Fiscal Stimulus and Distortionary Taxation

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June 30, 2011
Outline

1. Fiscal Stimulus 2009 and its Aftermath
2. Fiscal Stimulus: The Keynesian Textbook
3. An NK model with distort. taxes and gov. capital.
   - Estimation and Historical Shocks
   - Explaining the financial crisis
4. Results
   - Benchmark
   - Sensitivity analysis
5. The power of monetary policy?
6. Challenges
7. Conclusion
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Total Gov. Spending and Receipts: in % of GDP

Total Gov. Spending and Receipts: in % of GDP

Receipts for 2010 IV=III.


IV=III.

State and Local Spending and Receipts: in bill US $.

Source:
Fiscal Stimulus 2009 and its Aftermath


<table>
<thead>
<tr>
<th>Year</th>
<th>Total government Net saving (NIPA)</th>
<th>Federal Government Net saving (NIPA)</th>
<th>State and local government Net saving (NIPA)</th>
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<tr>
<td>2010</td>
<td>-1,600</td>
<td>-1,600</td>
<td>-1,600</td>
</tr>
</tbody>
</table>

Debt Development: in % of GDP.

Source: usgovernmentspending.com
Debt Development: in % of GDP.

Source: usgovernmentspending.com
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IS-LM

- Output: $Y$
- Internal rate
- IS
- LM
- $Y'$
- $Y$

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Fiscal Stimulus and Distortionary Taxation
June 30, 2011
Aggregate Supply and Demand

Prices: $P$

Output

AD

AS

A

Y
Aggregate Supply and Demand
Aggregate Supply and Demand

Prices: $P$

Output: $Y$, $Y'$

Graphical representation of aggregate supply and demand, showing the impact of fiscal stimulus (G) on the AD curve shifting from AD to AD'. Points A and B illustrate the initial and new equilibrium points before and after the fiscal stimulus.
What the textbook says

Fiscal stimulus works great, if

- The central bank keeps interest rates unchanged.
- Inflation is low and stable.
- There is a lot of “slack of demand”.
What the textbook leaves out

- Consumption and labor supply: not a mechanical rule, but forward looking.
- Government deficits create debt.
- Debt creates future taxes.
- Future taxes need to be repaid.
- That lessens the incentives to work and to invest.
The modern approach

- Dynamic Stochastic General Equilibrium Analysis.
- New-Keynesian model with fiscal distortions.
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The Approach

- Question: what is the fiscal multiplier for the ARRA?
- ARRA has gov. purchases, gov. investment, transfers.
- Start from Smets-Wouters, AER 2007.
- Add:
  1. Distortionary taxation.
  2. “Rule-of-thumb” (RoT) households: consume earnings each period.
  3. Baseline: 25% RoT’s, receive 25% of transfers.
  5. Government capital.
  6. ZLB. Benchmark 8 quarters. Consider 0, 4, 8, 12, endog.

- Fiscal multiplier at horizon $s$: compare NPV’s.
- Estimate, provide Bayesian posteriors.
- Calculate sensitivity to key ingredients.
CCTW Stimulus: CCWT vs DU

DU ("new") vs CCTW: Aggregate

Different Stimulus Plans

DU in Detail

Components of the Stimulus Plan

Sources: CCTW (2010), Congressional Budget Office (2009).
The Fiscal Multiplier

\[ \varphi_t = \sum_{s=1}^{t} \left( \mu^s \prod_{j=1}^{s} R_j^{-1} \right) \hat{y}_s / \sum_{s=1}^{t} \left( \mu^s \prod_{j=1}^{s} R_j^{-1} \right) \hat{g}_s \]

- \( \varphi_t \): horizon-\( t \) multiplier.
- \( R_{j,ARRA} \): government bond return, from \( j - 1 \) to \( j \) under ARRA.
- \( \hat{y}_s \): output change at date \( s \) due to ARRA, in % of GDP.
- \( \hat{g}_s \): ARRA spending at date \( s \), in % of GDP.
- \( \mu \): balanced-growth factor.
- **Net present value** (NPV) fiscal multiplier.
Fiscal multipliers. ZLB-target 8 qrts. Short-run ...
Fiscal multipliers. ZLB-target 8 qrts. ... and long run
Fiscal multipliers. ZLB-target 8 qrts.
Smets-Wouters (2007): overview

- Elaborate New Keynesian model.
- Continuum of households. They supply household-specific labor in monopolistic competition. They set Calvo-sticky wages.
- Continuum of intermediate good firms. They supply intermediate goods in monopolistic competition. They set Calvo-sticky prices.
- Final goods use intermediate goods. Perfect competition.
- Habit formation, adjustment costs to investment, variable capital utilization.
- Monetary authority: Taylor-type rule.
Modifications

- Distortionary labor taxation, consumption taxes, capital income taxes. Steady state levels: Trabandt-Uhlig (2009).
- ZLB: hold FFR at zero for $k$ quarters.
- “Credit-constrained” or “rule-of-thumb” consumers (25%).
- Government capital.
- Estimate. Provide Bayesian posteriors for fiscal multipliers.
- Stimulus: path per ARRA
  - 24%: Government consumption.
  - 59%: Transfers to credit-constrained consumers.
Tax rule

- Remaining deficit, prior to new debt and labor taxes ...

\[ d_t = \text{gov.spend.} + \text{subs.}_t + \text{old debt repaym.}_t \]
\[ - \text{consump.tax rev.}, \text{cap.tax rev.}_t - \bar{\tau}^l \text{lab.income}_t \]

- ... needs to be financed:

\[ \tau^l_t \text{lab.income}_t + \text{new debt}_t = d_t \]

- Balanced growth debt, taxes, deficit: \( \ddot{d}_t \).

- Tax rule:

\[ (\tau^l_t - \bar{\tau}^l) \text{lab.income}_t = \psi_\tau (d_t - \ddot{d}_t) \]
An NK model with distort. taxes and gov. capital.

Financial friction: bond premium shock.

\[
1 = \beta E_t \left[ \frac{u_{c,t+1}}{u_{c,t}} \frac{R_{t}^{gov}}{\pi_{t+1}} \right] = \beta E_t \left[ \frac{u_{c,t+1}}{u_{c,t}} \left( 1 + \omega^t_{gov} \right) \frac{R_{t}^{FFR}}{\pi_{t+1}} \right]
\]

\[
= \beta E_t \left[ \frac{u_{c,t+1}}{u_{c,t}} \left( (1 - \omega^t_{k}) \left[ (1 - \tau^k_{t}) r_{t+1}^k + \delta \tau^k \right] + (1 - \delta) \frac{Q_{t+1}}{Q_t} \right) \right]
\]

1. Gov. bond shock $\omega^t_{gov}$: wedge between FFR and gov’t bonds.
2. Priv. bond shock $\omega^t_{k}$: wedge between gov’t bonds and priv. capital.

Stand-in for financial friction. With perfect foresight:

\[
\frac{R_{t}^{FFR}}{\pi_{t+1}} = \frac{1}{(1 + \omega^t_{gov})} \left( (1 - \omega^t_{k}) \left[ r_{t+1}^k - \tau^k (r_{t+1}^k - \delta) \right] + (1 - \delta) \right).
\]
Government capital in production

- Technology for intermediate goods production:
  \[ Y_t(i) = \tilde{\epsilon}_t^a \left( \frac{K^g_{t-1}}{\int_0^1 Y_t(j) dj + \Phi \mu^t} \right)^{-\frac{\zeta}{1-\zeta}} K^s_t(i)^\alpha [\mu^t n_t(i)]^{1-\alpha} - \mu^t \Phi, \]

  where \( \Phi \) are fixed costs, \( K^s_t \) are capital services.

- \( \epsilon_t^a \) is TFP, \( \log \epsilon_t^a \sim AR(1) \).

- Government capital services \( K^g_{t-1} \) subject to congestion.

- Aggregate production function:
  \[ Y_t = \epsilon_t^a K^g_{t-1} \zeta K^s_t(1-\zeta) [\mu^t n_t]^{(1-\alpha)(1-\zeta)} - \mu^t \Phi, \quad \epsilon_t^a \equiv (\tilde{\epsilon}_t^a)^{1-\zeta}. \]

  Along the balanced growth path: \( \bar{\epsilon}^a \equiv 1 \).

- Current profits:
  \[ P_t(i) Y_t(i) - W_t n_t(i) - R^k_t K^s_t(i) \]
Government capital accumulation

\[ k_t^g = (1 - \delta) \frac{k_{t-1}^g}{\mu} + q_t^g \left( 1 - S_g \left( \frac{x_t^g}{x_{t-1}^g} \mu \right) \right) x_t^g \]

where

- \( S_g(\mu) = S'_g(\mu) = 0, S''_g(\cdot) > 0 \): adjustment costs.
- \( q_t^{x,g} \): shock to the relative price of government investment.
- Constant capacity utilization.
ZLB

- Benchmark implementation: “Switching off”:
  \[ \hat{R}_t = (1 - 1_{ZLB,t}) \hat{R}_{t}^{TR} + 1_{ZLB,t} \hat{R}_{t-1}^{TR}. \]
- Endogenous ZLB: FFR equals max of original SW Taylor rule and approximately zero (0.25% at annual rates):
  \[
  \begin{align*}
  \hat{R}_t &= \max\{-(1 - \bar{R}) + \frac{0.25}{400}, \hat{R}_t^{TR}\}, \\
  \hat{R}_t^{TR} &= \psi_1 (1 - \rho_R) \hat{\pi}_t + \psi_2 (1 - \rho_r) (\hat{y}_t - \hat{y}_t^f) \\
  &\quad + \psi_3 \Delta(\hat{y}_t - \hat{y}_t^f) + \rho_R \hat{R}_{t-1}^{TR} + m_{st}.
  \end{align*}
  \]
The Stimulus


Total Spending

- The CBO divides the bill’s spending into direct payments to individuals (i.e., unemployment compensation or tax credits) and purchases of goods and services, either directly by the federal government or indirectly in the form of grants to states and local governments.

Democrats say tax cuts represent one-third of the overall stimulus package, not a huge difference from Obama’s original goal of 40 percent. But congressional budget analysts count nearly $100 billion of these measures as spending because they are credits going to people who don’t pay taxes. The CBO adjustment reduces the tax-cut portion of the package to 22 percent.

Direct payments to individuals

- Democrats define some of this as tax cuts.

Totals for 2009-2019, in billions of dollars:

- Agriculture, nutrition, and rural development: $26.9
- Commerce, justice, and science: $13.9
- Energy and water: $4.8
- Environment, interior: $48.9
- Federal facilities: $14.3
- Health, labor, and education: $8.5
- Housing, transportation: $91.3
- Homeland security: $1.1
- Military, veterans: $62.3
- State Dept.: $7
- State stabilization fund: $0.5
- Tax provisions: $79
- Medicaid: $45.7
- Health insurance: $40.8
- Health information technology: $20.2
- Assistance to unemployed, families: $89.7
- Total: $819 billion

House bill introduced Jan. 26

Congressional Budget Office analysis of original House bill

CBO analysis of House-approved bill

SPENDING + TAX CUTS = TOTAL COST

- $550 billion
- $604 billion
- $637 billion
- $275 billion (33%)
- $212 billion (26%)
- $182 billion (22%)
- $825 billion
- $816 billion
- $819 billion
### Categorizing the stimulus – Government Consumption

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount (bn USD)</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dept. of Defense</td>
<td>4.53</td>
<td>0.59</td>
</tr>
<tr>
<td>Employment and Training</td>
<td>4.31</td>
<td>0.56</td>
</tr>
<tr>
<td>Legislative Branch</td>
<td>0.03</td>
<td>0</td>
</tr>
<tr>
<td>National Coordinator for Health Information Technology</td>
<td>1.98</td>
<td>0.26</td>
</tr>
<tr>
<td>National Institute of Health</td>
<td>9.74</td>
<td>1.26</td>
</tr>
<tr>
<td>Other Agriculture, Food, FDA</td>
<td>3.94</td>
<td>0.51</td>
</tr>
<tr>
<td>Other Commerce, Justice, Science</td>
<td>5.36</td>
<td>0.69</td>
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<tr>
<td>Other Dpt. of Education</td>
<td>2.12</td>
<td>0.28</td>
</tr>
<tr>
<td>Other Dpt. of Health and Human Services</td>
<td>9.81</td>
<td>1.27</td>
</tr>
<tr>
<td>Other Financial Services and gen. Govt</td>
<td>1.31</td>
<td>0.17</td>
</tr>
<tr>
<td>Other Interior and Environment</td>
<td>4.76</td>
<td>0.62</td>
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<tr>
<td>Special education</td>
<td>12.2</td>
<td>1.58</td>
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<tr>
<td>State and local law enforcement</td>
<td>2.77</td>
<td>0.36</td>
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<tr>
<td>State Fiscal Relief</td>
<td>90.04</td>
<td>11.68</td>
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<tr>
<td>State fiscal stabilization fund</td>
<td>53.6</td>
<td>6.95</td>
</tr>
<tr>
<td>State, foreign operations, and related programs</td>
<td>0.6</td>
<td>0.08</td>
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<tr>
<td>Other</td>
<td>2.55</td>
<td>0.33</td>
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<tr>
<td><strong>Consumption</strong></td>
<td><strong>209.64</strong></td>
<td><strong>27.2</strong></td>
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### Categorizing the stimulus – Government Investment

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<tr>
<th>Item</th>
<th>Amount (bn USD)</th>
<th>Share</th>
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</thead>
<tbody>
<tr>
<td>Broadband Technology opportunities program</td>
<td>4.7</td>
<td>0.61</td>
</tr>
<tr>
<td>Clean Water and Drinking Water State Revolving Fund</td>
<td>5.79</td>
<td>0.75</td>
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<tr>
<td>Corps of Engineers</td>
<td>4.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Distance Learning, Telemedicine, and Broadband Program</td>
<td>1.93</td>
<td>0.25</td>
</tr>
<tr>
<td>Energy Efficiency and Renewable Energy</td>
<td>16.7</td>
<td>2.17</td>
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<tr>
<td>Federal Buildings Fund</td>
<td>5.4</td>
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<tr>
<td>Health Information Technology</td>
<td>17.56</td>
<td>2.28</td>
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<tr>
<td>Highway construction</td>
<td>27.5</td>
<td>3.57</td>
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<tr>
<td>Innovative Technology Loan Guarantee</td>
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<td>0.78</td>
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<tr>
<td>NSF</td>
<td>2.99</td>
<td>0.39</td>
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<td>Other Energy</td>
<td>22.38</td>
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<td>Other transportation</td>
<td>20.56</td>
<td>2.67</td>
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<tr>
<td>Investment</td>
<td>136.09</td>
<td>17.66</td>
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### Categorizing the stimulus – Transfers

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<th>Item</th>
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<tr>
<td>Assistance for the unemployed</td>
<td>0.88</td>
<td>0.11</td>
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<td>Economic Recovery Programs, TANF, Child support</td>
<td>18.04</td>
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<tr>
<td>Health Insurance Assistance</td>
<td>25.07</td>
<td>3.25</td>
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<td>Health Insurance Assistance</td>
<td>-0.39</td>
<td>-0.05</td>
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<tr>
<td>Low Income Housing Program</td>
<td>0.14</td>
<td>0.02</td>
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<tr>
<td>Military Construction and Veteran Affairs</td>
<td>4.25</td>
<td>0.55</td>
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<tr>
<td>Other housing assistance</td>
<td>9</td>
<td>1.17</td>
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<tr>
<td>Other Tax Provisions</td>
<td>4.81</td>
<td>0.62</td>
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<tr>
<td>Public housing capital fund</td>
<td>4</td>
<td>0.52</td>
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<tr>
<td>Refundable Tax Credits</td>
<td>68.96</td>
<td>8.95</td>
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<td>Student financial assistance</td>
<td>16.56</td>
<td>2.15</td>
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<tr>
<td>Supplemental Nutrition Assistance Program</td>
<td>19.99</td>
<td>2.59</td>
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<tr>
<td>Tax Provisions</td>
<td>214.56</td>
<td>27.84</td>
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<tr>
<td>Unemployment Compensation</td>
<td>39.23</td>
<td>5.09</td>
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<tr>
<td><strong>Transfers and Tax cuts</strong></td>
<td><strong>425.09</strong></td>
<td><strong>55.15</strong></td>
</tr>
</tbody>
</table>
Which sample? Barro, Ramey.
Postwar GDP and government spending

Index, 1947.1=1 (log-scale)

Start SW sample
Start extended sample

Gov. spending
GDP

An NK model with distortionary taxes and government capital.
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Estimation and Calculation.

Shocks: AR(1).

1. Technology.
2. Bond shock: wedge between FFR and gov’t bonds.
5. Investment specific (rel. price).
6. Gov. investment specific. Used with gov. investment time series only.
7. Monetary policy.
8. Labor tax rates.
9. Mark-up: prices: ARMA(1,1).
10. Mark-up: wages: ARMA(1,1).
Observations – Time Series

2. Consumption: Private consumption expenditure, growth rates.
3. Investment: private fixed investment, growth rates.
5. Hours worked: Civilian employment index × average nonfarm business weekly hours worked index. Demeaned log.
8. FFR: Converted to quarterly rates.
Observations: Comments

- Sources: NIPA, FRED 2, BLS.
- Nominal series for wages, consumption, government and private investment deflated with general GDP deflator.
- All series but real wages have a correlation of 100% across the two datasets. For the change in real wages, the correlation is 0.9.
- No data for the Corporate-Treasury bond yield spread before 1953:1. Set to zero.
- No data on FFR before 1954:3. Use secondary market rate for 3-month TBill before.
- Dallas Fed federal debt data.
Calibrated parameters

- Tax rates, and debt-GDP ratio from NIPA (Trabandt-Uhlig, 2009).
- Government spending components from NIPA.
- Kimball curvature parameters set to roughly match empirical frequency of price adjustment (Eichenbaum-Fisher, 2007).
- Depreciation per Cooley-Prescott (1994) based on $\frac{\bar{x}}{k} = 0.0076$.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SW 66:1–04:4</th>
<th>Extension 48:2–08:4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depreciation $\delta$</td>
<td>0.025</td>
<td>0.0145</td>
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<td>Wage mark-up $\lambda_w$</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Kimball curvature goods mkt. $\hat{\eta}_p$</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Kimball curvature labor mkt. $\hat{\eta}_w$</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Capital tax $\tau^k$</td>
<td>n/a</td>
<td>0.36</td>
</tr>
<tr>
<td>Consumption tax $\tau^c$</td>
<td>n/a</td>
<td>0.05</td>
</tr>
<tr>
<td>Labor tax $\tau^n$</td>
<td>n/a</td>
<td>0.28</td>
</tr>
<tr>
<td>Share credit constrained $\phi$</td>
<td>n/a</td>
<td>0.25</td>
</tr>
<tr>
<td>Gov. spending, net exports-GDP $\frac{q}{y}$</td>
<td>0.18</td>
<td>0.153</td>
</tr>
<tr>
<td>Gov. investment-GDP $\frac{\bar{x}^g}{y}$</td>
<td>n/a</td>
<td>0.04</td>
</tr>
<tr>
<td>Debt-GDP $\frac{\bar{b}}{y}$</td>
<td>n/a</td>
<td>$4 \times 0.63$</td>
</tr>
</tbody>
</table>
### Estimates – Extended Model

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adj. cost $S''(\mu)$</td>
<td>norm</td>
<td>4.000 (1.500)</td>
<td>5.93 (1.1)</td>
<td>5.38 (1.03)</td>
<td>4.57 (0.82)</td>
</tr>
<tr>
<td>Risk aversion $\sigma$</td>
<td>norm</td>
<td>1.500 (0.375)</td>
<td>1.42 (0.11)</td>
<td>1.31 (0.1)</td>
<td>1.18 (0.07)</td>
</tr>
<tr>
<td>Habit $h$</td>
<td>beta</td>
<td>0.700 (0.100)</td>
<td>0.7 (0.04)</td>
<td>0.8 (0.03)</td>
<td>0.85 (0.02)</td>
</tr>
<tr>
<td>Calvo wage $\zeta_w$</td>
<td>beta</td>
<td>0.500 (0.100)</td>
<td>0.77 (0.05)</td>
<td>0.77 (0.05)</td>
<td>0.84 (0.03)</td>
</tr>
<tr>
<td>Inv. labor sup. ela. $\nu$</td>
<td>norm</td>
<td>2.000 (0.750)</td>
<td>1.96 (0.54)</td>
<td>2.14 (0.47)</td>
<td>2.33 (0.56)</td>
</tr>
<tr>
<td>Calvo prices $\zeta_p$</td>
<td>beta</td>
<td>0.500 (0.100)</td>
<td>0.69 (0.05)</td>
<td>0.73 (0.06)</td>
<td>0.81 (0.04)</td>
</tr>
<tr>
<td>Wage indexation $\iota_w$</td>
<td>beta</td>
<td>0.500 (0.150)</td>
<td>0.62 (0.1)</td>
<td>0.61 (0.12)</td>
<td>0.44 (0.09)</td>
</tr>
<tr>
<td>Price indexation $\iota_p$</td>
<td>beta</td>
<td>0.500 (0.150)</td>
<td>0.26 (0.08)</td>
<td>0.29 (0.1)</td>
<td>0.3 (0.09)</td>
</tr>
<tr>
<td>Capacity util.</td>
<td>beta</td>
<td>0.500 (0.150)</td>
<td>0.59 (0.1)</td>
<td>0.54 (0.1)</td>
<td>0.45 (0.08)</td>
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<tr>
<td>1+ Fix. cost $= 1 + \lambda_p$</td>
<td>norm</td>
<td>1.250 (0.125)</td>
<td>1.64 (0.08)</td>
<td>1.63 (0.08)</td>
<td>1.93 (0.06)</td>
</tr>
<tr>
<td>Taylor rule infl. $\psi_1$</td>
<td>norm</td>
<td>1.500 (0.250)</td>
<td>2 (0.17)</td>
<td>2.1 (0.17)</td>
<td>1.64 (0.19)</td>
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<tr>
<td>same, smoothing $\rho_R$</td>
<td>beta</td>
<td>0.750 (0.100)</td>
<td>0.82 (0.02)</td>
<td>0.83 (0.02)</td>
<td>0.92 (0.01)</td>
</tr>
<tr>
<td>same, LR gap $\psi_2$</td>
<td>norm</td>
<td>0.125 (0.050)</td>
<td>0.09 (0.02)</td>
<td>0.12 (0.03)</td>
<td>0.13 (0.03)</td>
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<td>same, SR gap $\psi_3$</td>
<td>norm</td>
<td>0.125 (0.050)</td>
<td>0.24 (0.03)</td>
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<td>0.2 (0.02)</td>
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<tr>
<td>Mean inflation (data)</td>
<td>gamm</td>
<td>0.625 (0.100)</td>
<td>0.76 (0.09)</td>
<td>0.73 (0.12)</td>
<td>0.56 (0.08)</td>
</tr>
<tr>
<td>100 $\times$ time pref.</td>
<td>gamm</td>
<td>0.250 (0.100)</td>
<td>0.16 (0.05)</td>
<td>0.14 (0.04)</td>
<td>0.11 (0.04)</td>
</tr>
<tr>
<td>Mean hours (data)</td>
<td>norm</td>
<td>0.000 (2.000)</td>
<td>1.07 (0.95)</td>
<td>1.07 (1.16)</td>
<td>-0.25 (0.67)</td>
</tr>
<tr>
<td>Trend $(\mu - 1) \times 100$</td>
<td>norm</td>
<td>0.400 (0.100)</td>
<td>0.43 (0.02)</td>
<td>0.44 (0.01)</td>
<td>0.48 (0.01)</td>
</tr>
<tr>
<td>Capital share $\alpha$</td>
<td>norm</td>
<td>0.300 (0.050)</td>
<td>0.19 (0.02)</td>
<td>0.21 (0.01)</td>
<td>0.24 (0.01)</td>
</tr>
<tr>
<td>Gov. adj. cost $S_g''(\mu)$</td>
<td>norm</td>
<td>0.000 (0.500)</td>
<td>n/a</td>
<td>n/a</td>
<td>6.85 (1.03)</td>
</tr>
<tr>
<td>Budget bal speed $\frac{\psi_T}{\psi_T - 0.025 \div 0.175}$</td>
<td>beta</td>
<td>0.30 (0.20)</td>
<td>n/a</td>
<td>n/a</td>
<td>0.07 (0.05)</td>
</tr>
<tr>
<td>Implied $\psi_T$</td>
<td>n/a</td>
<td>0.078 (0.035)</td>
<td>n/a</td>
<td>n/a</td>
<td>0.0373 (0.01)</td>
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<tr>
<td>Mean gov. debt</td>
<td>norm</td>
<td>0.000 (0.500)</td>
<td>n/a</td>
<td>n/a</td>
<td>0 (0.49)</td>
</tr>
<tr>
<td>Mean bond spread</td>
<td>gamm</td>
<td>0.500 (0.100)</td>
<td>n/a</td>
<td>n/a</td>
<td>0.45 (0.05)</td>
</tr>
</tbody>
</table>

Implied government share in production: $\zeta = 2.30\%$. 

Harald Uhlig (University of Chicago)  Fiscal Stimulus and Distortionary Taxation  June 30, 2011 49 / 85
## Estimates – Shock processes

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>s.d. tech.</td>
<td>invg</td>
<td>0.100 (2.000)</td>
<td>0.46 (0.03)</td>
<td>0.48 (0.03)</td>
<td>0.48 (0.02)</td>
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<tr>
<td>AR(1) tech.</td>
<td>beta</td>
<td>0.500 (0.200)</td>
<td>0.95 (0.01)</td>
<td>0.94 (0.01)</td>
<td>0.94 (0.01)</td>
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<tr>
<td>s.d. bond</td>
<td>invg</td>
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<td>0.24 (0.03)</td>
<td>0.17 (0.02)</td>
<td>0.97 (0.05)</td>
</tr>
<tr>
<td>AR(1) bond $\rho_q$</td>
<td>beta</td>
<td>0.500 (0.200)</td>
<td>0.27 (0.1)</td>
<td>0.26 (0.07)</td>
<td>0.68 (0.03)</td>
</tr>
<tr>
<td>s.d. gov’t</td>
<td>invg</td>
<td>0.100 (2.000)</td>
<td>0.54 (0.03)</td>
<td>0.3 (0.01)</td>
<td>0.35 (0.02)</td>
</tr>
<tr>
<td>AR(1) gov’t</td>
<td>beta</td>
<td>0.500 (0.200)</td>
<td>0.98 (0.01)</td>
<td>0.99 (0.01)</td>
<td>0.98 (0.01)</td>
</tr>
<tr>
<td>Cov(gov’t, tech.)</td>
<td>norm</td>
<td>0.500 (0.250)</td>
<td>0.53 (0.09)</td>
<td>0.36 (0.05)</td>
<td>0.3 (0.05)</td>
</tr>
<tr>
<td>s.d. inv. price</td>
<td>invg</td>
<td>0.100 (2.000)</td>
<td>0.43 (0.04)</td>
<td>1.17 (0.11)</td>
<td>1.26 (0.11)</td>
</tr>
<tr>
<td>AR(1) inv. price</td>
<td>beta</td>
<td>0.500 (0.200)</td>
<td>0.73 (0.06)</td>
<td>0.43 (0.07)</td>
<td>0.55 (0.06)</td>
</tr>
<tr>
<td>s.d. mon. pol.</td>
<td>invg</td>
<td>0.100 (2.000)</td>
<td>0.24 (0.02)</td>
<td>0.24 (0.01)</td>
<td>0.23 (0.01)</td>
</tr>
<tr>
<td>AR(1) mon. pol.</td>
<td>beta</td>
<td>0.500 (0.200)</td>
<td>0.16 (0.07)</td>
<td>0.14 (0.05)</td>
<td>0.22 (0.06)</td>
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<tr>
<td>s.d. goods m-up</td>
<td>invg</td>
<td>0.100 (2.000)</td>
<td>0.14 (0.01)</td>
<td>0.14 (0.01)</td>
<td>0.31 (0.02)</td>
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<td>AR(1) goods m-up</td>
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<td>0.500 (0.200)</td>
<td>0.89 (0.04)</td>
<td>0.89 (0.05)</td>
<td>0.91 (0.05)</td>
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<tr>
<td>MA(1) goods m-up</td>
<td>beta</td>
<td>0.500 (0.200)</td>
<td>0.73 (0.08)</td>
<td>0.77 (0.07)</td>
<td>0.96 (0.02)</td>
</tr>
<tr>
<td>s.d. wage m-up</td>
<td>invg</td>
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<td>0.26 (0.02)</td>
<td>0.26 (0.02)</td>
<td>0.23 (0.02)</td>
</tr>
<tr>
<td>AR(1) wage m-up</td>
<td>beta</td>
<td>0.500 (0.200)</td>
<td>0.97 (0.01)</td>
<td>0.97 (0.01)</td>
<td>0.96 (0.02)</td>
</tr>
<tr>
<td>MA(1) wage m-up</td>
<td>beta</td>
<td>0.500 (0.200)</td>
<td>0.91 (0.03)</td>
<td>0.91 (0.03)</td>
<td>0.91 (0.04)</td>
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<tr>
<td>s.d. Tax shock</td>
<td>invg</td>
<td>0.100 (2.000)</td>
<td>n/a</td>
<td>n/a</td>
<td>1.42 (0.07)</td>
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<tr>
<td>AR(1) tax shock</td>
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<td>n/a</td>
<td>n/a</td>
<td>0.97 (0.01)</td>
</tr>
<tr>
<td>s.d. gov. inv. price</td>
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<td>n/a</td>
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<td>AR(1) gov. inv. price</td>
<td>beta</td>
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<td>n/a</td>
<td>0.97 (0.01)</td>
</tr>
<tr>
<td>s.d. bond spread</td>
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<td>n/a</td>
<td>n/a</td>
<td>0.08 (0)</td>
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<tr>
<td>AR(1) bond spread</td>
<td>beta</td>
<td>0.500 (0.200)</td>
<td>n/a</td>
<td>n/a</td>
<td>0.91 (0.02)</td>
</tr>
</tbody>
</table>
Outline

1. Fiscal Stimulus 2009 and its Aftermath
2. Fiscal Stimulus: The Keynesian Textbook
3. An NK model with distort. taxes and gov. capital.
   - Estimation and Historical Shocks
   - Explaining the financial crisis
4. Results
   - Benchmark
   - Sensitivity analysis
5. The power of monetary policy?
6. Challenges
7. Conclusion

An NK model with distort. taxes and gov. capital.
Explaining the financial crisis
Historical Shock Decomposition: Output

Note: At posterior mean. 2007:4 is the NBER recession date.
Historical Shock Decomposition: Interest rates

Note: At posterior mean. 2007:4 is the NBER recession date.
Decomposing the recession vs variance decomposition

<table>
<thead>
<tr>
<th>Shock</th>
<th>2008:4 vs. 2007:4</th>
<th>Total Sample</th>
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<tr>
<td></td>
<td>Historical</td>
<td>Variance</td>
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<tr>
<td></td>
<td>decomposition</td>
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<tr>
<td>%</td>
<td>%</td>
<td>%</td>
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<tr>
<td>Gov. bond</td>
<td>-3.75</td>
<td>81.52</td>
</tr>
<tr>
<td>Priv. bond</td>
<td>-1.42</td>
<td>30.81</td>
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<tr>
<td>Technology</td>
<td>0.90</td>
<td>-19.53</td>
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<td>Price markup</td>
<td>-0.73</td>
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<td>Gov. spending</td>
<td>0.60</td>
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<td>Priv. inv.</td>
<td>-0.30</td>
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<tr>
<td>Labor tax</td>
<td>-0.27</td>
<td>5.91</td>
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<td>Monetary pol.</td>
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<td>-4.44</td>
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<td>Wage Markup</td>
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<td>Gov. inv.</td>
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<td>-0.73</td>
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<td>Initial Values</td>
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<td>0.22</td>
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<tr>
<td>Sum</td>
<td>-4.60</td>
<td>100.00</td>
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</table>
An NK model with distort. taxes and gov. capital.

Explaining the financial crisis

Implied interest rate spread: Gov. bonds vs. FFR

10 year spread at annual rates

Note: At posterior mean. 2007:4 is the NBER recession date.
An NK model with distort. taxes and gov. capital.

Explaining the financial crisis

**Government Bond Shock**

### Output & Consumption

Response to Government bonds shock

- **Output**
- **Consumption**

### Investment

Response to Government bonds shock

- **Priv. investment**
- **Gov. investment**

### FFR & Inflation

Response to Government bonds shock

- **FFR**
- **Inflation**
- **FFR+Bond Premium**

### Debt & Labor tax

Response to Government bonds shock

- **Debt**
- **Labor tax rates**

Note: Response to a one standard deviation shock.
Private-Government Bond Spread Shock

Output & Consumption

Investment

FFR & Inflation

Debt & Labor tax

Note: Response to a one standard deviation shock.
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ARRA impact on output: short-run ...
ARRA impact on output: ... and long-run
Debt: long-run
Labor tax rates: long run
**Fiscal Multiplier: short and long run**

**short run**

- **2009**
- **2010**
- **2011**
- **2012**
- **2013**
- **2014**
- **2015**
- **2016**

**multiplier**

- **−0.2**
- **−0.1**
- **0**
- **0.1**
- **0.2**
- **0.3**
- **0.4**
- **0.5**

**long run**

- **2010**
- **2020**
- **2030**
- **2040**
- **2050**

**multiplier**

- **−1**
- **−0.5**
- **0**
- **0.5**
- **1**

Harald Uhlig (University of Chicago)
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Lump sum vs distortionary taxation.

Lump-sum

Distortionary
Multiplier: Sensitivity Analysis

(Note: DU stimulus, posterior medians)
Multiplier: Components

(Note: Components of DU stimulus, posterior medians, ZLB=8 qtrs.)
# One-year fiscal multipliers: sensitivity

<table>
<thead>
<tr>
<th>Scenario</th>
<th>5 %</th>
<th>16.5 %</th>
<th>median</th>
<th>83.5 %</th>
<th>95 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>0.46</td>
<td>0.48</td>
<td>0.52</td>
<td>0.57</td>
<td>0.60</td>
</tr>
<tr>
<td>lump-sum taxes</td>
<td>0.55</td>
<td>0.57</td>
<td>0.61</td>
<td>0.66</td>
<td>0.70</td>
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<tr>
<td>consumption taxes</td>
<td>0.48</td>
<td>0.50</td>
<td>0.54</td>
<td>0.58</td>
<td>0.61</td>
</tr>
<tr>
<td>ZLB: 0 Quart.</td>
<td>0.17</td>
<td>0.20</td>
<td>0.23</td>
<td>0.27</td>
<td>0.30</td>
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<tr>
<td>ZLB: 12 Quart.</td>
<td>0.75</td>
<td>0.78</td>
<td>0.84</td>
<td>0.93</td>
<td>1.02</td>
</tr>
<tr>
<td>ZLB: Endogenous</td>
<td>0.51</td>
<td>0.54</td>
<td>0.60</td>
<td>0.69</td>
<td>0.78</td>
</tr>
<tr>
<td>RoT=0.15</td>
<td>0.39</td>
<td>0.42</td>
<td>0.46</td>
<td>0.49</td>
<td>0.52</td>
</tr>
<tr>
<td>RoT=0.35</td>
<td>0.47</td>
<td>0.54</td>
<td>0.59</td>
<td>0.64</td>
<td>0.69</td>
</tr>
<tr>
<td>Share transfers to RoT= 0%</td>
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<td>0.26</td>
<td>0.29</td>
<td>0.31</td>
<td>0.33</td>
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<td>Share transfers to RoT= 50%</td>
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<td>0.69</td>
<td>0.75</td>
<td>0.81</td>
<td>0.85</td>
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<td>Share transfers to RoT= 100%</td>
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<td>1.11</td>
<td>1.21</td>
<td>1.32</td>
<td>1.39</td>
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<td>Priv. capital share=0.35</td>
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<td>0.47</td>
<td>0.52</td>
<td>0.57</td>
<td>0.61</td>
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<td>price/wage-stickiness=10% of estim.</td>
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<td>0.07</td>
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<td>0.38</td>
<td>0.42</td>
<td>0.47</td>
<td>0.50</td>
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<tr>
<td>price/wage-stickiness=115% of estim.</td>
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<td>0.46</td>
<td>0.50</td>
<td>0.53</td>
<td>0.56</td>
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<td>Budget balance: $\psi = 0.025$</td>
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<td>0.51</td>
<td>0.54</td>
<td>0.58</td>
<td>0.61</td>
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<tr>
<td>Budget balance: $\psi = 0.05$</td>
<td>0.43</td>
<td>0.46</td>
<td>0.49</td>
<td>0.53</td>
<td>0.56</td>
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### Long run fiscal multipliers as $t \to \infty$: sensitivity

<table>
<thead>
<tr>
<th>Scenario</th>
<th>5 %</th>
<th>16.5 %</th>
<th>median</th>
<th>83.5 %</th>
<th>95 %</th>
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<tbody>
<tr>
<td>Benchmark</td>
<td>-0.72</td>
<td>-0.61</td>
<td>-0.42</td>
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<td>0.34</td>
<td>0.44</td>
<td>0.60</td>
<td>0.78</td>
<td>0.94</td>
</tr>
<tr>
<td>consumption taxes</td>
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<td>-0.38</td>
<td>-0.20</td>
<td>-0.02</td>
<td>0.14</td>
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<td>ZLB: 0 Quart.</td>
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<td>-1.18</td>
<td>-1.03</td>
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<td>ZLB: 12 Quart.</td>
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<td>-0.31</td>
<td>-0.03</td>
<td>0.27</td>
<td>0.52</td>
</tr>
<tr>
<td>ZLB: Endogenous</td>
<td>-0.56</td>
<td>-0.43</td>
<td>-0.19</td>
<td>0.14</td>
<td>0.57</td>
</tr>
<tr>
<td>RoT=0.15</td>
<td>-0.91</td>
<td>-0.79</td>
<td>-0.63</td>
<td>-0.43</td>
<td>-0.26</td>
</tr>
<tr>
<td>RoT=0.35</td>
<td>-0.59</td>
<td>-0.44</td>
<td>-0.24</td>
<td>-0.04</td>
<td>0.18</td>
</tr>
<tr>
<td>Share transfers to RoT= 0%</td>
<td>-0.86</td>
<td>-0.77</td>
<td>-0.65</td>
<td>-0.52</td>
<td>-0.42</td>
</tr>
<tr>
<td>Share transfers to RoT= 50%</td>
<td>-0.64</td>
<td>-0.50</td>
<td>-0.24</td>
<td>0.03</td>
<td>0.29</td>
</tr>
<tr>
<td>Share transfers to RoT= 100%</td>
<td>-0.50</td>
<td>-0.28</td>
<td>0.16</td>
<td>0.64</td>
<td>1.05</td>
</tr>
<tr>
<td>Priv. capital share=0.35</td>
<td>-1.13</td>
<td>-0.98</td>
<td>-0.76</td>
<td>-0.51</td>
<td>-0.27</td>
</tr>
<tr>
<td>price/wage-stickiness=10% of estim.</td>
<td>-0.96</td>
<td>-0.87</td>
<td>-0.75</td>
<td>-0.62</td>
<td>-0.52</td>
</tr>
<tr>
<td>price/wage-stickiness=50% of estim.</td>
<td>-0.78</td>
<td>-0.69</td>
<td>-0.58</td>
<td>-0.46</td>
<td>-0.37</td>
</tr>
<tr>
<td>price/wage-stickiness=115% of estim.</td>
<td>-0.91</td>
<td>-0.76</td>
<td>-0.56</td>
<td>-0.33</td>
<td>-0.12</td>
</tr>
<tr>
<td>Budget balance: $\psi_\tau = 0.025$</td>
<td>-0.70</td>
<td>-0.58</td>
<td>-0.40</td>
<td>-0.21</td>
<td>-0.04</td>
</tr>
<tr>
<td>Budget balance: $\psi_\tau = 0.05$</td>
<td>-0.77</td>
<td>-0.66</td>
<td>-0.49</td>
<td>-0.30</td>
<td>-0.13</td>
</tr>
</tbody>
</table>
Sensitivity to RoTs and Transfers

<table>
<thead>
<tr>
<th></th>
<th>one year mult.</th>
<th>long-run mult.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfers = RoT fraction =</td>
<td>0.10 0.25 0.40</td>
<td>0.10 0.25 0.40</td>
</tr>
<tr>
<td>Const. transfers/household:</td>
<td>0.33 0.54 0.82</td>
<td>-0.62 -0.31 0.12</td>
</tr>
<tr>
<td>Transfers =0.25, RoT fraction =</td>
<td>0.10 0.25 0.40</td>
<td>0.10 0.25 0.40</td>
</tr>
<tr>
<td>Fixed absolute transfers</td>
<td>0.45 0.54 0.66</td>
<td>-0.53 -0.31 -0.03</td>
</tr>
<tr>
<td>RoT Share =0.25, Transfers =</td>
<td>0 0.25 1.00</td>
<td>0 0.25 1.00</td>
</tr>
<tr>
<td>Fixed population share</td>
<td>0.31 0.54 1.23</td>
<td>-0.51 -0.31 0.29</td>
</tr>
</tbody>
</table>

Note: Multiplier not discounted with historical interest rate.
Sensitivity to RoT share of transfers

![Graph showing the relationship between the percentage of transfers to RoT agents and the long-run multiplier. The graph has a linear scale on the x-axis for the percentage of transfers to RoT agents, ranging from 0 to 1, and a linear scale on the y-axis for the long-run multiplier, ranging from -1 to 1. The graph includes multiple lines, each representing a different scenario or parameter setting.](image)
Sensitivity to RoT share of population
Sensitivity analysis

Sensitivity to capital share: 0.24 vs 0.35.

Estimated: $\approx 0.24$

Calibrated: 0.35
Sensitivity to price stickiness: scaling Calvo

One Year

Long-run
Sensitivity of long-run fiscal multiplier.

Note: Multiplier not discounted with historical interest rate.
Outline

1. Fiscal Stimulus 2009 and its Aftermath
2. Fiscal Stimulus: The Keynesian Textbook
3. An NK model with distort. taxes and gov. capital.
   - Estimation and Historical Shocks
   - Explaining the financial crisis
4. Results
   - Benchmark
   - Sensitivity analysis
5. The power of monetary policy?
6. Challenges
7. Conclusion
The power of monetary policy?

The shadow Taylor rule

Harald Uhlig (University of Chicago)
Sensitivity to ZLB: 8 quart. vs endog.

8 Quarters

Endogenous
Sensitivity to length of ZLB

One Year

Long-run

Harald Uhlig (University of Chicago)
Changing ZLB length from 0 to \( k \). No ARRA.

<table>
<thead>
<tr>
<th>ZLB imposed for ...</th>
<th>Output change (in %)</th>
<th>Inflation change (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 yr</td>
<td>5 yr’s</td>
</tr>
<tr>
<td>( k = 4 ) quarters</td>
<td>-0.52</td>
<td>-0.05</td>
</tr>
<tr>
<td>( k = 8 ) quarters</td>
<td>-0.81</td>
<td>-0.07</td>
</tr>
<tr>
<td>( k = 12 ) quarters</td>
<td>0.87</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Note: Posterior medians.
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Challenges going forward


2. How rich do the models have to be?
   - Agent heterogeneity?
   - Nonlinear tax schedules?
   - Range of public finance tools?
   - Policy feedback rules?
   - Financial sector?

3. ZLB: nonlinear solution and simulation methods ("occasionally binding constraints") for stochastic models.

4. VARs: identification of public finance shocks.
   - Blanchard-Perotti, Mountford-Uhlig, Ramey
   - Leeper-Yang-Walker: non-fundamental shocks!

5. VARs with ZLB / 2009-2011: linear? Regime changes?

6. Money-Fiscal interaction. Fiscal theory of the price level?

7. How to get policy makers use this?
Outline

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7 Conclusion
Conclusions

1. We have quantified the size, uncertainty and sensitivity of fiscal multipliers in response to the American Recovery and Reinvestment Act (ARRA) of 2009.

2. Smets-Wouters meets CCWT meets Uhlig, extended.

3. Long run: debt repayment, higher taxes, lower output.

4. Benchmark:
   - modestly positive short-run multipliers, post. mean: 0.52.
   - modestly negative long-run multipliers, post mean: -0.42.

5. Particularly sensitive to
   - fraction of transfers to RoTs.
   - Length of ZLB.

6. Monetary policy is very powerful!