The Quality-Adjusted Cyclical Price of Labor

Mark Bils
University of Rochester
FRB Richmond, NBER

Marianna Kudlyak
FRB San Francisco
Hoover, IZA, CEPR

Paulo Lins
University of Rochester

NBER SI, The Micro and Macro Perspectives of the Aggregate Labor Market
July 17-20, 2023 | Boston

Sources of employment fluctuations

- Labor's price cyclicality helps disentangle sources of employment fluct.-ns:
  - If labor's price is strongly procyclical, need models of cyclical labor demand (e.g., financial constraints)

How cyclical is the price of labor?

Not answered by behavior of observed wage because:

1. Ignores wage smoothing within matches

   Hall (1980): "Wages are insensitive to current economic conditions because they are effectively installment payments on the employer's obligation"

2. Fails to control for how quality of worker, firm, or match varies over cycle

Focus on wages of job stayers—exacerbates pr 1, might eliminate pr 2

Focus on wages of new hires—does not eliminate pr 1, exacerbates pr 2

What we do

- Propose match's expected long-run wage as proxy for *match* quality
- Estimate cyclicality of quality-adjusted price of labor (its user cost)

What we find

- Labor's user cost increases by 4.2-4.7% for a 1 pp decline in unemployment. Its elasticity with respect to real GDP is about 2.6
- The cyclicality reflects three components
  - 2.3% reflects a procyclical quality-adjusted new-hire wage
  - A larger "lock-in" effect on future wages—total wage effect $\approx$ 5.3%
  - Somewhat offset by higher turnover of matches that start in recession

Related literature

Wage smoothing:

- History dependence in wages:
  Beaudry and DiNardo (1991), Baker and Gibbs (1994), Bellou & Kaymak (2020)
- Cyclicality of wages of new hires vs incumbent workers:
  Bils (1985), Carneiro, Guimaraes and Portugal (2012), Grigsby, Hurst and Yildirmaz (2021)
- Impact on earnings of graduating in a recession:
  Kahn (2010), Oreopoulos, von Wachter and Heisz (2012)
- Cyclicality of the price of labor with wage smoothing:
  Kudlyak (2014), Basu and House (2016), Doniger (2021)

Cyclicality of match quality:

Okun (1973), Vroman (1977), Devereux (2004), Gertler, Huckfeldt and Trigari (2020), Figueiredo (2022)

This paper: measure cyclicality of price of labor accounting for (1) wage smoothing and (2) cyclical variation in match quality

Price of labor

Model of wage

Wage in $t+\tau$ for a match started in t is

$$w^{ij}_{t,t+\tau} = \phi_{t,t+\tau} q^{ij}_{t,t+\tau}$$

- $q^{ij}_{t,t+\tau}$ is the idiosyncratic component of productivity, e.g., match quality
  - Reflects worker i, firm j, and worker-firm ij match effects
  - May vary with $t+\tau$ throughout the match
- $\phi_{t,t+\tau}$ is the quality-adjusted wage

Price of labor

- What is firm's cost of having worker work in period t?

Price of labor

- What is firm's cost of having worker work in period t?
- As employment relation durable $\Longrightarrow$ need to account for any impact of hiring in t on future wages
- Firm's decision problem: hire in t versus postpone hiring till $t+1$
  $\Longrightarrow$ one additional worker in t, equal number of workers from $t+1$ onward
- The cost of that decision is the user cost of labor in t

Value of a match

- Firm's value of a match created at t of quality q_t^{ij}

$$q_t^{ij} V_t = q_t^{ij} \left[-\kappa_t + E_t \sum_{\tau=0}^{\infty} \Lambda_{t,t+\tau} \left(\frac{y_{t,t+\tau}^{ij}}{q_t^{ij}} - \frac{w_{t,t+\tau}^{ij}}{q_t^{ij}} \right) \right]$$

$$= q_t^{ij} \left[-\kappa_t + E_t \sum_{\tau=0}^{\infty} \Lambda_{t,t+\tau} \left(z_{t+\tau} - \phi_{t,t+\tau} \right) \right]$$

$$\Lambda_{t,t+\tau} = \prod_{k=0}^{\tau-1} \beta_{t+k} (1 - \delta_{t,t+k})$$

  - Match separates with probability $\delta_{t,t+\tau}$—history-dependent separation rate
  - Hiring cost per hire is $q_t^{ij} \kappa_t$ (upfront cost, generalize in empirics)
  - All scales by q_t^{ij}; can normalize to 1

Value of a position

- Value of a position created in t, maintaining in expectations one unit of labor

$$\mathcal{P}_t = E_t \sum_{\tau=0}^{\infty} \mathfrak{B}_{t,t+\tau} \pi_{t,t+\tau} V_{t+\tau}$$

  - $\mathfrak{B}_{t,t+\tau}$ reflects time discounting: $\mathfrak{B}_{t,t+\tau} = \prod_{j=0}^{\tau-1} \beta_{t+j}$
  - $\pi_{t,t+\tau}$ is probability require new match in $t+\tau$, given start in t; function of δ's

Value of creating a position in t versus $t+1$

- Value of starting a position in t rather than $t+1$, which leaves expected labor input unaffected in $t+1$ and beyond:

$$E_t\left(\mathcal{P}_t - \beta_t \mathcal{P}_{t+1}\right) =$$

$$E_t\Big[\underbrace{V_t - \beta_t(1-\delta_{t,t})V_{t+1}}_{\text{create match in } t \text{ vs } t+1} + \underbrace{\sum_{\tau=2}^{\infty} \mathfrak{B}_{t,t+\tau}\left(\pi_{t,t+\tau} - \pi_{t+1,t+\tau}\right)V_{t+\tau}}_{\text{replace a separated match from } t+2 \text{ onward}}\Big],$$

Value of creating a position in t versus $t+1$

$$E_t\left(\mathcal{P}_t - \beta_t \mathcal{P}_{t+1}\right) = \underbrace{z_t}_{\text{benefit}}$$

$$\underbrace{- E_t\left[\kappa_t - \beta_t(1-\delta_{t,t})\kappa_{t+1} + \sum_{\tau=2}^{\infty} \mathfrak{B}_{t,t+\tau}\left(\pi_{t,t+\tau} - \pi_{t+1,t+\tau}\right)\kappa_{t+\tau}\right]}_{\text{hiring component of the user cost of labor, } UC^{\kappa}}$$

$$\underbrace{- E_t\left[\Phi_t - \beta_t(1-\delta_{t,t})\Phi_{t+1} + \sum_{\tau=2}^{\infty} \mathfrak{B}_{t,t+\tau}\left(\pi_{t,t+\tau} - \pi_{t+1,t+\tau}\right)\Phi_{t+\tau}\right]}_{\text{wage component of the user cost of labor, } UC^{W}}$$

$$= z_t - \left(UC_t^{\kappa} + UC_t^{W}\right)$$

where $\Phi_{t+\tau} = \sum_{k=0}^{\infty} \Lambda_{t+\tau,t+\tau+k}\phi_{t+\tau,t+\tau+k}$ is PDV of quality-adjusted wages

Wage component of the user cost of labor

$$UC_t^W = \underbrace{\phi_{t,t}}_{\text{new hire wage at } t} + \underbrace{E_t \sum_{\tau=1}^{\infty} \left(\Lambda_{t,t+\tau} \phi_{t,t+\tau} - \beta_t (1 - \delta_{t,t}) \Lambda_{t+1,t+\tau} \phi_{t+1,t+\tau} \right)}_{\text{differences between wages in } t\text{-start vs } (t+1)\text{-start matches}} + \underbrace{E_t \sum_{\tau=2}^{\infty} \mathfrak{B}_{t,t+\tau} \left(\pi_{t,t+\tau} - \pi_{t+1,t+\tau} \right) \sum_{h=\tau}^{\infty} \Lambda_{t+\tau,t+h} \phi_{t+\tau,t+h}}_{\text{wages in } (t+2)\text{-start and onward matches}}$$

User cost, no history dependence in sep. rates

- If $\delta_{t,t+\tau} = \delta_{t+\tau}$

$$E_t\left(\mathcal{P}_t - \beta_t \mathcal{P}_{t+1}\right) = z_t - \left[\kappa_t - E_t \beta_t (1-\delta_t)\kappa_{t+1}\right] - \underbrace{\left[\phi_{t,t} + E_t \sum_{\tau=1}^{\infty} \Lambda_{t,t+\tau}(\phi_{t,t+\tau} - \phi_{t+1,t+\tau})\right]}_{UC_t^W}$$

- Interior solution, $E_t\left(\mathcal{P}_t - \beta_t \mathcal{P}_{t+1}\right) = 0 \implies$

$$z_t = \left[\kappa_t - \beta(1-\delta) E_t \kappa_{t+1}\right] + UC_t^W$$

User cost, if history dependence in sep. rates

$$E_t\left(\mathcal{P}_t - \beta_t \mathcal{P}_{t+1}\right) = z_t$$

$$\underbrace{- E_t\left[\kappa_t - \beta_t(1-\delta_{t,t})\kappa_{t+1} + \sum_{\tau=2}^{\infty} \mathfrak{B}_{t,t+\tau}\left(\pi_{t,t+\tau} - \pi_{t+1,t+\tau}\right)\kappa_{t+\tau}\right]}_{\text{hiring component of the user cost of labor, } UC^{\kappa}}$$

$$\underbrace{- E_t\left[\Phi_t - \beta_t(1-\delta_{t,t})\Phi_{t+1} + \sum_{\tau=2}^{\infty} \mathfrak{B}_{t,t+\tau}\left(\pi_{t,t+\tau} - \pi_{t+1,t+\tau}\right)\Phi_{t+\tau}\right]}_{\text{wage component of the user cost of labor, } UC^{W}}$$

1. Have to factor-in wage paths starting $\geq t+2$
2. Quantify compensating differential in wages for match durability:
   - If recession-start matches last shorter - must compensate by lower wages
   - Higher turnover is another element of quality, makes UC_t^W more pro-cyclical

Identifying match quality by its expected long-run wage

Impact of cyclical quality on new-hire wage

- New-hire wage is

$$\ln w_{t,t}^{ij} = \ln q_{t,t}^{ij} + \ln \phi_{t,t}$$

- Cyclicality of the quality-adjusted new-hire wage is

$$\begin{aligned}\mathrm{Cov}(Cycle_t, \ln \phi_{t,t}) &= \mathrm{Cov}(Cycle_t, \ln w_{t,t}^{ij}) - \mathrm{Cov}(Cycle_t, \ln q_{t,t}^{ij}) \\ &= \mathrm{Cov}(Cycle_t, \ln w_{t,t}) - \mathrm{Cov}(Cycle_t, \ln q_{t,t}),\end{aligned}$$

  where $\ln w_{t,t} = \int_{ij} \ln w_{t,t}^{ij}$, $\ln q_{t,t} = \int_{ij} \ln q_{t,t}^{ij}$

- $w_{t,t}$ reflects cyclical selection on $q_{t,t}$ unless $\mathrm{Cov}(Cycle_t, \ln q_{t,t}) = 0$

Identifying cyclicality of quality-adjusted wage

- Can write quality-adjusted new-hire wage as:

$$\begin{aligned}\ln \phi_{t,t} &= \ln w^{ij}_{t,t} - \ln q^{ij}_{t,t} \\ &= \ln w^{ij}_{t,t} - \ln w^{ij}_{t,t+\tau} + \left(\ln q^{ij}_{t,t+\tau} - \ln q^{ij}_{t,t}\right) + \ln \phi_{t,t+\tau}\end{aligned}$$

- So has cyclicality:

$$\begin{aligned}\mathrm{Cov}(Cycle_t, \ln \phi_{t,t}) = \mathrm{Cov}(Cycle_t, &\ln w_{t,t} - \ln w_{t,t+\tau}) \\ &+ \mathrm{Cov}(Cycle_t, \ln q_{t,t+\tau} - \ln q_{t,t}) + \mathrm{Cov}(Cycle_t, \ln \phi_{t,t+\tau})\end{aligned}$$

Assumptions for identifying cyclicality of quality-adjusted wage

Assumption 1: $\text{Cov}(Cycle_t,\ \ln q_{t,t+\tau} - \ln q_{t,t}) = 0$

i.e., mean change in quality for matches started at t orthogonal to cycle at t

Assumptions for identifying cyclicality of quality-adjusted wage

Assumption 1: $\text{Cov}(Cycle_t,\ \ln q_{t,t+\tau} - \ln q_{t,t}) = 0$

i.e., mean change in quality for matches started at t orthogonal to cycle at t

- Understanding Assumption 1:
  - If quality is constant through match, this is non-binding
    - e.g., quality concerns in Gertler et al (2020)

Assumptions for identifying cyclicality of quality-adjusted wage

Assumption 1: $\text{Cov}(Cycle_t,\ \ln q_{t,t+\tau} - \ln q_{t,t}) = 0$

i.e., mean change in quality for matches started at t orthogonal to cycle at t

- Understanding Assumption 1:
  - If quality is constant through match, this is non-binding
    - e.g., quality concerns in Gertler et al (2020)
  - If quality growth within match is higher for matches that start in recessions
    - It will bias our estimates pro-cyclically
    - We examine this empirically

Assumptions for identifying cyclicality of quality-adjusted wage

Assumption 2: For a sufficiently large, $\text{Cov}(Cycle_t,\ \ln \phi_{t,t+a}) = 0$

1. $\text{Cov}(Cycle_t,\ \ln \phi_{t+a,t+a}) = 0$, cannot predict $Cycle_{t+a}$ at t

2. $\text{Cov}(Cycle_t,\ \ln \phi_{t,t+a} - \ln \phi_{t+a,t+a}) = 0$, wage smoothing transitory

Assumptions for identifying cyclicality of quality-adjusted wage

Assumption 2: For a sufficiently large, $\text{Cov}(Cycle_t,\ \ln \phi_{t,t+a}) = 0$

1. $\text{Cov}(Cycle_t,\ \ln \phi_{t+a,t+a}) = 0$, cannot predict $Cycle_{t+a}$ at t

2. $\text{Cov}(Cycle_t,\ \ln \phi_{t,t+a} - \ln \phi_{t+a,t+a}) = 0$, wage smoothing transitory

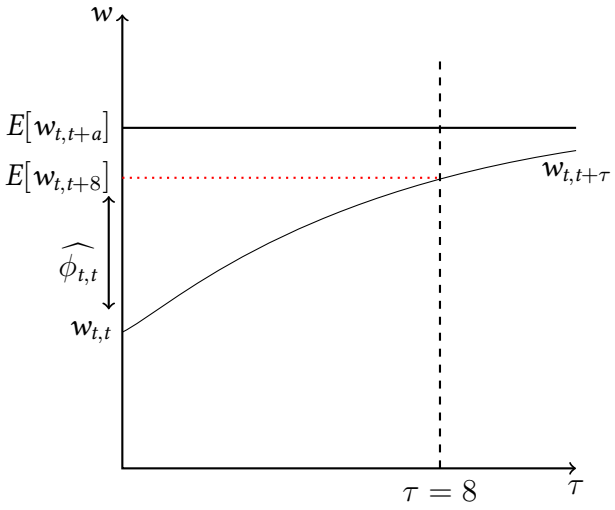
- Understanding Assumption 2:
  - If violated (wage smoothing persists)—understate procyclicality of q-adj wage

Cyclicality of quality-adjusted wage

Implication 1: *Given Assumptions 1 and 2,*

$$\text{Cov}(Cycle_t\ , \ln \phi_{t,t}) = \text{Cov}\left(Cycle_t,\ \ln w_{t,t} - \ln w_{t,t+a}\right) \text{ for } a \gg 1.$$

The greater is the cumulative growth of match wage towards its long-run wage, the lower is the quality-adjusted wage


w
$E[w_{t,t+a}]$
$E[w_{t,t+8}]$
$w_{t,t+\tau}$
$\widehat{\phi}_{t,t}$
$w_{t,t}$
$\tau = 8$
τ

Cyclicality of user cost

Implication 2: *Given Assumptions 1 and 2, for* $a \gg 1$

$$\mathrm{Cov}(Cycle_t, \ln UC_t^W) = \mathrm{Cov}\Bigg(Cycle_t,\ \ln w_{t,t} - \ln w_{t,t+a} + \sum_{\tau=1}^{a} \Lambda_{t,t+\tau} \Big[\Big(\ln w_{t,t+\tau} - \ln w_{t,t+a} \Big) - \Big(\ln w_{t+1,t+\tau} - \ln w_{t+1,t+a+1} \Big) \Big] \Bigg)$$

1. For a match started in t, the higher is cumulative wage growth to $t+a$—the lower is the quality-adjusted new-hire wage at t, and so the lower is user cost
2. Higher wage growth for t-start matches than $t+1 \implies$ lower user cost at t

Note: For the empirics, we consider the *ln* of user cost

Data and empirical implementation

Data

- Combine NLSY79 and NLSY97 individual wage panels
  - NLSY79: Annual from 1979-1993, bi-annual 1994-2018
  - NLSY97: Annual from 1997-2010, bi-annual 2011-2019
- Restrict to respondents over 21
  - Work at least 25 hours a week
  - In private sector and not enrolled in school
  - Oldest respondent is 62 in NLSY79 and 39 in NLSY97
  - 11,675 unique individuals; 135,782 wage observations
- Measure of cycle:
  - Use the unemployment rate, also use real GDP
  - Detrending to define cycle: Cubic trend as baseline

Wage measure

- Hourly wage constructed in the NLSY by the BLS
  - Reflects any tips, overtime, and bonuses
- New hire
  - We define a match as a new hire if it represents the first wage observed for the worker at that job and it has match tenure of less than one year
  - When available, we use a retrospective question for the wage at the job's start: 1986-onward in the NLSY79; all years in the NLSY97
- Compute real wage deflating by the CPI

Empirical implementation

- Estimate cyclicality of quality-adjusted new-hire wage, i.e.,

$$\text{Cov}\left(Cycle_t,\ \ln w_{t,t} - \ln w_{t,t+a}\right)$$

by χ from

$$\ln w_{t,t} - \ln w_{t,t+a} = \chi Cycle_t + trend_t + \epsilon_t$$

- Similarly, the cyclicality of the user cost

Empirical implementation

1. Choice of a:
   - Want far enough in future so initial conditions no longer affect wage
   - Choose $a = 8$

2. Cumulative wage growth from annual wage growth

$$\ln w_{t,t}^{ij} - \ln w_{t,t+a}^{ij} = -\sum_{\tau=1}^{a} \Delta \ln w_{t,t+\tau}^{ij}$$

Empirical implementation

3. Obtain $\Delta \ln w_{t,t+\tau}$'s by $\widehat{\psi}$'s from regression

$$\Delta \ln w^{ij}_{t,t+\tau} = \Psi x^{ij}_{t+\tau} + \sum_{d_0=1980}^{2011} \sum_{d=d_0+1}^{2019} \psi_{d_0,d} D^{ij}_{d_0,d} + \epsilon^{ij}_{t+\tau}$$

- Dummies $D^{ij}_{d_0,d}$ equal 1 if $d_0 = t$ and $d = t + \tau$, 0 otherwise
- $x^{ij}_{t+\tau}$ sex, race, educ dummies, NLSY97 survey dummy, quadratic in age
- Use jobs of duration 18+ months

Empirical implementation

3. Obtain $\Delta \ln w_{t,t+\tau}$'s by $\widehat{\psi}$'s from regression

$$\Delta \ln w_{t,t+\tau}^{ij} = \Psi x_{t+\tau}^{ij} + \sum_{d_0=1980}^{2011} \sum_{d=d_0+1}^{2019} \psi_{d_0,d} D_{d_0,d}^{ij} + \epsilon_{t+\tau}^{ij}$$

- Do not require matches to last 8 years
- Impute average wage growth from surviving matches to those ending earlier
  - Biases procyclically if positive selection of surviving matches on quality change *AND* that selection stronger for matches started in recessions
  - We investigate this empirically

Empirical implementation

4. Given $\widehat{\psi}_{t,t+\tau}$'s, estimate cyclicality of new-hire wage and UC^W

$$\mathrm{Cov}(Cycle_t\,, \ln \phi_{t,t}) = \mathrm{Cov}\left(Cycle_t,\ -\sum_{\tau=1}^{8} \widehat{\psi_{t,t+\tau}}\right)$$

$$\mathrm{Cov}(Cyc_t, \ln UC_t^W) = \mathrm{Cov}\left(Cyc_t,\ -\sum_{\tau=1}^{8} \widehat{\psi_{t,t+\tau}} - \sum_{\tau=2}^{8}\sum_{i=0}^{\tau-2} \Lambda_{t,t+i+1}\left(\widehat{\psi_{t,t+\tau}} - \widehat{\psi_{t+1,t+\tau}}\right)\right)$$

- Estimate using 32 annual observations – from 1980 to 2011

Cyclicality of quality-adjusted new-hire wage

Cyclicality of average hourly earnings

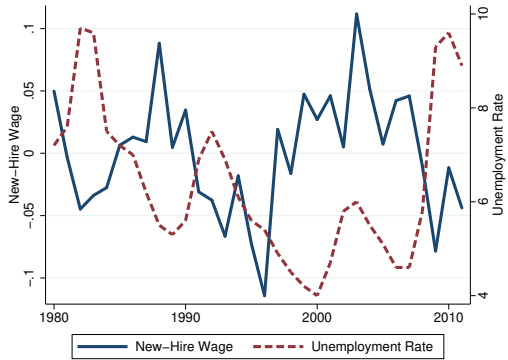
Dependent Variable is log of real wage: $\ln(\frac{w}{p})$

	(1) Age Control	(2) Individual FE	(3) Match FE
Unemp Rate	-0.29	-0.83	-0.50
	(0.49)	(0.34)	(0.31)

Notes: Combined NLSY79 and NYSY97 sample, 110,047 obs., 1980-2011. Add. controls: a cubic trend and dummies for sex, race, education and cubics in age, tenure. All coefficients are specific to the NLSY79 and NLSY97 samples except those for unemployment and trend. St. errors are clustered by survey year. All regressions reflect survey sampling weights.

- Average wage is acyclical, reflecting composition changes
- Changes with match f.e. reflect cyclical match quality or wage smoothing

Cyclicality of quality-adjusted new-hire wage



- The figure plots $-\sum_{\tau=1}^{8} \widehat{\psi_{t,t+\tau}}$
- We estimate new-hire wage is highly procyclical:
  - It decreases by 2.35% (0.67%) in response to a 1 pp increase in unemployment

Robustness to possible procyclical biases

Assumption 1 is that $Cycle_t$ does not predict quality growth within matches

1. either fundamentally
2. or via selection in the matches that we can follow

- We find lower match survival for matches that begin in recessions
- If match survival selects on higher growth *and* more so in recessions, it will impart procyclical bias

Robustness to possible procyclical biases

1. Estimate cyclicality of quality changes within matches (occ index)

	(1) Δ ln (wage)	(2) Δ (occ index)
Unrate at t_0	0.318	-0.003
	(0.102)	(0.056)
Δ Unrate	-0.002	-0.001
	(0.001)	(0.001)

- No evidence measures of quality grow faster in matches started in recessions

Robustness to possible procyclical biases

2. Implement a robustness exercises for match survival selecting on higher growth *and* more so in recessions

   - shorten the duration we follow matches
   - control for cyclical selection
     - a match's relative duration in its cohort of matches
     - Heckman correction in our wage-growth estimates
   - follow wages for 8 years from the start of matches, even if the worker moves to a new match
     - but control for observable differences in match-quality between any new job at $t + 8$ versus the job started at t

- Find: New-hire wage still highly procyclical; some evidence that surviving matches in recession more selected

Robustness wrt selection

	(1) Benchmark after 8 years	(2) Cutoff after 6 years	(3) Cutoff after 4 years	(4) Heckman correction
URate	-2.35	-2.42	-1.53	-2.17
	(0.67)	(0.51)	(0.58)	(0.65)

Notes: 32 annual observations: 1980-2011. Regressions include cubic trend. Robust standard errors in parentheses.

Cumul. growth 8 years ahead even if change jobs

	(1)	(2)	(3)	(4)
	$\geq$ 18 mo. duration		All Matches	
	Quality Controls		Quality Controls	
	No	Yes	No	Yes
URate	-2.90	-2.88	-3.17	-3.13
	(0.70)	(0.66)	(0.64)	(0.62)

Notes: 32 annual observations: 1980-2011. Regressions include cubic trend. Robust standard errors in parentheses. Quality controls reflect workweeks and realized duration in jobs started at t and at $t + 8$.

Cyclicality of the user cost of labor

Cyclicality of the quality-adjusted new-hire wage and wage component of user cost

	Unemployment
New-Hire Wage	-2.35
	(0.67)
Wage Component of Labor's User Cost	
User Cost w/ constant δ and β	-4.81
	(1.83)
User Cost w/ time-varying separation & discount rates	-5.28
	(2.08)
User Cost w/ time-varying sep. & disc. rates, sep. rate start-date specific	-5.32
	(1.87)

Notes: 32 annual observations: 1980-2011. Regressions include cubic trend. Robust standard errors in parentheses.

Quantifying compensating cyclicality for UC_t^{κ}

How cyclical is the wage component of user cost, if one adjusted wage payments to compensate firms for any cyclicality in future hiring costs?

- With history-dependence in δ, match durability is second quality factor
- Calculate "excess" cyclicality of UC_t^{κ} due to history-dep. in $\delta_{t,t+\tau}$:
  - Estimate cyclicality of $UC_t^{\kappa}(\delta_{t,t+\tau})$, χ^{κ}
  - Estimate cyclicality of counterfact. w/o history in sep. rates $UC_t^{\kappa}(\delta_{t+\tau})$, $\chi^{\tilde{\kappa}}$
  - Compute $\Delta\chi^{\kappa} = \chi^{\kappa} - \chi^{\tilde{\kappa}}$
- Calculate cyclicality of UC_t^{W}, compensated for the excess cyclicality of UC_t^{κ}
  - $\tilde{\chi}^{W} = \chi^{W} + \frac{UC^{\kappa}}{UC^{W}}\Delta\chi^{\kappa}$

Quantifying compensating cyclicality for UC_t^{κ}

- Construct two versions for κ's
  1) Upfront cost equal to one quarter's earnings (large relative to literature)
  2) *In addition*, persistent but declining training costs such that rents grow 3.5% yearly for 8 years
     - $\rightarrow$ $\kappa_{t,t} = 0.25 + 0.32 = 0.57;\ \kappa_{t,t+\tau} = 1.035^{8-\tau} - 1,\ \text{for}\ 1 \leq \tau \leq 8$
     - $\rightarrow$ $PDV = 0.96$ of annual earnings

- Estimate counter-cyclical $UC_t^{\kappa}(\delta_{t,t+\tau})$ and acyclical counterfactual $UC_t^{\kappa}(\delta_{t+\tau})$

  Version 1 $\chi^{\kappa} = 7.72(4.61), \chi^{\tilde{\kappa}} = 1.51(4.47), \Delta\chi^{\kappa} = 6.21\%(1.32), \frac{UC^{\kappa}}{UC^{W}} = 0.0857$

  Version 2 $\chi^{\kappa} = 5.72(2.97), \chi^{\tilde{\kappa}} = 2.01(2.89), \Delta\chi^{\kappa} = 3.72\%(0.78), \frac{UC^{\kappa}}{UC^{W}} = 0.3005$

- Compensate cyclicality of UC_t^{W} for the excess counter-cyclicality of UC_t^{κ} due to match duration

Cyclicality of the quality-adjusted new-hire wage and user cost of labor

	Unemployment
New-Hire Wage	-2.35
	(0.67)
User Cost (Table 7, row 5)	-5.32
	(1.87)
Wage Component of Labor's User Cost, adjusted for match durability	
User Cost w/ hiring costs	-4.79
	(1.88)
User Cost w/ hiring and persistent training costs	-4.21
	(1.90)

Notes: 32 annual observations: 1980-2011. Regressions include cubic trend. Robust standard errors in parentheses.

Comparison with treatments of quality in the literature

Prior treatments of quality

Two widely-used approaches to control for quality in cyclicality of $w_{t,t}$

1. Wage change, e.g., Bils (1985), Gertler, Huckfeldt and Trigari (2020)
2. Fixed effects, e.g., Carneiro, Guimaraes and Portugal (2012), Kudlyak (2014)

Treatments of quality in new hire wage

Model of wage:

$$\ln w_{t,t}^{ij} = \ln \phi_{t,t} + \ln q_{t,t+\tau}^{ij}$$

- This paper: Quality control is the expected long-run current-match wage

$$\ln w_{t,t}^{ij} - \ln w_{t,t+a}^{ij} = \alpha \, Cycle_t + \epsilon_{t,t}^{ij}$$

- Wage-change approach: Quality control is last previous-match wage

$$\ln w_{t,t}^{ij} - \ln w_{\cdot,t-1}^{ij-1} = \alpha \, \Delta Cycle_t + (\epsilon_{t,t}^{ij} - \epsilon_{\cdot,t-1}^{ij-1})$$

- Fixed-effects approach: Q-control is worker fixed effect over all periods

$$\ln w_{t,t}^{ij} = \alpha \, Cycle_t + \ln w_{fe}^{i} + \epsilon_{t,t}^{ij}$$

Prior treatments: Wage change approach

- Quality control is the last wage in the previous-match

$$\ln w_{i,t}^{ij} - \ln w_{\cdot,t-1}^{ij-1} = \alpha \, \Delta Cycle_t + (\epsilon_{i,t}^{ij} - \epsilon_{\cdot,t-1}^{ij-1})$$

Estimated change in quality-adjusted new hire wage is

$$\implies \ln \left(\frac{\widehat{\phi_{t,t}}}{\phi_{t-1,t-1}} \right) = \ln \left(\frac{\phi_{t,t}}{\phi_{t-1,t-1}} \right) + \left(\ln q_{i,t}^{ij} - \ln q_{\cdot,t-1}^{ij-1} \right) + \left(\ln \phi_{t-1,t-1} - \ln \phi_{\cdot,t-1}^{t-1} \right)$$

- $w_{\cdot,t-1}^{t-1}$ and $q_{\cdot,t-1}^{ij-1}$ are wage and quality for job began $\leq t-1$ *and* ended $t-1$
- $\phi_{\cdot,t-1}^{t-1}$ is last previous-match quality-adjusted wage

Wage change approach

Estimated cyclicality biased if

$$\text{Cov}(\Delta Cycle_t, \ln q^{ij} - \ln q^{ij-1}) + \text{Cov}(\Delta Cycle_t, \ln \phi_{t-1,t-1} - \ln \phi^{t-1}_{\cdot,t-1}) \neq 0$$

- $\text{Cov}(\Delta Cycle_t, \ln q^{ij} - \ln q^{ij-1})$

  < 0, procyclical bias, if workers move to better matches as Urate is falling

  - might be the case for E-to-E movers

  > 0, countercycl bias, if workers move to worse matches as Urate is falling

  - might be the case for E-N-E movers

- $\text{Cov}(\Delta Cycle_t, \ln \phi_{t-1,t-1} - \ln \phi^{t-1}_{\cdot,t-1})$ likely > 0

  countercyclical bias reflecting auto-correlation of changes in the cycle: if an expansion (declining unemployment) is typically preceded by a bust (rising unemployment), then in expansions $\phi_{t-1,t-1} < \phi_{\cdot,t-1}$

Cyclicality of wages, wage-change approach

	(1) Δ log(wage)	(2) Δ log(wage)
Stayer $\times\Delta$ Urate	-0.23	-0.24
	(0.29)	(0.29)
New Hires $\times\Delta$ Urate	-0.80	
	(0.43)	
Via Non-Emp $\times\Delta$ Urate		0.01
		(0.80)
Job-to-Job $\times\Delta$ Urate		-0.90
		(0.48)

Notes: The table shows the percent change in wages in response to 1 pp in the unemployment rate. The sample covers 1980 to 2011 reflecting 42,293 wage changes. Additional controls are dummies for sex, race and education groups, and quadratic trend, age and tenure polynomials. We allow all coefficients to differ for the NLSY79 and NLSY97, except the unemployment rate and quadratic trend coefficients. Standard errors are clustered by survey year. All regressions are estimated using survey sampling weights.

Prior treatments: Fixed-effects approach

- Quality control is estimated worker fixed effect *over all periods*

$$\ln w_{t,t}^{ij} = \alpha \, Cycle_t + \ln w_{fe}^{i} + \epsilon_{t,t}^{ij}$$

Estimated quality-adjusted new hire wage is

$$\ln \widehat{\phi}_{t,t} = \ln \phi_{t,t} + (\ln q_{t,t}^{ij} - \widehat{\ln w_{fe}^{i}})$$

  - $\widehat{\ln w_{fe}^{i}}$ reflects firm/match qualities of all jobs
  - $\widehat{\ln w_{fe}^{i}}$ reflects $\ln \phi_{t,t}$ in shorter panels if wages smoothed

- Estimated cyclicality biased if

$$\mathrm{Cov}\left(Cycle_t, \ln q_{t,t}^{ij} - \widehat{\ln w_{fe}^{i}} \right) \neq 0$$

Cyclicality of new-hire wage, job-to-job versus via non-employment

	All New Hires	Via Non-emp	Job-to-Job
Benchmark	-2.35	-2.31	-2.89
	(0.67)	(1.01)	(0.60)
Heckman Correction	-2.17	-2.08	-2.69
	(0.65)	(0.98)	(0.58)
8-years Change w/ Quality Controls	-2.88	-2.84	-2.73
	(0.66)	(0.70)	(0.70)

Notes: 32 annual observations: 1980-2011. Regressions include cubic trend. Robust standard errors in parentheses.

Conclusions

Conclusions

- Quality-adjusted new-hire wage is highly procyclical
  - Increases by 2.3% for 1pp decline in unemployment
- Price of labor is yet more procyclical than new-hire wage
  - Increases by more than 4% for 1 pp decline in unemployment
- Need models of cyclical labor demand

Separation and discount rates

- Baseline assumes time-varying separation and discount rate
  - Estimate $_{t+\tau}$, $\delta_{t,t+\tau}$ using our dataset
  - Allow for time-varying discount rate
    - Using NIPA consumption (non-durable + services) and $\theta = 2$, construct the discount factor as the exponential of

$$\log(1/R) - \theta \Delta \log(C_{t+1}/C_t),$$

      where C_t is consumption and R is the average real one-month T-bill rate
- Case of constant separation and discount rate:
  - Set $\beta = 0.989$ and $\delta = 0.285$

Robustness to measure of cycle

	New-Hire Wage		User Cost		Adj. User Cost	
	Unemp	log(GDP)	Unemp	log(GDP)	Unemp	log(GDP)
Quadratic trend	-2.48	1.40	-5.24	2.68	-4.10	2.25
	(0.39)	(0.20)	(1.59)	(0.70)	(1.62)	(0.70)
Cubic	-2.35	1.51	-5.32	2.98	-4.21	2.58
	(0.67)	(0.28)	(1.87)	(0.79)	(1.90)	(0.78)
HP filter	-1.59	1.05	-5.33	3.22	-4.08	2.70
	(0.69)	(0.36)	(2.76)	(1.39)	(2.80)	(1.38)
One-Sided HP filter	-1.75	1.20	-4.83	2.91	-3.64	2.40
	(0.43)	(0.26)	(2.57)	(1.42)	(2.34)	(1.24)
Hamilton Filter	-1.64	0.79	-4.02	1.76	-3.25	1.53
	(0.48)	(0.21)	(1.76)	(0.77)	(1.91)	(0.78)

Notes: All regressions have 32 annual observations from 1980-2011, except the ones using using Hamilton Filter that has 29 observations from 1983-2011. Robust standard errors are in parentheses.

Cyclicality of wages, fixed-effect approach

	(1) log(wage)	(2) log(wage)
Stayer × Urate	-0.64	-0.64
	(0.31)	(0.31)
New Hires × Urate	-1.94	
	(0.36)	
Via Non-Emp × Urate		-1.31
		(0.35)
Job-to-Job × Urate		-2.21
		(0.47)

Notes: The table shows the percent change in wages in response to 1 pp in the unemployment rate. The sample covers 1980 to 2011 reflecting 42,293 wage changes. Additional controls are dummies for sex, race and education groups, and quadratic trend, age and tenure polynomials. We allow all coefficients to differ for the NLSY79 and NLSY97, except the unemployment rate and quadratic trend coefficients. Standard errors are clustered by survey year. All regressions are estimated using survey sampling weights.

Cyclicality of new-hire match quality

- Construct the average match quality for new hires as the average start wage at t plus the predicted eight-year wage growth for t-start matches
  - Construct the average star wage at t by controling for gender, race, educ, age—the implied match quality is net of these worker characteristics

- Find that the quality of new hire matches is acyclical
  - Estimated coefficient on unemployment is 0.05% (st. error 0.65%)

Bibliography I

Baker, George and Bengt Gibbs Michael Holmstrom, "The Wage Policy of a Firm," *Quarterly Journal of Economics*, 1994, *109* (4), 921–55.

Beaudry, Paul and John DiNardo, "The Effect of Implicit Contracts on the Movement of Wages over the Business Cycle: Evidence from Micro Data," *Journal of Political Economy*, 1991, *99* (4), 665–88.

Bils, Mark J., "Real Wages over the Business Cycle: Evidence from Panel Data," *Journal of Political Economy*, 1985, *93* (4), 666–89.

Carneiro, Anabela, Paulo Guimaraes, and Pedro Portugal, "Real Wages and the Business Cycle: Accounting for Worker, Firm, and Job Title Heterogeneity," *American Economic Journal: Macroeconomics*, 2012, *4* (2), 133–52.

Devereux, Paul J., "Cyclical Quality Adjustment in the Labor Market," *Southern Economic Journal*, 2004, *70* (3), 600–615.

Bibliography II

Doniger, Cynthia L., "The Ways the Cookie Crumbles: Education and the Margins of Cyclical Adjustment in the Labor Market," Working Paper, Federal Reserve Board 2021.

Figueiredo, Ana, "Wage Cyclicality and Labor Market Sorting," *American Economic Review: Insights*, 2022, *4* (4), 425–42.

Gertler, Mark, Christopher Huckfeldt, and Antonella Trigari, "Unemployment Fluctuations, Match Quality, and the Wage Cyclicality of New Hires," *The Review of Economic Studies*, 2020, *87*, 1876–1914.

Grigsby, John, Erik Hurst, and Ahu Yildirmaz, "Aggregate Nominal Wage Adjustments: New Evidence from Administrative Payroll Data," *American Economic Review*, 2021, *111* (2), 428–471.

Kahn, Lisa, "The Long-term Consequences of Graduating in a Bad Economy," *Labour Economics*, 2010, *17*, 303–16.

Bibliography III

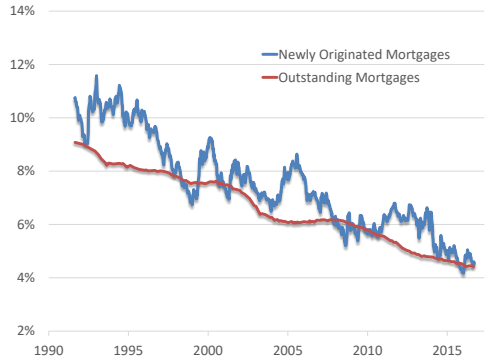
Kudlyak, Marianna, "The Cyclicality of the User Cost of Labor," *Journal of Monetary Economics*, 2014, *68*, 53–67.

Okun, Arthur, "Upward Mobility in a High-pressure Economy," *Brookings Papers on Economic Activity*, 1973, *1*, 207–52.

Oreopoulos, Philip, Till von Wachter, and Andrew Heisz, "The Short- and Long-Term Career Effects of Graduating in a Recession," *American Economic Journal: Applied Economics*, 2012, *4*, 1–29.

Vroman, Wayne, "Worker Upgrading and the Business Cycle," *Brookings Papers on Economic Activity*, 1977, *8*, 229–52.

Interest rate on new and outstanding mortgages



Origination rate source: Freddie Mac Primary Mortgage Market Survey. Outstanding mortgages from Berger et al. (2020). Return