Macro Uncertainty and Unemployment Risk

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Motivation

**Question:** ‘How does uncertainty affect the macroeconomy?’

+ **Empirical evidence:** Identified macro uncertainty shock reduces
  - Output, Consumption, Investment, Employment, Inflation

+ **Existing models:** Unable to match empirical evidence
  - RANK: Response of macro variables muted
  - Inflation increases
Households’ heterogeneity key for uncertainty propagation

+ **VAR evidence** using both aggregate and household-level data:
  ▶ Macro uncertainty shock acts like aggregate demand shock
  ▶ Households in bottom 60% of income distrib. most responsive to uncertainty

+ **HANK model** with SaM and Calvo:
  ▶ Unemployment risk reinforces precautionary savings of uninsured HHs
  ▶ Uncertainty generates drop in prices & amplifies responses to match data
Empirical Evidence
VAR Evidence

- Data: US quarterly, 1982Q1-2015Q3
  - Macro uncertainty: Jurado et al. (2015)
    Common variation in macro indicators' unforecastable factors
  - Macro data: National Income and Product Account
  - Household-level data: Consumer Expenditure Surveys

- Identification: Cholesky ordering
  - Macro uncertainty ordered first:
    [Macro uncertainty, GDP, Job finding rate, Separation rate, Unemployment rate, Consumption, Inflation, Policy rate]
  - Constant and two lags
VAR Evidence: Micro Data

Robustness

Bottom 60% Income

Top 40% Income

Bottom 60%/Top 40%

Percentage Point

Bottom 60% Income

Top 40% Income

Bottom 60%/Top 40%
Model
Feedback Loop

Uncertainty $\uparrow$

$C^{Imp} \downarrow$ $\rightarrow$ AD $\downarrow$ $\rightarrow$ AD $\downarrow$ & AS $\downarrow$

Savings of imp. insured HHs $\uparrow$

Y $\downarrow$

IMRS $\uparrow$ $\rightarrow$ Unemployment risk $\uparrow$ $\rightarrow$ job finding rate $\downarrow$, separation rate $\uparrow$
HANK: IRFs to 1SD Technology Uncertainty Shock

- Calibration
- Different $\Omega$
- Robust

**Output**: 
- HANK (solid blue line)
- RANK (dashed red line)

**Consumption**: 
- HANK (solid blue line)
- RANK (dashed red line)

**Unemployment Rate**: 
- HANK (solid blue line)
- RANK (dashed red line)

**Vacancy**: 
- HANK (solid blue line)
- RANK (dashed red line)

**Job Finding Rate**: 
- HANK (solid blue line)
- RANK (dashed red line)

**Real Wage**: 
- HANK (solid blue line)
- RANK (dashed red line)

**Inflation**: 
- HANK (solid blue line)
- RANK (dashed red line)

**Policy Rate**: 
- HANK (solid blue line)
- RANK (dashed red line)
Consumption Heterogeneity

![Graph showing consumption heterogeneity over quarters. The graph displays the percentage change in consumption for different scenarios. The x-axis represents quarters, and the y-axis represents percent change. The graph includes lines for 'Imp. Insured HHs', 'Perf. Insured HHs', and 'Aggregation.' The graph illustrates the varying trends and implications of consumption heterogeneity.]
Conclusion

Households’ heterogeneity important to uncertainty propagation

1. Macro uncertainty \(\uparrow\) → consumption, inflation, policy rate \(\downarrow\)

2. Most responsive HHs: Bottom 60% of income distrib.

3. HA + Calvo + SaM
   - Uncertainty reduces AD and AS
   - Uninsured unemployment risk reinforces prec. savings (AD)
   - Responses in line with data

Calvo vs Rotem
Appendix
Consumer Expenditure Surveys

CEX: Rotating panel data

▶ Consumption: Non-durable
   Food and beverages, tobacco, apparel and services, personal care, gasoline, public transportation, household operation, medical care, entertainment, reading material, and education

▶ Income: before tax
   Wages, salaries, business and farm income, financial income, and transfers

▶ Real per capita: divide by number of family members, deflate by CPI-U series, and seasonally adjust by X-12-ARIMA
Literature

- **HANK**
  McKay and Reis (2016), Kaplan et al. (2018)

- **HANK and SaM**

- **Uncertainty**
HANK with SaM and Uncertainty

- Unit mass of **Households**
  - Share $1 - \Omega$ perfectly insured against unemployment risk
    $\Rightarrow$ Assets and $C$ do **not** depend on employment status

  - Share $\Omega$ imperfectly insured against unemployment risk
    $\Rightarrow$ Subject to borrowing limit tighter than natural
    $\Rightarrow$ Assets and $C$ **do** depend on employment status
ASSUMPTION: Borrowing limit binding after 1 period unemp. (Challe et al. (2017))

- Three corresponding types of imperfectly insured households:
  1. Employed
  2. Unemployed for 1 period
  3. Unemployed for > 1 period

- Three consumption levels

- Two asset levels
  1. Assets for the employed impatient
  2. Borrowing limit

With 3 types of imperfectly insured, no need to keep track of whole distribution
HANK with SaM and Uncertainty

+ **Firms** ▶ More
  - Search and matching frictions
  - Calvo pricing

+ **Monetary authority**
  - Taylor rule

+ **Uncertainty** in technology process

\[
\begin{align*}
  \log z &= \rho_z \log z_{-1} + \sigma^z \varepsilon^z \\
  \log \sigma^z &= (1 - \rho_{\sigma^z}) \log \bar{\sigma}^z + \rho_{\sigma^z} \log \sigma^z_{-1} + \sigma^{\sigma^z} \varepsilon^{\sigma^z}
\end{align*}
\]

+ Third-order perturbation method
  (Fernandez-Villaverde et al., 2011)
RANK: IRFs to 1SD Technology Uncertainty Shock
Direct Effect of Increased Uncertainty (RANK)

- **Households: Precautionary savings**
  
  \[ U \uparrow \rightarrow C \downarrow \because \text{Risk aversion} \]
  
  \[ \rightarrow \text{Nominal marginal cost} \downarrow \rightarrow \text{Price} \downarrow \rightarrow \text{Markup} \uparrow \because \text{Sticky prices} \]
  
  \[ \Rightarrow Y \downarrow, P \downarrow \because \text{AD} \downarrow \]

- **Firms: Precautionary pricing**
  
  \[ U \uparrow \rightarrow P \uparrow \rightarrow \text{Markup} \uparrow \because \text{Risk aversion} \]
  
  \[ \Rightarrow Y \downarrow, P \uparrow \because \text{AS} \downarrow \]

- **P \uparrow \text{since AS} \downarrow > \text{AD} \downarrow**
Indirect Effect: Uninsured Unemployment Risk (HANK)

- Uncertainty ↑
  1. Precautionary savings: AD↓
  2. Precautionary pricing: AS↓

- Y↓ → Vacancy↓ → Job finding rate↓ → Separation rate↑

- Unemployment risk↑ → Imperfectly insured HHs’ savings ↑

- C′↓ → AD↓
Perfectly Insured Households

\[ V^p (a^p, n^p, X) = \max_{a^{p'}, c^p} \left\{ u (c^p) + \beta^p E \left[ V^p (a^{p'}, n^{p'}, X') \right] \right\} \]

subject to:

\[ c^p + a^{p'} = w^p n^p + (1 + r) a^p + \Pi \]

Perfect insurance \( \Rightarrow \) \( a^{p'} \) & \( c^p \) do not depend on employment status
Imperfectly Insured Households

ASSUMPTIONS:
1. Partial risk sharing
2. Borrowing limit tighter than natural

- Cross-sectional distribution $\mu(a, N)$ over:
  - Assets $a \in \mathbb{R}$
  - Length of unemployment spell $N \in \mathbb{Z}_+$

- Becomes with countable and finite support

- Can be summarized by:
  - Assets: $a^i(N)$
  - Associated number of HHs: $n^i(N)$
Imperfectly Insured Households

\[ V^i \left( a^i (N), n^i (N), X \right) = \]

\[ \max_{\{a''(N), c'(N)\} \in \mathbb{Z}_+} \left\{ \sum_{N \geq 0} n^i (N) u \left( c^i (N) \right) + \beta^i \mathbb{E}_\mu, X \left[ V^i \left( a'' (N), n'' (N), X' \right) \right] \right\} \]

subject to:

- Borrowing constraint
  \[ a'' (N) \geq a \]

- Budget constraint if employed, \( N = 0 \)
  \[ a'' (0) + c^i (0) = (1 - \tau) w + (1 + r) A \]

- Budget constraint if unemployed for \( N \geq 1 \) periods
  \[ a^i (N) + c^i (N) = b^u + (1 + r) a \]
Tilde variables correspond to beginning of labor transition stage.

\[ X = \{ \tilde{\mu}(.), a^p, a^i(0), R_{-1}, \Delta_{-1}, \tilde{n}, z, \sigma^z \} \]
If \( N = 0 \)

\[
A' = \frac{1}{n''(0)} \left[ (1 - s') a''(0) + f' \sum_{N \geq 1} a''(N) n'(N) \right]
\]

\[
n''(0) = (1 - s') n'(0) + f' (1 - n'(0))
\]

If \( N \geq 1 \)

\[
a^i(N) = a''(N-1)
\]

\[
n''(1) = s' n'(0) \text{ and } n''(N) = (1 - f') n'(N-1) \text{ if } N \geq 2
\]
Monetary Policy and Unemployment Insurance Scheme

▶ Taylor rule

\[
\frac{1 + R}{1 + \bar{R}} = \left( \frac{1 + R_{-1}}{1 + \bar{R}} \right)^{\rho_R} \left( \frac{1 + \pi}{1 + \bar{\pi}} \phi_\pi \left( \frac{y}{y_{-1}} \phi_y \right)^{1-\rho_R} \right)
\]

▶ Balanced unemployment insurance scheme

\[
\tau_w n^i = b^u \left( 1 - n^i \right)
\]
\[
\tau_w^p n^p = b^{up} \left( 1 - n^p \right)
\]
Firms

1. Final goods firms: Perfectly competitive

2. Intermediate goods firms: Face Calvo pricing

3. Wholesale goods firms: Perfectly competitive
   ▶ Use technology $y_m = z\tilde{n}$

4. Labor intermediaries: Hire both types of households
   ▶ Job finding rate
     \[ f = \frac{m}{u} = \frac{\mu u^x v^{1-x}}{u} \]
   ▶ Period-to-period job loss rate
     \[ s = \rho (1 - f) \]
   ▶ Wages set according to rule
Final Goods Firms

- Solve

$$\max_y y - \int_0^1 p_i y_i \, di$$

subject to

$$y = \left( \int_0^1 y_i^{\frac{\epsilon - 1}{\epsilon}} \, di \right)^{\frac{\epsilon}{\epsilon - 1}}$$

- Solution: final goods firms' demand of intermediate good

$$y_i (p_i) = p_i^{-\epsilon} y$$
Intermediate Goods Firms I

- Linear technology with fixed cost: $y_i = x_i - \Phi$

- Produce intermediate goods sold at price $p_m$

- Earn profit: $\Xi = (p_i - p_m)y_i - p_m\Phi$

- Value if reset prices:
  \[
  V^R(X) = \max_{p_i} \left\{ \Xi + \theta \mathbb{E}_X \left[ M^{P'} V^N(p_i, X') \right] + (1 - \theta) \mathbb{E}_X \left[ M^{P'} V^R(X') \right] \right\}
  \]

  - Set optimal price:
    \[
    p^* = \frac{\varepsilon}{\varepsilon - 1} \frac{p^A}{p^B}
    \]
    
    \[
    p^A = p_m y + \theta \mathbb{E}_X \left[ M^{P'} \left( \frac{1 + \pi'}{1 + \bar{\pi}} \right)^\varepsilon p^{A'} \right]
    \]
    
    \[
    p^B = y + \theta \mathbb{E}_X \left[ M^{P'} \left( \frac{1 + \pi'}{1 + \bar{\pi}} \right)^{\varepsilon - 1} p^{B'} \right]
    \]
Intermediate Goods Firms II

- Inflation law of motion:
  \[ \pi = \frac{\theta(1 + \bar{\pi})}{(1 - (1 - \theta)p^*^{1-\varepsilon})^{\frac{1}{1-\varepsilon}}} - 1 \]

- Price dispersion:
  \[ \Delta = (1 - \theta) p^*^{1-\varepsilon} + \theta \left( \frac{1 + \pi}{1 + \bar{\pi}} \right)^\varepsilon \Delta_{-1} \]

- Value if do not reset prices:
  \[ \mathcal{V}^N(p_i_{-1}, X) = \Xi + \theta \mathbb{E}_X [M^{P'} \mathcal{V}^N (p_i, X')] + (1 - \theta) \mathbb{E}_X [M^{P'} \mathcal{V}^R (X')] \]

- Index price
  \[ p_i = \frac{1 + \bar{\pi}}{1 + \pi} p_i_{-1} \]
Wholesale Firms

- Perfectly competitive, use linear technology: $y_m = z^n$

- Solve:
  \[
  \max_{n^d} \left\{ p_m z^n - Q^n \right\}
  \]

- $Q$ is real unit price of labor services $n$, given by FOC:
  \[
  Q = p_m z
  \]
Labor Intermediaries

- Beginning of period exogenous separation rate $\rho$

- Skill premium $\psi$ for patient households

- Value of match with impatient and patient
  
  \[
  J^i = Q - w + E_X [(1 - \rho') M^{ii} J^{ii}]
  \]
  
  \[
  J^p = \psi Q - \psi w + E_X [(1 - \rho') M^{pp} J^{pp}]
  \]

- Free entry condition where $\lambda$ is job filling rate

  \[
  \lambda \left( \Omega J^i + (1 - \Omega) J^p \right) = \kappa
  \]

- Wage rule

  \[
  w = w_{-1} \gamma_w \left( \bar{w} \left( \frac{n}{\bar{n}} \phi_w \right) \right)^{1-\gamma_w}
  \]
Uncertainty

\[ \log z = \rho_z \log z_{-1} + \sigma_z^z \varepsilon_z^z \]

\[ \log \sigma^z = (1 - \rho_{\sigma^z}) \log \bar{\sigma}^z + \rho_{\sigma^z} \log \sigma_{-1}^z + \sigma_{\sigma^z}^z \varepsilon_{\sigma^z}^z \]

- Third-order perturbation method
  (Fernandez-Villaverde et al., 2011)
Market Clearing

▶ Labor market

Beginning of period  \( \tilde{n}^p = \tilde{n}^i = \tilde{n}^p = \tilde{n}^i = \tilde{n} \)

End of period  \( n^p = n^i = n^p = n_i = n \)

\[ \Omega n^i + (1 - \Omega) \psi n^p = (\Omega + (1 - \Omega) \psi) n = \tilde{n} \]

▶ Asset market

\[ \Omega (A + (1 - n) a) + (1 - \Omega) a^p = 0 \]

▶ Goods market

▶ Final

\[ c + \kappa \nu = y \]

▶ Intermediate

\[ \Delta y = y_m - \Phi \]

▶ Wholesale

\[ \int_0^1 x_i di = y_m = z \tilde{n} \]
## Quarterly Calibration 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Target/Source</th>
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<tbody>
<tr>
<td></td>
<td><strong>Households</strong></td>
<td></td>
<td></td>
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<tr>
<td>$\Omega$</td>
<td>Share of imperf. households</td>
<td>0.60</td>
<td>Challe et al. (2017)</td>
</tr>
<tr>
<td>$a$</td>
<td>Borrowing limit</td>
<td>0</td>
<td>Challe et al. (2017)</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Risk aversion</td>
<td>2.00</td>
<td>Standard</td>
</tr>
<tr>
<td>$\beta^l$</td>
<td>Discount factor of imperf. households</td>
<td>0.917</td>
<td>21% consumption loss</td>
</tr>
<tr>
<td>$\beta^P$</td>
<td>Discount factor of pat. households</td>
<td>0.993</td>
<td>3% annual real interest rate</td>
</tr>
<tr>
<td>$b^u$</td>
<td>Unemployment benefits</td>
<td>0.27</td>
<td>33% replacement rate</td>
</tr>
<tr>
<td></td>
<td><strong>Firms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>Elasticity of substitution btw goods</td>
<td>6.00</td>
<td>20% markup</td>
</tr>
<tr>
<td>$\Phi$</td>
<td>Production fixed cost</td>
<td>0.22</td>
<td>Zero steady-state profit</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Price stickiness</td>
<td>0.75</td>
<td>4-quarter stickiness</td>
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## Quarterly Calibration 2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Labor Market</strong></td>
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<tr>
<td>$\mu$</td>
<td>Matching efficiency</td>
<td>0.72</td>
<td>71% job filling rate</td>
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<tr>
<td>$\chi$</td>
<td>Matching function elasticity</td>
<td>0.50</td>
<td>Standard</td>
</tr>
<tr>
<td>$\rho$</td>
<td>Job separation rate</td>
<td>0.23</td>
<td>73% job find. &amp; 6.1% job loss rates</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>Vacancy posting cost</td>
<td>0.037</td>
<td>1% of output</td>
</tr>
<tr>
<td>$\psi$</td>
<td>Skill premium</td>
<td>2.04</td>
<td>Bottom 60% cons. share (42%)</td>
</tr>
<tr>
<td>$\gamma_w$</td>
<td>Wage stickiness</td>
<td>0.75</td>
<td>Challe et al. (2017)</td>
</tr>
<tr>
<td>$\phi_w$</td>
<td>Wage elasticity wrt employment</td>
<td>1.50</td>
<td>Challe et al. (2017)</td>
</tr>
<tr>
<td><strong>Monetary Authority</strong></td>
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<td></td>
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<tr>
<td>$\bar{\pi}$</td>
<td>Steady-state inflation</td>
<td>1.005</td>
<td>2% annual inflation rate</td>
</tr>
<tr>
<td>$\rho_R$</td>
<td>Interest rate inertia</td>
<td>0</td>
<td>Standard</td>
</tr>
<tr>
<td>$\phi_\pi$</td>
<td>Taylor rule coefficient for inflation</td>
<td>1.50</td>
<td>Standard</td>
</tr>
<tr>
<td>$\phi_y$</td>
<td>Taylor rule coefficient for output</td>
<td>0.20</td>
<td>Standard</td>
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<tr>
<td>Parameter</td>
<td>Description</td>
<td>Value</td>
<td>Target/Source</td>
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<tr>
<td>-----------</td>
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<td>---------------------------</td>
</tr>
<tr>
<td>$\rho_z$</td>
<td>Persistence of technology shock</td>
<td>0.95</td>
<td>Standard</td>
</tr>
<tr>
<td>$\sigma^z$</td>
<td>Volatility of technology shock</td>
<td>0.007</td>
<td>Standard</td>
</tr>
<tr>
<td>$\rho_{\sigma^z}$</td>
<td>Persistence of uncertainty shock</td>
<td>0.85</td>
<td>Katayama &amp; Kim (2018)</td>
</tr>
<tr>
<td>$\sigma_{\sigma^z}$</td>
<td>Volatility of uncertainty shock</td>
<td>0.37</td>
<td>Katayama &amp; Kim (2018)</td>
</tr>
</tbody>
</table>
Different Degrees of Heterogeneity

- Output
- Consumption
- Unemployment Rate
- Vacancy
- Job Finding Rate
- Real Wage
- Inflation
- Policy Rate

Graphs show the impact of different degrees of heterogeneity on various economic indicators over a period of quarters.
Robustness Check 1
Robustness Check 2

**Consumption**

- $\gamma_w = 0$
- $\gamma_w = 0.35$
- $\gamma_w = 0.70$

**Inflation**

- $\phi_R = 0$
- $\phi_R = 0.35$
- $\phi_R = 0.70$

- $\phi = 1.3$
- $\phi = 1.5$
- $\phi = 2.0$

- $\phi = 0$
- $\phi = 0.25$
- $\phi = 0.50$
Precautionary Savings

- Risk averse households

\[ \beta \left( \frac{c'}{c} \right)^{-\gamma} = \text{IMRS}' \]

- Jensen’s inequality \((0 < q < 1)\)

\[
\text{IMRS}_{\text{certainty}} = \beta \left( cc \right)^{-\gamma}
\]

\[
\leq q \beta \left( cc^l \right)^{-\gamma} + (1 - q) \beta \left( cc^h \right)^{-\gamma} = \text{IMRS}_{\text{uncertainty}}
\]
IMRS of Impatient Households

- \( N = 0 \)

- IMRS increasing in separation rate

\[
M_i^i(0) = \beta_i (1 - s') u_c^{i'}(0) + s' u_c^{i'}(1) \]

\[
u_c^{i'}(0) \]
Precautionary Savings

Stochastic Discount Factor vs. Relative Consumption
Precautionary Pricing

- Certainty

$$MP = \left( (1 - \varepsilon) \left( \frac{P^*_\text{certainty}}{P} \right)^{1-\varepsilon} + \varepsilon mc \left( \frac{P^*_\text{certainty}}{P} \right)^{-\varepsilon} \right) Y$$

- Uncertainty: EMP > MP ⇒ Risk averse

$$EMP = q \left( (1 - \varepsilon) \left( \frac{P^*_\text{uncertainty}}{P^l} \right)^{1-\varepsilon} + \varepsilon mc \left( \frac{P^*_\text{uncertainty}}{P^l} \right)^{-\varepsilon} \right) Y$$

$$+ (1 - q) \left( (1 - \varepsilon) \left( \frac{P^*_\text{uncertainty}}{P^h} \right)^{1-\varepsilon} + \varepsilon mc \left( \frac{P^*_\text{uncertainty}}{P^h} \right)^{-\varepsilon} \right) Y$$
AS-AD: Firms

Graph showing the AD and AS curves with points P0, P1, P2, Y0, Y1, and Y2.
AS-AD: HHs’ Heterogeneity

Diagram showing AD0, AD1, AS1, and AS2 with various points labeled P0, P1, P2, and P3, and Y0, Y1, Y2, Y3 on the horizontal axis.