Small and Orthodox Fiscal Multipliers at the Zero Lower Bound

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Outline

1. Introduction
2. Model
3. Our Parameterization
4. Results for the Great Recession
5. Conclusions
Motivation

- The nominal interest rate has fallen to (almost) zero in many countries around the world.

- Does fiscal policy have large and qualitatively different effects when the nominal interest rate is zero?

- An emerging consensus in the New Keynesian (NK) literature is that the answer is yes.
Labor tax increase

- **In normal times:** labor tax ↑ → hours ↓

- **At the ZLB:** labor tax ↑ → hours ↑
  ("Paradox of Toil", Eggertsson(2011))
Government spending multiplier

- **In normal times:** government spending multiplier $\leq 1$

- **At the ZLB:** government spending multiplier $>> 1$
  (Christiano, Eichenbaum and Rebelo (2011))

  $\rightarrow$ Policy implication: Fiscal stimulus is particularly effective when monetary policy is constrained by the ZLB.
Our paper

- Provides new evidence that the properties of fiscal policy in the NK model at the ZLB and away from the ZLB are generally quite similar:
  - labor tax $\uparrow \rightarrow$ hours $\downarrow$, or hours are inelastic
  - government spending multiplier $\approx 1$.

- How do we reach this conclusion?
  - Formulate a tractable, nonlinear, stochastic NK model with an occasionally binding ZLB.
  - Calibrate shock parameters to reproduce declines in GDP and inflation from the Great Recession and Great Depression.
  - Analyze the global properties of the model using analytical and numerical methods.
Fiscal multipliers are *generally* small

- **Great Recession**
  1. GDP government purchase multiplier is about 1.15 or less.
  2. Employment generally falls or shows no response at all to an increase in the labor tax.

- **Great Depression**
  1. GDP government purchase multiplier is 1.13 or less.
  2. Employment falls when the labor tax is increased.
Fiscal multiplier asymptotes

- Near asymptotes fiscal multipliers can be arbitrarily large and positive or large and negative.

- This region of the parameter space is small.

- Woodford (2011) and Carlstrom, Fuerst and Paustian (2012) have also documented asymptotes using loglinearized solutions.
What explains the difference between our results and the previous literature?

- **Parameterization of the model**
  - This paper uses parameterizations that can reproduce output and inflation responses from the Great Recession or the Great Depression.
  - Some previous work uses parameterizations of the NK model that cannot reproduce these responses.

- **Solution method**
  - Loglinear solutions may get the local dynamics of the model wrong.
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1 Introduction

2 Model

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2. Model

Overview

- Standard New Keynesian model of a closed economy.
- Nominal price rigidity à la Rotemberg (1996) adjustment costs.
- No need to loglinearize.
- Equilibrium employment and inflation in the ZLB state can be found by solving two nonlinear equations.
1. Model

State of the economy

- State $s \in \{H, L\}$.
- 2 state Markov chain with $L$ as the initial state.
- Stays in $L$ with probability $p$. (Persistence)
- $H$ is the absorbing state.
- Household’s one-step discount factor and firms’ technology depends on $s$.
- Fiscal policy is also Markov in $s$. 
1. Model

Households

- Momentary utility function:
  \[
  \frac{c_t^{1-\sigma}}{1-\sigma} - \frac{h_t^{1+\nu}}{1+\nu}
  \]

- One-step preference discount factor \( \beta \times d_{t+1} \) \((t + 1 \to t)\).

- \( d_{t+1} = d^L \) in the \( L \) state, \( d_{t+1} = 1 \) in the \( H \) state.

- Labor income subject to linear tax \( \tau_{w,t} \).

- Optimality condition:
  \[
  1 = \beta d_{t+1} E_t \left[ \frac{c_{t+1}^{-\sigma}}{c_t^{-\sigma}} \frac{1}{1 + \pi_{t+1}} \right] (1 + R_t)
  \]

  \[
  w_t = \frac{h_t^\nu}{c_t^{-\sigma}(1 - \tau_{w,t})}
  \]


2. Model

**Final good firms**

- Produce the final foods using intermediate goods \( i \in [0, 1] \).
- CES aggregator:
  \[
  y_t = \left[ \int_0^1 y_t(i)^{\frac{\theta}{\theta-1}} \, di \right]^{\frac{\theta-1}{\theta}}.
  \]
- Profit maximizing input demand:
  \[
  y_t^d(i) = \left( \frac{p_t(i)}{P_t} \right)^{-\theta} y_t
  \]
  where \( P_t = \left[ \int_0^1 p_t(i)^{1-\theta} \, di \right]^{\frac{1}{1-\theta}} \) is the price of the final good and \( p_t(i) \) is the price of intermediate good \( i \).
2. Model

**Intermediate goods producers**

- Use linear production function:

\[ y_t(i) = z_t h_t(i), \]

which implies that the marginal cost is

\[ w_t / z_t. \]

- \( z_t = z^L \) in the \( L \) state, \( z_t = 1 \) in the \( H \) state.
2. Model

Intermediate goods producers

- Set prices \( \{ p_t(i) \}_{t=0}^{\infty} \) to maximize PV of profits subject to the demand function.

- Momentary profit function:

\[
(1 + \tau_s) \frac{p_t(i)}{P_t} y_t(i) - \frac{w_t}{z_t} \frac{\gamma}{2} \left( \frac{p_t(i)}{p_{t-1}(i)} - 1 \right)^2 y_t.
\]

- \( y_t = z_t h_t \) is the aggregate production.

- In a symmetric equilibrium the fraction \( \frac{\gamma}{2} \pi_t^2 \) of agg. production is used for price adjustment.
2. Model

Policy

- Fiscal policy is Ricardian.
- The Central Bank follows a Taylor rule:

\[ R_t = \max(0, r_t + \phi_\pi \pi_t + \phi_y \hat{gdp}_t) \]

where \( r_t = \frac{1}{\beta d_{t+1}} - 1 \).
2. Model

Aggregate resource constraint

- Aggregate resource constraint:

\[ GDP_t \equiv c_t + g_t = (1 - \kappa_t)z_t h_t. \]

- \( \kappa_t \equiv \frac{\gamma}{2} \pi^2_t \) represents the resource costs of price adjustment.

- \( \kappa_t \) plays an important role in a severe, deflationary recession.

1. Magnitude and sign of employment and GDP responses can differ.
2. \( \kappa \) disappears when loglinearized about a constant price steady-state.
3. If the economy is far from the steady state this problem can be severe.
4. Same issue arises under Calvo pricing.
2. Model

ZLB Markov equilibrium of Eggertsson and Woodford (2003)

- Markov equilibrium with state \( s \in \{L, H\} \).
  
  (Fiscal policy is also Markov in \( s \).)

- Assume: Zero inflation steady-state occurs in state H.

- Assume: ZLB binds in state L. (Taylor rule checked).

- ZLB Equilibrium: \((c^L, h^L, w^L, \pi^L)\).
  
  - Eqm condition reduces to two equations with \((\pi^L, h^L)\).
  - ”AD” and ”AS” equations.
2. Model

Equilibrium condition at the ZLB

1. NKPC:

\[ \pi^L (1 + \pi^L) = \frac{\theta}{\gamma} \left( \frac{w^L}{z^L} - 1 \right) + p \beta d^L \pi^L (1 + \pi^L) \]

2. Euler equation:

\[ (c^L)^{-\sigma} = p \beta d^L (c^L)^{-\sigma} \frac{1 + \pi^L}{1 + \pi^L} + (1 - p) \beta d^L c^{-\sigma} \]

3. Labor supply:

\[ w^L = (c^L)^{\sigma} (h^L)^{\nu} / (1 - \tau_w^L). \]

4. Resource constraint:

\[ c^L = (1 - \eta^L - \kappa^L) z^L h^L. \quad (g^L = \eta^L z^L h^L.) \]
2. Model

Equilibrium employment and inflation at the ZLB

1. **AS:** Price setting condition (+ labor supply and resource constraint)

\[ \pi^L(1 + \pi^L) = \frac{\theta}{\gamma} \left( \frac{(1 - \kappa^L - \eta^L)^\sigma (h^L)^{\sigma + \nu}}{(1 - \tau^L_w)(z^L)^{1 - \sigma}} - 1 \right) + p \beta d^L \pi^L (1 + \pi^L) \]

2. **AD:** Euler equation (+ production function and resource constraint)

\[ 1 = p \left( \frac{\beta d^L}{1 + \pi^L} \right) + (1 - p) \beta d^L \left( \frac{(1 - \kappa^L - \eta^L)^\sigma (h^L)^\sigma}{(1 - \eta)^\sigma h^\sigma} \right) \]

3. \( R^{\text{Taylor}} < 0 \)
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5. Our Parameterization

**Estimated parameters**

- Key parameters are estimated by Bayesian methods using the loglinear equilibrium conditions.
- Model: loglinearized three-equation model (quarterly)
- Shocks: technology, demand, and monetary policy.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Prior distribution</th>
<th>Prior mean</th>
<th>Prior std. dev.</th>
<th>Posterior mode</th>
<th>Posterior 5%</th>
<th>Posterior 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\nu$</td>
<td>Labour supply elasticity</td>
<td>gamma</td>
<td>0.5</td>
<td>0.25</td>
<td>0.28</td>
<td>0.08</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>Price adj. costs</td>
<td>normal</td>
<td>150</td>
<td>200</td>
<td>458</td>
<td>315</td>
</tr>
<tr>
<td>$\phi_y$</td>
<td>TR coefficient on GDP</td>
<td>normal</td>
<td>0</td>
<td>1</td>
<td>1.63</td>
<td>1.06</td>
</tr>
<tr>
<td>$\phi_\pi$</td>
<td>TR coefficient on inflation</td>
<td>normal</td>
<td>3</td>
<td>1</td>
<td>3.46</td>
<td>2.38</td>
</tr>
<tr>
<td>$\rho_r$</td>
<td>TR coefficient on $R_{t-1}$</td>
<td>beta</td>
<td>0.75</td>
<td>0.1</td>
<td>0.86</td>
<td>0.81</td>
</tr>
</tbody>
</table>
5. Our Parameterization

Other parameters

- The remaining parameters are fixed a priori as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$  Discount factor</td>
<td>0.997</td>
</tr>
<tr>
<td>$\sigma$  Relative risk aversion</td>
<td>1</td>
</tr>
<tr>
<td>$\frac{\theta}{\theta - 1}$ Steady state gross markup</td>
<td>1.15</td>
</tr>
</tbody>
</table>

- Resulting slope of NK Phillips Curve is: 0.021.
- Close to estimate of Rotemberg and Woodford (1997): 0.024.
5. Our Parameterization

**Targets from the Great Recession and the Great Depression**

<table>
<thead>
<tr>
<th></th>
<th>Inflation</th>
<th>GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Recession (2008-09)</td>
<td>-1%</td>
<td>-7%</td>
</tr>
<tr>
<td>Great Depression (1929-30s)</td>
<td>-10%</td>
<td>-30%</td>
</tr>
</tbody>
</table>

- Consider a wide range of $p$ (duration of the ZLB) $\in [0, 0.95]$.
- For each $p$ we adjust $z^L$ and $d^L$ to reproduce these numbers at ZLB.
- This presentation focuses on the GR calibration.
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All equilibria are MSV solutions.

Left case doesn’t occur if loglinearized around zero inflation steady-state.

Measure policy effects by perturbing fiscal policy in state L.
6. Results for the Great Recession

**The response of hours to a labor tax increase**

<table>
<thead>
<tr>
<th>Case</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) p &lt; 0.6</td>
<td>AS shifts up. Employment ↓ for the left and the right cases.</td>
</tr>
<tr>
<td>(ii) 0.6 &lt; p &lt; 0.86</td>
<td>Employment ↓ for the left and the right cases. Employment ↑ for the middle case.</td>
</tr>
<tr>
<td>(iii) p &gt; 0.87</td>
<td>Employment ↑ for the middle case.</td>
</tr>
</tbody>
</table>

- *Labor tax ↑ ⇒ AS shifts up.*
- *Employment ↓ for the left and the right cases.*
- *Employment ↑ for the middle case.*
6. Results for the Great Recession

The response of hours to a labor tax increase

- Third equilibrium can exist (red).
- Labor tax multiplier proportional to \( \frac{1}{\text{slope}(AD)/\text{slope}(AS)-1} \).
6. Results for the Great Recession

Government spending multiplier

- Government spending $\uparrow \approx$ AD shifts toward the right.
- Inflation $\uparrow$ for the left and the middle cases. $\rightarrow C \uparrow \Rightarrow$ Multiplier $> 1$.
- Inflation $\downarrow$ for the right case $\rightarrow C \downarrow \Rightarrow$ Multiplier $< 1$. 
6. Results for the Great Recession

**Government spending multiplier**

- Very large multiplier only around the asymptote.
- Right panel corresponds to Mertens and Ravn (2014).
Conclusions

Our findings:

- For a broad and empirically relevant range of parameter/shock configurations
  - labor tax $\uparrow \rightarrow$ hours $\downarrow$ or hours are inelastic
  - government spending multiplier $\approx 1$

- Fiscal multipliers can be very large and positive or large and negative near asymptotes.

These properties also hold in

- Specifications with preference shock only, and
- Specifications that are calibrated to Great Depression.