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); Galusca, 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

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

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

Firm's period-$t$ problem:

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

s.t.

$$n_{s+1} = h_{s+1} + (1 - \delta) n_s \quad \forall s \geq t$$  \hspace{1cm} (2)

$$\Phi_{s+1} = w_{c=s+1} h_{s+1} + (1 - \delta) \Phi_s \quad \forall s \geq t$$  \hspace{1cm} (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:

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

Key insights:

- Standard amplification of hiring depends on the sensitivity of new hires’ wages, \( \frac{dw_{c=t+1}}{dp} \).
- Incumbent workers’ wages \( w_c = \bar{w}_{c \leq t} \forall c \leq t \) 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 Yildirimaz, 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)
  \[ \Rightarrow \text{Firms must finance investment out of current cash flow — adding a constraint to firm's problem} \]

\[
c(h_{t+1}) \leq p_t n_t - \Phi_t. \quad (7)
\]

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

\[
(1 + \tau_t) \cdot c'(h^*_{t+1}) = E_t \sum_{s>t} \beta^{s-t} (1 + \tau_s)(1 - \delta)^{s-(t+1)} (p_s - w_{c=t+1}). \quad (8)
\]

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

\[
c(h^*_{t+1}) = p_t n_t - \Phi_t \quad (9)
\]

\[
= (p_t - \bar{w}_{c\leq t}) \cdot n_t \quad (10)
\]

\[
\Rightarrow \frac{d \ln h^*_{t+1}}{d \ln p} = \frac{1}{hc'} \cdot \frac{p}{p - \bar{w}_{c\leq t}} \cdot \left(1 - \frac{d \bar{w}_{c\leq t}}{dp}\right). \quad (11)
\]
Outline

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   - Industry level: labor share amplifies fluctuations

3. DMP model w/ financial constraints & incumbents’ wage rigidity.
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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: $-454 billion
Debt raised: $474 billion
Dividends paid: $-637 billion
Interest paid: $223 billion
External finance: $-839 billion
Capital expenditure: $2,148 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)

-0.06 -0.04 -0.02 0.00 0.02 0.04

Normalized by value added, deviations from trend

-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

-0.6  -0.3  0.0  0.3  0.6

Vacancies (log deviations from trend)

1950q1  1960q1  1970q1  1980q1  1990q1  2000q1  2010q1  2020q1

Capital expenditure
Vacancies (Help Wanted Index)
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:

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

(14)
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: $1,098 billion (positive)
- Debt raised: $474 billion (positive)
- Dividends paid: $637 billion (negative)
- Interest paid: $223 billion (negative)
- External finance: $839 billion (negative)
- Capital expenditure: $2,148 billion

Cash flow calculations:

\[ \text{Equity raised} + \text{Debt raised} - \text{Dividends paid} - \text{Interest paid} = \text{Capital expenditure} \]
Cash Flow and Cash-Flow-Stabilizing Additional Wage Fluctuations: Time Series

Cash flow (log deviations from trend)

Cash-flow-stabilizing wage fluctuations

1950q1 1960q1 1970q1 1980q1 1990q1 2000q1 2010q1 2020q1
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

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

(15)

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

\[
= -3.28 \cdot 0.463 = -1.52
\]

(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
Cash Flow and Cash-Flow-Stabilizing Additional Wage Fluctuations: Okun’s Laws

Unemployment rate (deviations from trend) vs. Cash flow (log deviations from trend) and Cash-flow-stabilizing wage fluctuations.

- Coeff.: -3.28 (SE: 0.317)
- Coeff.: -1.49 (SE: 0.146)
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

Unemployment rate (deviations from trend)

Coeff.: -6.87 (SE: 0.804)

Coeff.: -1.40 (SE: 0.168)

Average trend ratio: 0.206
Industry-Level Test

Idea:

\[ CF = \frac{y}{p} - \Phi \]  \hspace{1cm} (17)

\[ \frac{d \ln CF}{d \ln p} = \frac{1 - \frac{dw}{dp}}{1 - \frac{\Phi}{y}} \hspace{1cm} (18) \]

= labor share!

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)

Labor share

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
Alternative Labor Share Measure: Labor Costs Over Revenue

Semi-elasticity w.r.t. unemployment rate

Cash flow: Coeff.: -7.29 (SE: 2.397)
Employment: Coeff.: -8.32 (SE: 1.205)
Capital expenditure: Coeff.: -25.34 (SE: 3.028)
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)

Labor share vs. Elasticities w.r.t. labor productivity

Graph showing the relationship between labor share and elasticities for cash flow, employment, and capital expenditure.
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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:

  \[ u_{t+1} = u_t + \delta (1 - u_t) - f(\theta_t) u_t \quad (19) \]

- 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:

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

(21)

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

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

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

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

(22)

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

(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 $d$:

$$V(n^-,\Phi^-,h,B^-;s) = \max_{v,d,B} \left\{ d - \frac{\kappa_d}{2} (d - d^{ss})^2 - \frac{\kappa_B}{2} (B - B^{ss})^2 + \mathbb{E} \beta V(n,\Phi, h^+, B; s^+) \right\}$$  \hspace{1cm} (25)

s.t.:

$$\Phi = w h + (1 - \delta) \left( \frac{w}{w^-} \right)^{1-\rho} \Phi^-$$  \hspace{1cm} (26)

$$n = (1 - \delta) n^- + h$$  \hspace{1cm} (27)

$$h^+ = v q(\theta)$$  \hspace{1cm} (28)

$$kv = pn - \Phi - d + (\Delta B - r(1 - t^B) B^- - rt^B \bar{B}^-)$$  \hspace{1cm} (29)

$$B \leq \bar{B},$$  \hspace{1cm} (30)

$v$: 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 $w_{t,c} = w_{c,c}^\rho \cdot w_{t,t}^{1-\rho}$

$\bar{B}$: debt limit

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

Recall firm’s budget constraint:

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

(31)

Rewrite to highlight demand for external finance:

\[
\begin{align*}
\text{Financing gap} & \\
\iff & \\
\left( \frac{kv}{\text{Investment (Rec. Exp.)}} \right) - \left( \frac{pn - \Phi}{\text{Cash flow}} \right) & = -d + \left( \Delta B - r(1 - t)B^- - rt\tilde{B}^- \right)
\end{align*}
\]

(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

\[ V_d = 0 : \quad \tau = 1 - \kappa^d (d^* - d^{ss}) \]  
\[ V_B = 0 : \quad \tau = (1 + r(1 - t^B)) \mathbb{E} [\beta \tau^+] + \kappa^B (B^* - B^{ss}) + \nu \]  
\[ V_\Phi = 0 : \quad \lambda = -\tau + \mathbb{E} \left[ \beta (1 - \delta) \left( \frac{w^+}{w} \right)^{1-\rho} \lambda^+ \right] \]  
\[ V_n = 0 : \quad \mu = p\tau + \mathbb{E} [\beta (1 - \delta) \mu^+] \]  
\[ V_{h^+} = 0 : \quad \eta = \mathbb{E} [\beta (\mu^+ + \lambda^+ w^+)] \]  
\[ V_v = 0 : \quad \eta = \tau \frac{k}{q(\theta)} \]  

⇒ Hiring, or “zero profit condition:”

\[ \tau \frac{k}{q(\theta)} = \beta^{s-t} \frac{\tau_s (1-\delta)^{s-(t+1)}}{\tau_t} \mathbb{E} [\beta (\mu^+ + \lambda^+ w^+)] \]  
\[ \tau \frac{k}{q(\theta)} = \mathbb{E} \left[ \frac{w^+ + \rho \lambda^{++} (w^{++1-\rho} - w^{++})}{\tau^+} \right] \]
Household’s Problem: Analogous

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

(42)

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

(43)

\[ n = (1 - \delta) n^- + h \]

(44)

\[ h^+ = f(\theta)(1 - n) \]

(45)

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

FOCs/Env Con’s:

\[ V^H_B = 0 : \quad 1 = \mathbb{E} \left\{ \beta (1 + r) \right\} \]

(46)

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

(47)

\[ V^H_n = 0 : \quad \mu^H = -z - f(\theta) \eta^H + \mathbb{E} \left[ \beta (1 - \delta) \mu^{H+} \right] \]

(48)

\[ V^H_{h^+} = 0 : \quad \eta^H = \mathbb{E} \left[ \beta (\lambda^{H+} w^+ + \mu^{H+}) \right] \]

(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:

$$V_n^F(\tilde{w}) = \lambda^F \tilde{w} + \mu^F$$  \hspace{1cm} (50)

$$V_n^H(\tilde{w}) = \lambda^H \tilde{w} + \mu^H$$  \hspace{1cm} (51)

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

$$w = \arg\max_{\tilde{w}} \{ V_n^H(\tilde{w})^\phi V_n^F(\tilde{w})^{1-\phi} \}$$  \hspace{1cm} (52)

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

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

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

Maximize comparability with standard DMP wage:

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

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

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

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

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 $\rho$:

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

○ Present-value neutrality of incumbent’ wages—canonical macro-labor paradigm

○ When $\kappa^d > 0$, firms’ hiring is financially constrained:

\[
kv = pn - \Phi - d + (\Delta B - r(1 - tB)B^- - rtB\tilde{B}^-)
\] (58)

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

⇒ FCs break the neutrality of incumbent workers’ wages/wage rigidity!

⇒ (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>$\zeta$ 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>
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<td>$\phi$ Bargaining power</td>
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<td>$z$ Unemployment flow payoff</td>
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<td>$k$ Vacancy posting cost</td>
<td>0.2149</td>
<td>Normalization $\theta^{ss} = 1$</td>
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<td>$\bar{z}$ Productivity, mean</td>
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<td>$\sigma^e_p$ Productivity innovation, SD</td>
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<td>SD of ALP (quarterly)</td>
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<tr>
<td>$\rho^p$ Productivity, autocorrelation</td>
<td>0.98</td>
<td>Persistence of ALP (quarterly)</td>
<td>0.892</td>
<td>0.901</td>
</tr>
</tbody>
</table>

| $\rho$ (One minus) indexation of incumbents’ wages to new hires’ entry wages | No Wage Rigidity | Wage Rigidity for Incumbent Workers | Relative cyclicality of new to average wages (Figure ??) | 2.5 | 2.5 |
| $t^B$ Tax benefit of debt      | 0.3     | Fraction of periods constraint binding (Figure ??) | " |
| $B$ Borrowing limit            | 0.03    | " |
| $\kappa^B$ Debt adjustment cost| 100     | " |
| $\kappa^d$ Dividend adjustment cost | No Constraints | Financial Constraints | Judge by hiring-cash flow sensitivity (Figure ??) |

Note: Parameter values and targets are the same across all model variants, except for $\kappa^d$ and $\rho$. 
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### Panel E: Financial Constraints, but no Incumbents’ Wage Rigidity

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Calibrating Incumbent Workers’ Wage Rigidity $\rho$ to $\rho$ on Relative Semi-Elasticity of New Hires’ vs. Average Wages

![Graph showing the relationship between wage rigidity parameter $\rho$ and relative semi-elasticity of wages for new hires versus average wages.](image-url)
Sensitivity: Effect of $\rho$ on the SD of Labor Market Tightness

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

Standard deviation of labor market tightness $\theta$

Wage rigidity parameter $\rho$

Calibration
Sensitivity: Dividend Adjustment Cost Parameter $\kappa^d$

- 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

Cost of dividend adjustment $\kappa^d$
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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:

$$kv = zn - (1 + x(s))\Phi - T^x(s) - d + \left( \Delta B - r(1 - t^B)B^- - rt^B\tilde{B}^- \right), \quad (59)$$

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

$$x(s) = \left( \frac{\theta_t}{\theta^{ss}} \right)^\alpha - 1. \quad (60)$$

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)
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Conclusion: The Interaction of Wage Rigidity & Financial Constraints

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”:

\[
\varepsilon_{n,w}^{\text{Total}} = \varepsilon_{n,w}^{\text{Marginal}} \bigg|_{d\text{Liquidity}=0} - \frac{wdn}{dCF} \tag{61}
\]
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
Cash Flow and Investment: Accounting for Heterogeneity/Fin Intermediation
Robustness Check: Pre-tax Profits

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

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
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

Coeff.: 5.82 (SE: 84.093)
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

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- 1970 vs. 1968
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Industry-Level Recession Case Studies: Employment

Rearrangements:
- 1970 vs. 1968
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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
Sensitivity Analysis: On-Impact Responses to Perfectly Transitory Cash Flow Shocks

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


References II


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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 VIII


References X


References XII


References XIII


