The Quality-Adjusted Cyclical Price of Labor

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How cyclical is the price of labor?

- A rigid wage is key to employment fluctuations in many models
- If labor's price is strongly procyclical, need models of cyclical labor demand (e.g., financial constraints)

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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

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

- Focus on wages of job stayers—might eliminate problem (2), but exacerbates problem (1)
- Focus on wages of new hires—does not eliminate problem (1) and exacerbates problem (2)

What we do

1. Propose match's expected long-run wage as proxy for worker, firm, *and* match quality

2. Estimate cyclicality of the quality-adjusted new-hire wage and price of labor (user cost) from quality-adjusted wage paths of hiring now versus later

Expected long-run wage in the match as a proxy for match quality

- Look at wage growth *within* jobs
  - The further is wage from its long-run wage, the greater is growth towards its long-run wage—the lower the quality-adjusted wage
- Exploit long worker panels in NLSY1979 & NLSY1997
  - Prior efforts: panels on workers, firms, or workers-firms
  - But do not address worker-firm match effects

What we find

- Labor's user cost increases by more than 5% for a 1 pp decline in unemployment
- Nearly half reflects a procyclical quality-adjusted new-hire wage—2.3%, while the rest reflects that hiring in a boom predicts higher subsequent wages within a match

Related literatures

- 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), Martins, Solon and Thomas (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 (Forthcoming)

This paper: measures the cyclicality of price of labor taking into account wage smoothing and 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
- $\phi_{t,t}$ is the quality-adjusted new-hire wage

Price of labor

- As employment relation durable $\Longrightarrow$ measure labor's price by its user cost
- Firm's decision: hire in t versus postpone hiring until t+1
- The costs of the decision are the user cost of labor:
  - **The wage component of the user cost of labor in t**:

$$UC_t = E_t\Big[PDV_t - \beta(1-\delta)PDV_{t+1}\Big],$$

    where $PDV_t^W = \phi_{t,t} + \sum_{\tau=1}^{\infty} \beta^\tau (1-\delta)^\tau \phi_{t,t+\tau}$.

    Expressed for constant separation rate (δ) and discount rate (β), relaxed later.
  - Other costs - hiring, training etc- similar approach.

Labor's user cost

- The user cost of labor

$$UC_t = E_t \left[\phi_{t,t} + \sum_{\tau=1}^{\infty} \beta^{\tau} (1-\delta)^{\tau} \left(\phi_{t,t+\tau} - \phi_{t+1,t+\tau} \right) \right]$$

- Reflects differential *wage paths* starting t vs. $t+1$, as well as new-hire wage

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 $\mathrm{Cov}(Cycle_t, \ln q_{t,t}) = 0$
  - Cleansing effect of recessions (higher threshold) $\implies$ countercyclical bias
  - Sullying effect of recessions ("good jobs" not hiring) $\implies$ procyclical bias

Identifying cyclicality of quality-adjusted wage

- Quality-adjusted new-hire wage:

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

- The cyclicality of the quality-adjusted new-hire wage can be expressed as:

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

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., that the mean change in match quality for matches started at t is orthogonal to cycle at t

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
   - We test this assumption in the data.

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

   Consistent with
   - Models with limited commitment, e.g., Thomas and Worrall (1988)
   - Empirics, e.g., Beaudry and DiNardo (1991), Bellou and Kaymak (2021)

Cyclicality of q-adjusted new-hire wage

Implication 1. *Given Assumptions 1 and 2, cyclicality of q-adj new-hire wage is*

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

i.e., the (-) cyclicality of the cumulative growth between t and $t + \tau$

Cyclicality of user cost

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

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

- The higher is subsequent growth for matches started at t, compared to those started in $t+1$, the lower is the user cost in t.

Understanding the assumptions

- Assumption 1:
  - If the quality is constant throughout the match, this is non-binding
    - i.e., our approach is robust to match quality concerns in Gertler, Huckfeldt and Trigari (2020), Hagedorn and Manovskii (2013)
  - If the quality growth within a match is higher for matches that start in recessions—our measure is biased pro-cyclically. We examine this empirically

- Assumption 2:
  - To the extent this assumption is violated in practice, it will cause us to understate procyclicality of new-hire wages

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
  - Working at least 25 hours a week
  - Working in the private sector and not enrolled in college/ school
  - Oldest respondent is 62 in NLSY79 and 39 in NLSY97
  - 11,769 unique individuals
- Measure of cycle:
  - Use the unemployment rate, also use the real GDP
  - Detrending to define cycle: Cubic trend as baseline

Empirical implementation

- We estimate cyclicality, 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:
   - $a = 8$—far enough into future so that initial conditions no longer affect wage
     - Duration of a typical business cycle (Thomas and Worrall, 1988)
     - Robustness of our estimates to shorter cutoff periods

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2. Cumulative wage growth from annual wage growth

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

$$\text{Cov}(Cycle_t, \ln \phi_{t,t}) = \text{Cov}\left(Cycle_t, \ -\sum_{\tau=1}^{a} \Delta \ln w_{t,t+\tau} \right) \quad \text{for } a \gg 1$$

Empirical implementation

3. Obtain $\Delta \ln w_{t,t+\tau}$
   - as estimates of ψ's from regression

$$\Delta \ln w^{ij}_{t,t+\tau} = \Psi x^{ij}_{t+\tau} + \sum_{d_0=1979}^{2010} \sum_{d=d_0+1}^{2018} \psi_{d_0,d} D^{ij}_{d_0,d} + \epsilon^{ij}_{t+\tau}$$

   - 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

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   - Do not require matches to last 8 years
   - Impute the average wage change from $t + \tau - 1$ to $t + \tau$ for matches that survive to $t + \tau$ for the wage growth for matches that end before $t + \tau$
   - Might bias our estimates pro-cyclically if
     - there is a positive selection of surviving matches on change in quality, AND
     - the selection is stronger in recessions

Empirical implementation

4. Estimate cyclicality using a measure constructed from estimates for $\psi_{t,t+\tau}$

- Given estimates for $\psi_{t,t+\tau}$, obtain:

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

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

- Estimate using 32 annual observations – from 1980 to 2011
  - As benchmark, use constant separation rate δ and discount rate β
  - Relax later by using $\delta_{t,t+\tau}$ and $\beta_{t+\tau}$, estimated from the data

Cyclicality of quality-adjusted new-hire wage

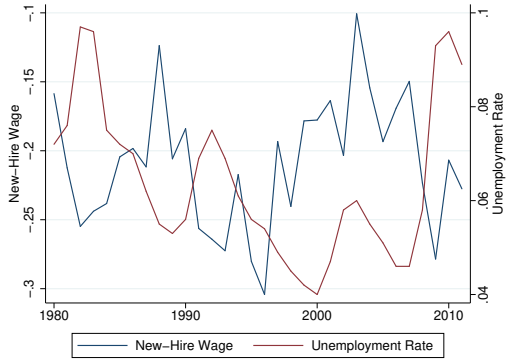
Cyclicality of average hourly earnings

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

	(1) Age Control	(2) Individual FE	(3) Matching FE
Unemp Rate	-0.25	-0.76	-0.41
	(0.48)	(0.35)	(0.32)

Notes: Our sample – NLSY79 and NYSY97 panels – has 115,795 observations for 1980 to 2011. Additional controls are a cubic trend and dummies for sex, race and education groups and cubics in age and tenure. All coefficients are specific to the NLSY79 and NLSY97 samples except those for the unemployment rate and cubic trend. Standard errors are clustered by survey year. All regressions reflect survey sampling weights.

Cyclicality of quality-adjusted new-hire wage



- New-hire wage is highly procyclical: decreases by 2.30% (0.67) in response to a 1 pp increase in unemployment

Dealing with procyclical bias concerns

1. If quality growth within a match is higher for those that start in recessions (violates Assumption 1), this would bias our measure pro-cyclically

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   - Estimate cyclicality of quality changes within matches (occ index, work week)

	(1) Δ ln (wage)	(2) Δ (occ index)	(3) Δ ln (wk week)
Unrate at t_0	0.317	-0.011	-0.041
	(0.099)	(0.057)	(0.046)
Δ Unrate	-0.002	-0.001	-0.004
	(0.002)	(0.001)	(0.001)

- Find no evidence that typical measures of quality grow faster in matches that start in recessions

Dealing with procyclical bias concerns

2. If surviving matches are selected on a higher growth and relatively more so in recessions than booms, this would bias our measure pro-cyclically

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   - Implement a number of robustness exercises:

	(1) Benchmark	(2) Heckman Correction	(3) 8 Years Out
URate	-2.30	-2.03	-2.89
	(0.67)	(0.64)	(0.61)

- New-hire wage is still highly procyclical; find some evidence that surviving matches in recession are relatively more selected on positive growth

Cyclicality of the user cost of labor

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

	Unemployment
New-Hire Wage	-2.30
	(0.67)
User Cost	-5.69
	(2.03)
User Cost w/ time-varying discount rates	-5.96
	(2.07)
User Cost w/ time-varying separation & discount rates	-5.69
	(2.16)
User Cost w/ time-varying sep. & disc. rates, sep. rate start-date specific	-5.46
	(2.38)

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

Conclusions

- Quality-adjusted new-hire wage is highly procyclical — increases by 2.3% for 1pp decline in unemployment
  - Pro-cyclical for new hires via job-to-job or via non-employment
- Price of labor is yet more procyclical than new-hire wage
  - Increases by 5-6% for 1 pp decline in unemployment
- Need models of cyclical labor demand

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

	All New Hires	Via Non-emp	Job-to-Job
Benchmark	-2.30	-2.09	-2.91
	(0.67)	(0.97)	(0.60)
Heckman Correction	-2.03	-1.72	-2.68
	(0.64)	(0.93)	(0.59)
8-years Change w/ Quality Controls	-2.89	-2.85	-2.68
	(0.61)	(0.66)	(0.65)

Notes: 32 annual observations: 1980-2011. Coefficients are percent responses to the unemployment rate. Regressions include cubic trend. Robust standard errors in parentheses.

Robustness to measure of cycle

	New-Hire Wage		User Cost	
	Unemployment	log(GDP)	Unemployment	log(GDP)
Quadratic trend	-2.41	1.33	-4.99	2.39
	(0.39)	(0.18)	(1.51)	(0.70)
Cubic	-2.30	1.44	-5.69	2.94
	(0.67)	(0.26)	(2.03)	(0.90)
HP filter	-1.73	1.11	-6.42	3.83
	(0.70)	(0.35)	(2.63)	(1.42)
One-Sided HP filter	-1.82	1.21	-5.47	3.18
	(0.46)	(0.26)	(2.12)	(1.31)
Hamilton Filter	-1.68	0.84	-3.12	1.28
	(0.49)	(0.20)	(1.74)	(0.81)

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.