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Temporary Layoffs, Loss-of-Recall, and Cyclical Unemployment Dynamics

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Macroeconomics of Labor Markets

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What We Do (1/2)

- Document the contribution of temporary layoffs (TL) to unemployment dynamics, from 1978 onwards
- Study contribution of "loss-of-recall" to the cyclicality of unemployment
- Develop model of unemployment fluctuations that distinguishes between temporary and permanent separations ...

What We Do (2/2)

- Model allows for two types of unemployment:
  - Jobless unemployment (JL): search for new job
  - Temporary-layoff unemployment (TL): wait for recall

  Worker in u_{TL} moves to u_{JL} if prior job is destroyed (i.e., loss-of-recall)
- Calibrate model to dynamics of jobless and temporary-layoff unemployment using CPS, 1979-2019
- Adapt the model to study the Covid-19 labor market

Why We Do It (1/2)

Revisit recessionary impact of temporary layoffs

- Stabilizing "direct" effect: recalls $\downarrow \Rightarrow u_{TL} \uparrow$
  - Workers in u_{TL} return to work faster than workers in u_{JL}
  - Thus, TL's are stabilizing relative to permanent separations
  - Traditional view
- De-stablizing "indirect" effect: loss-of-recall $\uparrow \Rightarrow u_{JL} \uparrow$
  - Workers move from u_{TL} to u_{JL} at a higher rate during recessions
  - We estimate *JL*-from-*TL* to be countercyclical and highly volatile

Note: recall and loss-of-recall are endogenous and thus *policy-dependent*

Why We Do It (2/2)

- Onset of Covid-19 pandemic: surge of temporary layoffs
  - First month: 15% of employed workers move to u_{TL}
  - u_{TL} remains persistently high thereafter (across all sectors)
- Fiscal response: Paycheck Protection Program (PPP)
  - Forgivable loans for firms to recall workers
  - $953-billion program— larger than 2009 Recovery Act
- What role did PPP play in shaping employment recovery?
  - What is the no-PPP counterfactual? Require structural model
- Our findings: Large monthly reductions in u_{JL} due to PPP
  - $\approx$ 2 p.p. in short-run, $\geq$ 1 p.p. thru May 2021
  - Achieved by preventing loss-of-recall

Plan

- Empirics of temporary-layoff unemployment
- Model (three stocks, five flows)
- Model evaluation

and then

- Application to Covid-19 Recession

Empirics of Temporary-Layoff Unemployment & “Loss-of-Recall”

Empirics of Loss-of-Recall

1. u_{TL} comprises just 1/8 of total unemployment (u)

Table: Unemployment, jobless unemployment, and temporary-layoff unemployment

	$U =$ $JL + TL$	JL	TL
mean(x)	0.062	0.054	0.008
std(x)/std(Y)	8.518	8.532	10.906
corr(x, Y)	−0.848	−0.810	−0.788

CPS, 1978-2009. For second and third row, series are taken as (1) quarterly averages of seasonally adjusted monthly series, (2) logged, (3) HP-filtered with smoothing parameter 1600

Empirics of Loss-of-Recall

1. u_{TL} comprises just 1/8 of total unemployment (u)
2. But look at flows: E-to-TL's account for 1/3 of all separations to u

Table: Gross worker flows, 1978–2019

	To			
From	*E*	*TL*	*JL*	*I*
E	0.955	0.005	0.011	0.029
TL	0.435	0.245	0.191	0.129
JL	0.244	0.022	0.475	0.259
I	0.043	0.001	0.027	0.929

Empirics of Loss-of-Recall

1. u_{TL} comprises just 1/8 of total unemployment (u)
2. But look at flows: E-to-TL's account for 1/3 of all separations to u
3. And, JL-from-TL's return to employment at substantially lower rate

Table: Transitions from JL, TL, and JL-from-TL (1978–2019)

	To			
From	*E*	*TL*	*JL*	*I*
JL, unconditional	0.244	0.022	0.475	0.259
TL, unconditional	0.435	0.245	0.191	0.129
JL-from-*TL*	0.271	0.000	0.556	0.173

Empirics of Loss-of-Recall

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4. E-to-TL's are particularly important during recessions:

Table: Cyclical properties, gross worker flows

	$p_{E,TL}$	$p_{E,JL}$	$p_{TL,E}$	$p_{JL,E}$	$p_{TL,JL}$
std(x)/std(Y)	11.264	4.962	6.609	7.126	10.084
corr(x, Y)	−0.393	−0.674	0.599	0.803	−0.192

CPS, 1978-2009. Series are taken as (1) quarterly averages of seasonally adjusted monthly series, (2) logged, (3) HP-filtered with smoothing parameter 1600

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Direct effect: $p_{E,TL} \uparrow$ & $p_{TL,E} \downarrow \Rightarrow u_{TL} \uparrow$

Indirect effect: $p_{E,TL} \uparrow$ & $p_{TL,JL} \uparrow \Rightarrow u_{JL\text{-from-}TL} \uparrow$

Empirics of Loss-of-Recall

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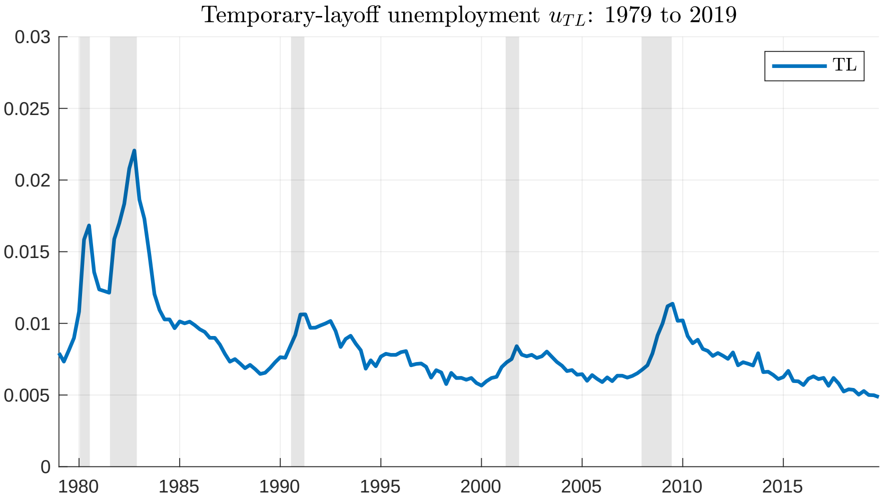
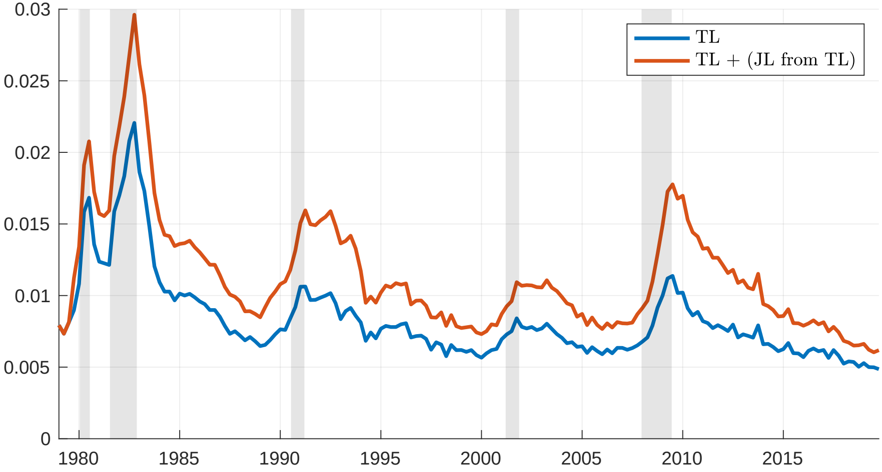
4. E-to-TL's are particularly important during recessions:
   4.1 More employed workers are put on TL
   4.2 Fewer workers from u_{TL} are recalled to employment
   4.3 More workers move from u_{TL} to u_{JL} (loss-of-recall)
5. We develop methods to estimate the *indirect effect*, i.e. JL-from-TL

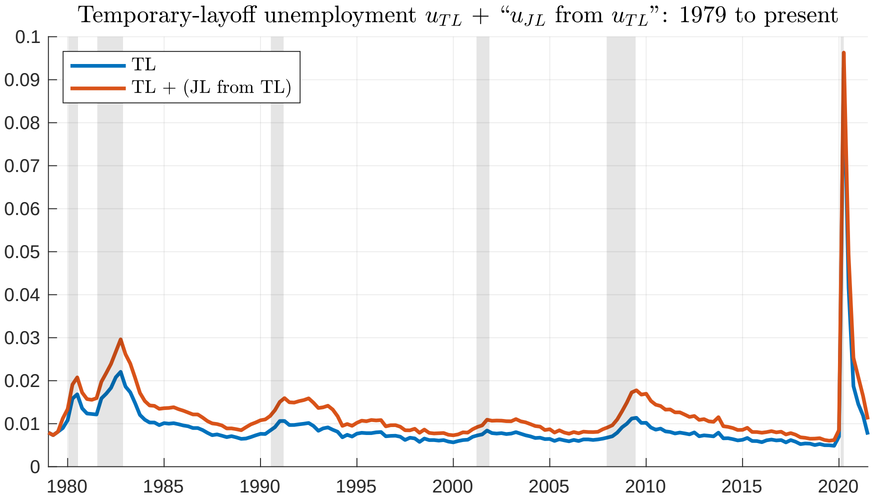
Direct effect: $p_{E,TL} \uparrow \& \; p_{TL,E} \downarrow \Rightarrow u_{TL} \uparrow$

Indirect effect: $p_{E,TL} \uparrow \& \; p_{TL,JL} \uparrow \Rightarrow u_{JL\text{-from-}TL} \uparrow$


Temporary-layoff unemployment u_{TL}: 1979 to 2019
0.03
0.025
0.02
0.015
0.01
0.005
0
1980
1985
1990
1995
2000
2005
2010
2015
TL

Temporary-layoff unemployment u_{TL} + "u_{JL} from u_{TL}": 1979 to 2019

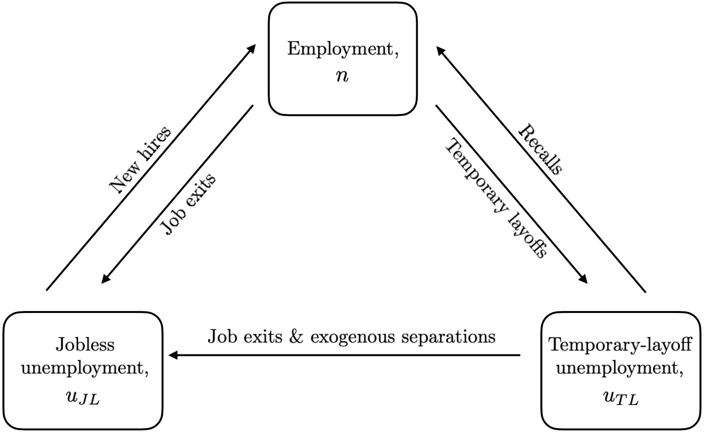




Temporary-layoff unemployment u_{TL} + "u_{JL} from u_{TL}": 1979 to present
TL
TL + (JL from TL)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1980
1985
1990
1995
2000
2005
2010
2015
2020

Model

Model



Employment,
n
New hires
Job exits
Temporary layoffs
Recalls
Jobless
unemployment,
u_{JL}
Job exits & exogenous separations
Temporary-layoff
unemployment,
u_{TL}

Model

Starting point: RBC model with search and matching

- Perfect consumption insurance
- Wage rigidity via staggered Nash wage bargaining

Key variations:

- Endog. separations into temporary-layoff unemp.
- Recall hiring from temporary-layoff unemployment
- Endogenous separations into jobless unemployment
  - Allow for temporary paycuts: no inefficient separations
  - Permanent sep. triggers $u_{TL} \rightarrow u_{JL}$ for some workers
- Hiring from jobless unemployment

Details of Model

- Unemployed are either in

  JL: Searching for work in a DMP-style matching market

  TL: Waiting for recall or loss-of-recall

- Firms, w/ CRS technology in labor and capital, draws cost shocks
  - Overhead costs to entire firm $\Rightarrow$ separations to JL and JL-from-TL
  - Worker-specific overhead costs $\Rightarrow$ separations to TL

- After separations: firms rent capital, hire from JL, and recall from TL

- Base wages set via staggered Nash bargaining
  - But temporary paycuts avoid inefficient exit

Model: full slides

Firm's Problem

- Start of period, aggregate & worker shocks revealed.
- Then,
  1. Temporary layoffs: Firms assigns $1 - \mathcal{F}(\vartheta^*)$ workers to u_{TL}
  2. Permanent separations: Common shock γ within firm
     - Firm exits if $\gamma \geq \gamma^*$, workers and TL's move to u_{JL}
     - Otherwise, firm continues
  3. Continuing firms operate:
     - Rents capital and produces output
     - Hires workers from u_{JL}, recalls workers from u_{TL}
     - Possibility of temporary paycuts, i.e. remitted wages $\omega < w$
- Solve backwards

Firm Problem (at non-exiting firms w/ TL policy ϑ^*)

Let $J(w, \gamma, \mathbf{s})$ be firm's value per worker after TL's and exits. Then,

$$
\begin{aligned}
J(w, \gamma, \mathbf{s}) = \max_{k, x, x_r} \Big\{ & z\mathcal{F}(\vartheta^*)\breve{k}^{\alpha} - \omega\left(w, \gamma, \mathbf{s}\right)\mathcal{F}(\vartheta^*) - r\mathcal{F}(\vartheta^*)\breve{k} \\
& - \left(\iota(x)\mathcal{F}(\vartheta^*) + \iota_r(x_r)\mathcal{F}(\vartheta^*)\right) - \varsigma(\vartheta^*, \gamma) \\
& + \mathbb{E}\Big\{\Lambda(\mathbf{s}, \mathbf{s}')\mathcal{J}\left(w', \mathbf{s}'\right)|, w, \mathbf{s}\Big\}\Big\},
\end{aligned}
$$

with

$$\varsigma(\gamma, \vartheta^*) = \varsigma_{\gamma}\gamma + \varsigma_{\vartheta}\int^{\vartheta^*} \vartheta d\mathcal{F}(\vartheta)$$

$$\iota(x) = \chi x + \frac{\kappa}{2}\left(x - \tilde{x}\right)^2 \quad \iota_r(x_r) = \chi x_r + \frac{\kappa_r}{2}\left(x_r - \tilde{x}_r\right)^2$$

$$\mathcal{J}(w, \mathbf{s}) = \max_{\vartheta^*}\int^{\gamma^*} J(w, \gamma, \mathbf{s})d\mathcal{G}(\gamma)$$

Hiring and Recall (at non-exiting firms w/ policy ϑ^*)

- FOC's for hiring and recall:

$$\chi + \kappa\left(x - \tilde{x}\right) = \mathbb{E}\left\{\Lambda(\mathbf{s},\mathbf{s}')\mathcal{J}\left(w',\mathbf{s}'\right)|w,\mathbf{s}\right\}$$

$$\chi + \kappa_r\left(x_r - \tilde{x}_r\right) = \mathbb{E}\left\{\Lambda(\mathbf{s},\mathbf{s}')\mathcal{J}\left(w',\mathbf{s}'\right)|w,\mathbf{s}\right\}$$

- Calibrated model (and data):

$$\underbrace{\left(\frac{\chi_r}{\kappa_r\tilde{x}_r}\right)}_{\text{Recall elasticity}} > \underbrace{\left(\frac{\chi}{\kappa\tilde{x}}\right)}_{\text{Hiring elasticity}}$$

- Relation of $\{x, x_r\}$ to job-finding/recall probabilities $\{p, p_r\}$:

$$x = \frac{p u_{JL}}{\mathcal{F}(\vartheta^*)n}, \quad x_r = \frac{p_r u_{TL}}{\mathcal{F}(\vartheta^*)n}$$

Firm Exits (and Temporary Paycuts)

- Given cost shock γ and base wage w, allow temp. paycuts to avoid exit
- Shutdown threshold γ^* solves $J(\underline{w}, \gamma^*, \mathbf{s}) = 0$
  - $\underline{w} \equiv$ reservation wage
- Paycut threshold $\gamma^\dagger \in (0, \gamma^*)$ solves $J(w, \gamma^\dagger, \mathbf{s}) = 0$
  - Zero firm surplus for $\gamma \in (\gamma^\dagger, \gamma^*)$
- Firm's active laborforce $+$ workers on TL go to u_{JL} upon exit

Temporary layoffs

- Firm must pay overhead costs to continue to operate:

$$\varsigma(\gamma, \vartheta^*) = \varsigma_\gamma \gamma + \varsigma_\vartheta \int^{\vartheta^*} \vartheta d\mathcal{F}(\vartheta)$$

- FOC for optimal θ^* determines TL threshold:

$$\underbrace{\mathcal{J}(w, \mathbf{s}) + \varsigma_\gamma \Gamma + \varsigma_\vartheta \mathcal{G}(\gamma^*) \Theta}_{\text{Job value net of period overhead costs}} = \varsigma_\vartheta \vartheta^* \mathcal{F}(\vartheta^*) \mathcal{G}(\gamma^*)$$

with $\Gamma \equiv \int^{\gamma^*} \gamma d\mathcal{G}(\gamma)$ and $\Theta \equiv \int^{\vartheta^*} \vartheta d\mathcal{F}(\vartheta)$.

Model Evaluation

Calibration

- Calibrate model to match standard labor market stocks and flows…
  - Plus characteristics of temporary layoff, recall, and loss-of-recall
- Nested, two-stage estimation of 16 parameters
  - Inner loop: long-run moments
  - Outer loop: business cycle features

▸ Parameters and moments

- Where we tie our hands:
  - Not a small-surplus calibration
  - Wage rigidity to match evidence on contract duration
  - Temporary paycuts can undo wage rigidity
- Model does well!

▸ Stocks & Wages ▸ Flows ▸ Loss-of-Recall

Application to the Covid-19 Recession

Adapting the Model to the Covid-19 Recession

- Introduce two shocks:
  - "Lockdown" shocks: workers move to lockdown-TL (MIT shock)
  - Persistent shocks to effective TFP w/ each wave (social distancing)
- Add two parameters specific to workers on lockdown-TL:
  - Allow for different recall cost (vs. TL)
  - Allow for different rate for loss-of-recall (vs. TL)
- Treatment of PPP:
  - Direct factor payment subsidy, à la Kaplan, Moll, Violante (2020)
  - Pre-announcement: program is unexpected
  - Post-announcement: availability of funds is known
- Estimate shocks and parameters to match stocks and flows
  - Model does well! Stocks, model vs. data Flows, model vs. data

No-PPP Counterfactual

Q: What did PPP do?

- Keep decision rules, parameters, and shocks, but remove PPP

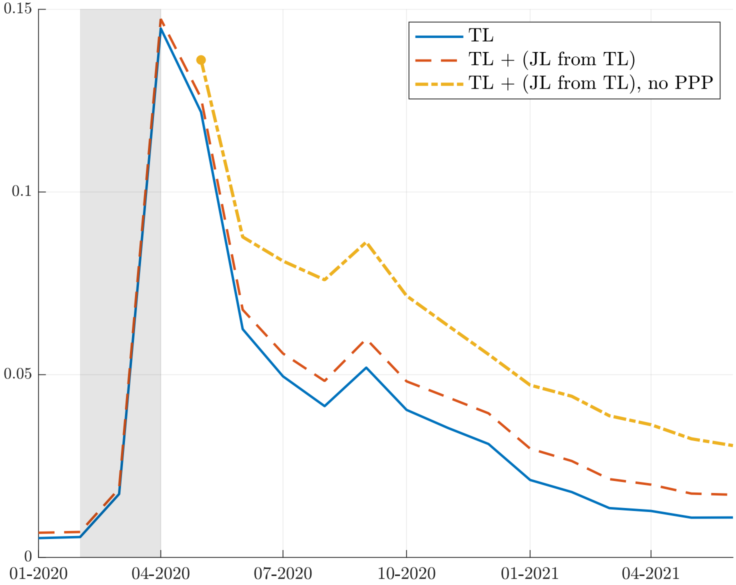
A: Save a lot of worker/job matches!

- Average monthly empl. gains of $\approx$ 2.14 p.p. in first 6 months
- Doubles number of recalls over the same period
- Achieved through reduction of loss-of-recall

▸ Stocks, no-PPP counterfactual

▸ Flows, no-PPP counterfactual

Counterfactual: JL-from-TL without PPP



Conclusion

Concluding Remarks

Two Directions for Further Work

1. Match-specific capital
   - Recalls preserve match-specific capital
   - Thus, interesting to consider heterogenous match quality
2. Reallocation
   - Evidence that smaller firms benefited more from PPP
   - PPP might have hindered efficient reallocation

Supplementary Slides

Estimating JL-from-TL

- Use accumulation equations:

$$u_{JL\text{-from-}TL,t} = \sum_{j=0}^{T} e'_{JL} x_{t-j-1,t}$$

where $x_{t-j-1,t}$ is the distribution of workers at time t whose last exit from employment was for u_{TL} at time $t-j-1$, s.t.

$$x_{t-m,t-j} = \tilde{P}_t x_{t-m,t-j-1}$$
$$x_{t-m,t-m} = e_{TL} \cdot (n^{E}_{t-m-1} \cdot p^{E,TL}_{t-m})$$

- Relatively small: $u_{JL\text{-from-}TL}$ is 40% of u_{TL}
- Highly volatile: twice as volatile as total unemployment, $16\times$ as GDP

Model: Full Slides

Searchers, Matching and Recalls

- Jobless unemployment (DMP matching market)
  - New hires m from unemployment

$$m = \sigma_m (u_{JL})^{\sigma} (\upsilon)^{1-\sigma}$$

  - Job finding and hiring probabilities p and q, hiring rate x

$$p = \frac{m}{u_{JL}}, \quad q = \frac{m}{\upsilon}, \quad x = \frac{p \cdot u_{JL}}{\mathcal{F}(\vartheta^*) n} = \frac{q \cdot \upsilon}{\mathcal{F}(\vartheta^*) n}$$

- Temporary-layoff unemployment
  - Recalls m_r from TL unemp., recall hiring rate x_r

$$m_r = p_r u_{TL}, \quad x_r = \frac{p_r u_{TL}}{\mathcal{F}(\vartheta^*) n}$$

  - Workers in u_{TL} move to u_{JL} with exog. probability $1 - \rho_r$
    - or if firm exits (with prob. $1 - \mathcal{G}(\gamma^*)$)

Firms (or plants, shifts, production unit, etc.)

- Firms are “large”, i.e hire a continuum of workers
  - Firm, or establishment, or assembly line, etc.
- CRS technology
  - $n \equiv$ beginning of period employment
  - $\mathcal{F} \equiv$ fraction of workers not on temporary layoff
  - $\xi_k, \xi_n \equiv$ factor utilization rates

$$
\begin{aligned}
y &= \check{z}(\xi_k k)^{\alpha}(\xi_n \mathcal{F} n)^{1-\alpha} \\
&= z k^{\alpha}(\mathcal{F} n)^{1-\alpha}
\end{aligned}
$$

- Given CRS technology, firm decisions scale independent

Overhead Costs: Temporary versus Permanent Layoffs

$\gamma \equiv$ *i.i.d* firm specific cost shock

$\vartheta \equiv$ *i.i.d.* worker-specific cost shock

- Non-exiting firms ($\gamma < \gamma^*$) pay overhead costs to operate:

$$\varsigma(\gamma, \vartheta^*)n = \left[\varsigma_\gamma \gamma + \varsigma_\vartheta \int^{\vartheta^*} \vartheta d\mathcal{F}(\vartheta)\right] n$$

$$\mathcal{F}(\vartheta^*) = \Pr\{\vartheta \leq \vartheta^*\} \qquad \mathcal{G}(\gamma^*) = \Pr\{\gamma \leq \gamma^*\}$$

- Temporary layoff: each worker draws ϑ
  - Workers w/ $\vartheta \geq \vartheta^*$ (endog. thresh.) go on temporary layoff
- Permanent layoff: firms draws γ
  - Firm operates if $\gamma < \gamma^*$ (endog. thresh.); otherwise exits

Timing of Events

1. Firm enters period with stock of workers n
2. Aggregate & worker-specific shocks revealed
3. Firms and workers bargain over base wages w
4. Firms assigns $1 - \mathcal{F}(\vartheta^*)$ workers to temporary layoff,
5. Firm-specific shock γ revealed
   - If $\gamma \geq \gamma^* \rightarrow$ firm exits, workers move to u_{JL}
     - Firm's workers in u_{TL} move to u_{JL}
   - If $\gamma < \gamma^* \rightarrow$ firm continues
     - Rents capital and produces output
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Solve backwards

Behind the Timing

- Timing accomplishes the following:
  1. Temporary layoff policy ϑ^* independent of γ
     - Tractability
  2. Base wages are independent of γ
     - Tractability
  3. Firm cannot cut wages to avoid temporary layoffs
     - Consistent with data
- (1) and (2) achieved by mid-period realization of γ
- (3) achieved by separation of temporary layoffs and bargaining

Firm Problem (at non-exiting firms w/ TL policy ϑ^*)

$$
\begin{aligned}
J(w,\gamma,\mathbf{s}) = \max_{k,x,x_r} \Big\{ & z\mathcal{F}(\vartheta^*)\breve{k}^{\alpha} - \omega\left(w,\gamma,\mathbf{s}\right)\mathcal{F}(\vartheta^*) - r\mathcal{F}(\vartheta^*)\breve{k} \\
& - \left(\iota(x)\mathcal{F}(\vartheta^*) + \iota_r(x_r)\mathcal{F}(\vartheta^*)\right) - \varsigma(\vartheta^*,\gamma) \\
& + \mathbb{E}\left\{\Lambda(\mathbf{s},\mathbf{s}')\mathcal{J}\left(w',\mathbf{s}'\right)|,w,\mathbf{s}\right\}\Big\},
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$$

with

$$\varsigma(\gamma,\vartheta^*) = \varsigma_\gamma\gamma + \varsigma_\vartheta\int^{\vartheta^*}\vartheta d\mathcal{F}(\vartheta),$$

$$\iota(x) = \chi x + \frac{\kappa}{2}\left(x - \tilde{x}\right)^2, \quad \iota_r(x_r) = \chi x_r + \frac{\kappa_r}{2}\left(x_r - \tilde{x}_r\right)^2,$$

$$\mathcal{J}(w,\mathbf{s}) = \max_{\vartheta^*}\int^{\gamma^*} J(w,\gamma,\mathbf{s})d\mathcal{G}(\gamma),$$

Hiring Conditions (at non-exiting firms w/ policy ϑ^*)

- Let $J(w,\gamma) \equiv F(n,w,\gamma)/n$ be the firm value per worker

$$\chi + \kappa(x - \tilde{x}) = \mathbb{E}\{\Lambda(\mathbf{s},\mathbf{s}')\mathcal{J}(w',\mathbf{s}')|w,\mathbf{s}\}$$

$$\chi + \kappa_r(x_r - \tilde{x}_r) = \mathbb{E}\{\Lambda(\mathbf{s},\mathbf{s}')\mathcal{J}(w',\mathbf{s}')|w,\mathbf{s}\}$$

- $\frac{\chi}{\kappa x}, \frac{\chi}{\kappa_r x_r} \equiv$ elasticities of x, x_r w/r.t. J

- Link between x_r and recall rate p_r: $x_r = \frac{p_r u_{TL}}{\mathcal{F}(\vartheta^*)n}$

Temporary Layoffs

- Temporary layoffs $= (1 - \mathcal{F}(\vartheta^*))\,\mathcal{G}(\gamma^*)n$

- TL threshold ϑ^* maximizes $\int^{\gamma^*} J(w, \gamma, \mathbf{s})d\mathcal{G}(\gamma)$:

$$\mathcal{J}(w, \mathbf{s}) + \varsigma_\gamma \Gamma + \varsigma_\vartheta \mathcal{G}\left(\gamma^*\right)\Theta = \varsigma_\vartheta \vartheta^* \mathcal{F}(\vartheta^*)\mathcal{G}\left(\gamma^*\right)$$

where $\Gamma = \int^{\gamma^*} \gamma d\mathcal{G}(\gamma)$ and $\Theta = \int^{\theta^*} \theta d\mathcal{F}(\theta)$

Shutdowns (permanent layoffs)

- Permanent separations from employment = $(1 - \mathcal{G}(\gamma^*))n$
- Shutdown threshold γ^* solves

$$J\left(\underline{w}, \gamma^*, \mathbf{s}\right) = 0$$

  with $\underline{w} \equiv$ reservation wage

- Paycut threshold $\gamma^\dagger \in (0, \gamma^*)$ solves

$$J(w, \gamma^\dagger, \mathbf{s}) = 0$$

  Paycuts for $\gamma \in (\gamma^\dagger, \gamma^*)$ (firm gets 0 surplus in this region)

Workers (1/2)

- Value of work

$$V(w,\gamma,\mathbf{s}) = \omega\left(w,\gamma,\mathbf{s}\right) + \mathbb{E}\left\{\Lambda\left(\mathbf{s},\mathbf{s}'\right)\mathcal{V}(w',\mathbf{s}')|w,\mathbf{s}\right\},$$

with

$$\mathcal{V}(w,\mathbf{s}) = \mathcal{F}(\vartheta^*)\left[\int^{\gamma^*} V\left(w,\gamma,\mathbf{s}\right)d\mathcal{G}(\gamma) + \left(1-\mathcal{G}(\gamma^*)\right)U_{JL}(\mathbf{s})\right] + \left(1-\mathcal{F}(\vartheta^*)\right)\mathcal{U}_{TL}(w,\mathbf{s})$$

where

  - $U_{JL}(\mathbf{s})$ is the value of jobless unemployment
  - $\mathcal{U}_{TL}$ is the expected value of temporary-layoff unemployment
  - $\omega(w,\gamma,\mathbf{s})$ are remitted wages

Workers (2/2)

- Value of jobless unemployment

$$U_{JL}(\mathbf{s}) = b + \mathbb{E}\left\{\Lambda(\mathbf{s},\mathbf{s}')\left[p\bar{V}_x(\mathbf{s}') + (1-p)\,U_{JL}(\mathbf{s}')\right]|\mathbf{s}\right\}$$

where $\bar{V}_x$ is the expected value of being a new hire

- Value of temporary-layoff unemployment

$$\begin{aligned} U_{TL}(w,\mathbf{s}) = b + \mathbb{E}\{\Lambda(\mathbf{s},\mathbf{s}')\,[&p_r\mathcal{V}(w',\mathbf{s}') \\ &+ (1-p_r)\,\rho_r\mathcal{U}_{TL}(w',\mathbf{s}') \\ &+ (1-p_r)(1-\rho_r)\,U_{JL}(\mathbf{s}')]\,|w,\mathbf{s}\}\,. \end{aligned}$$

with

$$\mathcal{U}_{TL}(w,\mathbf{s}) = \mathcal{G}(\gamma^*)\,U_{TL}(w,\mathbf{s}) + (1-\mathcal{G}(\gamma^*))\,U_{JL}(\mathbf{s})\,.$$

Staggered Nash Wage Bargaining

- Each period, probability $1 - \lambda$ of renegotiating base wage
- Parties bargain over surpluses prior to realization of γ
  - Worker surplus: $\mathcal{H}(w, \mathbf{s}) \equiv \mathcal{V}(w, \mathbf{s}) - U_{JL}(\mathbf{s})$
  - Firm surplus: $\mathcal{J}(w, \mathbf{s}) \equiv \max_{\vartheta^*} \int^{\gamma^*} J(w, \mathbf{s}) d\mathcal{G}(\gamma)$
- Contract wage w^* solves

$$\max_{w^*} \mathcal{H}(w, \mathbf{s})^{\eta} \mathcal{J}\left(w, \mathbf{s}\right)^{1-\eta}$$

subject to

$$w' = \begin{cases} w \text{ with probability } \lambda \\ w^{*\prime} \text{ with probability } 1 - \lambda \end{cases}$$

and to wage cut policy

Model Evaluation: Full Slides

Calibration: Assigned Parameters

Parameter values		
Discount factor	β	$0.997 = 0.99^{1/3}$
Capital depreciation rate	δ	$0.008 = 0.025/3$
Production function parameter	α	0.33
Autoregressive parameter, TFP	ρ_z	$0.99^{1/3}$
Standard deviation, TFP	σ_z	0.007
Elasticity of matches to searchers	σ	0.5
Bargaining power parameter	η	0.5
Matching function constant	σ_m	1.0
Renegotiation frequency	λ	$8/9$ (3 quarters)

Calibration: Estimated Parameters (inner loop)

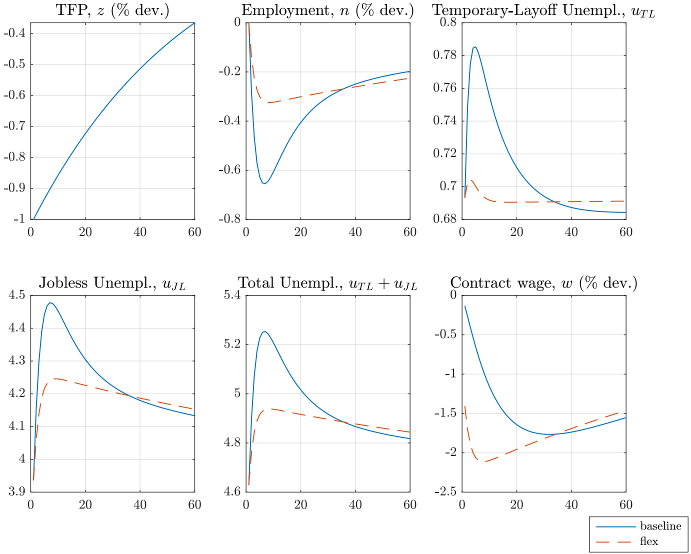
Parameter	Description	Value	Target
χ	Scale, hiring costs	1.0567	Average JL, E rate (0.304)
$\varsigma_{\vartheta} \cdot e^{\mu_{\vartheta}}$	Scale, overhead costs, worker	0.0893	Average E, TL rate (0.005)
$\varsigma_{\gamma} \cdot e^{\mu_{\gamma}}$	Scale, overhead costs, firm	2.0097	Average E, JL rate (0.011)
$1 - \rho_r$	Loss of recall rate	0.3925	Average TL, JL rate (0.210)
b	Flow value of unemp.	0.8848	Rel. value non-work (0.71)

Calibration: Estimated Parameters (outer loop)

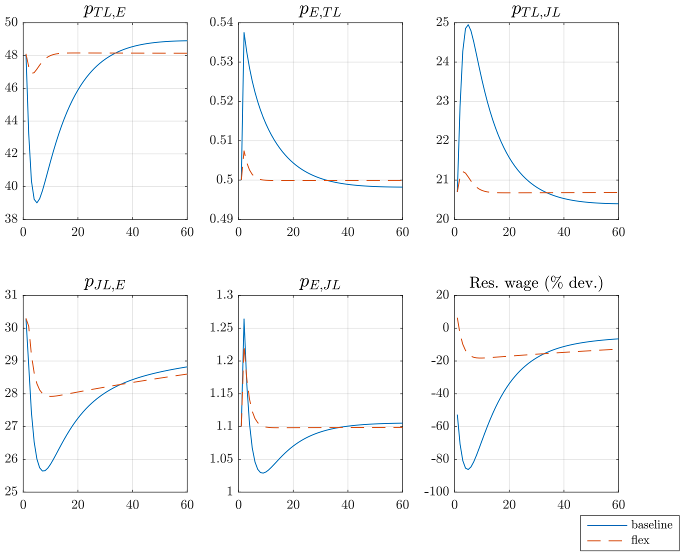
Parameter	Description	Value
$\chi/(\kappa\tilde{x})$	Hiring elasticity, new hires	0.3942
$\chi/(\kappa_r\tilde{x}_r)$	Hiring elasticity, recalls	0.8912
σ_ϑ	Parameter lognormal $\mathcal{F}$	1.4140
σ_γ	Parameter lognormal $\mathcal{G}$	0.3215

Moment	Target	Model
SD of hiring rate	3.304	3.253
SD of total separation rate	6.620	4.707
SD of temporary-layoff unemployment, u_{TL}	10.906	10.969
SD of jobless unemployment, u_{JL}	8.532	10.519
SD of hiring rate from u_{JL} relative to SD of recall hiring rate from u_{TL}	0.445	0.442

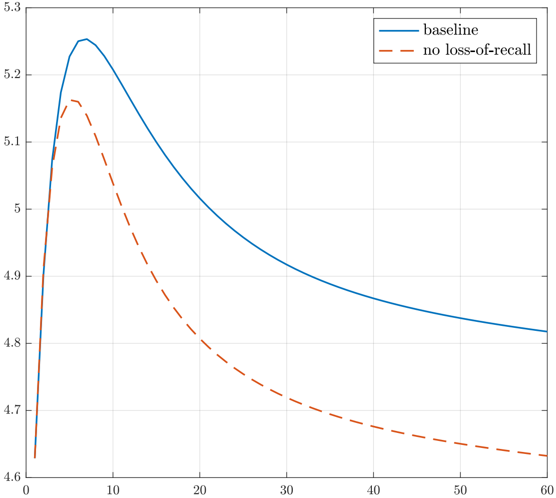
TFP Shock: Employment, Unemployment and Wages



TFP Shock: Transition Probabilities



TFP Shock: Shut off u_{JL} from u_{TL}



Application to PPP: Full Slides

Adapting the Model to the Covid-19 Recession

Introduce series of shocks and two parameters

1. Shocks:
   - "Lockdown" shocks
     - Beginning of period: fraction $1 - \nu$ move to TL unemp
     - Unanticipated (MIT shock)
   - Utilization restrictions on capital and labor
     - Transitory shock at start of pandemic
     - New persistent shock with each Covid wave
   - PPP as factor payment subsidy (as in KMV)
     - PPP 2020: 12.5% of quarterly GDP, most payments May-July 2020
     - PPP 2021: 5.4% of quarterly GDP, most payments Jan-April 2021

Adapting the Model to the Covid-19 Recession, cont.

...

2. Two parameters:
   - (Possibly) reduced recall costs for workers in lockdown

$$\chi x_r + \frac{\kappa_r}{2}\left(x_r - \xi \underbrace{\frac{(1-\phi)u_{TL}}{\mathcal{F}(\vartheta^*)n}}_{\text{Workers on lockdown}} - \tilde{x}_r\right)^2$$

     - $0 \leq \xi \leq 1$
   - Different rate of exog. TL-to-JL for workers on lockdown, $\rho_{r\phi}$

Recession Experiment

- Thus, need to estimate:
  1. Lockdown shocks for each month of pandemic $(+T)$
  2. Size of transitory utilization shock at onset of pandemic $(+1)$
  3. Size of persistent utilization shock for three waves $(+3)$
  4. Autoregressive parameter of persistent utilization shock $(+1)$
  5. Two model parameters $(+2)$
- Moments to match:
  1. Stocks: $\{u_{TL}, u_{JL}\}_\tau$ since onset of pandemic
  2. Gross flows: $\{g_{E,TL},\ g_{TL,E},\ g_{TL,JL}\}_\tau$ since onset
  3. Inflows into u_{JL}: March-April 2020 only
     - To discipline size of transitory shock

Recession Experiment, cont.

- Estimate by SMM:
  - T months of pandemic w/ 3 waves (for now)
    - $(5 \cdot T + 1)$ moments to match
    - $(T + 7)$ parameters to estimate
  - System is highly overidentified

Parameter and Shock Estimates

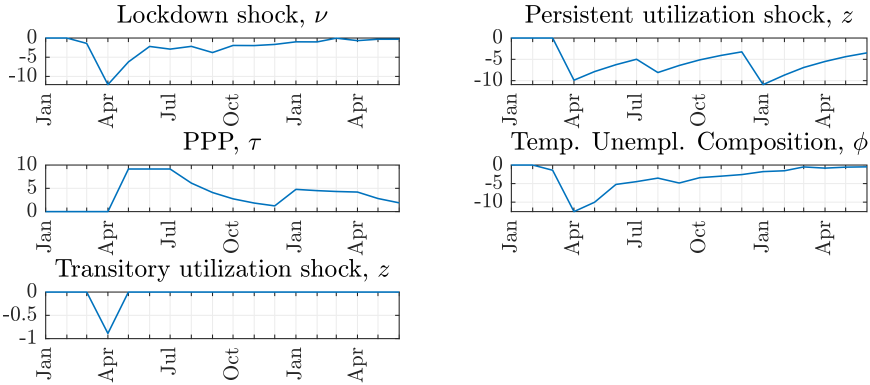
Parameters

Variable	Description	Value
ρ_z	Autoregressive coefficient for persistent utilization shocks	0.7651
ξ	Adjustment costs for workers on lockdown	0.4988
$1 - \rho_{r\phi}$	Probability of exogenous loss of recall for workers in temporary unemployment	0.6329

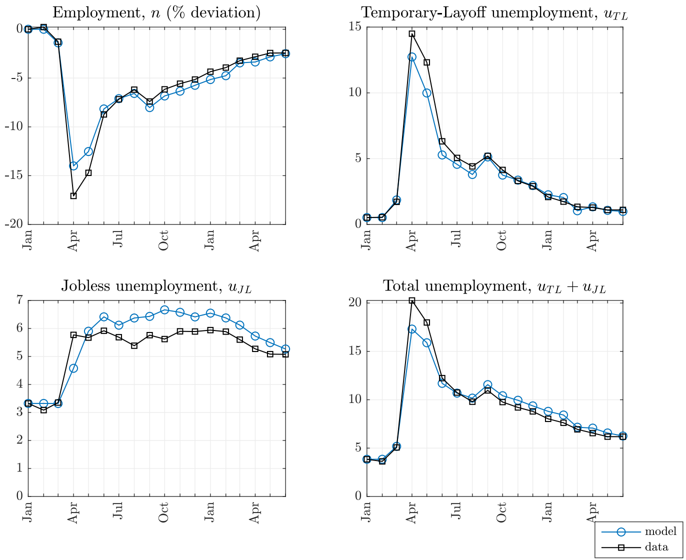
Shocks

Description	Value
Persistent utilization shock, April 2020	-10.28%
Transitory utilization shock, April 2020	-0.90%
Persistent utilization shock, September 2020	-4.23%
Persistent utilization shock, January 2021	-9.56%

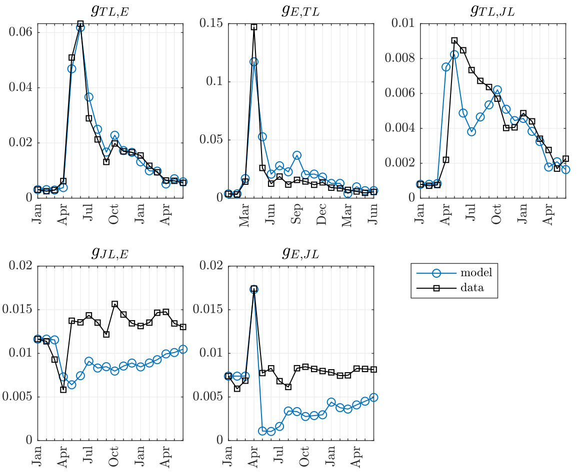
Parameter and Shock Estimates, cont.



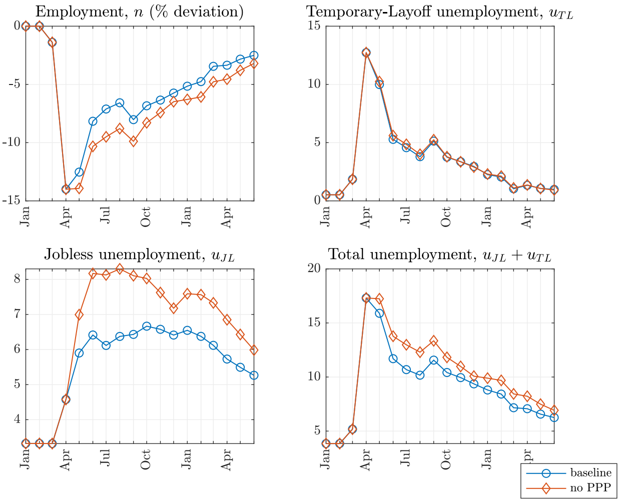
Covid Onset, Stocks



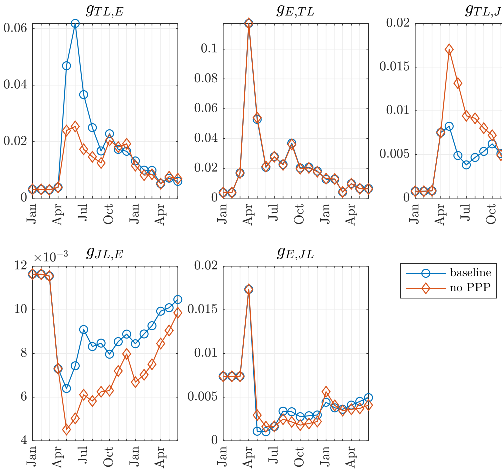
Covid Onset, Gross Flows



Policy Counterfactual: No PPP, stocks



Policy Counterfactual: No PPP, flows



PPP takeaway

- PPP achieved sizeable employment gains
- Immediate term: May to September 2020
  - Achieved average monthly employment gains of 2.14%
  - Doubled cumulative recalls
- Longer term
  - Smaller persistent employment gains
  - Avg. monthly empl. at least 1% higher through May 2021
- Employment gains came from recalls
  - PPP preserved ties btwn firms and workers in u_{TL}
  - Fulfilled mandate