Redistribution and Fiscal Uncertainty Shocks

Hikaru Saijo

University of California, Santa Cruz

SITE 2017
Introduction

- How important is time-varying uncertainty about fiscal policies for business cycles and the slow recovery from the Great Recession?

- Many fiscal policies are redistributive

- This paper: Once concerns about redistributional effects of fiscal policy taken into account, fiscal uncertainty shocks have much larger impact and induce co-movement of macro variables
Introduction

New Keynesian model with two additional features:

1. Limited capital market participation
   - $1 - \chi$ fraction of households hold capital, $\chi$ fraction do not
   - Standard model with full participation if $\chi = 0$

2. Ambiguity averse households: act as if the true DGP is the worst-case scenario
   - Fiscal uncertainty shocks: increase in ambiguity about future fiscal policy $\rightarrow$ worst-case becomes worse

(1) and (2) $\rightarrow$ worst-case potentially heterogeneous across agents
Increase in uncertainty about future capital income tax rate

- **Representative-agent model**
  
  - Household fears high tax $\rightarrow$ cut investment and increase consumption
  
  - Mild decline in hours and output

- **Limited capital market participation model**
  
  - Capital holders fear high tax and non-capital holders fear low tax
  
  - Both households worry about substantially lower after-tax income due to redistribution
  
  - (Perceived) negative income effect $\rightarrow$ lower consumption
  
  - Lower aggregate demand $\rightarrow$ sizable drop in hours and output
Fiscal shocks and fiscal uncertainty shocks

- Each fiscal instrument $x \in \{g, \tau_c, \tau_h, \tau_k\}$ follows
  \[
  \hat{x}_{t+1} = (1 - \rho_x) \bar{x} + \rho_x \hat{x}_t + \phi_x, y \hat{Y}_t + \phi_x, B \hat{B}_t^g + \mu_{x,t} + u_{x,t+1}
  \]
  feedback

- $\mu_{x,t}$: ambiguous component, parameterized by a set of conditional means $\mu_{x,t} \in [-a_{x,t}, a_{x,t}]$

  - Agents lack confidence in assigning probabilities to alternative means inside $\mu_{x,t}$

  - Higher $a_{x,t} \rightarrow$ larger belief set and higher ambiguity about the fiscal instrument $x$

  - Later allow one-sided change in ambiguity

- $a_{x,t}$ follows an AR(1) process
  \[
  a_{x,t+1} = (1 - \rho_{a_x}) \bar{a}_x + \rho_{a_x} a_{x,t} + \epsilon_{x,t}
  \]
Government

- Government budget constraint:

\[
T_t + G_t = \frac{B_t^g}{P_t} - R_{t-1} \frac{B_{t-1}^g}{P_t}
\]

\[
+ \tau_{c,t} C_t + \tau_{h,t} \int_{0}^{1} W_{i,t} H_{i,t} di + \tau_{k,t} (R_k^t - \delta) K_{t-1}
\]

- Government bond \(B_t^g\) follows

\[
\hat{B}_t^g = \rho_B \hat{B}_{t-1}^g + \phi_{B,Y} \hat{Y}_{t-1} + \phi_{B,T} \hat{T}_{t-1}
\]
Capital holders

\[
U_t^c(C^c; s^t) = \ln C_t^c - \frac{(H_t^c)^{1+\phi}}{1 + \phi} + \beta \min_{\mu x, t \in [-a_x, a_x], \forall x} E^\mu[U_{t+1}(C^c; s^t, s_{t+1})] 
\]

- Budget constraint:

\[
(1 + \tau_{c,t}) C_t^c + I_t^c + \frac{B_t^c}{P_t} \leq (1 - \tau_{h,t}) W_t H_t^c + (1 - \tau_{k,t}) R_t^k K_{t-1}^c + \tau_{k,t} \delta K_{t-1}^c + R_{t-1} \frac{B_{t-1}^c}{P_t} + T_t + \cdots
\]

- Capital accumulation:

\[
K_t^c = (1 - \delta) K_{t-1}^c + \{1 - S(I_t^c / I_{t-1}^c)\} I_t^c
\]

\(S(\cdot)\): investment adjustment cost
Non-capital holders

\[ U_t^n(C^n; s^t) = \ln C^n_t - \frac{(H^n_t)^{1+\phi}}{1+\phi} + \beta \min_{\mu_x,t \in [-a_x,t,a_x,t], \forall x} E^\mu[U_{t+1}^n(C^n; s^t, s_{t+1})] \]

subject to

\[ (1 + \tau_{c,t})C^n_t + \frac{B^n_t}{P_t} + \frac{v}{2} \left( \frac{B^n_t}{P_t Y_t} \right)^2 Y_t \leq (1 - \tau_{h,t})W_t H^n_t + R_{t-1} \frac{B^n_{t-1}}{P_t} + T_t \]

bond holding cost
Firms

- Final goods $Y_t$ produced by combining intermediate goods $Y_{j,t}$ using technology

$$Y_t = \left[ \int_0^1 Y_{j,t}^\theta p \frac{\theta p - 1}{\theta p - 1} dj \right]^{\frac{\theta p}{\theta p - 1}}$$

- Production function

$$Y_{j,t} = A_t K_{j,t}^\alpha H_{j,t}^{1-\alpha}$$

- Sticky price: in each period, intermediate firms can re-optimize their prices with probability $(1 - \xi_p)$
Employment

- Households supply differentiated labor service to employment agency:

\[ H_t = \left[ \int_0^1 H_{i,t}^{\frac{\theta_w - 1}{\theta_w}} \, di \right]^{\frac{\theta_w}{\theta_w - 1}} \]

- Sticky wage: in each period, household can re-optimize its wage with probability \((1 - \xi_w)\)
Resource constraint and monetary policy

- Resource constraint:

\[
C_t + I_t + G_t + \frac{\nu}{2} \left( \frac{B^n_t}{P_t Y_t} \right)^2 Y_t = Y_t
\]

- \( G_t = g_t Y_t \) : government spending

- Bond market clearing:

\[
\chi B^n_t + (1 - \chi) B^c_t = B^g_t
\]

- Monetary policy:

\[
\frac{R_t}{\bar{R}} = \left( \frac{R_{t-1}}{\bar{R}} \right)^{\rho_R} \left\{ \left( \frac{\pi_t}{\bar{\pi}} \right)^{\phi_{\pi}} \left( \frac{Y_t}{\bar{Y}} \right)^{\phi_Y} \right\}^{1-\rho_R}
\]
Quantitative analysis
Quantitative analysis

- Comparison of heterogeneous- and representative-agent model
  - Impulse response analysis
  - Great Recession counterfactual experiment
- Solution method developed in Ilut et al (2016)
  - Allow for heterogeneous worst-case scenarios among households
  - Resulting decision rules are linear
Parameterization

- Fiscal rules estimated from data

- Capital market participation rate $1 - \chi = 0.2$
  - In line with micro evidence
  - Rep. agent model if $1 - \chi = 1$

- Size of ambiguity
  - Basic idea: ambiguity should not be “too large” compared to the actual variability of data
    - Ilut & Schneider (2014): $a_x \leq 2\sigma_x$
    - Set $a_x = \sigma_x$

- Other parameters standard
1-std capital income tax ambiguity shock
(rep. agent, het. agent)

Output
Consumption
Investment
Hours

Real wage
Inflation
Nominal rate

\[ \alpha_{t+k} \]
1-std capital income tax ambiguity shock
(true DGP, worst-case DGP)
Effect of worst-case heterogeneity
(rep. agent, het. agent, het. agent with homogeneous worst case)
Effect of worst-case heterogeneity (counterfactual) 
(true DGP, worst-case DGP)
Effect of zero lower bound
(rep. agent, rep. agent & ZLB, het. agent, het. agent & ZLB)

- Output
- Consumption
- Investment
- Hours
- Real wage
- Inflation
- Nominal rate
- \(a_{1-k}\)
Additional analysis

- Effect of removing nominal rigidities
  - Impact of ambiguity small if no nominal rigidities

- Effect of one-sided increase in ambiguity
  - Up-side and down-side increases in ambiguity similar macro impact
Great Recession experiment

• How much can fiscal uncertainty shocks explain the Great Recession and its slow recovery?

• Feed in the BBD index into the decision rule under the zlb

• Quantify the effect by removing simulated path with fiscal uncertainty shocks from actual path
Effect of removing capital income tax ambiguity shock

All fiscal ambiguity
No zlb

Output

Hours

Investment

Consumption

2008 2009 2010 2011
-6 -4 -2 0

2008 2009 2010 2011
-15 -10 -5 0

2008 2009 2010 2011
-40 -30 -20 -10 0

2008 2009 2010 2011
-6 -4 -2 0 2

Rep. agent
Het. agent
Data
Conclusion

- New Keynesian model with limited capital market participation and ambiguity averse households

- Fiscal uncertainty shocks have large macroeconomic impact because the model captures concerns about redistribution

- Quantitatively important factor in accounting for the Great Recession and its slow recovery
Backup slides
Beliefs vs data

• True DGP for shock $x$

$$x_{t+1} = \rho x_t + \sigma^* \epsilon_{t+1} + \mu_t^*$$

• Deterministic sequence $\{\mu_t^*\}$ unknown
  Empirical moments same as iid normal process with mean zero & variance $\sigma^2_{\mu}$
• Cannot identify $\mu_t^*, \sigma^*$ without further assumptions

• Econometrician
  • Resolve uncertainty probabilistically by assuming stationarity
  • Represent uncertainty as risk

$$x_{t+1} = \rho x_t + \sigma \epsilon_{t+1}$$

where $\sigma^2 = (\sigma^*)^2 + \sigma^2_{\mu}$

• Agents
  • Consider nonstationary models given by different $\tilde{\mu}_t$s and $\tilde{\sigma}$
  • Treat one-step ahead mean as ambiguous
  • Respond to uncertainty as if minimizing over $[-a_t, a_t]$
## Estimated fiscal rules

<table>
<thead>
<tr>
<th></th>
<th>$g$</th>
<th>$\tau_c$</th>
<th>$\tau_h$</th>
<th>$\tau_k$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{x}$</td>
<td>ln(0.19)</td>
<td>ln(0.07)</td>
<td>ln(0.23)</td>
<td>ln(0.35)</td>
</tr>
<tr>
<td>$\rho_x$</td>
<td>0.97</td>
<td>0.97</td>
<td>0.94</td>
<td>0.87</td>
</tr>
<tr>
<td>$\phi_{x,Y}$</td>
<td>-0.006</td>
<td>0.017</td>
<td>0.015</td>
<td>0.132</td>
</tr>
<tr>
<td>$\phi_{x,B}$</td>
<td>-0.017</td>
<td>0.015</td>
<td>0.015</td>
<td>0.067</td>
</tr>
<tr>
<td>$\sigma_x$</td>
<td>0.011</td>
<td>0.010</td>
<td>0.024</td>
<td>0.024</td>
</tr>
</tbody>
</table>
## Parameterization

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology growth</td>
<td>1.004</td>
</tr>
<tr>
<td>Capital share</td>
<td>0.35</td>
</tr>
<tr>
<td>Discount factor</td>
<td>0.99</td>
</tr>
<tr>
<td>Depreciation rate</td>
<td>0.015</td>
</tr>
<tr>
<td>Frisch elasticity</td>
<td>1</td>
</tr>
<tr>
<td>Investment adj. cost</td>
<td>1.5</td>
</tr>
<tr>
<td>Goods/wage demand elasticity</td>
<td>21, 21</td>
</tr>
<tr>
<td>Calvo price/wage</td>
<td>0.75, 0.75</td>
</tr>
<tr>
<td>Taylor rule</td>
<td>0.5, 1.5, 0.05</td>
</tr>
<tr>
<td>Bond holding cost</td>
<td>0.5</td>
</tr>
<tr>
<td>SS gov. debt-to-output</td>
<td>0.64</td>
</tr>
<tr>
<td>Gov. bond rule</td>
<td>0.98, 0.0080, 0.0076</td>
</tr>
<tr>
<td>Gov. spending ambiguity</td>
<td>0.68, 0.58</td>
</tr>
<tr>
<td>Tax ambiguity</td>
<td>0.67, 0.38</td>
</tr>
</tbody>
</table>
SVAR: 1-std shock to tax uncertainty (1985Q1–2007Q4)
1-std fiscal ambiguity shock ($a_g, a_{\tau_c}, a_{\tau_h}, a_{\tau_k}$ combined)
(rep. agent, het. agent)
1-std tax ambiguity shock \( (a_{Tc}, a_{Th}, a_{Tk} \text{ combined}) \)

(rep. agent, het. agent)
Effect of nominal rigidities
(rep. agent & sticky price, rep. agent & flex price, het. agent & sticky price, het. agent & flex price)
One-sided ambiguity shock: $\mu_{\tau_k,t} \in [a_{\tau_k}, t\bar{a}_{\tau_k}, a_{\tau_k}, t]$ (rep. agent, het. agent)
One-sided ambiguity shock: $\mu_{\tau k, t} \in [-a_{\tau k, t}, \bar{a}_{\tau k}]$

(rep. agent, het. agent)

- Output
- Consumption
- Investment
- Hours
- Real wage
- Inflation
- Nominal rate
- $a_{\tau k}$
Effect of removing fiscal ambiguity shock ($a_g, a_{\tau_c}, a_{\tau_h}, a_{\tau_k}$ combined)

- Output
- Hours
- Investment
- Consumption

![Graphs showing output, hours, investment, and consumption fluctuations over years 2008 to 2011. The graphs compare the data with Representative and Heterogeneous agents' predictions.](image-url)
Effect of removing capital income tax ambiguity shock: no zlb

Output

Hours

Investment

Consumption