a common survey belief gives 1.38.

The firm-side measure closest to the object the user cost capitalizes, the compensation-increase assumption in pension disclosures (Section V), implies a belief at least as persistent as workers'. Its median is 3.0 percent in every year from 2013 to 2023, while realized wage growth moves with labor-market tightness, so over those years its response to tightness, and with it the ratio ω of expected to realized responses, is zero, which maps into perceived persistence of one. With that firm belief the Hall–Milgrom amplification is about 3.2, above the 2.1 of the common survey belief. The rest of the paper gives firms and workers the common survey belief.

Further moments. Table 4 reports three moments in addition to those of Table 2: the elasticity of the average wage to productivity, the volatility of the FIRE user cost relative to the new-hire wage, and the correlation of unemployment and vacancies.

Table 4: Moments: Data and Model, Additional Moments

Moment	Data	FIRE	Subjective
Average wage elasticity to productivity, $\varepsilon_{\bar{w},z}$	0.46	0.14	0.14
FIRE user cost vs new-hire wage volatility, $\sigma(UC_t^{\text{FIRE}})/\sigma(w_{t,t})$	2.5	1.4	1.4
Beveridge correlation, $\text{corr}(\log u_t, \log v_t)$	-0.90	-0.92	-0.92

Notes: Definitions, samples and sources as in Table 2. $\varepsilon_{\bar{w},z}$: labor share times output per person on output per person, quarterly, 1951–2019, Hodrick–Prescott filtered (smoothing parameter 1,600), as in Hagedorn and Manovskii (2008); in the model, the average wage of a fixed workforce under the staggered resets, filtered in the same way. $\sigma(UC_t^{\text{FIRE}})/\sigma(w_{t,t})$: the Bils et al. (2023) series, 1980–2011. Beveridge correlation: Hodrick–Prescott filtered (smoothing parameter 10^5) quarterly log unemployment and log vacancies, 1951–2019.

D Solving the Staggered Hall–Milgrom General Equilibrium

This appendix describes the global solution of the staggered Hall–Milgrom economy whose amplification is reported in Section VI. Aggregate productivity z_t follows the calibrated AR(1), discretized into a Markov chain with 161 states spanning ± 9 unconditional standard deviations (Tauchen, 1986). Wages are set by alternating-offer bargaining in the manner of Hall and Milgrom (2008) with infrequent renegotiation, the reduced form of a self-enforcing or long-term wage contract (MacLeod and Malcomson, 1993; Rudanko, 2009). Each period a fraction λ of matches, together with all new hires, reset to the Hall–Milgrom wage $w^*(z) = \gamma + \xi\,(z - \gamma)$, while the remainder keep their existing wage. The reset wage splits the *current* gains from agreement over delay, so it loads on current productivity and the fixed flow value of delay γ but carries no perceived-persistence term. The reset wage is invariant to the belief $\hat{\rho}$, so a belief that overstates persistence flattens expected wage growth without steepening the wage's response to current conditions.

A match's wage always equals the reset wage $w^*(z_j)$ of the productivity state z_j at its last renegotiation, so the payoff-relevant state is the pair (z_t, z_j). The firm value is affine in the match wage, $J(z, w) = G(z) - w/[1 - \varphi(1 - \lambda)]$, and G solves the linear system $G = z - \varphi\lambda\,\tilde{P}\,w^*/[1 - \varphi(1 - \lambda)] + \varphi\tilde{P}G$, where $\tilde{P}$ is the transition used to form expectations; free entry $\kappa/q(\theta) = J(z, w^*(z))$ pins tightness. The two belief regimes differ only in $\tilde{P}$: the FIRE economy uses the true productivity transition, the subjective economy a perceived

first-order autoregressive transition on the same states with persistence $\hat{\rho} = 0.945$ and the true innovation variance. Moments are computed under the stationary distribution of the true transition, an internally rational equilibrium in the sense of Adam et al. (2016). The reset weight is $\xi = 0.25$, which gives a new-hire wage pass-through of 0.28 and matches the slope of new-hire wage growth on the change in unemployment, and the renegotiation rate is $\lambda = 0.25$, one renegotiation a year on average (Gertler et al., 2020). The amplification reported in the text is the ratio of the standard deviation of log market tightness in the subjective economy to that in the FIRE economy; at the calibration it is $\mathcal{A} \approx 2.1$.

E Mean Reversion of Realized Wages

This appendix shows that realized wages contain a predictable, mean-reverting component that the survey expectations of Section V do not track. The belief the model uses is that agents overstate the persistence of the wage state, $\hat{\rho} > \rho$; the evidence for it is that realized wages mean-revert while expected wages do not.

Wages and productivity. Real manufacturing wages mean-revert toward labor productivity: when the real wage falls below productivity, as in the wake of a recession, it subsequently catches up. Let the wage–productivity gap be $g_t^p \equiv \log(\text{productivity}_t) - \log(\text{real wage}_t)$, with productivity (output per hour, nonfarm business) entering after its release and the gap detrended linearly. Regressing realized one-year-ahead real manufacturing wage growth on the gap and the change in unemployment over 1949–2023 yields an R^2 of 0.29, with a gap coefficient of 0.12 ($t = 3.2$): a below-productivity real wage predicts faster subsequent growth. Future wage growth is therefore predictable from information available at the forecast date, while the survey forecasts documented in Section V are flat.

F Average Compensation in the Model

In a fixed-employment version of the staggered Hall–Milgrom wage recursion of Section VI, the mean log wage of employed workers follows $m_{t+1} = (1-\delta)(1-\lambda)\, m_t + \big[1 - (1-\delta)(1-\lambda)\big] \log w^*(z_{t+1})$, since a share λ of continuing matches resets to the reset wage and new hires start at it. Under the belief $\hat{\rho} = 0.945$, the expected change in m over the next two quarters

has a slope of 0.0022 on log tightness, and the realized change a slope of −0.0001; under FIRE they are −0.0002 and −0.0001. A firm that perceives current conditions as persistent expects average compensation to keep moving toward the current reset wage.

G Cyclicality of Actual and Expected Wage Growth: Estimates

Table 5 reports the estimates plotted in Figure 3, and Table 6 those plotted in Figure 4.

Table 5: Cyclicality of Wage Growth: Actual vs. Subjective Expectations

Actual: $\Delta \log w_t = \beta_0 + \beta_1 \Delta u_t + \varepsilon_t$ Subjective: $\mathbb{F}_{t-1}[\Delta \log w_t] = \beta_0 + \beta_1 \mathbb{F}_{t-1}[\Delta u_t] + \varepsilon_t$								
	1961–2022		2001–2022		2015–2022		2011–2023	
	Actual	Livingston	Actual	CFO	Actual	SCE	Actual	ASC 715
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δu	−0.0068***	−0.0004	−0.0096**	−0.0013	−0.0082**	−0.0001	−0.0074*	−0.0002
t-stat	(−6.69)	(−0.20)	(−2.29)	(−0.82)	(−1.99)	(−0.23)	(−1.68)	(−0.49)
R^2	0.1883	0.0006	0.1744	0.0199	0.1584	0.0014	0.1276	0.0044
N	124	124	85	85	31	92	49	13
Frequency	Semiann.	Semiann.	Quarterly	Quarterly	Quarterly	Monthly	Quarterly	Annual
Sector	Manuf.	Manuf.	Private	Private	Private	All	Private	All

Notes: Time-series regressions of annual log real wage growth on the change in the unemployment rate over the same twelve months, in percentage points; $\mathbb{F}_t$ denotes survey forecasts. Column (1): growth of the Livingston Survey base-period values of average weekly earnings in manufacturing from one survey to the survey a year later; column (2): Livingston median forecast of the annualized growth of the same series between the six- and twelve-month horizons. Columns (3) and (5): four-quarter log growth of average monthly earnings of stable new hires (LEHD Quarterly Workforce Indicators, private employers), the series of Figure 1. Column (4): CFO Survey expected growth of wages and salaries at the respondent's firm over the next twelve months through 2020Q1, and of the firm's wage bill over the next calendar year from 2020Q2. Column (6): SCE median expected earnings growth over the next twelve months. Column (7): the same four-quarter growth of new-hire earnings, quarterly from 2011Q4 to 2023Q4. Column (8): median across defined-benefit plan sponsors with a December fiscal year-end of the assumed rate of compensation increase disclosed under ASC 715, $\log(1 + \text{rate})$; the sample consists of firms that sponsor defined-benefit plans and file with the Securities and Exchange Commission. Columns (7) and (8) are in nominal terms. In columns (1) to (6), realized and expected nominal wage growth are deflated by the same CPI inflation forecast: the Livingston median forecast in columns (1) and (2), and the median forecast of the Survey of Professional Forecasters (SPF) for the next four quarters in columns (3) to (6). The regressor is the realized change in the unemployment rate (quarterly averages in the quarterly columns) in columns (1), (3), (5), and (7); twice the difference between the Livingston median forecasts of the unemployment rate twelve and six months ahead in column (2); and the SPF median forecast of the unemployment rate four quarters ahead less its forecast for the current quarter in columns (4), (6), and (8). SPF forecasts are from the latest survey released at each date. Newey–West t-statistics with lags 2 (semiannual), 4 (quarterly), 12 (monthly), 1 (annual) in parentheses. *sig. at 10%. **sig. at 5%. ***sig. at 1%.

Table 6: Actual and Expected Earnings Growth: Job Stayers and Job Changers

(1): $\Delta \log w_{i,t} = \alpha_m + \beta X_{t-1} + \varepsilon_{i,t}$ (2): $\mathbb{F}_{t-1}[\Delta \log w_{i,t}] = \alpha_m + \beta X_{t-1} + \varepsilon_{i,t}$
(3): $g_t^{\text{change}} - g_t^{\text{stay}} = \beta_0 + \beta X_t + \varepsilon_t$ (4): $\log \mathbb{F}_{t-1}[w_{i,t}^{\text{offer}}] - \log w_{i,t-1} = \alpha_m + \beta X_{t-1} + \varepsilon_{i,t}$

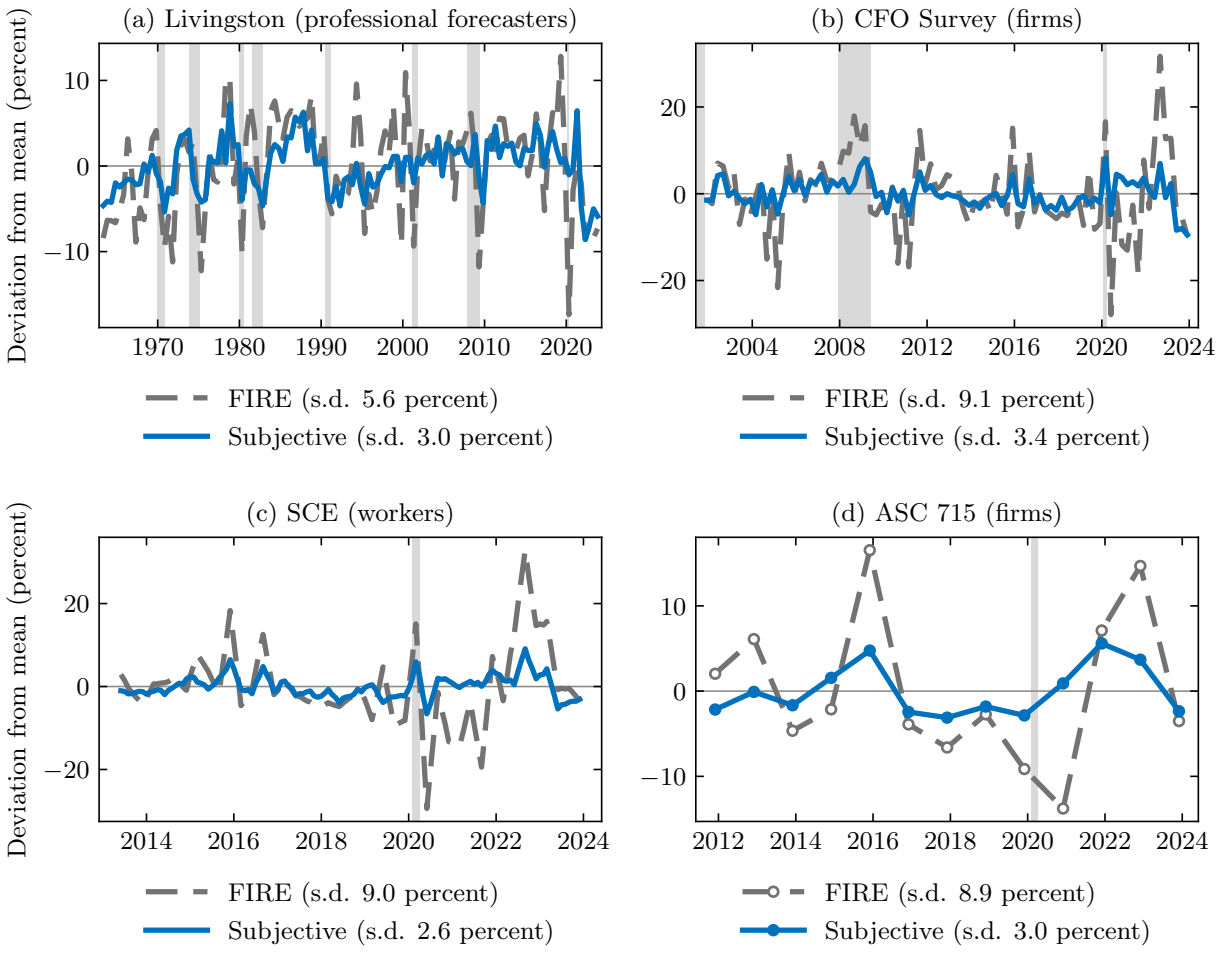
	Job stayers 2015–2022		Job changers 2000–2026	Job changers 2015–2022
	Actual	Expected	Actual	Expected
	(1)	(2)	(3)	(4)
Vacancy-unemployment ratio	2.571***	0.847	0.820***	−0.801
	(3.1)	(1.4)	(5.0)	(−1.1)
Quits rate	4.439***	1.119*	0.994***	−0.869
	(5.0)	(1.9)	(4.8)	(−1.0)
R^2	0.0031	0.0005	0.3434	0.0003
N	7,189	7,189	309	11,428
Frequency	4-month	4-month	Monthly	4-month
Sector	All	All	All	All

Notes: Columns (1), (2), and (4): SCE Labor Market Survey respondents, interviews from 2015M3 to 2022M11. Column (3): Current Population Survey workers, from the Wage Growth Tracker of the Federal Reserve Bank of Atlanta, monthly from 2000M12 to 2026M9 except 2025M10. Columns (1) and (2): workers interviewed in two consecutive waves (March, July, November) whose job at the second interview began in or before the month of the first interview; column (2): 300 times the log ratio of expected annual earnings four months ahead to current annual earnings at the first interview; column (1): 300 times the log change in the same worker's annual earnings between the two interviews; both columns use the same observations, deflated by the SPF median forecast of CPI inflation over the next calendar year (fourth quarter over fourth quarter), interpolated between surveys, at the first interview. Column (3): median twelve-month growth of hourly wages of job switchers less that of job stayers, three-month moving averages, in percentage points; job switchers are workers in a different occupation or industry than a year earlier or who changed employer or job duties in the past three months. Column (4): 100 times the log ratio of the first-year annual salary that an employed respondent expects from the best job offer received in the coming four months ("the offer you would be most likely to accept") to current annual earnings, at each interview. The dependent variables in columns (1), (2), and (4) are trimmed at their 5th and 95th percentiles. Regressors: the ratio of job openings to unemployed persons and the quits rate (Job Openings and Labor Turnover Survey, total nonfarm, percent of employment), at the month of the first interview in columns (1) and (2), of the interview in column (4), and at the end of the twelve-month growth window in column (3). Columns (1), (2), and (4) include survey-month fixed effects α_m. R^2 is for the specification with the vacancy-unemployment ratio. t-statistics in parentheses: clustered by interview date (24 dates) in columns (1), (2), and (4); Newey–West with 12 lags in column (3). *sig. at 10%. **sig. at 5%. ***sig. at 1%.

H The User Cost of Labor by Survey

Figure 8 plots, for each survey, the FIRE and subjective user costs whose standard deviations Figure 2 reports.

Figure 8: The User Cost of Labor under FIRE and Subjective Expectations, by Survey



Notes: FIRE user cost $w_t - \frac{\varphi}{1-\varphi}\frac{b}{\eta}(g_t - \bar{g})$ and subjective user cost $w_t - \frac{\varphi}{1-\varphi}\frac{b}{\eta}(\mathbb{F}_t[g] - \overline{\mathbb{F}[g]})$, $\varphi = 0.9569 \times (1 - 0.295)$, $b/\eta = 0.87$, where g_t is the realized and $\mathbb{F}_t[g]$ the expected real wage growth of Figure 1, and w_t is the log real wage net of a cubic trend over the panel sample; deviations from means over the panel sample, in percent (100 times the log deviation). Panels as in Figure 1: (a) professional forecasters (Livingston Survey), (b) firms (CFO Survey), (c) workers (SCE), (d) firms (ASC 715 pension disclosures). Panel (a): average weekly earnings of production and nonsupervisory employees in manufacturing. Panels (b) to (d): earnings of stable new hires (LEHD QWI). Realized and expected nominal wage growth are deflated by the same one-year CPI inflation forecast. Slopes on the unemployment rate control for a cubic time trend; Newey–West t-statistics. Standard deviations in the legends are of the plotted series, in percent. NBER recessions are shown with gray shaded bars.