The Financial Channel of Wage Rigidity

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Motivation and background:

○ Useful modeling tool for amplification: rigidity of marginal—i.e., new hires’—wages.
  
Erceg, Henderson, and Levin (2000); Shimer (2004); Hall (2005); Blanchard and Gali (2007); Elsby (2009); Gertler and Trigari (2009);
Michaillat (2012); Christiano, Eichenbaum, and Trabandt (2016); Schmitt-Grohé and Uribe (2016)

○ Ongoing empirical debate about new hires’ wage rigidity
  
Solon, Barsky, and Parker (1994); Pissarides (2009); Hagedorn and Manovskii (2013); Galuscak, Keeney, Nicolitsas, Smets, Strzelecki, and
Vodopivec (2012); Gertler, Huckfeldt, and Trigari (2020); Hazell and Taska (2020).

○ Average/incumbent workers’ wages are clearly rigid.

○ Theoretical paradigm: incumbents’ wages’ wages are, ex post, irrelevant for hiring.
  
Shimer (2004); Pissarides (2009) and many others; other recent work breaking the paradigm through effort channel (Bils, Chang, and Kim,
forthcoming) and wage posting (Fukui, 2020)

This paper proposes and explores a financial channel of wage rigidity:

○ Rigid average/incumbents’ wages ⇒ more volatile financial resources of firms ⇒ more volatile hiring.

○ Wage rigidity may be crucial to financial amplification
Outline

1. **Mechanism: simple model**

2. **Empirical evidence**
   - Aggregate: wage rigidity $\Rightarrow$ cash flow fluctuations
   - Industry level: labor share amplifies fluctuations

3. **DMP model w/ financial constraints & incumbents’ wage rigidity.**
   - Calibration: their interaction can provide substantial amplification.

4. **Policy application: stabilization from wage subsidies/payroll taxes**
   - Marginal subsidies for new hires’ vs. eligibility for incumbents too
Mechanism: Simple Model

In period $t$,
- the firm chooses hires $h_{t+1}$
- ... who start producing and earning wages in period $t+1$.

$\delta$: separation probability (after production/wages)

$w_c$: cohort-specific wages (related later)
- differentiated between hiring cohorts denoted by their first period of production $c$, and
- constant while the cohort members remain on that job.

$\beta$: discount factor (from the households)

Firm’s period-$t$ problem:

$$\max_{h_{t+1}} \mathbb{E}_t \sum_{s \geq t} \beta^{s-t} \left( p_s n_s - \Phi_s - c(h_{s+1}) \right)$$

(1)

s.t. $n_{s+1} = h_{s+1} + (1 - \delta) n_s \quad \forall s \geq t$

(2)

$$\Phi_{s+1} = w_c = s + 1 h_{s+1} + (1 - \delta) \Phi_s \quad \forall s \geq t$$

(3)

where

- $\Phi$: total wage bill
- $c(h)$: upfront hiring costs (training or recruitment costs, or complementary capital,...)
Hiring w/o Financial Constraints

Equilibrium labor demand:

\[ c'(h_{t+1}^*) = \mathbb{E}_t \sum_{s > t} \beta^{s-t}(1 - \delta)^{s-(t+1)}(p_s - w_{c=t+1}) \]  

\[ \Leftrightarrow c'(h_{t+1}^*) + \mathbb{E}_t \sum_{s > t} \beta^{s-t}(1 - \delta)^{s-(t+1)}w_{c=t+1} = \mathbb{E}_t \sum_{s > t} \beta^{s-t}(1 - \delta)^{s-(t+1)}p_s \]  

Fluctuations:

\[ \frac{d \ln h_{t+1}^*}{d \ln p} = \frac{1}{hc''_c} \cdot \frac{p}{p - w_{c=t+1}} \cdot \left( 1 - \frac{dw_{c=t+1}}{dp} \right) \]  

Key insights:

- Standard amplification of hiring depends on the sensitivity of new hires’ wages, \( \frac{dw_{c=t+1}}{dp} \).
- Incumbent workers’ wages \( w_c = \overline{w}_{c \leq t} \forall c \leq t \) do not show up — inframarginal fixed cost!

... Macro-labor paradigm (Shimer, 2004; Hall, 2005; Mortensen and Nagypal, 2007; Hall and Milgrom, 2008; Elsby, 2009; Pissarides, 2009; Michaillat, 2012; Haefke, Sonntag, and Van Rens, 2013; Kudlyak, 2014; Christiano, Eichenbaum, and Trabandt, 2016; Hazell and Taska, 2020; Grigsby, Hurst, and Yildirmaz, 2021)
Hiring with Financial Constraints

- Implicit assumption in standard hiring: firms have sufficient internal funds or can raise enough external financing (e.g., debt at interest rate $r = 1/\beta - 1$) to cover the hiring costs.

- Opposite, extreme case (relaxed later): no external finance (nor internal savings)
  
  $\Rightarrow$ Firms must finance investment out of current cash flow — adding a constraint to firm’s problem

$$c(h_{t+1}) \leq p_t n_t - \Phi_t .$$  \hspace{1cm} (7)

New FOC reflecting constraint in the form of Lagrange multiplier $\tau$:

$$ (1 + \tau_t) \cdot c'(h^*_{t+1}) = \mathbb{E}_t \sum_{s>t} \beta^{s-t} (1 + \tau_s)(1 - \delta)^{s-(t+1)} (p_s - w_{c=t+1}).$$  \hspace{1cm} (8)

For fluctuations, get clearer intuitions from direct comp stat of constraint:

$$c(h^*_{t+1}) = p_t n_t - \Phi_t$$  \hspace{1cm} (9)

$$= (p_t - \overline{w}_{c\leq t}) \cdot n_t$$  \hspace{1cm} (10)

$$\Rightarrow \frac{d \ln h^*_{t+1}}{d \ln p} = \frac{1}{hc'} \cdot \frac{p}{p - \overline{w}_{c\leq t}} \cdot \left(1 - \frac{d \overline{w}_{c\leq t}}{dp} \right).$$  \hspace{1cm} (11)
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   - Industry level: labor share amplifies fluctuations

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Aggregate Cash Flow Statement (2019) for the United States

- Gross value added: $10,458 billion
- Payroll: $6,301 billion
- Taxes (prod.): $915 billion
- Cash flow: $3,243 billion
- Equity raised: $474 billion
- Debt raised: $637 billion
- Dividends paid: $223 billion
- Interest paid: $839 billion
- External finance: $2,148 billion
- Capital expenditure: $2,000 billion

Source: quarterly FRB Flow of Funds data, US nonfinancial corporate sector (incl subseq slides)
Capital Expenditure and Liquidity Against Cash Flow

Cash flow (normalized by value added, deviations from trend)

Normalized by value added, deviations from trend

-0.06 -0.04 -0.02 0.00 0.02 0.04

Capital expenditure
Coeff.: 0.84 (SE: 0.061)

Total Liquidity
Coeff.: 1.47 (SE: 0.117)

[External fin. coeff.: 0.47 (SE: 0.117)]
Capital Expenditure and Vacancies (Help-Wanted Index)

- Coeff.: 2.07 (SE: 0.122)
- CapEx SD: 0.09, HWI SD: 0.24
- Correlation: 0.77

Vacancies (log deviations from trend)
- Capital expenditure (log deviations from trend)

Graph showing capital expenditure and vacancies over time (1950q1 to 2020q1) with plots for each variable.
Counterfactual: Cash-Flow-Stabilizing Additional Wage Fluctuations

Empirical (\(\tilde{x}\)) dev’ns from trend: total derivative of cash flow \(CF\) and its components value added \(y\) and payroll \(\Phi = wn\) (product of average wage \(w\) and employment \(n\)):

\[
\left( \frac{dCF}{CF} \right) = \left( \frac{dy}{y} \right) \cdot \left( \frac{y}{CF} \right) - \left( \frac{d\Phi}{\Phi} \right) \cdot \left( \frac{\Phi}{CF} \right).
\]  

(12)

Counterfactual cash flow movement (\(\tilde{x}\)) is empirical movement plus counterfactual, incremental wage change \(\Delta w\):

\[
\left( \frac{dCF}{CF} \right) = \left( \frac{dCF}{CF} \right) - \left( \Delta \frac{dw}{w} \right) \cdot \left( \frac{\Phi}{CF} \right)
\]  

(13)

And hence, the add. wage change required to stabilize a given cash flow fluctuation is:

\[
\Rightarrow \left. \left( \Delta \frac{dw}{w} \right) \right|_{\frac{dCF}{CF}=0} = \left( \frac{dCF}{CF} \right) \cdot \left( \frac{CF}{\Phi} \right)
\]  

(14)

US 1951-2019: 0.463
Aggregate Cash Flow Statement (2019) for the United States

Gross value added
Payroll
Taxes (prod.)
Cash flow
Equity raised
Debt raised
Dividends paid
Interest paid
External finance
Capital expenditure

$ billion

10,458 6,301 915 3,243 -454 474 637 223 -839 2,148
Cash Flow and Cash-Flow-Stabilizing Additional Wage Fluctuations: Time Series
Cash Flow and Cash-Flow-Stabilizing Additional Wage Fluctuations: Okun’s Laws

<table>
<thead>
<tr>
<th>Unemployment rate (deviations from trend)</th>
<th>Cash flow (log deviations from trend)</th>
<th>Cash-flow-stabilizing wage fluctuations</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.10</td>
<td>-3.28 (SE: 0.317)</td>
<td>-1.49 (SE: 0.146)</td>
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<tr>
<td>-0.05</td>
<td></td>
<td></td>
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<tr>
<td>0.00</td>
<td></td>
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</tr>
<tr>
<td>0.05</td>
<td></td>
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<tr>
<td>0.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Distribution of Cash-Flow-Stabilizing Incremental Wage Movements

Just a moderate volatility boost!

- Compare to idiosyncratic wage and earnings changes found in the micro data at similar frequencies (Guvenen, Karahan, Ozkan, and Song, 2020)
In Math: Zeroing Out the Okun’s Law of Cash Flow

\[
\left( \frac{\Delta d\bar{w}}{w} \right) \bigg|_{\left( \frac{dCF}{CF} \right) = 0} = \left( \frac{dCF}{CF} \right) \cdot \left( \frac{CF}{\Phi} \right)
\]  
(15)

\[
\Rightarrow \left( \frac{\Delta d\bar{w}}{w} \right) \bigg|_{\left( \frac{dCF}{CF} \right) = 0} = \left( \frac{dCF}{CF} \right) \left( \frac{CF}{\Phi} \right) = -3.28 \cdot 0.463 = -1.52
\]  
(16)

Just a moderate procyclicality boost!

-1.52 corresponds to the empirical wage cyclicality differential of about -1.75. estimated b/w new hires and incumbent workers estimated as semi-elasticities of wages to UR (Pissarides, 2009)

-1.25 for average/incumbents’ wages

-3.00 for new hires
Robustness Checks in Paper

- Profits rather than cash flow
- Smoothing parameter
- Annual data
- Alternative sources: dividends, interest expenditures
Robustness Check: Profits

- Pre-tax profits (log deviations from trend)
- Cash-flow-stabilizing wage fluctuations

Profits

Coeff.: -6.87 (SE: 0.804)
Coeff.: -1.40 (SE: 0.168)

Average trend ratio: 0.206

Mean: 0.0006, sd: 0.022
p10: -0.028, p25: -0.011, p75: 0.016, p90: 0.025

Unemployment rate (deviations from trend)

Pre-tax profits to payroll trend ratio
Industry-Level Test

Idea:

\[
CF = \frac{y}{pn} - \Phi
\]  

(17)

\[
\frac{d \ln CF}{d \ln p} = \frac{1 - \frac{dw}{dp}}{1 - \frac{\Phi}{y}} \quad \text{= labor share!}
\]

(18)

Data: US NBER-CES Manufacturing Productivity Database (1958 to 2016 for 457 industries), annual

Additional outcome variables: employment, investment.
Industry Labor Shares, 1958-2016 Averages

mean: 0.4023, sd: 0.100  
p10: 0.254, p25: 0.343, p75: 0.474, p90: 0.516
Industry-Level Evidence: Okun’s Laws of Cash Flow and Inputs

- Semi-elasticity w.r.t. unemployment rate
- Cash flow: Coeff. -10.34 (SE: 1.667)
- Employment: Coeff. -9.30 (SE: 0.831)
- Capital expenditure: Coeff. -21.73 (SE: 2.213)
Alternative Labor Share Measure: Labor Costs Over Revenue

Semi-elasticity w.r.t. unemployment rate

Labor share

Cash flow

Employment

Capital expenditure

Coeff.: -7.29 (SE: 2.397)
Coeff.: -8.32 (SE: 1.205)
Coeff.: -25.34 (SE: 3.028)

mean: -0.1105, sd: 0.049
p10: -0.170, p25: -0.140, p75: -0.078, p90: -0.055
Industry-Level Evidence: Long-Run Changes

Change in semi-elasticities

Cash flow: Coeff. -16.19 (SE: 5.689)
Employment: Coeff. -8.54 (SE: 2.929)
Capital expenditure: Coeff. -9.94 (SE: 8.007)

Change in labor share

Change in semi-elasticities

Cash flow: Coeff. -16.19 (SE: 5.689)
Employment: Coeff. -8.54 (SE: 2.929)
Capital expenditure: Coeff. -9.94 (SE: 8.007)
Industry-Level Recession Case Studies: Cash Flow

Recessions:
- 1970 vs. 1968
- 1975 vs. 1972
- 1982 vs. 1980
- 2002 vs. 2001
- 2009 vs. 2007
Industry-Level Recession Case Studies: Investment

Recessions:
- 1970 vs. 1968
- 1975 vs. 1972
- 1982 vs. 1980
- 2002 vs. 2001
- 2009 vs. 2007

Graph showing the relationship between labor share and capital expenditure change during different recession periods.
Industry-Level Recession Case Studies: Employment

Recessions:
- 1970 vs. 1968
- 1975 vs. 1972
- 1982 vs. 1980
- 2002 vs. 2001
- 2009 vs. 2007
Industry-Level Elasticities to Industry Shocks: Labor Productivity

Elasticities w.r.t. labor productivity

Cash flow: Coeff. 2.33 (SE: 0.158)
Employment: Coeff. 0.53 (SE: 0.136)
Capital expenditure: Coeff. 2.19 (SE: 0.312)
Industry-Level Elasticities to Industry Shocks: TFP

Elasticities w.r.t. TFP:
- Labor share: Coeff.: 4.42 (SE: 0.393)
- Cash flow: Coeff.: 1.81 (SE: 0.198)
- Employment: Coeff.: 3.83 (SE: 0.448)
- Capital expenditure: Coeff.: 4.42 (SE: 0.393)

Graph showing the relationship between labor share and various elasticities with respect to TFP.
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Equilibrium Model

○ DMP search and matching model

○ Calibrate DMP block following Shimer (2005)

○ Ex-post wage rigidity for incumbent workers — ax ante, new hires’ wages flexibly set at match formation
  ○ Calibrate incumbents’ wage rigidity following empirical meta analysis of Pissarides (2009)

○ Firm faces financial constraints a la Jermann and Quadrini (2012)

  ○ Neutrality of incumbents’ wage rigidity due to flexible bargaining of new hires’ entry wages to leave the present value of wages unaffected! (Shimer, 2004; Pissarides, 2009)

○ With financial constraints: interaction w/ incumbents’ wage rigidity is crucial!
DMP Aspects

○ Similar setup as simple model, but endogenous wages, (potentially frictional) access to external finance, and intermediate degrees of wage rigidity for incumbent workers

○ Long-term jobs – separate with probability \( \delta \)

○ Matching function \( M(u, v) \), gives aggregate hiring (worker flows from unemployment into employment), using inputs vacancies \( v \) and unemployed job seekers \( u \)

○ \( M(u, v) \) is constant returns (Cobb Douglas), random search

○ ...and so labor market tightness \( \theta = v/u \) determines the vacancy filling rate \( q(\theta) = M(u, v)/v = M(1/\theta, 1) \) and job finding rate \( f(\theta) = M(u, v)/u = M(1, \theta) = \theta q(\theta) \).

○ Unemployment LoM:

\[
    u_{t+1} = u_t + \delta (1 - u_t) - f(\theta_t) u_t
\]

○ Constant labor force of unit mass, so employment is \( n = 1 - u \).

○ Vacancy posting cost \( k \) per period — investment expenditure is in recruitment, \( vk \)

○ (No capital)
Incumbent-Only Wage Rigidity

The period-\(t\) wage of an incumbent worker that started employment in period \(c < t\):

\[
w_{t,c} = W_{c, c}^\rho \cdot W_{t, t}^{1-\rho},
\]

(20)

...with commentary:

\[
\begin{align*}
\text{Cohort } c \text{'s wage in period } t > c & = \underbrace{W_{t, c}}_{\text{Ex-post rigid cohort effect}} \\
& \text{Cohort } c \text{'s original, ex-ante flexible entry wage set in period } c \\
& \underbrace{W_{c, c}}_{\text{Cyclical wage component}} \cdot \underbrace{\text{Ex-post rigid cohort effect}}_{\text{Cyclical wage component}} \\
& \underbrace{W_{t, t}}_{\text{Entry wage of current new hires}}^{1-\rho}.
\end{align*}
\]

(21)

Incumbents’ wage rigidity parameter \(\rho \in [0, 1]\):

- weight on the cohort’s entry wage \(w_{c, c}\)
- controls the relative wage cyclicality (comovement) of incumbents vis-à-vis new hires (as \(\frac{d \ln w_{t,c}}{d \ln w_{t,t}} = 1 - \rho \forall c < t\))
Recursive Formulation

Wage rule \( w_{t,c} = \rho w_{c,c} \cdot w_{t-1}^{1-\rho} \) renders the LoM for payroll \( \Phi \) recursive:

\[
\Phi_t = \sum_{c \leq t} w_{t,c} n_{t,c}
\]

(22)

\[
= \sum_{c \leq t} w_{t-1}^{1-\rho} w_{c,c} \cdot (1 - \delta)^{t-c} h_c
\]

(23)

\[
= w_{t,t} h_t + (1 - \delta) \left( \frac{w_{t,t}}{w_{t-1,t-1}} \right)^{1-\rho} \Phi_{t-1}.
\]

(24)

(where \( n_{t,c} = (1 - \delta)^{t-c} h_c \): workers of the initial \( h_c = n_{c,c} \) hires of cohort \( c \) still employed in \( t \))

Recursive Notation:

- \( x^- \), \( x \), \( x^+ \) and \( x^{++} \) for \( x_{t-1} \), \( x_t \), \( x_{t+1} \) and \( x_{t+2} \), respectively.

- New hires’ entry wages: \( w = w_{t,t} \)

- ... flexibly bargained over at match formation (discussed soon)
Firm’s Problem

Max EPV of dividends $d$:

$$ V(n^-, \Phi^-, h, B^-; s) = \max_{v, d, B} \left\{ d - \frac{\kappa^d}{2} (d - d^{ss})^2 - \frac{\kappa^B}{2} (B - B^{ss})^2 + \mathbb{E} \beta V(n, \Phi, h^+, B; s^+) \right\} $$

s.t.

$$ \Phi = wh + \left(1 - \delta\right) \left(\frac{w}{w^-}\right)^{1-\rho} \Phi^- $$

$$ n = (1 - \delta) n^- + h $$

$$ h^+ = v q(\theta) $$

$$ kv = pn - \Phi - d + \left(\Delta B - r(1 - t^B) B^- - rt^B \overline{B}^-\right) $$

$$ B \leq \overline{B}, $$

$v$: vacancies, of which share $q$ give hires, giving employment $n$, separating with prob $\delta$

$d$: dividends, can adjust with adjustment cost cost guided by $\kappa^d$

$B$: one-period debt, interest rate $r$

$v$: vacancies, at cost $k$ per period

$\Phi$: total payroll, with follows wage rule $w_{t,c} = w^{\rho}_{c,c} \cdot w^{1-\rho}_{t,t}$

$\overline{B}$: debt limit

$t^B$: tax subsidy of interest expenditure (refunded as lump sum)
Firm’s Financing

Recall firm’s budget constraint:

\[ kv = pn - \Phi - d + (\Delta B - r(1 - t^B)B^- - rt^B\bar{B}^-) \]  (31)

Rewrite to highlight demand for external finance:

\[ \frac{kv - (pn - \Phi)}{\text{Investment (Rec. Exp.)}} = -d + (\Delta B - r(1 - t)B^- - rt\bar{B}^-) \]  (32)

Suppose the borrowing constraint binds and \( B^- = B = \bar{B} \):

\[ kv + d = pn - \Phi \]  (33)

Either adjust dividends \( d \) or recruitment expenditures \( kv \)!

If “dividends” cannot adjust easily, real effects of cash flow shocks on hiring investment (consistent w/ corp fin (CapEx) evidence, akin to rep firm and RBC in Jermann and Quadrini (2012)
First-order/Envelope Conditions

\[ V_d = 0: \quad \tau = 1 - \kappa^d (d^* - d^{ss}) \quad (34) \]

\[ V_B = 0: \quad \tau = (1 + r(1 - t^B)) \mathbb{E}[\beta \tau^+] + \kappa^B (B^* - B^{ss}) + \nu \quad (35) \]

\[ V_\Phi = 0: \quad \lambda = -\tau + \mathbb{E} \left[ \beta (1 - \delta) \left( \frac{w^+}{w} \right)^{1-\rho} \lambda^+ \right] \quad (36) \]

\[ V_n = 0: \quad \mu = p \tau + \mathbb{E} [\beta (1 - \delta) \mu^+] \quad (37) \]

\[ V_{h^+} = 0: \quad \eta = \mathbb{E} [\beta (\mu^+ + \lambda^+ w^+)] \quad (38) \]

\[ V_v = 0: \quad \eta = \tau \frac{k}{q(\theta)}. \quad (39) \]

⇒ Hiring, or “zero profit condition:”

\[ \tau \frac{k}{q(\theta)} = \mathbb{E} \left[ \beta (\mu^+ + \lambda^+ w^+) \right] \quad (40) \]

\[ = \mathbb{E}_t \sum_{s>t} \beta^{s-t} \tau_s (1-\delta)^{s-(t+1)} (p_s - w_{s,t+1}) \]

\[ = \mathbb{E} \left[ \beta \tau^+ \left( (p^+ - w^+) + (1-\delta) \frac{k}{q(\theta^+)} + \beta(1-\delta) \frac{\lambda^{++}}{\tau^+} (w^+ p^{++1-\rho} - w^{++}) \right) \right] \quad (41) \]
Household’s Problem

\[ V^H(n^-, \Phi^-, h, B^-; s) = \max_B \{ \Phi + d - zn + rB^- - \Delta B + \mathbb{E} \beta V^H(n, \Phi, h^+, B; s^+) \} \]  \hspace{1cm} (42)

s.t.: \quad \Phi = wh + (1 - \delta) \left( \frac{w}{w^-} \right)^{1-\rho} \Phi^-

\[ n = (1 - \delta)n^- + h \]  \hspace{1cm} (43)
\[ h^+ = f(\theta)(1 - n) \]  \hspace{1cm} (44)

One new parameter: \( z \), payoff from nonemployment (UI, leisure,...)

FOCs/Env Con’s:

\[ V^H_B = 0 : \quad 1 = \mathbb{E} [\beta (1 + r)] \]  \hspace{1cm} (46)
\[ V^H_\Phi = 0 : \quad \lambda^H = 1 + \mathbb{E} \left[ \beta (1 - \delta) \left( \frac{w^+}{w} \right)^{1-\rho} \lambda^{H+} \right] \]  \hspace{1cm} (47)
\[ V^H_n = 0 : \quad \mu^H = -z - f(\theta)\eta^H + \mathbb{E} \left[ \beta (1 - \delta) \mu^{H+} \right] \]  \hspace{1cm} (48)
\[ V^H_{h^+} = 0 : \quad \eta^H = \mathbb{E} \left[ \beta \left( \lambda^{H+}w^+ + \mu^{H+} \right) \right] \]  \hspace{1cm} (49)
Nash Bargaining Over New Hires’ Entry Wage $w$

Value of a new worker—hired at an arbitrary entry wage $\tilde{w}$—for the firm and for the household:

$$V_n^F(\tilde{w}) = \lambda^F \tilde{w} + \mu^F \tag{50}$$
$$V_n^H(\tilde{w}) = \lambda^H \tilde{w} + \mu^H \tag{51}$$

Nash bargained wage $w$ with worker bargaining power $\phi$:

$$w = \text{argmax}_{\tilde{w}} \{ V_n^H(\tilde{w})^\phi V_n^F(\tilde{w})^{1-\phi} \} \tag{52}$$

$$\Rightarrow \phi \frac{V_n^H(\tilde{w})}{V_n^H(w)} + (1 - \phi) \frac{V_n^F(\tilde{w})}{V_n^F(w)} = 0 \tag{53}$$

$$\Leftrightarrow \lambda^H w = (1 - \phi)(-\mu^H) + \phi \psi \mu^F \tag{54}$$

where $\psi = \frac{V_n^H(\tilde{w})}{V_n^F(\tilde{w})} = \lambda^H / -\lambda^F$
Further Characterization of the Wage Bargain a la DMP Wage

Maximize comparability with standard DMP wage:

\[ w = (1 - \tilde{\phi})z + \tilde{\phi}(p + k\theta) - \mathbb{E}\left\{ \beta(1 - \delta)w^{+}(1 - \rho)(w^\theta - w^{+\rho})[(1 - \tilde{\phi})\lambda^H + \tilde{\phi}(-\lambda^F)] \right\} + \gamma, \tag{55} \]

where \( \tilde{\phi} = \frac{\tau \psi \phi}{\tau \psi \phi + (1 - \phi)}, \psi = \frac{\lambda^H}{-\lambda^F}, \gamma = \mathbb{E}\left\{ \tilde{\phi}(1 - \frac{\psi^+}{\psi})(1 - \delta)\beta V_n^F(\tilde{w})^+ \right\} \).

When \( \tau = 1 \) and \( \rho = 0 \), the wage bargain gives the standard DMP wage:

\[ w_{DMP} = w_{\rho=0} = \phi(p + \theta k) + (1 - \phi)z \tag{56} \]

If \( \tau = 0 \) but \( \rho = 1 \), nest perfectly rigid incumbent wages considered in Shimer (2004).
Intuitions for Financial Channel of Wage Rigidity

○ Same as in simple model in essence!
○ Productivity shocks affect firms’ inframarginal cash flow—depending on $\rho$!
○ Effect on liquidity and hiring is guided by $\kappa^d$—external finance (dividend) adjustment cost
○ If $\kappa^d = 0$, standard DMP equilibrium irrespective of $\rho$

$$\frac{k}{q(\theta)} = \mathbb{E} \left[ \beta \left( (p^+ - z) + (1 - \delta) \frac{k}{q(\theta^+)} \right) \right]$$  \hfill (57)

○ Present-value neutrality of incumbent’ wages—canonical macro-labor paradigm
○ When $\kappa^d > 0$, firms’ hiring is financially constrained:

$$k \nu = p n - \Phi - d + (\Delta B - r(1 - t^B)B^- - rt^B\tilde{B}^-)$$  \hfill (58)

○ Manifests itself through $\tau$, the firm’s internal value of cash, or equivalently through distortions in the stochastic discount factor $\beta^{\frac{\tau^+}{\tau}}$.

$\Rightarrow$ FCs break the neutrality of incumbent workers’ wages/wage rigidity!

$\Rightarrow$ (Incumbents’) wage rigidity mediates financial amplification
Calibration

○ Follow Shimer (2005) for standard DMP parameters

○ Set $\rho$ to match incumbent/new hires’ wage cyclicality targeting values proposed by meta analysis in Pissarides (2009)

○ Explore various calibrations of $\kappa^d$ (see next)
Parameter Values – Tiny Print, But Will Become Clear As We Go Along!

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source/Strategy</th>
<th>Target</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$ Discount factor</td>
<td>0.996</td>
<td>Annual interest rate</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>$v$ Matching elasticity</td>
<td>0.72</td>
<td>Shimer (2005)</td>
<td>0.72</td>
<td>0.72</td>
</tr>
<tr>
<td>$m$ Matching efficiency</td>
<td>0.45</td>
<td>Job finding probability (s.s.)</td>
<td>0.45</td>
<td>0.45</td>
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<tr>
<td>$\delta$ Separation rate</td>
<td>0.0237</td>
<td>Unemployment rate (s.s.)</td>
<td>0.05</td>
<td>0.05</td>
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<tr>
<td>$\phi$ Bargaining power</td>
<td>0.72</td>
<td>Hosios condition</td>
<td>0.72</td>
<td>0.72</td>
</tr>
<tr>
<td>$z$ Unemployment flow payoff</td>
<td>0.4</td>
<td>Avg. replacement rate</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>$k$ Vacancy posting cost</td>
<td>0.2149</td>
<td>Normalization $\theta^{ss} = 1$</td>
<td>–</td>
<td>1.00</td>
</tr>
<tr>
<td>$z$ Productivity, mean</td>
<td>1</td>
<td>Normalization</td>
<td>–</td>
<td>1.00</td>
</tr>
<tr>
<td>$\sigma^{eP}$ Productivity innovation, SD</td>
<td>0.0064</td>
<td>SD of ALP (quarterly)</td>
<td>0.020</td>
<td>0.020</td>
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<tr>
<td>$\rho$ Productivity, autocorrelation</td>
<td>0.98</td>
<td>Persistence of ALP (quarterly)</td>
<td>0.892</td>
<td>0.901</td>
</tr>
<tr>
<td>$\rho$ (One minus) indexation of incumbents’ wages to new hires’ entry wages</td>
<td>No Wage Rigidity 0</td>
<td>Wage Rigidity for Incumbent Workers 0.8</td>
<td>Relative cyclicity of new to average wages (Figure ??)</td>
<td>2.5</td>
</tr>
<tr>
<td>$t^B$ Tax benefit of debt</td>
<td>0.3</td>
<td>Fraction of periods constraint binding (Figure ??)</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>$B$ Borrowing limit</td>
<td>0.03</td>
<td>&quot;</td>
<td>&quot;</td>
<td></td>
</tr>
<tr>
<td>$\kappa^B$ Debt adjustment cost</td>
<td>100</td>
<td>Judge by hiring-cash flow sensitivity (Figure ??)</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>$\kappa^d$ Dividend adjustment cost</td>
<td>No Constraints 0</td>
<td>Financial Constraints 20</td>
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<td>&quot;</td>
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</tbody>
</table>

Note: Parameter values and targets are the same across all model variants, except for $\kappa^d$ and $\rho$. 
<table>
<thead>
<tr>
<th></th>
<th>( \log u )</th>
<th>( \log v )</th>
<th>( \log \theta )</th>
<th>( \log f )</th>
<th>( \log p )</th>
<th>( \log w )</th>
<th>( \log \overline{w} )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Data</strong></td>
<td>( 0.203 )</td>
<td>( 0.206 )</td>
<td>( 0.400 )</td>
<td>( 0.139 )</td>
<td>( 0.020 )</td>
<td>( -0.239 )</td>
<td>\</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>( 0.946 )</td>
<td>( 0.941 )</td>
<td>( 0.947 )</td>
<td>( 0.928 )</td>
<td>( 0.892 )</td>
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<tr>
<td>Autocorrelation</td>
<td>( 0.977 )</td>
<td>( -0.904 )</td>
<td>( 0.960 )</td>
<td>( -0.956 )</td>
<td>( -0.239 )</td>
<td>\</td>
<td></td>
</tr>
<tr>
<td><strong>Panel B: Neither Financial Constraints Nor Incumbents’ Wage Rigidity</strong></td>
<td>( 0.009 )</td>
<td>( 0.025 )</td>
<td>( 0.033 )</td>
<td>( 0.009 )</td>
<td>( 0.020 )</td>
<td>( 0.020 )</td>
<td>( 0.020 )</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>( 0.924 )</td>
<td>( 0.860 )</td>
<td>( 0.895 )</td>
<td>( 0.894 )</td>
<td>( 0.894 )</td>
<td>( 0.894 )</td>
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</tr>
<tr>
<td>Autocorrelation</td>
<td>1.000</td>
<td>-0.926</td>
<td>-0.958</td>
<td>-0.958</td>
<td>-0.958</td>
<td>-0.958</td>
<td>-0.958</td>
</tr>
<tr>
<td>Correlation with ( u )</td>
<td>( 0.977 )</td>
<td>( -0.904 )</td>
<td>( 0.960 )</td>
<td>( -0.956 )</td>
<td>( -0.239 )</td>
<td>\</td>
<td></td>
</tr>
<tr>
<td><strong>Panel C: No Financial Constraints but Incumbents’ Wage Rigidity</strong></td>
<td>( 0.009 )</td>
<td>( 0.025 )</td>
<td>( 0.033 )</td>
<td>( 0.009 )</td>
<td>( 0.020 )</td>
<td>( 0.013 )</td>
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</tr>
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<td>( 0.894 )</td>
<td>( 0.967 )</td>
</tr>
<tr>
<td>Autocorrelation</td>
<td>1.000</td>
<td>-0.926</td>
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<tr>
<td>Correlation with ( u )</td>
<td>( 0.977 )</td>
<td>( -0.904 )</td>
<td>( 0.960 )</td>
<td>( -0.956 )</td>
<td>( -0.239 )</td>
<td>\</td>
<td></td>
</tr>
<tr>
<td><strong>Panel D: Both Financial Constraints and Incumbents’ Wage Rigidity</strong></td>
<td>( 0.052 )</td>
<td>( 0.159 )</td>
<td>( 0.225 )</td>
<td>( 0.056 )</td>
<td>( 0.020 )</td>
<td>( 0.013 )</td>
<td>( 0.007 )</td>
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<tr>
<td>Standard deviation</td>
<td>( 0.915 )</td>
<td>( 0.847 )</td>
<td>( 0.880 )</td>
<td>( 0.885 )</td>
<td>( 0.894 )</td>
<td>( 0.893 )</td>
<td>( 0.966 )</td>
</tr>
<tr>
<td>Autocorrelation</td>
<td>0.999</td>
<td>-0.906</td>
<td>-0.925</td>
<td>-0.953</td>
<td>-0.954</td>
<td>-0.955</td>
<td>-0.718</td>
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<tr>
<td>Correlation with ( u )</td>
<td>( 0.977 )</td>
<td>( -0.904 )</td>
<td>( 0.960 )</td>
<td>( -0.956 )</td>
<td>( -0.239 )</td>
<td>\</td>
<td></td>
</tr>
<tr>
<td><strong>Panel E: Financial Constraints, but no Incumbents’ Wage Rigidity</strong></td>
<td>( 0.009 )</td>
<td>( 0.027 )</td>
<td>( 0.035 )</td>
<td>( 0.010 )</td>
<td>( 0.020 )</td>
<td>( 0.020 )</td>
<td>( 0.020 )</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>( 0.925 )</td>
<td>( 0.865 )</td>
<td>( 0.898 )</td>
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<tr>
<td>Autocorrelation</td>
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<td>-0.959</td>
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<td>( -0.239 )</td>
<td>\</td>
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</table>
Calibrating Incumbent Workers’ Wage Rigidity $\rho$ to $\rho$ on Relative Semi-Elasticity of New Hires’ vs. Average Wages
Sensitivity: Effect of $\rho$ on the SD of Labor Market Tightness

- **Cost of dividend adjustment $\kappa^d = 0$**
- **$\kappa^d = 20$ (benchmark calibration)**
- **$\kappa^d = 100$**

- **Wage rigidity parameter $\theta$**
- **Standard deviation of labor market tightness $\sigma$**

- Calibration at $\kappa^d = 0$, $\kappa^d = 20$, $\kappa^d = 100$.

- Graph shows the relationship between wage rigidity parameter $\rho$ and standard deviation of labor market tightness $\theta$.

- At $\kappa^d = 0$, $\sigma$ is relatively low.
- As $\kappa^d$ increases, $\sigma$ increases significantly.

- The graph illustrates how different levels of wage rigidity affect labor market tightness.
Sensitivity: Dividend Adjustment Cost Parameter $\kappa^d$

Cost of dividend adjustment $\kappa^d$

- SD of labor market tightness $\theta$
- Hiring-cash flow sensitivity $k \cdot \frac{dv}{dCF}$
- Propensity to retain cash flow shocks $1 - \frac{dd}{dCF}$
- SD of labor market tightness $\theta$ when $\rho = 0$

Benchmark calibration
<table>
<thead>
<tr>
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<th>Panel B: Neither Financial Constraints Nor Incumbents’ Wage Rigidity</th>
<th>Panel C: No Financial Constraints but Incumbents’ Wage Rigidity</th>
<th>Panel D: Both Financial Constraints and Incumbents’ Wage Rigidity</th>
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<td>0.999 -0.906 -0.925 -0.953 -0.954 -0.955 -0.718</td>
</tr>
</tbody>
</table>

| \( \log u \) | \( \log v \) | \( \log \theta \) | \( \log f \) | \( \log p \) | \( \log w \) | \( \log \bar{w} \) |

| **Standard deviation** | 0.203 0.206 0.400 0.139 0.020  | 0.009 0.025 0.033 0.009 0.020 0.020 0.020  | 0.009 0.025 0.033 0.009 0.020 0.013 0.006  | 0.052 0.159 0.225 0.056 0.020 0.013 0.007  |
| **Autocorrelation** | 0.946 0.941 0.947 0.928 0.892  | 0.924 0.860 0.895 0.894 0.894 0.894 0.894  | 0.924 0.860 0.895 0.894 0.894 0.894 0.967  | 0.915 0.847 0.880 0.885 0.894 0.893 0.966  |
| **Correlation with \( u \)** | 0.977 -0.904 0.960 -0.956 -0.239  | 1.000 -0.926 -0.958 -0.958 -0.958 -0.958 -0.958  | 1.000 -0.926 -0.958 -0.958 -0.958 -0.958 -0.822  | 0.999 -0.906 -0.925 -0.953 -0.954 -0.955 -0.718  |
Outline

1. Mechanism: simple model

2. Empirical evidence
   ○ Aggregate: Wage rigidity $\Rightarrow$ cash flow fluctuations
   ○ Industry level: labor share amplifies fluctuations

3. DMP model w/ financial constraints & incumbents’ wage rigidity.
   ○ Calibration: their interaction can provide substantial amplification.

4. Policy application: stabilization from wage subsidies/payroll taxes
   ○ Marginal subsidies for new hires’ vs. eligibility for incumbents too
Fiscal Policy Application: Wage Subsidies and Payroll Taxes As Stabilization Tools

Introduce payroll tax $x$ on firm side:

$$kv = zn - (1 + x(s)) \Phi - T^x(s) - d + (\Delta B - r(1 - t^B)B^- - rt^B\bar{B}^-),$$

(59)

Payroll tax indexed to labor market tightness deviations from SS with procyclicality parameter $\alpha$:

$$x(s) = \left( \frac{\theta_t}{\theta^{ss}} \right)^{\alpha} - 1.$$

(60)

Three cases (see paper for details):

- **Case I: Cash Flow and Marginal Channels**: baseline.
- **Case II: Marginal Channel Only**: shut off cash flow channel.
- **Case III: Inframarginal, Financial Channel Only**: shut off effects on new hires’ net of tax wages.
$SD(\theta)$ by Countercyclicality of Wage Subsidy $\alpha$ w/ Financial Constraints (Left Axis) and w/o (Right Axis)
Outline

1. Mechanism: simple model

2. Empirical evidence
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   ○ Industry level: labor share amplifies fluctuations

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   ○ Marginal subsidies for new hires’ vs. eligibility for incumbents too
Many open questions and limitations!

- Quantitative role of financial factors in BCs and hence scope for the channel
- Heterogeneity
- Other investment margins
- Alternative driving forces than “productivity”
- Financial channel of wages in labor demand & investment – “Slutsky identity”:

\[
\varepsilon_{n,w}^{\text{Total}} = \varepsilon_{n,w}^{\text{Marginal}} \bigg|_{d\text{Liquidity}=0} - \frac{w_{dn}}{dCF}
\]  

(61)
Cash Flow and Balance Sheet Components (Divided by Trend Gross Value Added)
The Cyclical Comovement of U.S. Capital Expenditure, Hiring, Job Openings, and the Help-Wanted Index

![Diagram showing the cyclical comovement of U.S. capital expenditure, hiring, job openings, and the help-wanted index. The x-axis represents time from 2001q1 to 2016q1, and the y-axis represents log deviations from trend.]
Cash Flow and Investment: Accounting for Heterogeneity/Financial Intermediation

![Graph showing the share of aggregate CapEx financed internally from micro cash flow & w/o financial intermediation (EBITDA), aggregate cash flow & w/ financial intermediation (EBITDA), micro cash flow & w/o financial intermediation (income + dep.), and aggregate cash flow (income + dep.).](image-url)
Robustness Check: Pre-tax Profits

Pre-tax profits (log deviations from trend)
Coeff.: -6.87 (SE: 0.804)
Cash-flow-stabilizing wage fluctuations
Coeff.: -1.40 (SE: 0.168)

Pre-tax profits to payroll trend ratio
Average trend ratio: 0.206
Additional Facts: Cash-Flow-Stabilizing Incremental Wage Movements

(a) Cash Flow to Payroll Trend Ratios

(b) Distribution of Cash-Flow-Stabilizing Incremental Wage Movements

Average trend ratio: 0.463

Density

-0.06 -0.04 -0.02 0.00 0.02 0.04

p10: -0.025, p25: -0.012, p75: 0.013, p90: 0.024
Robustness Checks: Total Liquidity rather than Cash Flow, and Other Sources of Stabilization than Cash Flow (Dividends and Interest)

(c) Fluctuations of Total Liquidity and Total-Liquidity-Stabilizing Incremental Wage Movements

(d) Okun’s Laws for Total Liquidity and Total-Liquidity-Stabilizing Incremental Wage Movements
(e) Fluctuations of Total Liquidity and Total-Liquidity-Stabilizing Incremental Dividend Movements

(f) Okun’s Laws for Total Liquidity and Total-Liquidity-Stabilizing Incremental Dividend Movements

(g) Fluctuations of Total Liquidity and Total-Liquidity-Stabilizing Incremental Interest Expenditure Movements

(h) Okun’s Laws for Total Liquidity and Total-Liquidity-Stabilizing Incremental Interest Expenditure Movements
The Orthogonality of Fundamental Surplus Proxy vs. Standard Labor Income Share

![Graph showing the relationship between DMP fundamental surplus amplification factor (proxy) and Labor share with a regression line. The coefficient is 5.82 with a standard error of 84.093.]
Sensitivity Analysis: Average and New Hires’ Wage Cyclicality (Semi-elasticity w.r.t. the Unemployment Rate) by $\rho$ and for Models with and without Financial Constraints

(i) Average Wages
Sensitivity Analysis: On-Impact Responses to Perfectly Transitory Cash Flow Shocks

(k) Responses as Fraction of the Shock (+1% of Steady State GDP)
References


References II


References IV


References V


References VI


Giupponi, Giulia, Camille Landais, and Alice Lapeyre. 2021. “Should We Insure Workers or Jobs During Recessions?” *Working Paper*.


References VII


References VIII


References


References XI


References XIII


