Unemployment Insurance, Precautionary Savings, and Fiscal Multipliers

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Introduction

- **Unemployment insurance (UI) duration** systematically extended during bad times in the US
  - A four-fold increase during Great Recession and a three-fold increase during pandemic
  - Stands out as one of the main countercyclical stabilization measures

- **Opposing effects of UI extensions** on unemployment:
  - Supply: increase wages and depress hiring, moral hazard
  - Demand: increase transfers to high-MPC unemployed and reduce precautionary savings

- **Mixed results in the literature** leave debate unsettled
  - Contractionary effects: Hagedorn *et al.* (2019), Johnston and Mas (2018)
  - Expansionary or non-negative effects: Di Maggio and Kermani (2016),Chodorow-Reich *et al.* (2018),Boone *et al.* (2021), Dieterle *et al.* (2020)

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What we do

- We reconsider the **macroeconomic stabilization consequences of UI extensions**
  - Propose a new identification scheme based on non-linear design of UI policy
  - Use macroeconomic model to rationalize and extend empirical results

- **Identification based on the non-linear design of UI policy**

  → **UI duration response to falling unemployment depends on pre-existing length of UI**, e.g.

  - UI regular duration irrespective of state-level conditions
    - → Falling unemployment in state with regular UI will not change UI duration
  - UI additional extensions depend state-level unemployment
    - → Same fall in unemployment in state with extended UI can cut UI duration
  - Can apply similar logic to states that have *different lengths* of additional UI extensions
    - E,g. Regular UI provides a floor for UI duration

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- We implement this by estimating **local fiscal multipliers conditional on UI duration**
  - Gov't spending shock – demand shock – changes unemployment and hence UI duration
  - Variation in fiscal multipliers across levels of UI duration infers effects of UI extensions

- We find **UI extensions provide cushion against state-level shocks** (G shocks):
  - Gov't spending crowds out UI in line with identification idea
  - **Fiscal multipliers lower when UI duration extended**
  - Results unlikely to be driven by size of recession or unobserved state-level characteristics

- **Model of small-open-economy that incorporates main channels**
  - Model accounts well for empirical results
  - We use the model to recover a **UI multiplier** ≈ 1.2
  - We use the model to **quantify channels** affecting UI multiplier
    - Within demand-side channels: insurance $\geq$ transfers to high-MPC hhs.

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Related Literature

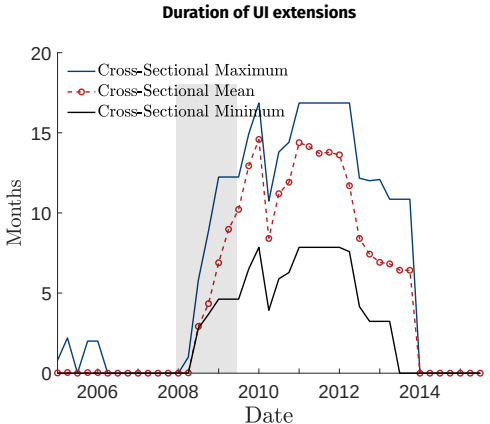
- **Macro effects of UI benefits**:
  - **Empirics**: Chodorow-Reich *et al.* (2018); Hagedorn *et al.* (2019); Di Maggio and Kermani (2016); Boone *et al.* (2021); Johnston and Mas (2018); Dieterle *et al.* (2020)
  - **Theory**: Kekre (2021); McKay and Reis (2021); Gorn and Trigari (2021); Mitman and Rabinovich (2019); Krusell *et al.* (2010); Jung and Kuester (2015); Landais *et al.* (2018); Gorn and Trigari (2021)
- **Fiscal multipliers**:
  - **Aggregate**: Ramey and Zubairy (2018); Ramey (2011); Auerbach and Gorodnichenko (2012); Barnichon *et al.* (Forthcoming)
  - **Regional**: Nakamura and Steinsson (2014); Bernardini *et al.* (2020); Dupor *et al.* (2022); Chodorow-Reich *et al.* (2012); Suárez Serrato and Wingender (2016); Acconcia *et al.* (2014); Basso and Rachedi (2021)
- **Open economy with heterogeneous households**: de Ferra *et al.* (2020); Auclert *et al.* (2021); Cugat (2019); Guo *et al.* (2020)

Empirical Strategy

UI Policy & Identification

Unemployment Insurance Duration in the US

- US states: 26 weeks of **regular UI duration**
  - Irrespective of local unemployment
- **UI duration extended** during bad times:
  - EB program: if unemployment above threshold states can obtain additional UI extension of one quarter
  - EUC program (financial crisis): states could get additional UI extension of four quarters depending on unemployment
- Substantial **variation in UI duration across time and states**



Idea behind identification strategy

- Exploit the **non-linear design of UI policy** together with time and cross-sectional variation in UI duration

- Why **UI policy non-linear**?
  - State with **extended UI** can reduce UI duration if unemployment falls
  - State with **regular UI** cannot in response to same fall in unemployment
  - **Conditional on UI extended**, there can be cross-sectional variation in UI response
    - E.g. Regular UI provides **floor**: states with longer UI duration can reduce UI by more

Idea behind identification strategy

Consider two states **A** and **B** to fix ideas:

- Unemployment in **A** temporarily higher: **A** has extended UI and **B** has regular UI
- Same demand shock (e.g. G_t) hits both **A** and **B** reducing unemployment
  - Effect on output in **A** = effect of G_t + effects of cutting UI duration
  - Effect on output in **B** = effect of G_t
- Can apply similar logic if **B** also has extended UI, but different from **A**:
  - E.g. regular UI as floor: size UI duration cut in A $\neq$ size UI duration cut in B
- Implementation: estimate **fiscal multipliers** is US states with different levels of **UI duration**

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Data

Data

- **Quarterly regional US dataset** from Regional Economic Accounts of BEA
  - Quarterly GDP and government value added at state-level
  - Gov. value added: spent within the region, excludes UI benefits
- **Government spending shocks** as in Blanchard and Perotti (2002):
  - Government spending predetermined within the quarter
- **UI benefits extensions**:
  - Actual additional UI duration for each US state (Chodorow-Reich *et al.*, 2018)
- **Sample period**: 2005Q1 - 2015Q4

Effects of Gov't Spending on UI duration

Government Spending crowds out UI

Key in our approach: G_t induces UI duration changes

1. Estimate the **response of UI duration to gov. spending** by LPs (Jordà, 2005):

$$\log \text{UI Duration}_{i,t+h} = \beta_h \log G_{i,t} + \gamma_h(L) Z_{i,t-1} + \alpha_{i,h} + \delta_{t,h} + \varepsilon_{i,t+h}, \quad h \geq 0,$$

- $G_{i,t}$: Gov't spending in state i
- $Z_{i,t}$: lags of $\{G, Y, \text{UI Duration}\}$
- $\alpha_{i,h}$, $\delta_{t,h}$: state & time fixed-effects

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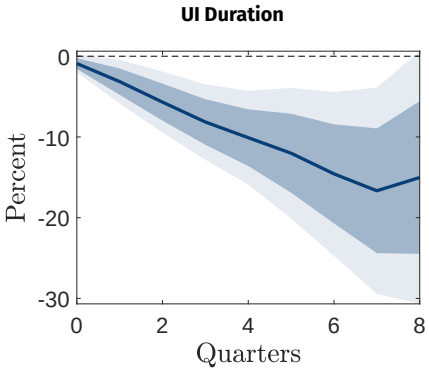

Government Spending crowds out UI – High vs. Low UI Duration

2. Conditionally on UI extended, **states with longer UI duration respond more**:

$$\begin{aligned}\log \text{UI Duration}_{i,t+h} = {} & \beta_h \log G_{i,t} + \gamma_h(L) Z_{i,t-1} + \alpha_{i,h} + \delta_{t,h} \\ & + \mathbb{I}^{HT}_{i,t-1}\left(\beta^{HT}_h \log G_{i,t} + \gamma^{HT}_h(L) \log Z_{i,t-1}\right) \\ & + \mathbb{I}^{LT}_{i,t-1}\left(\beta^{LT}_h \log G_{i,t+h} + \gamma^{LT}_h(L) \log Z_{i,t-1}\right) + \varepsilon_{i,t+h}\end{aligned}$$

- $\mathbb{I}^{HT}_{i,t-1} = 1$: UI extended and $>$ median
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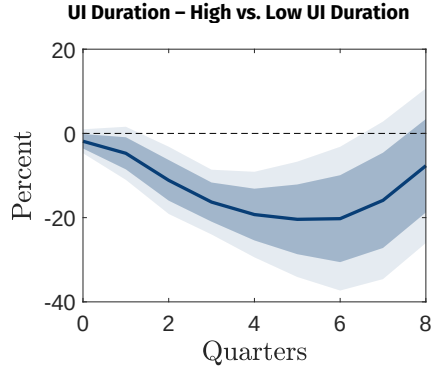

Fiscal Multipliers & UI duration

Empirical Specification – Fiscal Multipliers

- Estimate **local fiscal multipliers** using state-dependent LPs (Jordà, 2005; Ramey and Zubairy, 2018)

$$\sum_{h=0}^{H} Y_{i,t+h} = \beta_h \sum_{h=0}^{H} G_{i,t+h} + \gamma_h(L) Z_{i,t-1} + T^*_{i,t-1}\left(\beta_h^{UI} \sum_{h=0}^{H} G_{i,t+h} + \gamma_h^{UI}(L) Z_{i,t-1}\right) + \alpha_{i,h} + \delta_{t,h} + \eta_h T^*_{i,t-1} + \varepsilon_{i,t+h}, \quad h \geq 0,$$

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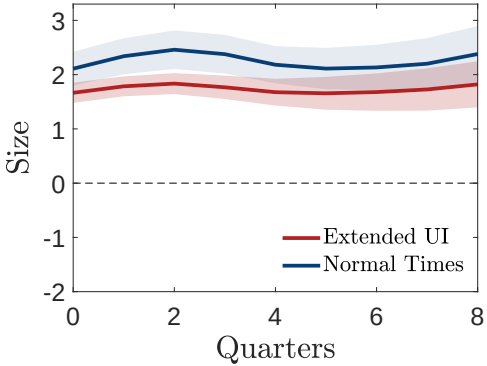
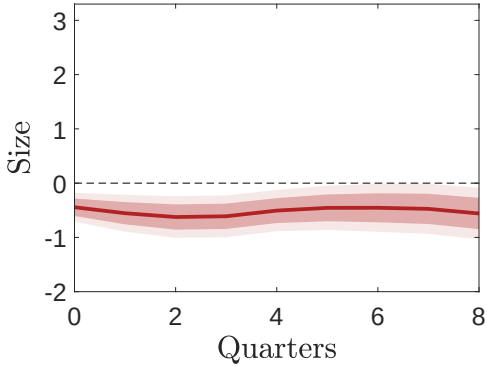
Fiscal Multipliers & UI Extensions

Multipliers: Extended UI vs. Normal Times



Difference



employment & consumption | gov't Direct Expenditure

Extensions

Extension I – Horse-race: Recessions vs Extended UI

Recessions or UI extensions?

- If anything, fiscal multipliers *larger* in recessions
  (Auerbach and Gorodnichenko, 2012)
- Yet, extend baseline to run **horse-race**:

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$$+ T^{UI}_{i,t-1} \left(\beta_h^{UI} \sum_{h=0}^{H} G_{i,t+h} + \gamma_h^{UI}(L) Z_{i,t-1} \right) + T^{RRC}_{i,t-1} \left(\beta_h^{RRC} \sum_{h=0}^{H} G_{i,t+h} + \gamma_h^{RRC}(L) Z_{i,t-1} \right)$$

- β_h^{UI}: additional effect of UI extended
- $T^{RRC}_{i,t-1}$: state i with 2 qrts. of negative growth
- β_h^{RRC}: additional effect of recession

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$$\sum_{h=0}^{H} Y_{i,t+h} = \beta_h \sum_{h=0}^{H} G_{i,t+h} + \gamma_h (L) Z_{i,t-1} + \alpha_{i,h} + \delta_{t,h} + \varepsilon_{i,t+h}$$
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- β_h^{UI}: additional effect of UI extended
- $\mathbb{I}^{REC}_{i,t-1}$: state i with 2 qrts. of negative growth
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Extension I – Horse-race: Recessions vs Extended UI

Recessions or UI extensions?

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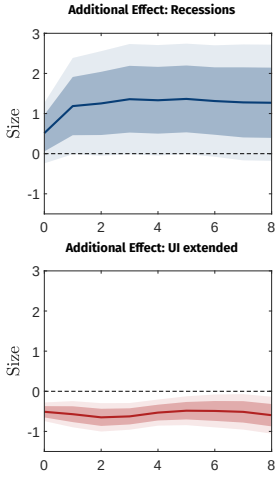

Extension II – Exogenous UI extensions: unemployment measurement error

- **Unobserved covariates** driving results?
  - E.g., local wage rigidity can affect T^* and multiplier
  - If anything, source of *amplification*
- Use **UI extensions due unemployment measurement error** (Chodorow-Reich *et al.*, 2018) , ie. *orthogonal* to fundamentals

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- $\mathbb{I}^{\widehat{T}}_{i,t-1} = 1$: UI extended due to *measurement error*
- $\beta^{\widehat{T}}_h$: additional effect of UI extended *due to measurement error*

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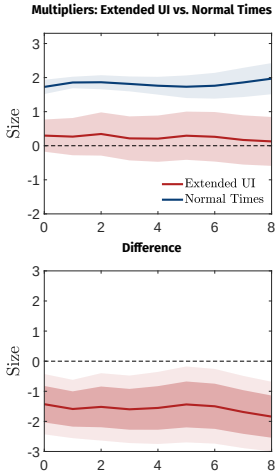

Model

Model Overview

- **Small-open-economy** in a monetary union (Galí and Monacelli, 2005)
- **Search-and-matching frictions** in the labor market (Mortensen and Pissarides, 1994)
- **Heterogeneous households** (Bewley-Hugget-Aiyagary):
  - **Receive unemployment benefits while unemployed if eligible**
  - **Risk of exhausting UI benefits** while unemployed
- **Firms**:
  - Standard New Keynesian block
  - Partly rigid **wages affected by UI policy**
- **Local fiscal authority**:
  - **Government consumption** on home goods
  - Sets **UI duration according to UI policy rule** that depends on unemployment

UI Eligibility & Households

UI eligibility labor market

- **UI benefits expire stochastically** ≈ limited duration of UI benefits
  - Loose eligibility during unemployment
  - Regain eligibility during employment

1. Eligible employed
- Keep job: remains eligible
- Loose job: loose eligibility with prob. pe_t

2. Non-eligible employed
- Keep job: eligible with prob. pr
- Loose job: remains non-eligible

3. Eligible unemployed
- Find job: remains eligible
- Unemployed: non-eligible with prob. pe_t

4. Non-eligible unempl.
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Domestic Households MF foreign

- Household with idiosyncratic state vector $s = \{\beta, h, n, e, a\}$
- Chooses consumption of home (c_{Ht}) and foreign (c_{Ft}) goods, savings a_t in mutual fund:

$$V_t(s) = \max_{c_{Ht}, c_{Ft}, a_t} u\left(c_{Ht}, c_{Ft}\right) + \beta \mathbb{E}_t V_{t+1}\left(s'\right)$$

$$\text{s.t.} \quad \frac{P_{Ht}}{P_t} c_{Ht} + \frac{P_{Ft}}{P_t} c_{Ft} + a_t = \left(1 - \tau_t\right) h_t \left(d_t + \mathbb{I}_{n=1} w_t + \mathbb{I}_{(n=0,e=1)} b_t + \mathbb{I}_{(n=0,e=0)} \tilde{b}_t\right)$$
$$+ (1 + r_t^a) a_{t-1}, \quad a_t \geq 0.$$

- **Income** depends on employment & eligibility status:
  - Employed: wage w_t
  - Unemployed and eligible: UI benefits b_t
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Firms & Wages

Firms

- **Differentiated goods producers**: set prices s.t. Rottemberg adjust. costs.
  - **NKPC**:

$$\log(1+\pi_{H,t}) = \kappa_p \left(\frac{MC_t}{P_{Ht}} - \frac{\varepsilon - 1}{\varepsilon} \right) + \mathbb{E}_t \frac{1}{1+r^a} \log(1+\pi_{H,t+1}) \frac{Y^D_{t+1}}{Y^D_t}$$

- **Labor goods producers**: post vacancies v_t to hire workers
  - **Free-entry**: value of job J^L_t, vacancy filling rate q_t

$$\kappa_v = q_t J^L_t$$

- **Wage rule**: weighted between Nash wage and st.-st. wage :

$$w_t = \left(w^{nash}_t\right)^{\phi^w} (\bar{w})^{1-\phi^w}$$

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Nash Wage full

- **Union** bargains w_t^{nash} on behalf of workers to maximize average surplus from employment

$$w_t^{nash} = \arg\max_{w_t} (J_t^L)^{1-\eta} (\Delta_t^{n,u})^{\eta}$$

- Average surplus from employment $\Delta_t^{n,u}$:

$$\Delta_t^{n,u} = (n_t^e + u_t^e)\Delta_{t,e=1}^{n,u} + (n_t^{ne} + u_t^{ne})\Delta_{t,e=0}^{n,u}$$

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Local Government

Government

- **Monetary authority** sets nominal rate to fix nominal exchange rate
- **Fiscal authority**, budget constraint:

$$\frac{P_{Ht}}{P_t} G_t + (1 + r_t) B_{H,t-1} + b_t U_t^e + \tilde{b}_t U_t^{ne} = B_{H,t} + \tau_t \left(w_t N_t + b_t U_t^e + \tilde{b}_t U_t^{ne} + d_t \right) + T_t$$

  - Government consumption G_t: $log\left(\frac{G_t}{G}\right) = \rho_G \log\left(\frac{G_{t-1}}{G}\right) + \varepsilon_t^G, \quad , \quad \varepsilon_t^G \sim \mathcal{N}(0,1)$
  - Federal transfers pay for UI expenses: $T_t - T = (b_t U_t^e + \tilde{b}_t U_t^{ne}) - (bU^e + \tilde{b}U^{ne})$
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Government - UI benefits extensions

- **UI benefits duration** $\text{UI}_t^D = 1/pe_t$:

$$\text{UI}_t^D = \begin{cases} \text{UI}^D & \text{if} \quad U_t \leq \tilde{U}, \\ \text{UI}^D \left(\frac{U_{t-1}}{\tilde{U}} \right)^{\phi_U} & \text{else.} \end{cases}$$

- **If unemployment below threshold** $\tilde{U}$ keep UI duration at regular UI duration UI^D
- We let UI duration follow a Taylor (1993)-type rule **when unemployment above** $\tilde{U}$
  - Captures parsimoniously multiple thresholds active during our sample period
  - We will calibrate ϕ_U to match dynamics of UI_t^D observed in our data

Calibration

Calibration

Parameter	Description	Value	Target / Source
Households			
$1/\sigma$	IES	0.5	Standard value
β_1	**Discount factor high**	0.98	$r = 0.04/4$
β_2	**Discount factor low**	0.85	MPC = 0.25
ρ_h	Persistence h	0.98	Bayer *et al.* (2019)
σ_h	Std. innovations to h	0.12	Bayer *et al.* (2019)
ε	Elast. subs. intermediate goods	7	Standard value
η	Elast. subs. H and F goods	2	Nakamura and Steinsson (2014)
α	Share imported goods	0.3	Nakamura and Steinsson (2014)
Firms			
κ_v	Vacancy posting cost	0.05	4.5% of quarterly wage
w	St-st. real wage	1.13	$q = 0.71$
ϕ^w	**Wage rigidity**	0.45	Elast. wage - productivity = 1/3
Z	St-st. productivity	1.33	$C = 1$
κ_p	Slope NKPC	0.05	Mean price duration of 5 q.

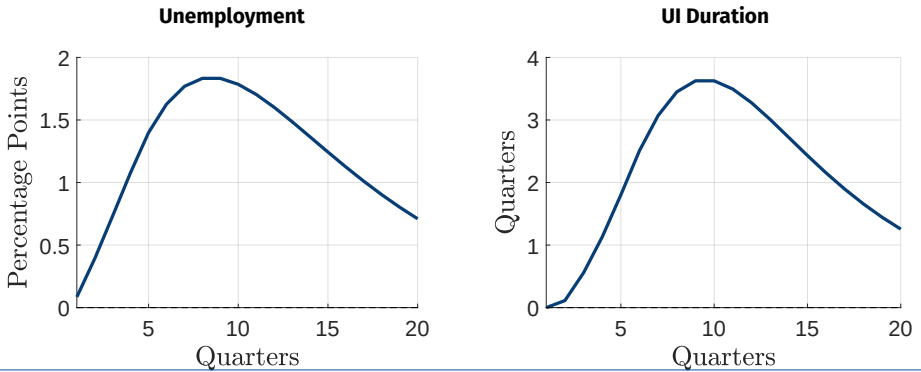
Calibration

Parameter	Description	Value	Target / Source
Labor market			
δ	Separation rate	0.10	Standard value
χ	Matching efficiency	0.66	$N = 0.94$
γ	Curvature matching function	0.5	Petrongolo and Pissarides (2001)
Government			
τ	Steady-state tax rate	0.24	G/Y = 0.20
B_H	Steady-state gov. debt	3	$B_H/4Y$ = 0.60
b	Replacement rate UI	0.4	Standard value
$\tilde{b}$	Replacement rate safety-net	0.2	Nakajima (2012)
pe	**Prob. loosing eligibility**	0.5	Avg. duration UI of 2 q.
pr	**Prop. regaining eligibility**	0.5	2 q. to regain eligibility
$\tilde{U}$	UI extension threshold	6.0%	Chodorow-Reich *et al.* (2018)

UI Extensions & Fiscal Multipliers in the model

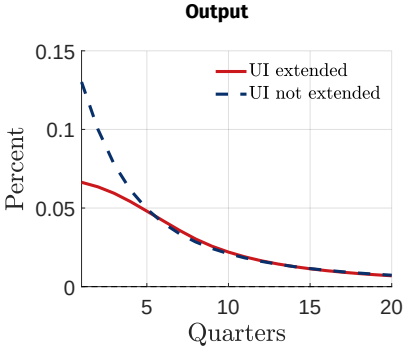
Extended UI benefits in the model

- We first replicate in the model the **average state in the data with extended UI**:
  - We feed in shocks such that U_t raises to 7.7% as in data
  - Pick response of UI duration ϕ^U such that UI_t^D raises to 5.5 qrts. as in data



UI Extensions & Effects of Government Spending

- We compare the marginal effects of a **gov't spending increase**:
  - Starting from st.-st. where **UI duration at regular level**
  - Starting from the recession where **UI duration extended**
- We then repeat the exercise but **assuming that UI duration is always at the regular level**



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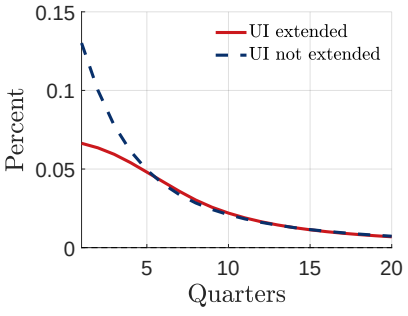
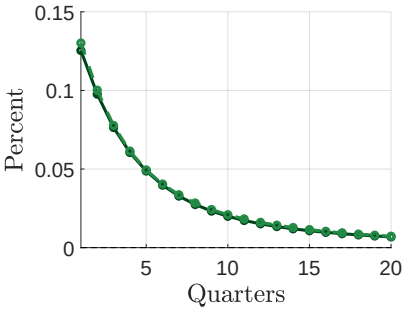
Output

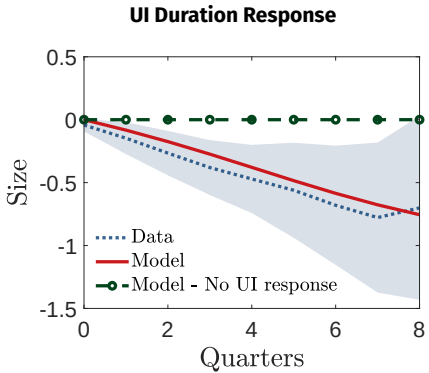


Output – No UI response



UI Extensions & Fiscal Multipliers in the model

- We pick the size of the G shock to **match a cumulative fall in UI duration of 15% as in the data**
- **Model matches perfectly the difference in fiscal multipliers on impact**
- Model **without UI response predicts no difference in fiscal multipliers**



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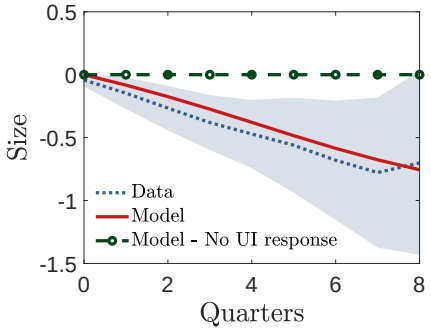
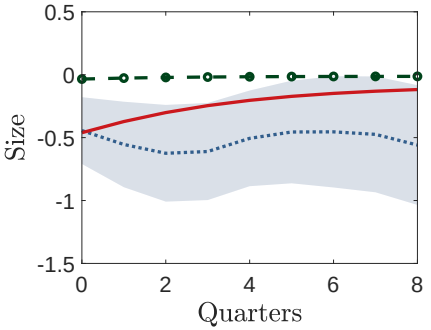
UI Duration Response



Fiscal Multipliers: Difference



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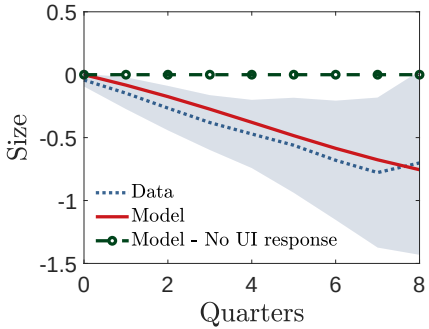

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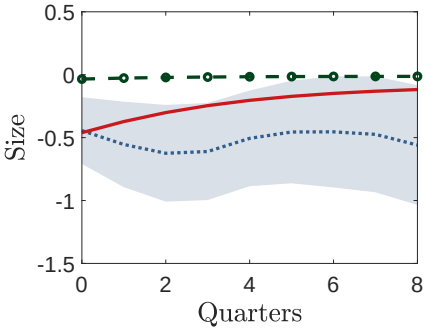

UI Multipliers & Channels

Recovering UI multipliers from the model

UI Multipliers
Baseline
1.20

- Recover **UI Multiplier** using model: how many dollars Y_t increases for each dollar spent on UI

$$\frac{\sum_{t=0}^{T}\left(Y_t - Y\right)/Y}{\sum_{t=0}^{T}\left(\text{UI expenditures}_t - \text{UI expenditures}\right)/Y}$$

- Well within the range of **previous empirical estimates**:
  - Di Maggio and Kermani (2016): multiplier of 1.9 for *UI levels*
  - Chodorow-Reich and Coglianese (2019): back out multiplier of 1
  - Congressional Budget Office (2012) uses output multiplier of 1

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UI multipliers & Channels

- **Three main channels** drive effects of more generous UI extensions:
  - **Wages**: improves outside option and raises wages
  - **Transfers**: increases transfers to unemployed workers, households with high MPCs
  - **Insurance**: reduces the need to accumulate precautionary savings

- Measure **contribution of each channel** through counterfactuals:
  - **Complete Markets**: only keeps detrimental effect from wages
  - **Transfers**: hhs. do expect changes in UI duration, but transfers never materialize
  - **Insurance**: shut down insurance by assuming that **hhs. do not expect changes in UI**

UI Multipliers

Baseline	Complete Markets	Transfers	Insurance
1.20	-0.20	0.78	0.51

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Conclusion

Conclusion

- **Stabilization consequences** of **countercyclical UI extensions**?

- Exploit institutional **non-linear design of UI policy** in the US
  - Government spending crowds out UI duration
  - UI extensions reduce local fiscal multipliers
  - Effects are unlikely to be explained by recessions or unobserved covariates

- **Model**: SOE in monetary union with equilibrium unemployment
  - Heterogeneous agents economy rationalizes empirical findings
  - Baseline **UI multiplier** of 1.2
  - Transfers to **high-MPC unemployed** and **insurance** both key in driving results

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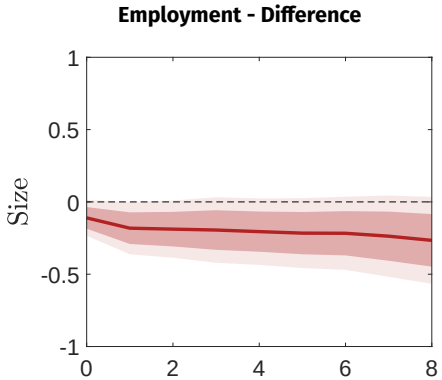
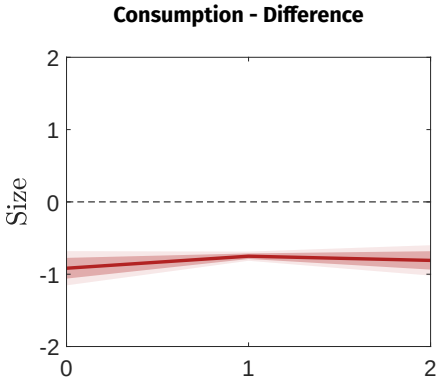
Appendix

Employment & Consumption Multiplier back

- State-level consumption expenditures from US Census at annual frequency
- State-level employment from Regional Accounts of BEA

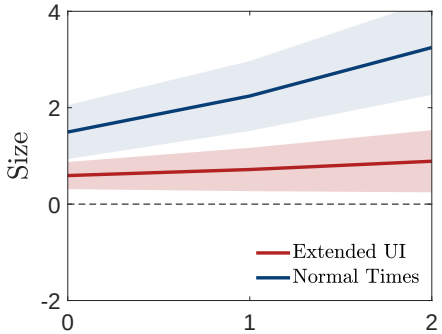




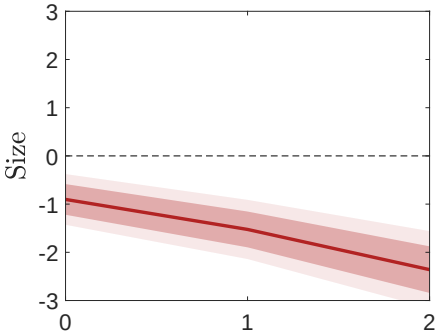
Gov't Direct Expenditures back

- We replace gov't value-added by state-level government expenditure
- Only available at annual frequency from US Census

Multipliers: Extended UI vs. Normal Times



Difference



Labor Market

- Law of motion for **employment** N_t:

$$N_t = (1-\delta)N_{t-1} + M_t$$

  - δ: exogenous separation rate
  - M_t: new matches

- **New matches** M_t formed according to:

$$M_t = \chi_t V_t^{\gamma} \left(1-(1-\delta)N_{t-1}\right)^{1-\gamma}$$

  - V_t: firms' vacancies, posted at cost κ_v
  - χ_t: matching efficiency follows log AR(1) process

UI eligibility

- N_t^e: employed eligible
- N_t^{ne}: employed non-eligible
- U_t^e: unemployed eligible
- U_t^{ne}: unemployed non-eligible
- pe_t: prob. loosing eligibility
- pr: prob. regaining eligibility

$$
\begin{aligned}
N_t^e &= (1-\delta+\delta f_t)N_{t-1}^e + pr(1-\delta+\delta f_t)N_{t-1}^{ne} + f_t\left(U_{t-1}^e + prU_{t-1}^{ne}\right) \\
N_t^{ne} &= (1-pr)(1-\delta+\delta f_t)N_{t-1}^{ne} + (1-pr)f_tU_{t-1}^{ne} \\
U_t^e &= (1-f_t)(1-pe_t)\left(U_{t-1}^e + \delta N_{t-1}^e\right) \\
U_t^{ne} &= (1-f_t)\left(U_{t-1}^{ne} + \delta N_{t-1}^{ne}\right) + (1-f_t)pe_t\left(U_{t-1}^e + \delta N_{t-1}^e\right)
\end{aligned}
$$

Foreign households back

- Export demand from Foreign households C^*_{Ht}:

$$C^*_{Ht} = \alpha \left(\frac{P^*_{Ht}}{P^*_t} \right)^{-\eta} C^*_t,$$

- Nominal exchange rate: $\mathscr{E}_t$
- Law of one price holds: $P_{Ht} = \mathscr{E}_t P^*_{Ht}$ and $P_{Ft} = \mathscr{E}_t P^*_{Ft}$
- Real exchange rate: $Q_t := \frac{\mathscr{E}_t P^*_t}{P_t}$
- Terms of trade: $S_t := \frac{P_{Ft}}{P_{Ht}}$

Firms - Labor good producers

- Value of a firm with a worker:

$$J_t^L = Z_t \frac{MC_t}{P_t} - \frac{W_t}{P_t} + \mathbb{E}_t \frac{1}{1+r^a}(1-\delta) J_{t+1}^L,$$

- Free entry:

$$\kappa_v = q_t J_t^L$$

Nash Wage back

- **Union** bargains w_t^{nash} on behalf of workers to maximize average surplus from employment

$$w_t^{nash} = \arg\max_{w_t} (J_t^L)^{1-\eta} (\Delta_t^{n,u})^{\eta}$$

- **Average surplus from employment $\Delta_t^{n,u}$**:

$$\Delta_t^{n,u} = (n_t^e + u_t^e)\Delta_{t,e=1}^{n,u} + (n_t^{ne} + u_t^{ne})\Delta_{t,e=0}^{n,u}$$

- **Average surplus from employment for eligible workers $\Delta_{t,e=1}^{n,u}$**:

$$\Delta_{t,e=1}^{n,u} = U(C_{t,e=1}^n) - U(C_{t,e=1}^u) + \beta(1-\delta)(1-f_{t+1})(\Delta_{t+1,e=1}^{n,u} + pe_t \Delta_{t+1,n=0}^{e,ne})$$

- **Average surplus from employment for non-eligible workers $\Delta_{t,e=0}^{n,u}$**:

$$\Delta_{t,e=0}^{n,u} = U(C_{t,e=0}^n) - U(C_{t,e=0}^u) + \beta(1-\delta)(1-f_{t+1})(\Delta_{t+1,e=0}^{n,u} + pr\Delta_{t+1,n=1}^{ne,e})$$

- **Average surplus from employment for eligible workers $\Delta^{n,u}_{t,e=1}$:**

$$\Delta^{n,u}_{t,e=1} = U(C^{n}_{t,e=1}) - U(C^{u}_{t,e=1}) + \beta(1-\delta)(1-f_{t+1})(\Delta^{n,u}_{t+1,e=1} + pe_t \Delta^{e,ne}_{t+1,n=0})$$

- **Average surplus from eligibility for unemployed workers $\Delta^{e,ne}_{t+1,n=0}$:**

$$\Delta^{e,ne}_{t,n=0} = U(C^{u}_{t,e=1}) - U(C^{u}_{t,e=1}) + \beta\left[(1-f_{t+1})(1-\mathrm{pe}_{t+1})\Delta^{e,ne}_{t+1,n=0} + f_{t+1}(1-\mathrm{pr})\Delta^{e,ne}_{t+1,n=1}\right]$$

- **Average surplus from employment for non-eligible workers $\Delta^{n,u}_{t,e=0}$:**

$$\Delta^{n,u}_{t,e=0} = U(C^{n}_{t,e=0}) - U(C^{u}_{t,e=0}) + \beta(1-\delta)(1-f_{t+1})(\Delta^{n,u}_{t+1,e=0} + pr \Delta^{ne,e}_{t+1,n=1})$$

- **Average surplus from eligibility for employed workers $\Delta^{e,ne}_{t+1,n=1}$:**

$$\Delta^{e,ne}_{t,n=1} = U(C^{n}_{t,e=1}) - U(C^{n}_{t,e=1}) + \beta\left[\left(1-\delta(1-f_{t+1})\right)(1-\mathrm{pr})\Delta^{e,ne}_{t+1,n=1} + \delta(1-f_{t+1})(1-\mathrm{pe}_{t+1})\Delta^{e,ne}_{t+1,n=0}\right]$$

Firms - Producers of differentiated goods

- Set prices s.t. quadratic adjustment costs:

$$\max_{\{P_{jHt+k}\}_{k=0}^{\infty}} \mathbb{E}_t \sum_{k=0}^{\infty} (1+r^a)^{-k} \left[\left(P_{jHt+k} - MC_{t+k} \right) Y^D_{jt+k} - \frac{\kappa_p}{2\varepsilon} \log\left(\frac{P_{jHt+k}}{P_{jHt+k-1}} \right)^2 P_{Ht+k} Y^D_{t+k} \right],$$

$$\text{subject to} \quad Y^D_{jt} = \left(\frac{P_{jHt}}{P_{Ht}} \right)^{-\varepsilon} \left(C_{Ht} + C^*_{Ht} + G_t \right).$$

- NKPC:

$$\log(1+\pi_{H,t}) = \kappa_p \left(\frac{MC_t}{P_{Ht}} - \frac{\varepsilon - 1}{\varepsilon} \right) + \mathbb{E}_t \frac{1}{1+r^a} \log(1+\pi_{H,t+1}) \frac{Y^D_{t+1}}{Y^D_t},$$

Mutual Fund back

- Risk-neutral mutual fund issues A_t, purchases domestic B_{Ht} and foreign B_{Ft} bonds

$$A_t = B_{Ht} + Q_t B_{Ft}$$

- Beginning-of-period flow constraint:

$$(1 + r_t^a)A_{t-1} = (1 + r_t)B_{H,t-1} + (1 + r_t^*)Q_t B_{F.t-1}.$$

- Non-arbitrage conditions:

$$\mathbb{E}_t \frac{1 + i_t}{1 + \pi_{t+1}} = \mathbb{E}_t \frac{1 + i_t^*}{1 + \pi_{t+1}^*} \frac{Q_{t+1}}{Q_t},$$

$$\mathbb{E}_t 1 + r_{t+1}^a = \mathbb{E}_t 1 + r_{t+1}$$