Fiscal Stimulus and Distortionary Taxation

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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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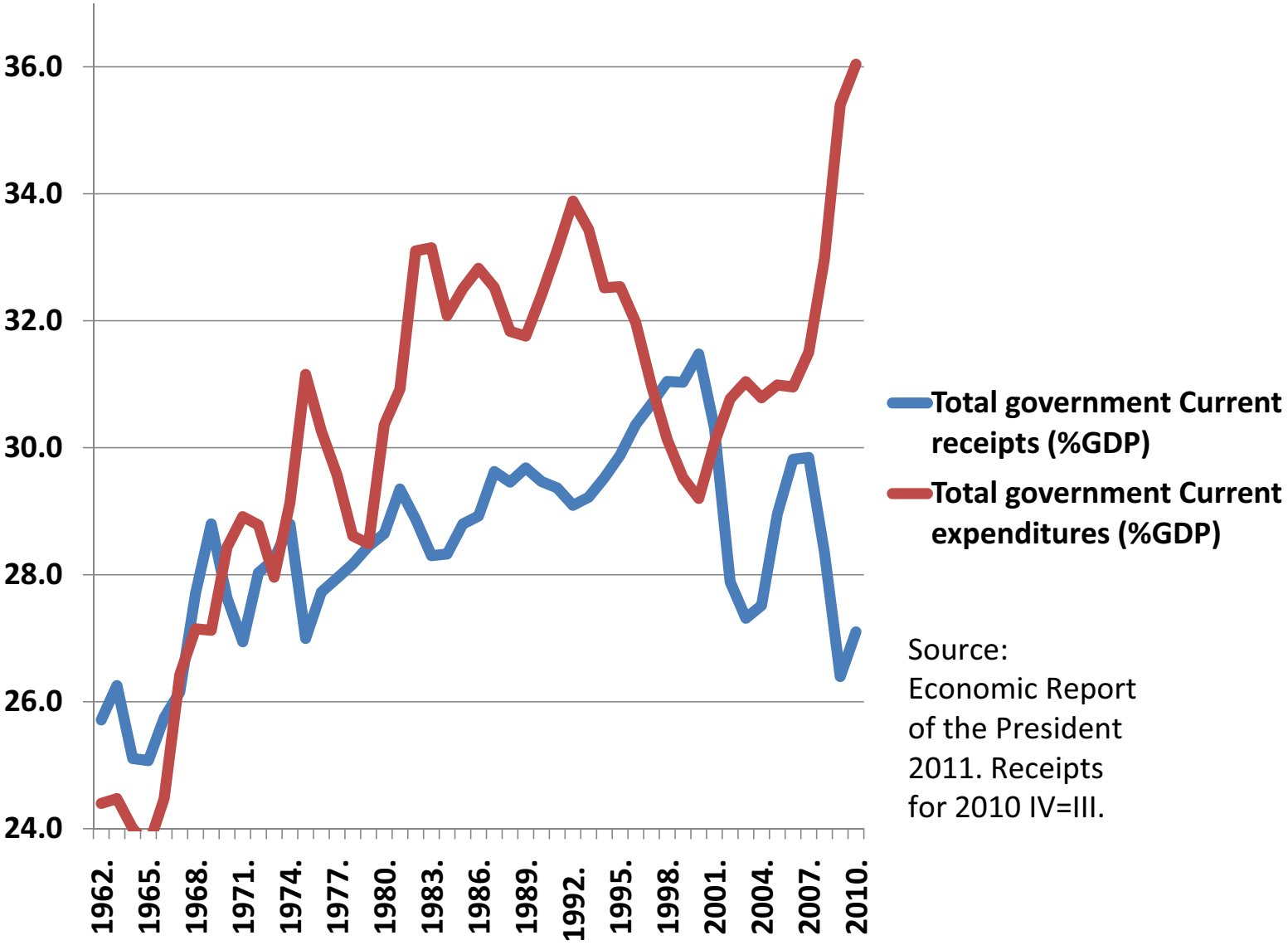
Total Gov. Spending and Receipts: in % of GDP



Source:
Economic Report of the President 2011. Receipts for 2010 IV=III.

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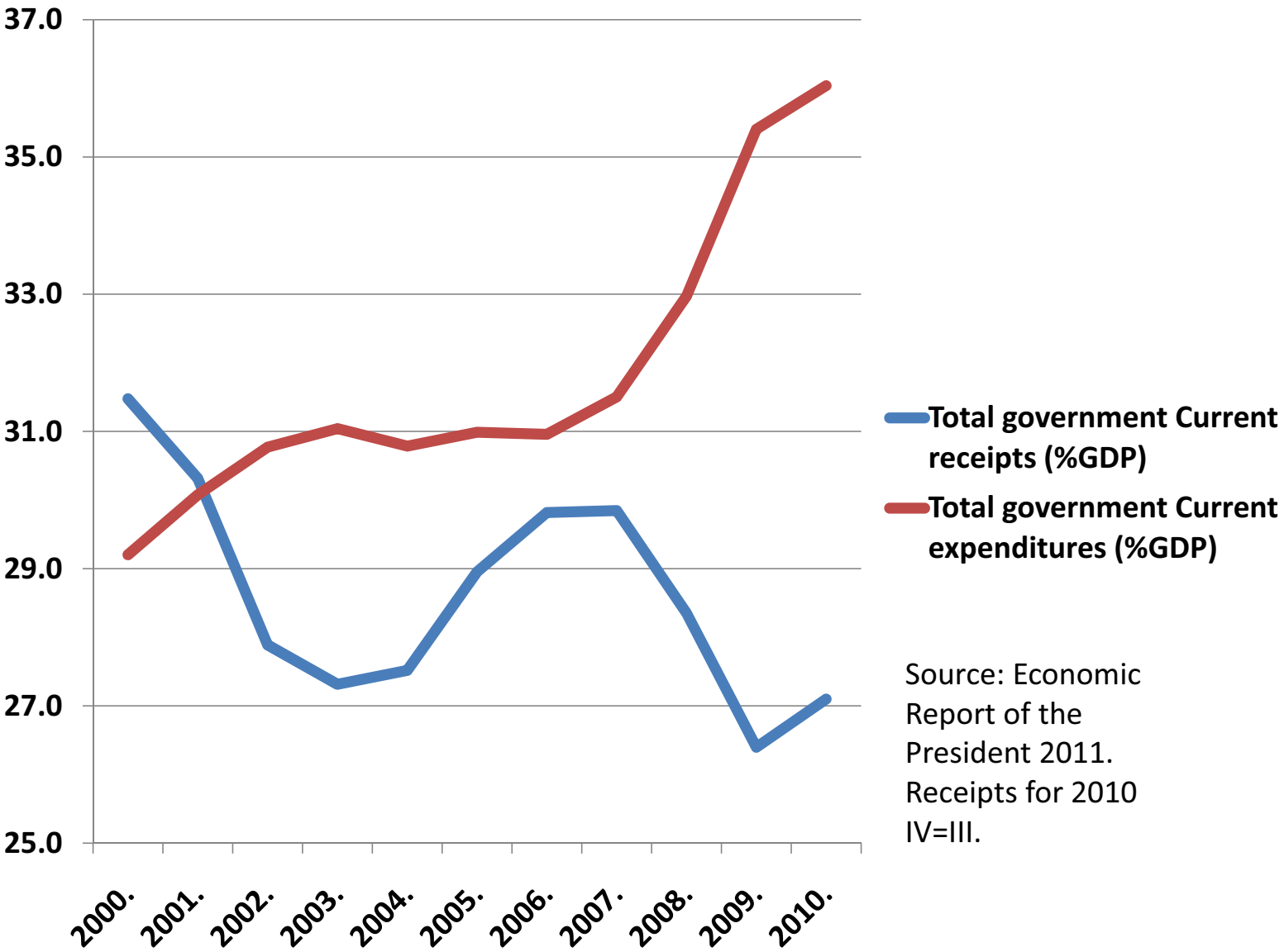

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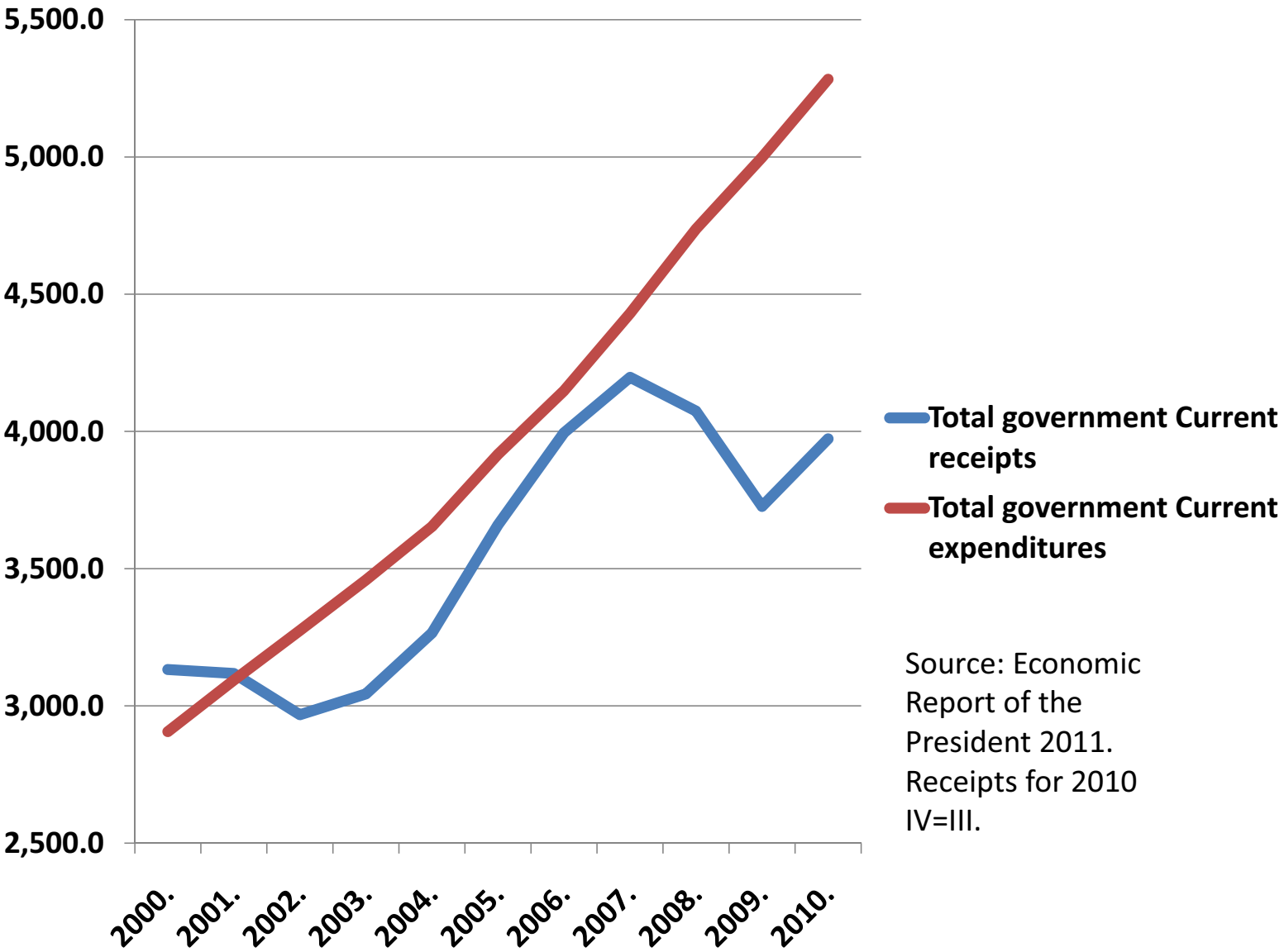

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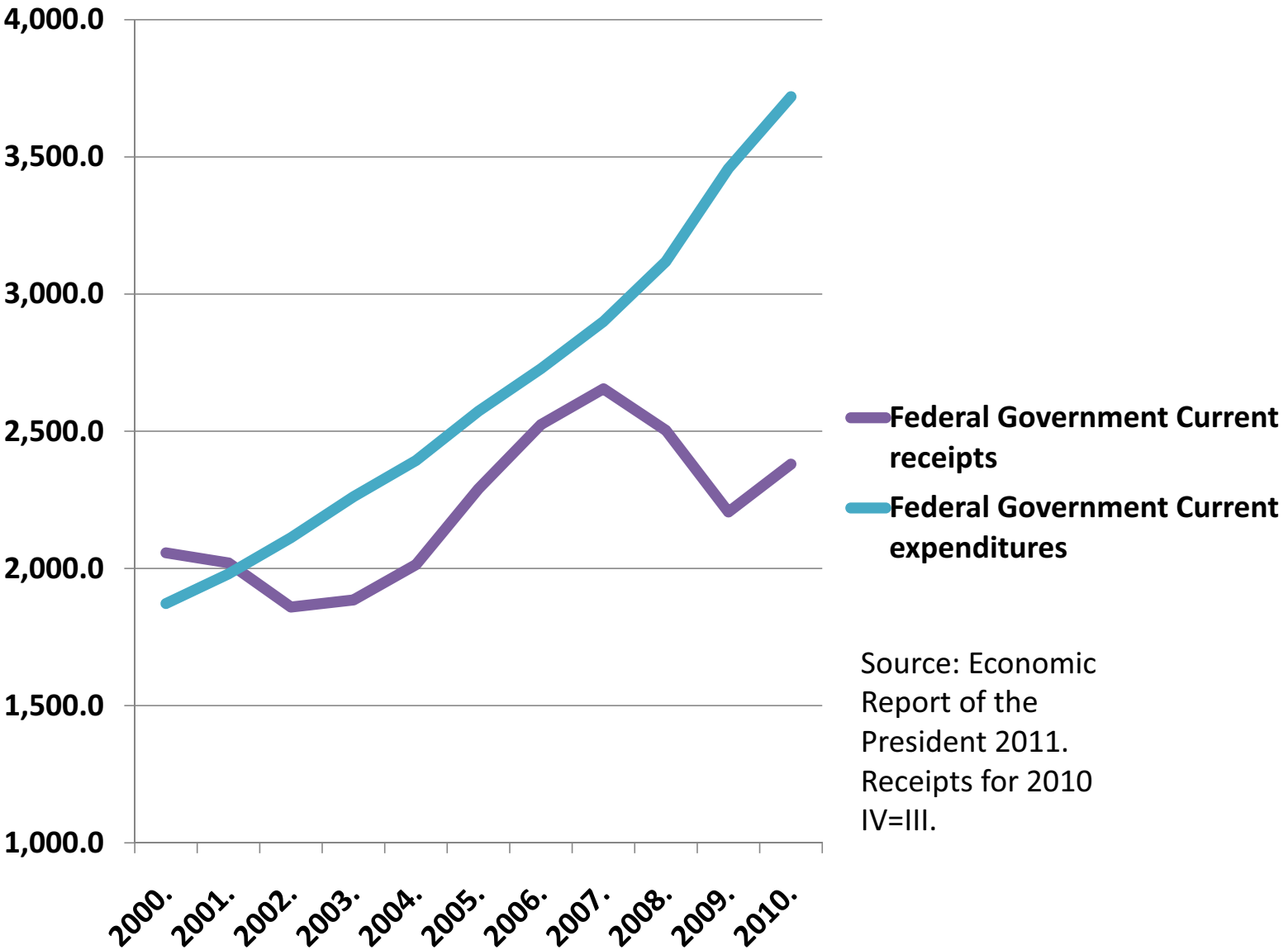
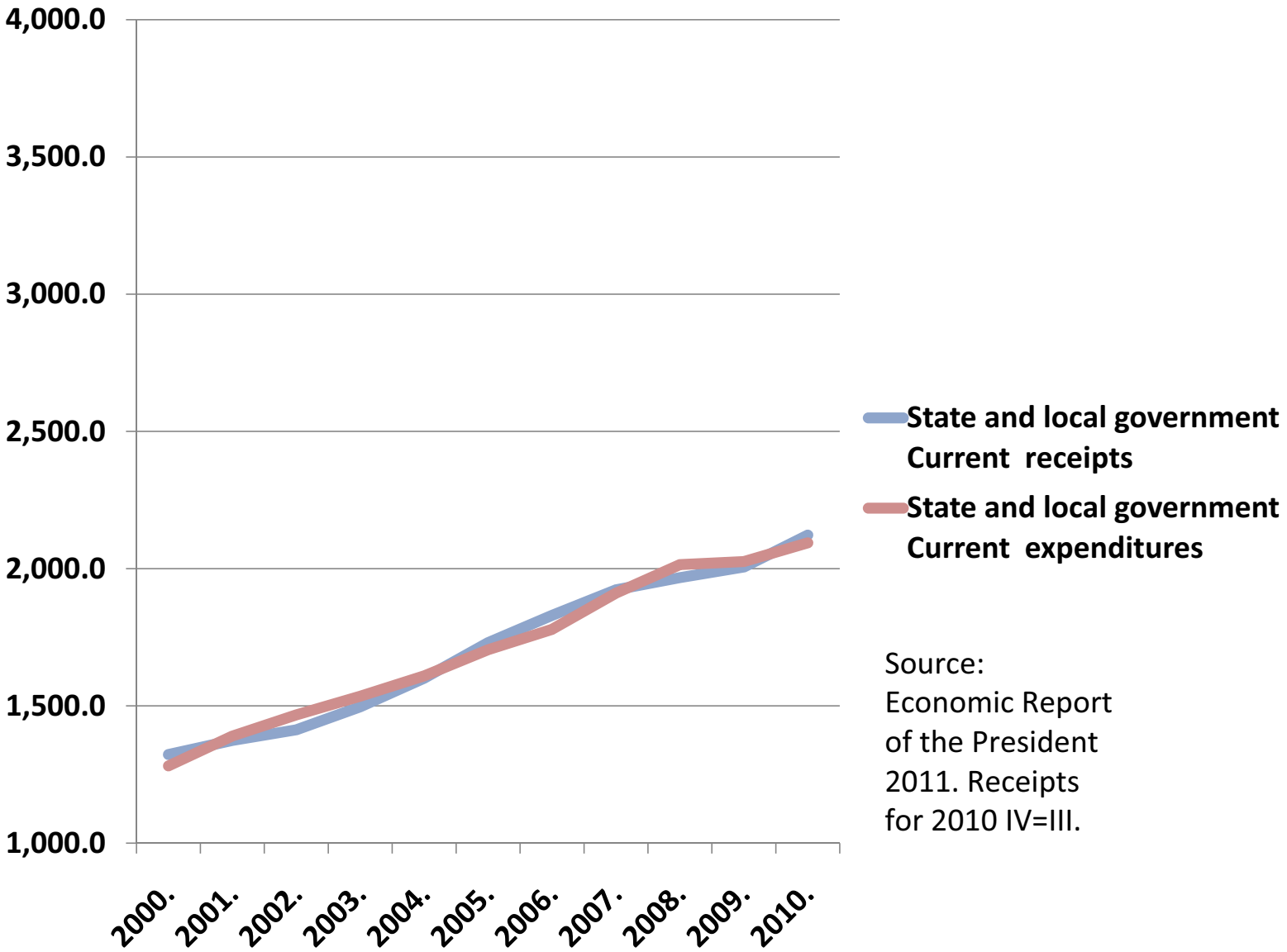
Federal Spending and Receipts: in bill US $.



Source: Economic Report of the President 2011. Receipts for 2010 IV=III.

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



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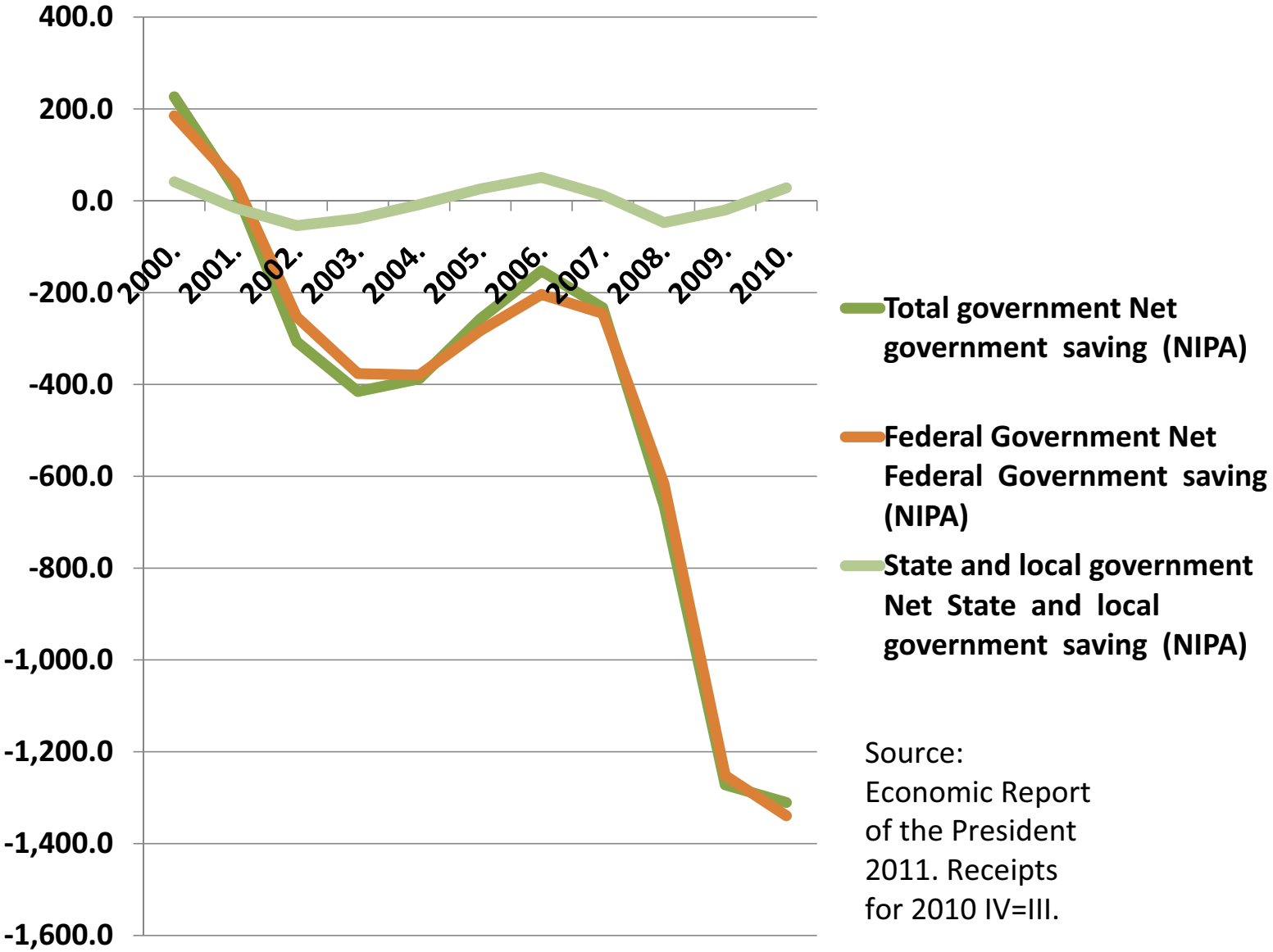
Net "Savings": in bill US $.



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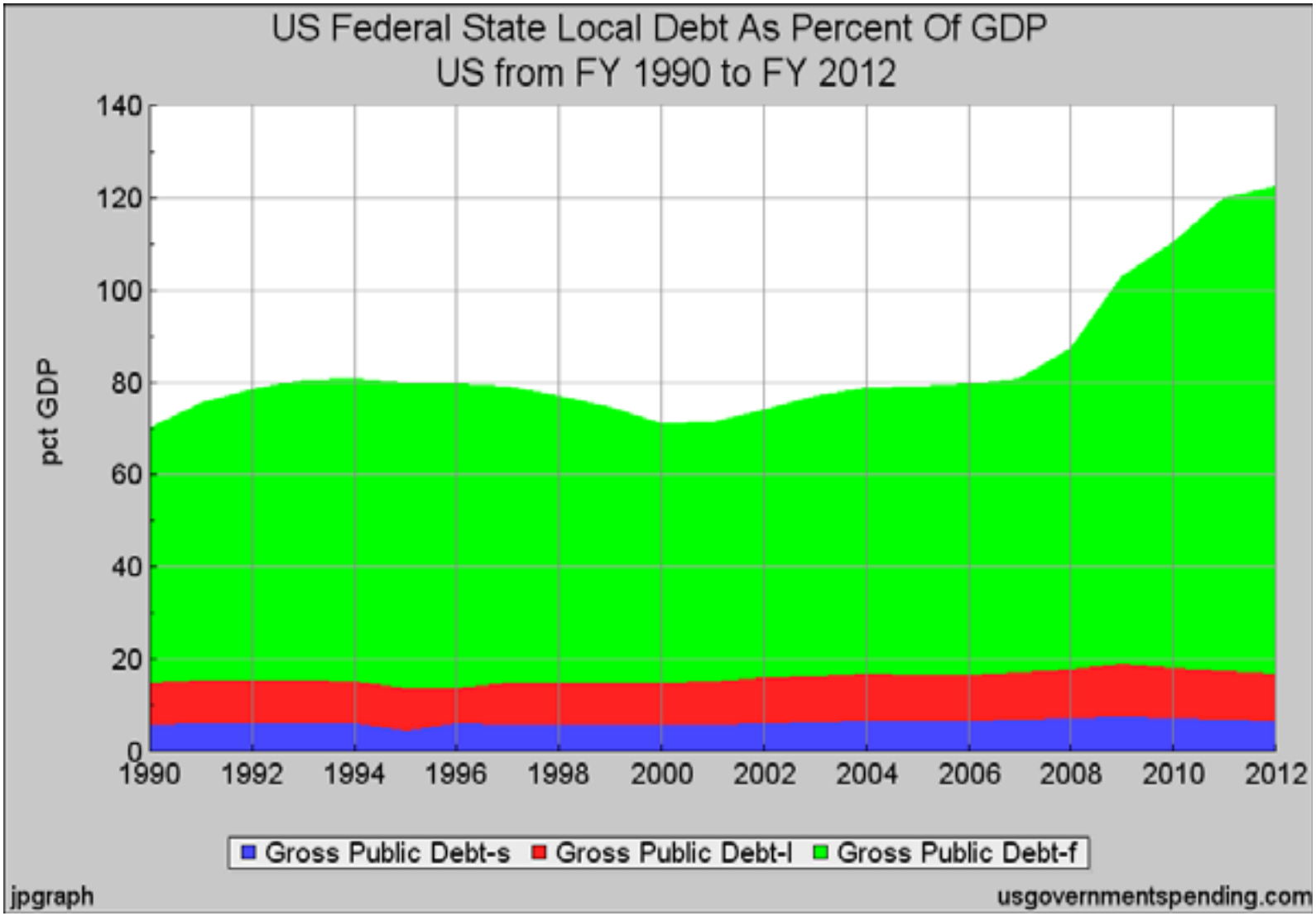
Debt Development: in % of GDP.



Source: usgovernmentspending.com

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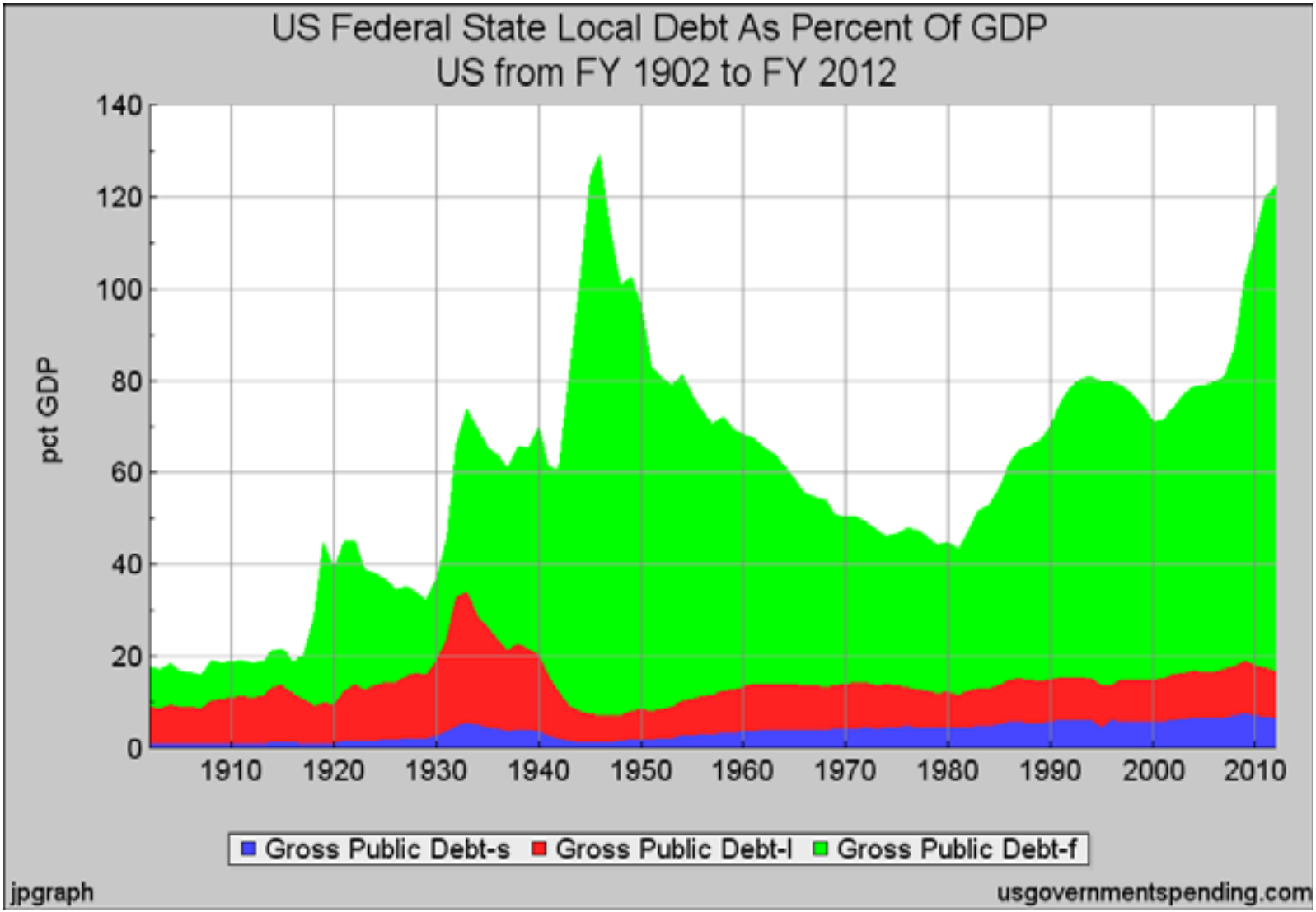

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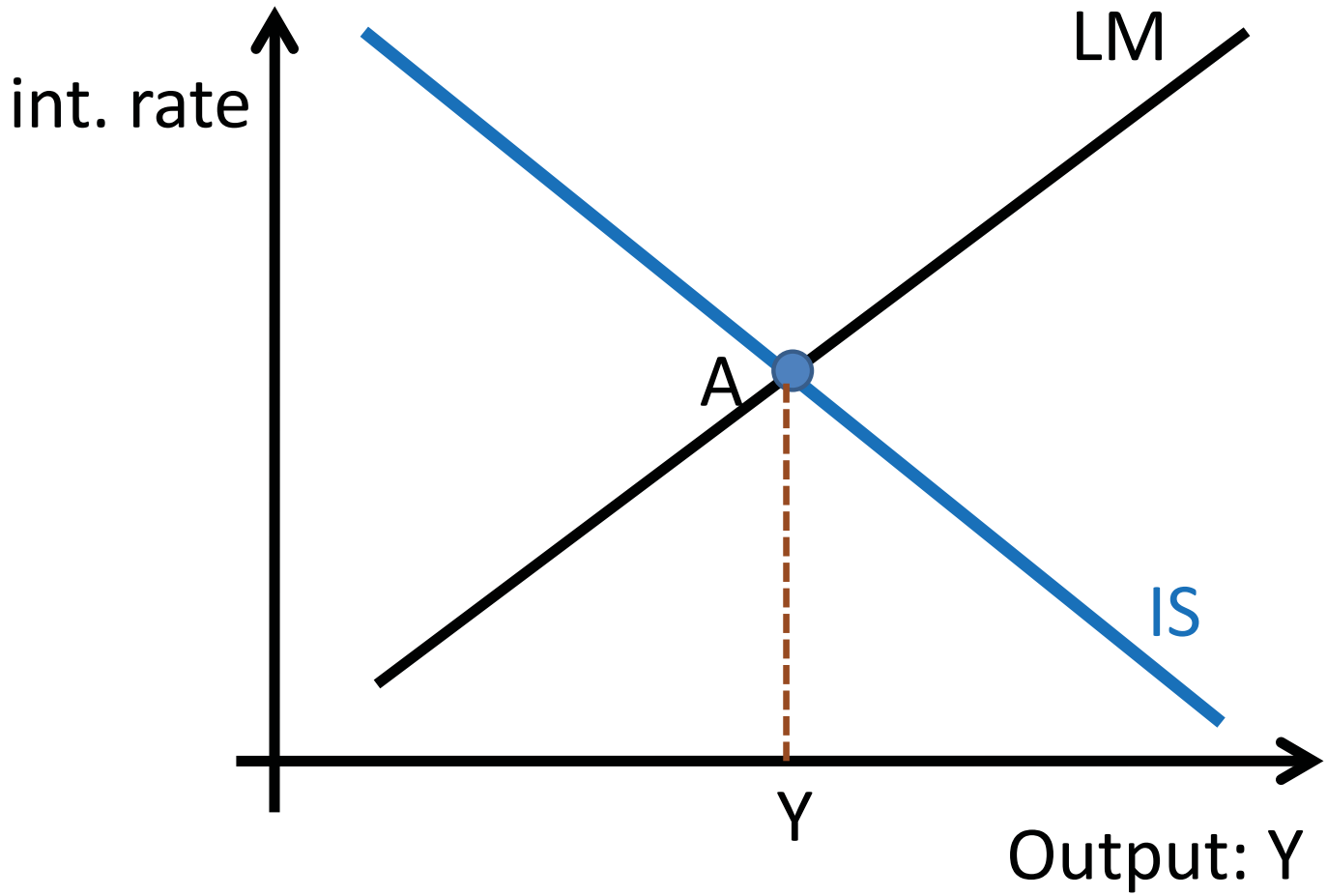
IS-LM



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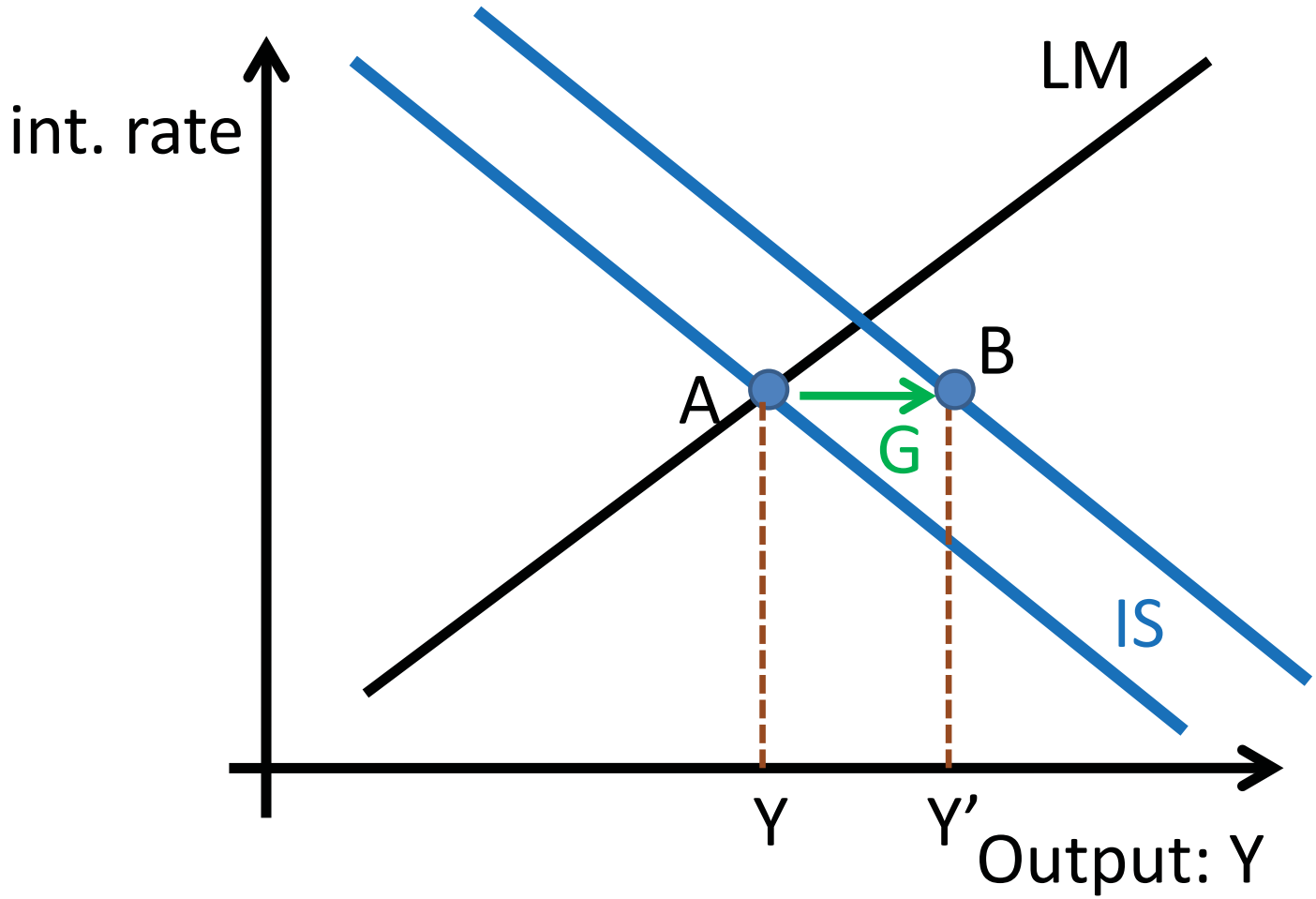

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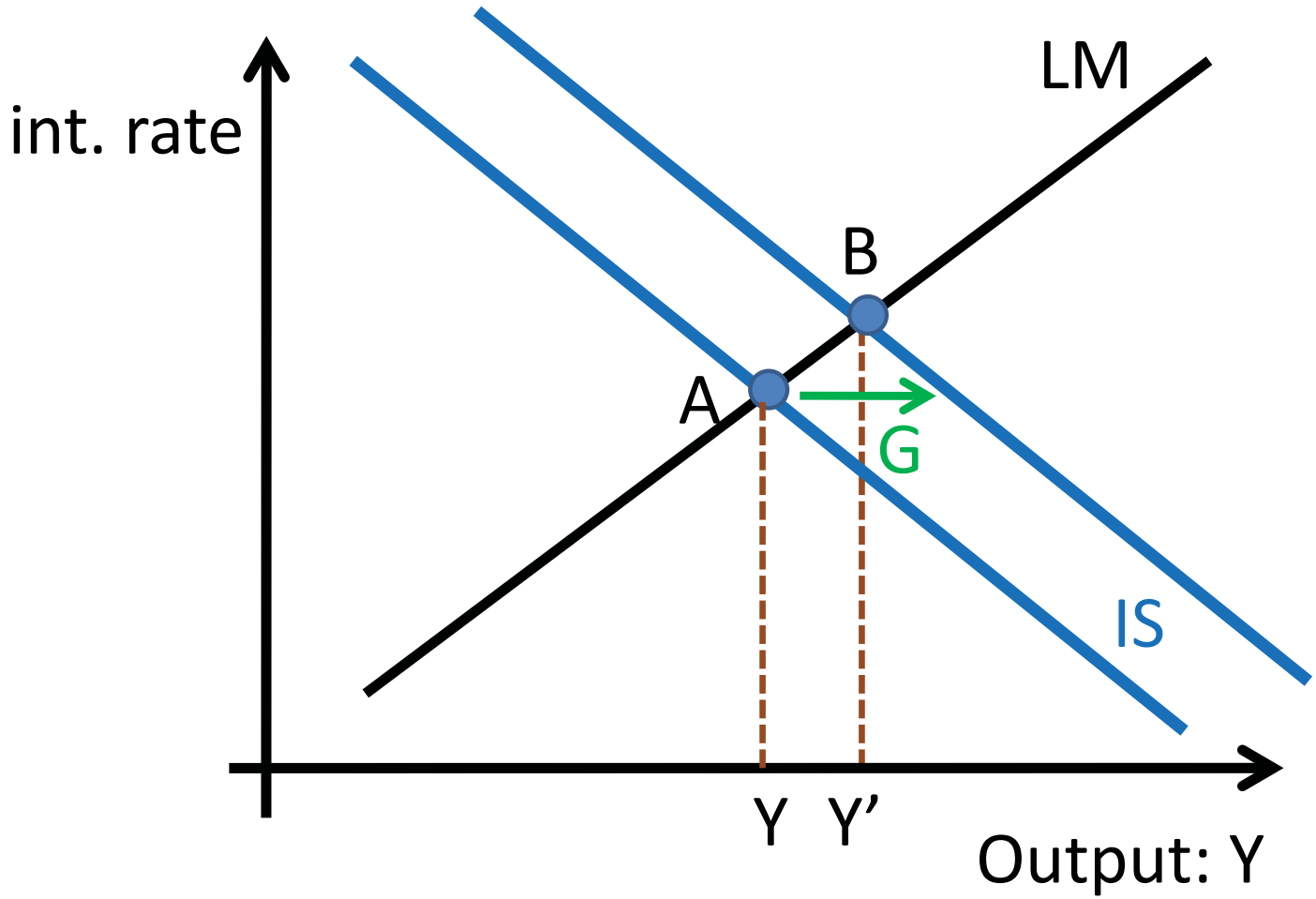

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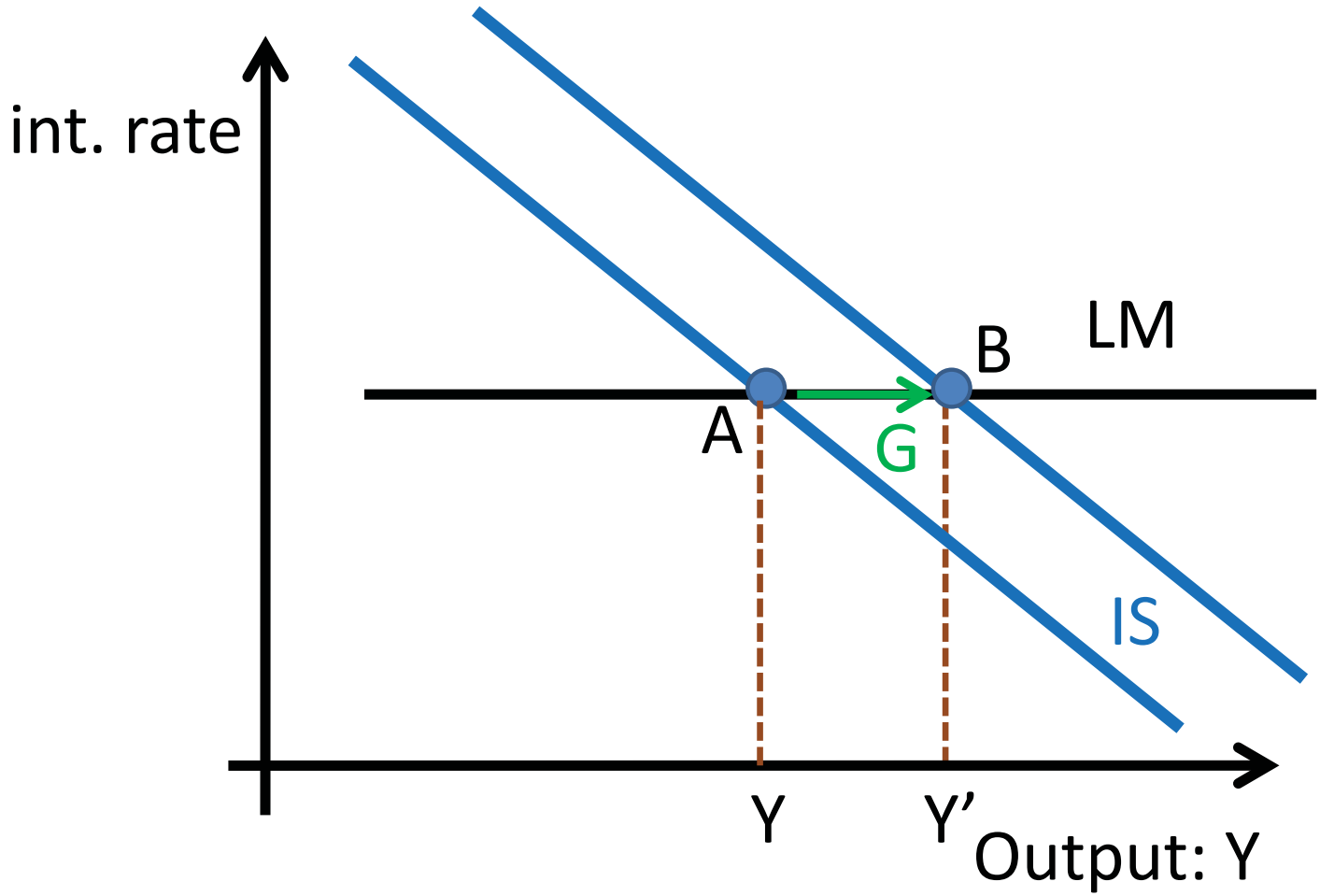
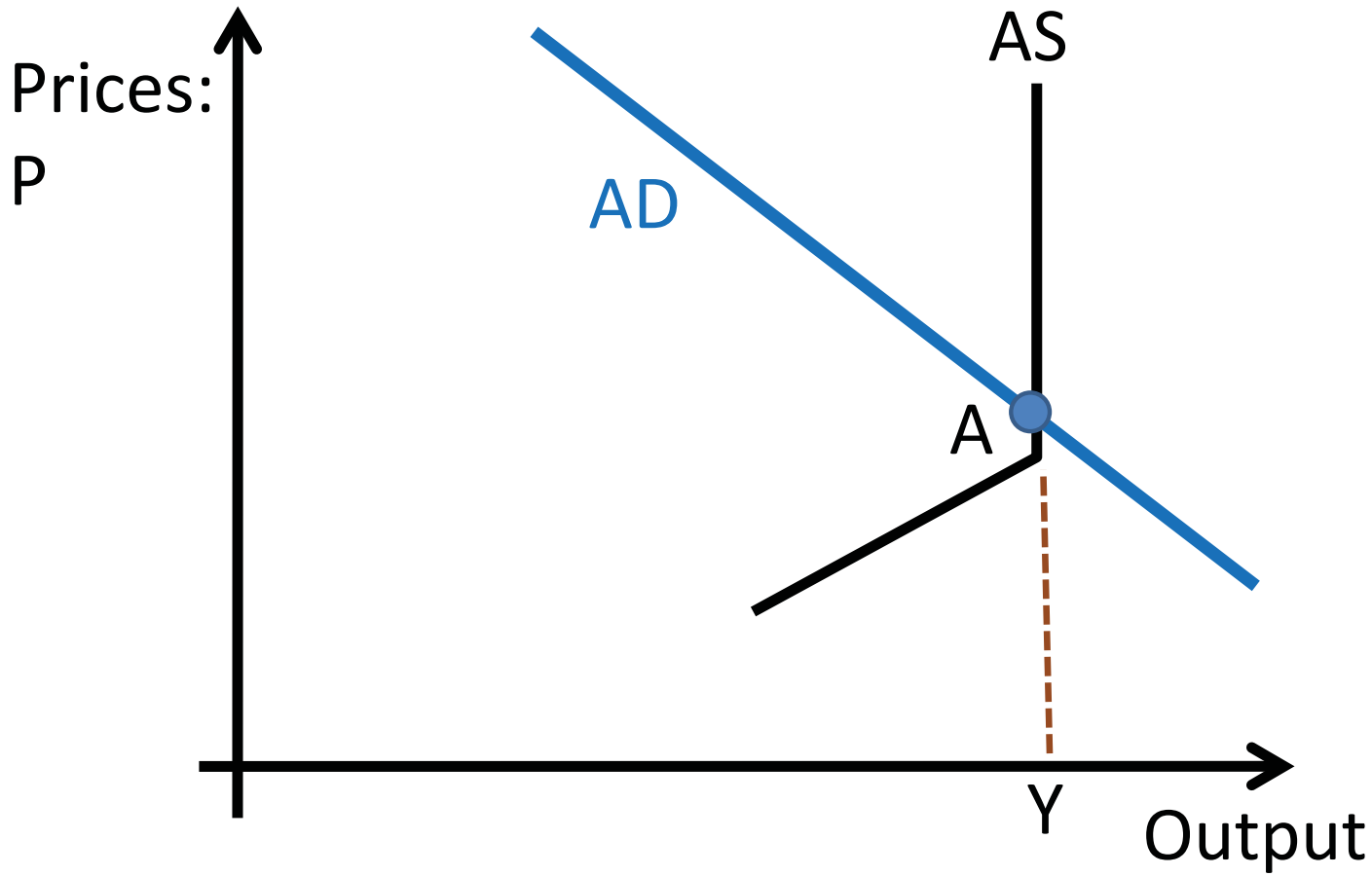


Aggregate Supply and Demand



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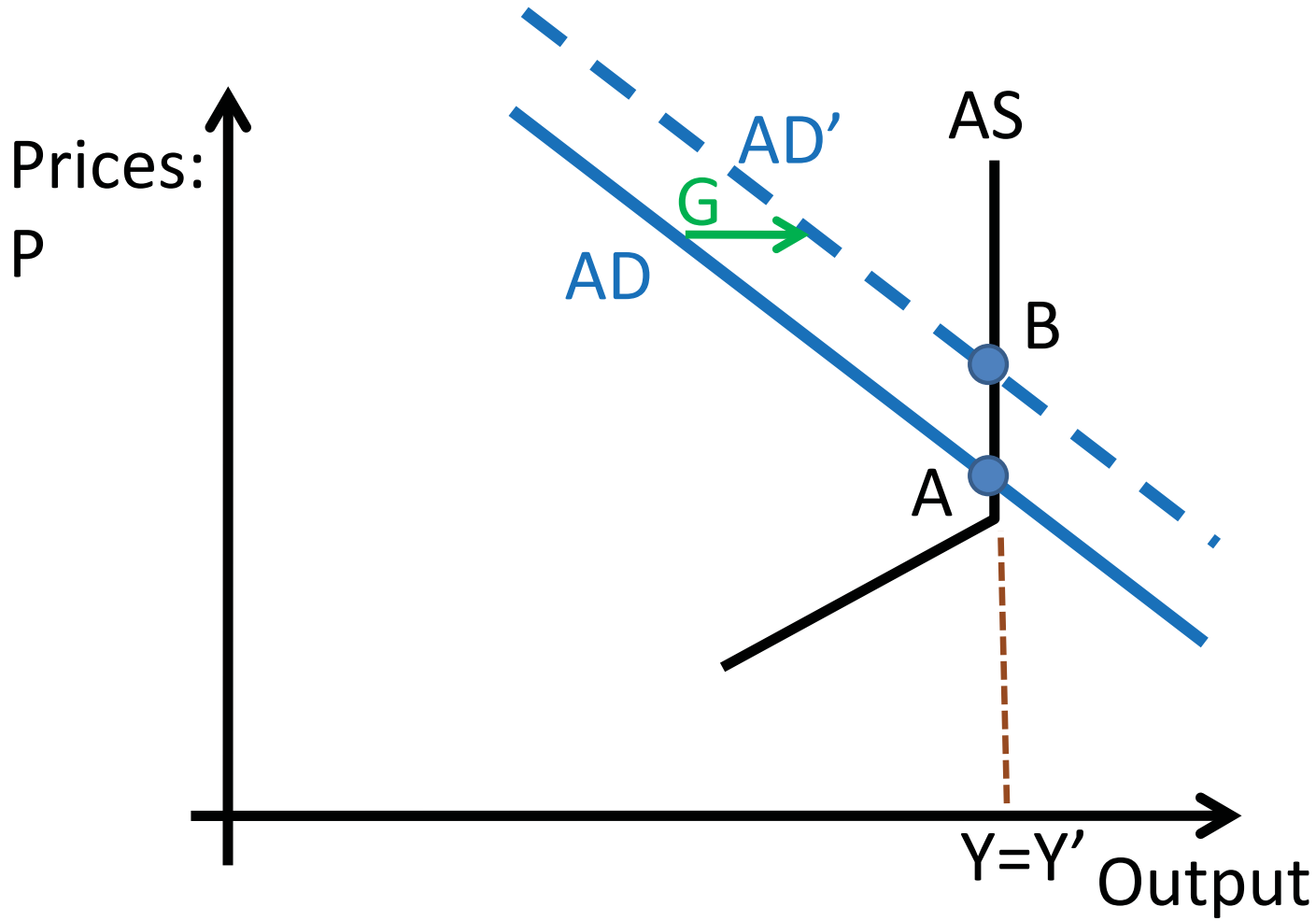

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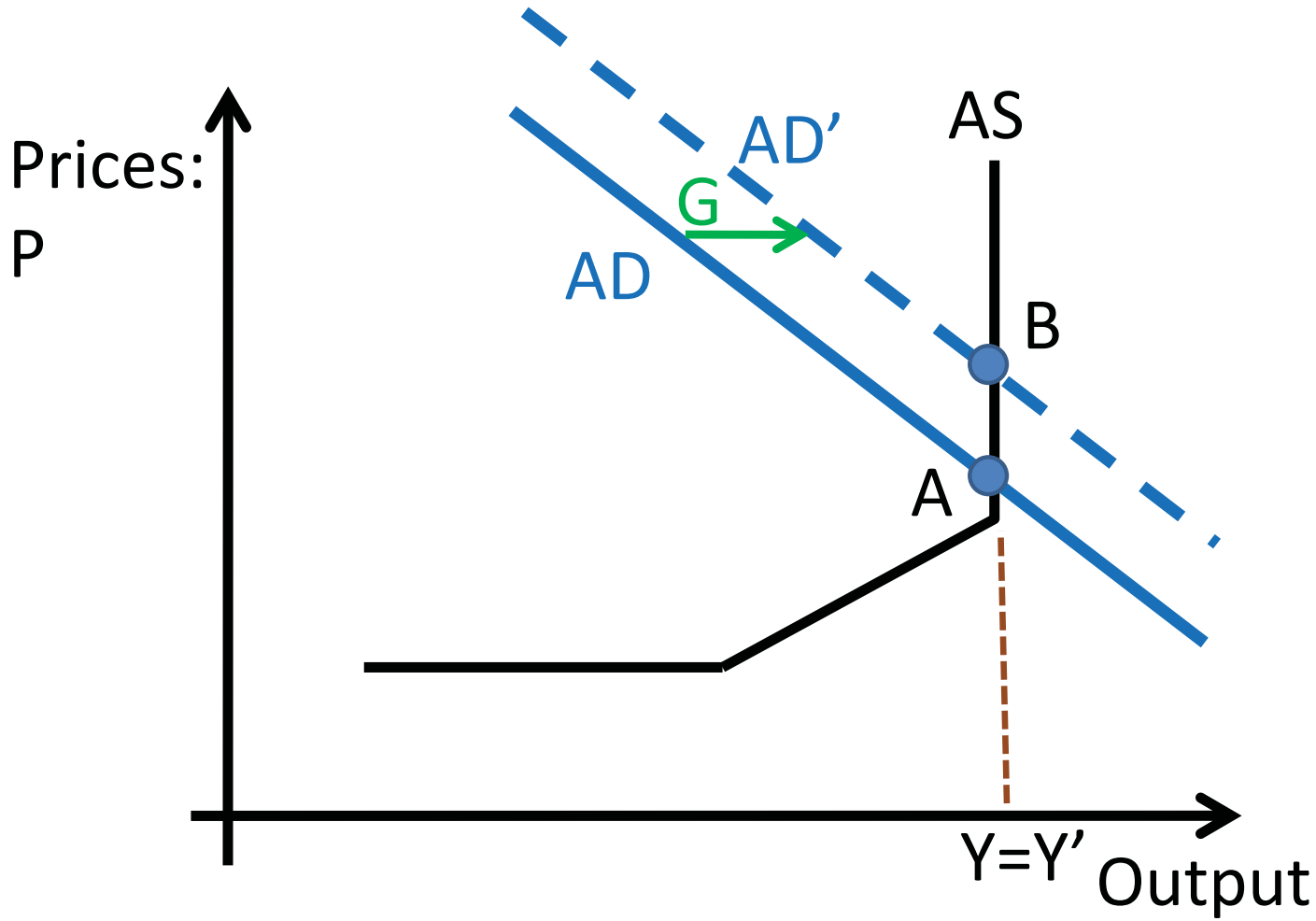

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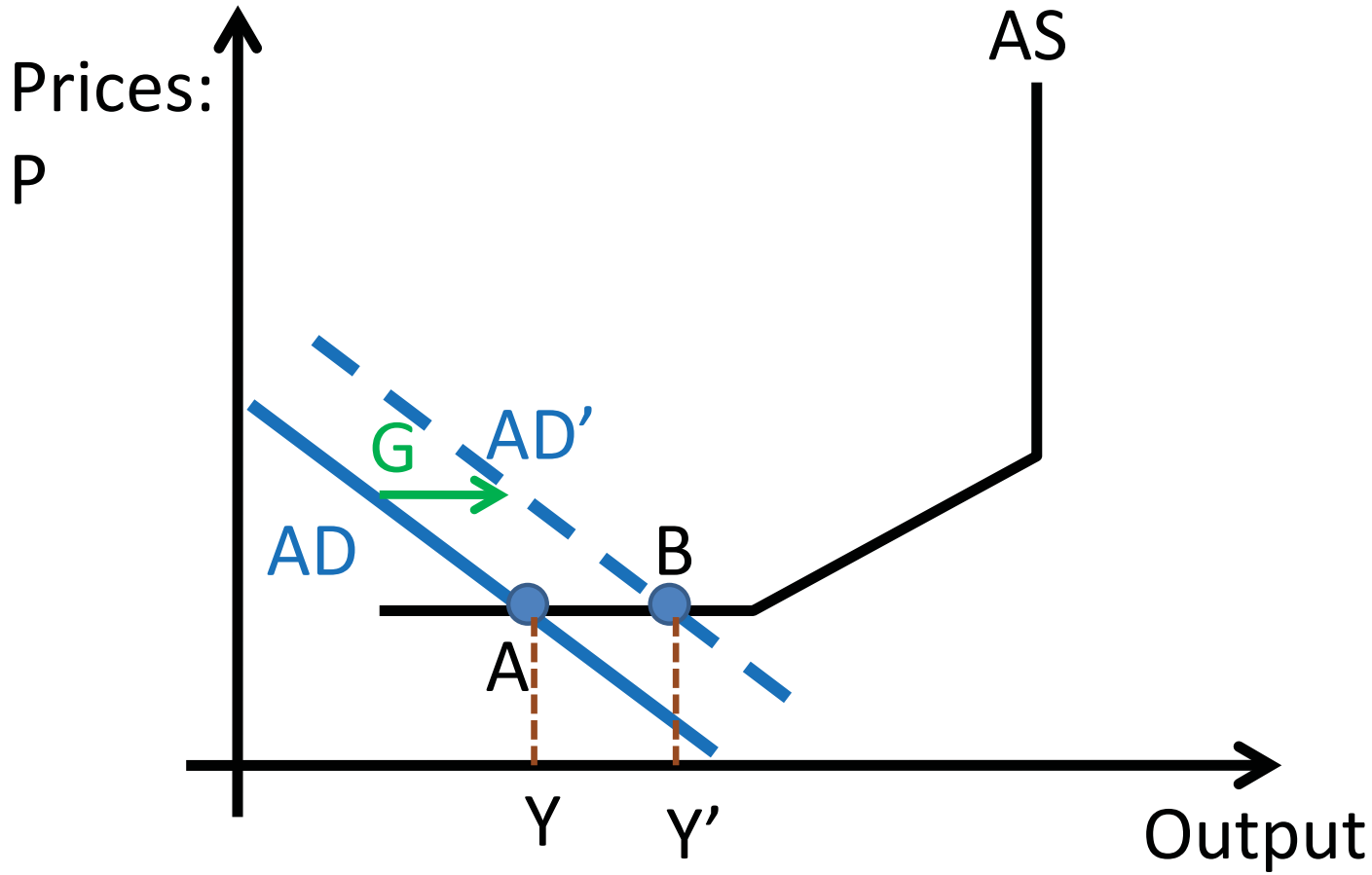

What the textbook says

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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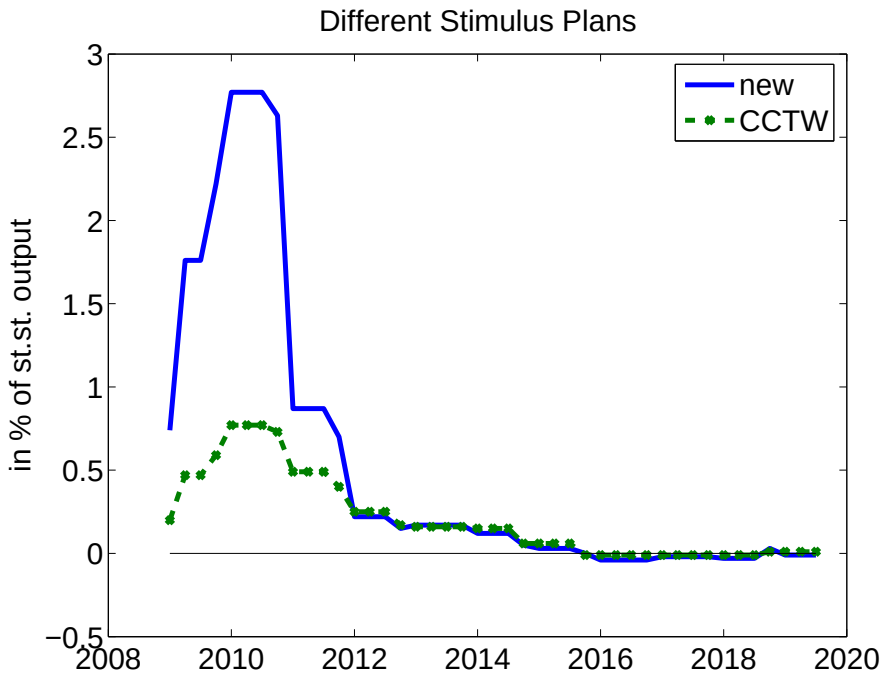
The Approach

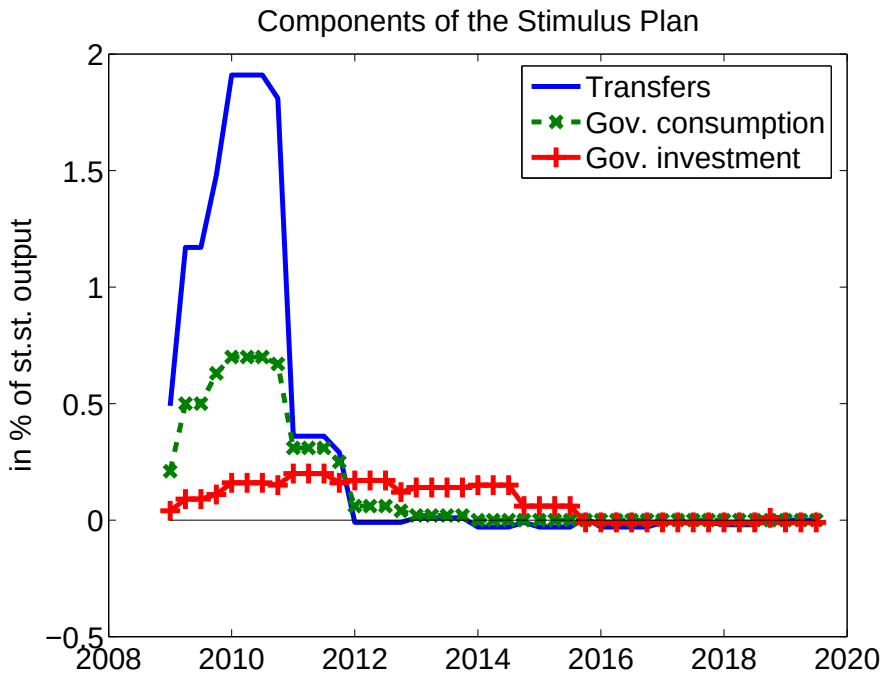
- Question: what is the fiscal multiplier for the ARRA?
- ARRA has gov. purchases, gov. investment, transfers.
- "Uhlig (2010) + Cogan-Cwik-Taylor-Wieland (CCTW), 2009." Extend.
- Start from Smets-Wouters, AER 2007.
- Add:
  1. Distortionary taxation.
  2. "Rule-of-thumb" (RoT) households: consume earnings each period.
  3. Baseline: 25% RoT's, receive 25% of transfers.
  4. Fiscal feedback rules for taxation.
  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



DU in Detail



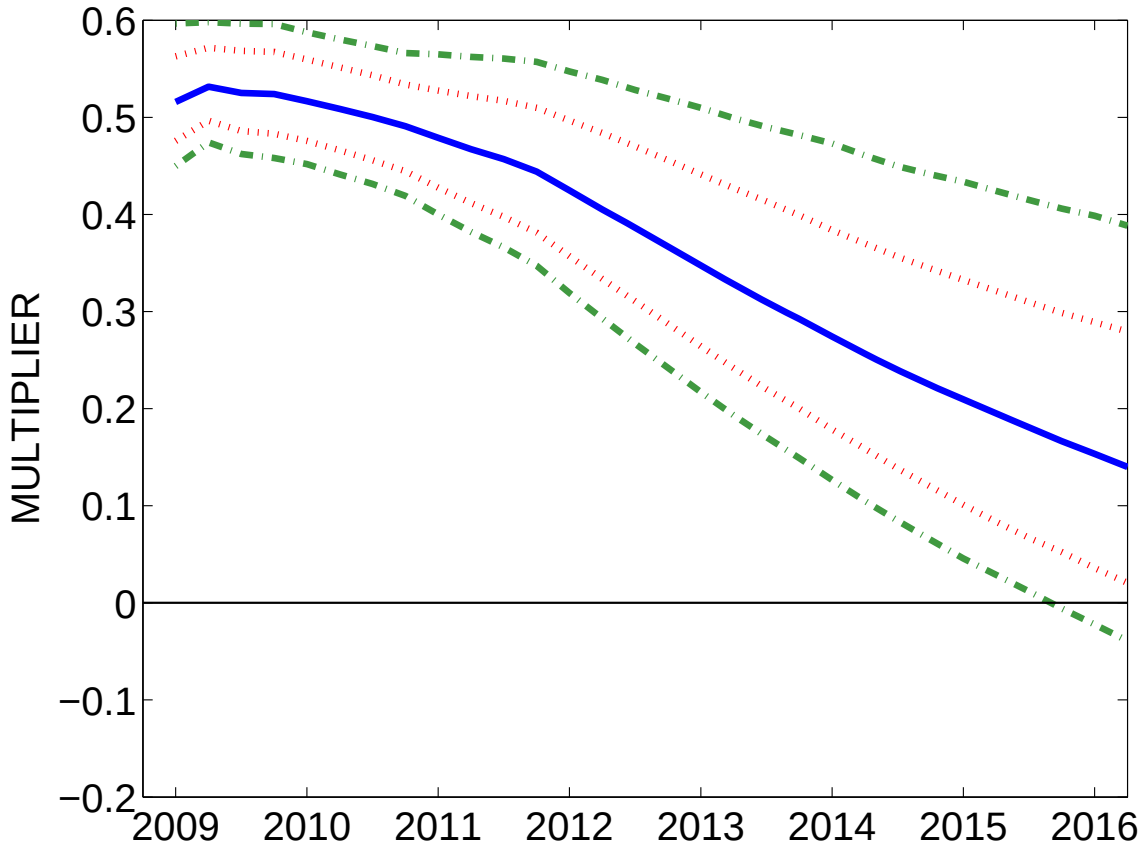
Sources: CCTW (2010), Congressional Budget Office (2009).

The Fiscal Multiplier

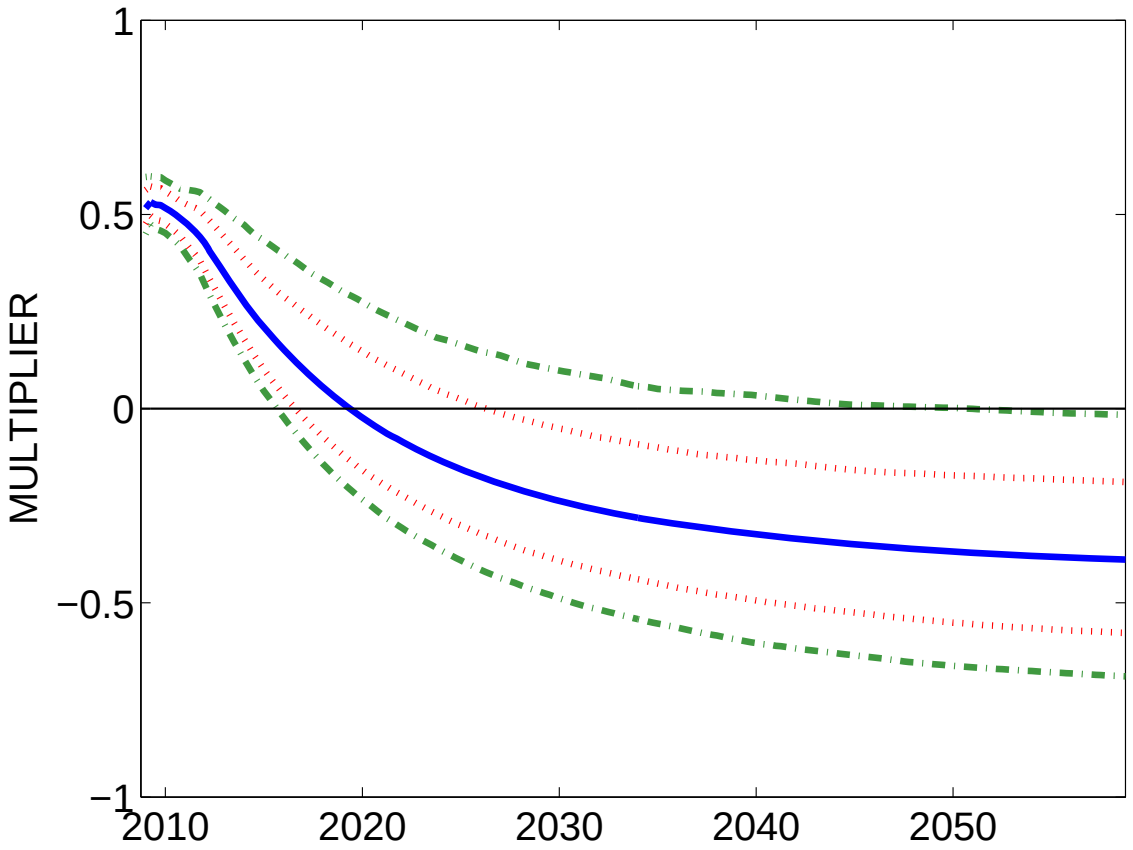
$$\varphi_t = \sum_{s=1}^{t} \left(\mu^s \prod_{j=1}^{s} R_j^{-1} \right) \hat{y}_s / \sum_{s=1}^{t} \left(\mu^s \prod_{j=1}^{s} R_j^{-1} \right) \hat{g}_s$$

- φ_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.
- μ: balanced-growth factor.
- **Net present value** (NPV) fiscal multiplier.

Fiscal multipliers. ZLB-target 8 qrts. Short-run ...

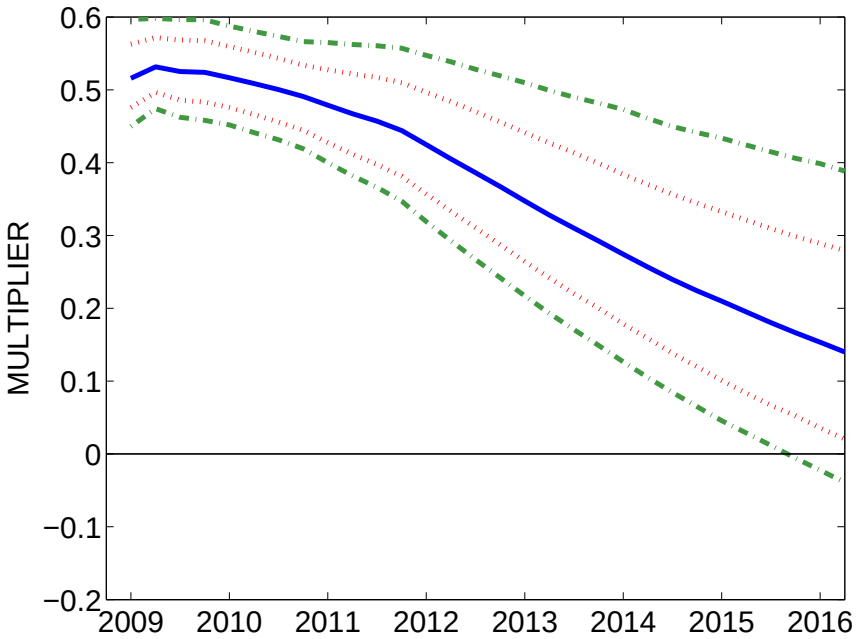


Fiscal multipliers. ZLB-target 8 qrts. ... and long run

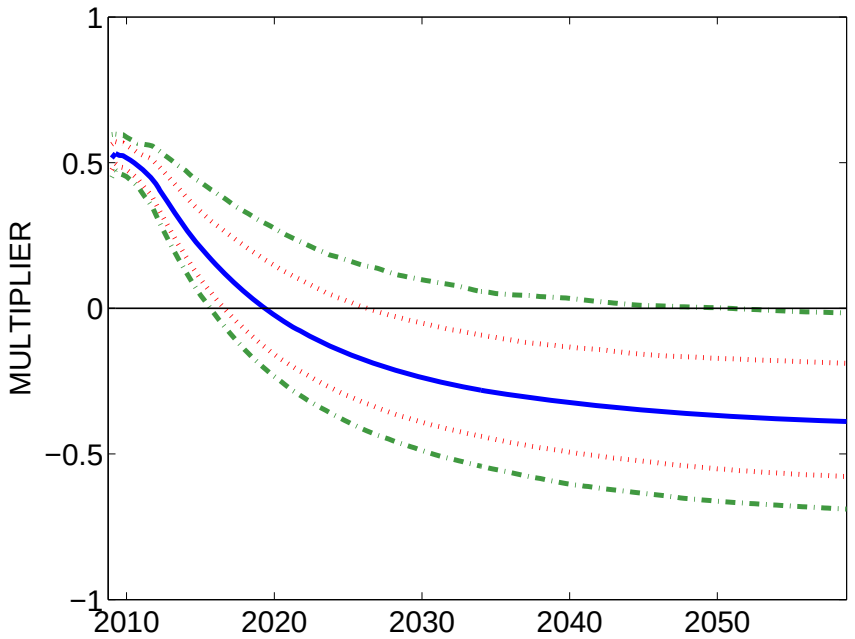


Fiscal multipliers. ZLB-target 8 qrts.

Short-run



Long-run



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
  - 17%: Government investment. Government capital.
  - 24%: Government consumption.
  - 59%: Transfers to credit-constrained consumers.

Tax rule

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

$$\begin{aligned} d_t &= \text{gov.spend.+subs.}_t + \text{old debt repaym.}_t \\ &\quad -\text{consump.tax rev.,cap.tax rev.}_t - \bar{\tau}^l \, \text{lab.income}_t \end{aligned}$$

- ... needs to be financed:

$$\tau_t^l \, \text{lab.income}_t + \text{new debt}_t = d_t$$

- Balanced growth debt, taxes, deficit: $\bar{d}_t$.
- Tax rule:

$$(\tau_t^l - \bar{\tau}^l) \, \text{lab.income}_t = \psi_\tau (d_t - \bar{d}_t)$$

Financial friction: bond premium shock.

$$
\begin{aligned}
1 &= \beta E_t\left[\frac{u_{c,t+1}}{u_{c,t}}\frac{R_t^{gov}}{\pi_{t+1}}\right] = \beta E_t\left[\frac{u_{c,t+1}}{u_{c,t}}(1+\omega_t^{gov})\frac{R_t^{FFR}}{\pi_{t+1}}\right] \\
&= \beta E_t\left[\frac{u_{c,t+1}}{u_{c,t}}\left((1-\omega_t^k)[(1-\tau^k)r_{t+1}^k+\delta\tau^k]+(1-\delta)\frac{Q_{t+1}}{Q_t}\right)\right]
\end{aligned}
$$

1. Gov. bond shock ω_t^{gov}: wedge between FFR and gov't bonds.
2. Priv. bond shock ω_t^k: wedge between gov't bonds and priv. capital.

Stand-in for financial friction. With perfect foresight:

$$
\frac{R_t^{FFR}}{\pi_{t+1}} = \frac{1}{(1+\omega_t^{gov})}\left((1-\omega_t^k)[r_{t+1}^k-\tau^k(r_{t+1}^k-\delta)]+(1-\delta)\right).
$$

Government capital in production

- Technology for intermediate goods production:

$$Y_t(i) = \tilde{\epsilon}_t^a \left(\frac{K_{t-1}^g}{\int_0^1 Y_t(j)dj + \Phi\mu^t} \right)^{\frac{\zeta}{1-\zeta}} K_t^s(i)^\alpha [\mu^t n_t(i)]^{1-\alpha} - \mu^t \Phi,$$

  where Φ are fixed costs, K_t^s are capital services.
- ϵ_t^a is TFP, $\log \epsilon_t^a \sim$ AR(1).
- Government capital services K_{t-1}^g subject to congestion.
- Aggregate production function:

$$Y_t = \epsilon_t^a {K_{t-1}^g}^\zeta K_t^{s\alpha(1-\zeta)} [\mu^t n_t]^{(1-\alpha)(1-\zeta)} - \mu^t \Phi, \quad \epsilon_t^a \equiv (\tilde{\epsilon}_t^a)^{1-\zeta}.$$

  Along the balanced growth path: $\bar{\epsilon}^a \equiv 1$.
- Current profits:

$$P_t(i)Y_t(i) - W_t n_t(i) - R_t^k K_t^s(i)$$

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.

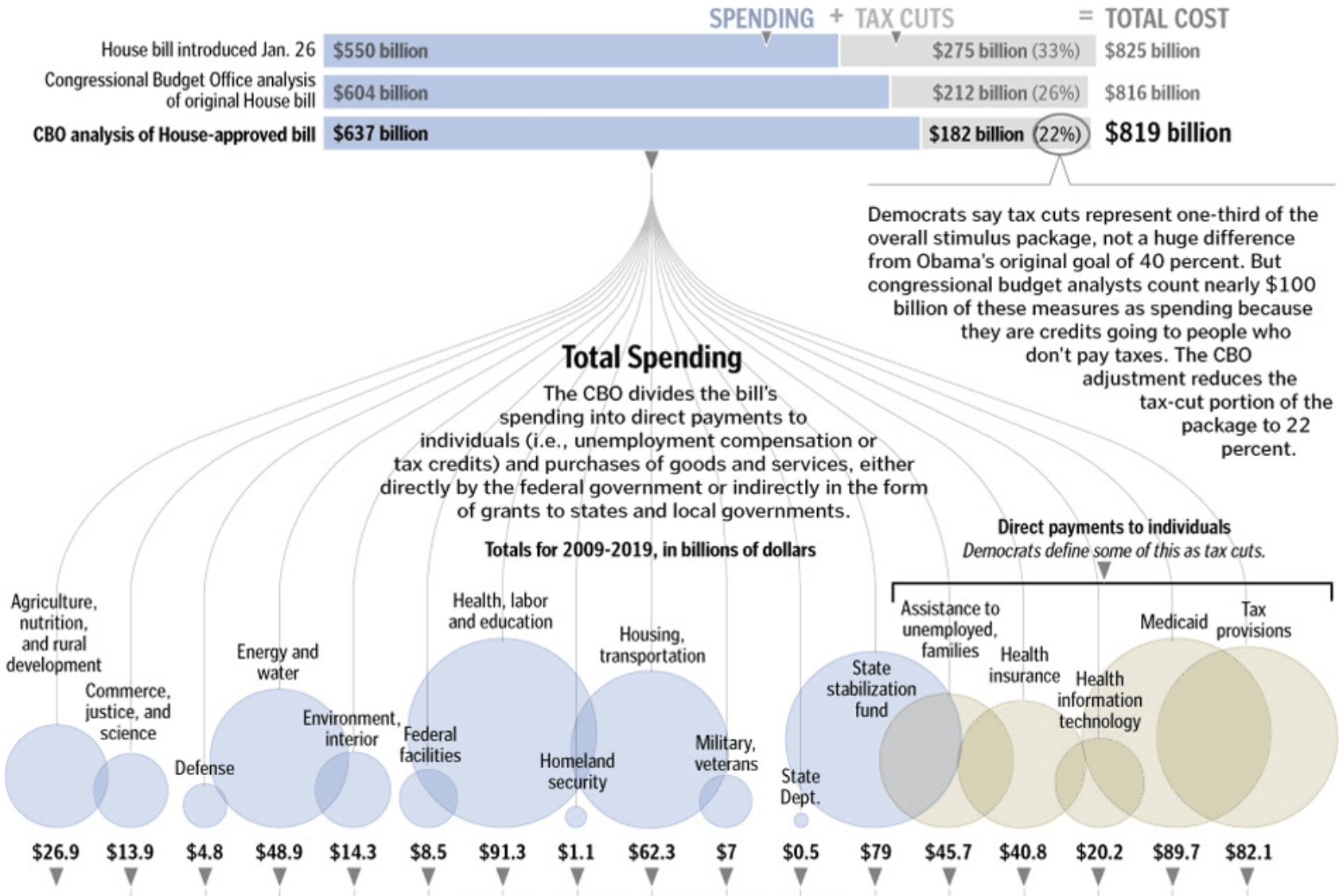
ZLB

- Benchmark implementation: “Switching off”: $\hat{R}_t = (1 - \mathbf{1}_{ZLB,t})\hat{R}_t^{TR} + \mathbf{1}_{ZLB,t}\hat{R}_{t-1}^{TR}$.
- Endogenous ZLB: FFR equals max of original SW Taylor rule and approximately zero (0.25% at annual rates):

$$\begin{aligned}
\hat{R}_t &= \max\{-(1-\bar{R}) + \frac{0.25}{400}, \hat{R}_t^{TR}\}, \\
\hat{R}_t^{TR} &= \psi_1(1-\rho_R)\hat{\pi}_t + \psi_2(1-\rho_r)(\hat{y}_t - \hat{y}_t^f) \\
&\quad + \psi_3\Delta(\hat{y}_t - \hat{y}_t^f) + \rho_R\hat{R}_{t-1}^{TR} + ms_t.
\end{aligned}$$

The Stimulus

Source: Washington Post 02/01/2009, accessed 10/31/2009



Categorizing the stimulus – Government Consumption

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

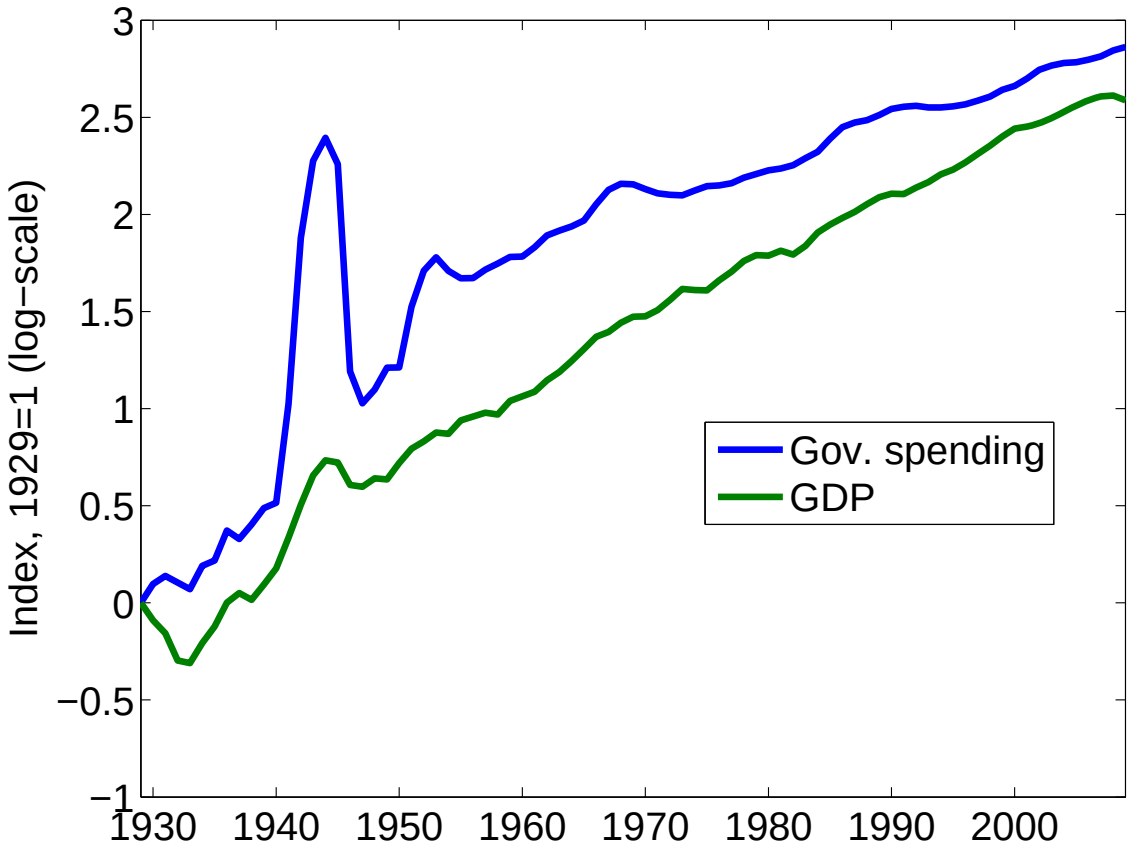
Categorizing the stimulus – Government Investment

Item	Amount (bn USD)	Share
Broadband Technology opportunities program	4.7	0.61
Clean Water and Drinking Water State Revolving Fund	5.79	0.75
Corps of Engineers	4.6	0.6
Distance Learning, Telemedicine, and Broadband Program	1.93	0.25
Energy Efficiency and Renewable Energy	16.7	2.17
Federal Buildings Fund	5.4	0.7
Health Information Technology	17.56	2.28
Highway construction	27.5	3.57
Innovative Technology Loan Guarantee	6	0.78
NSF	2.99	0.39
Other Energy	22.38	2.9
Other transportation	20.56	2.67
Investment	136.09	17.66

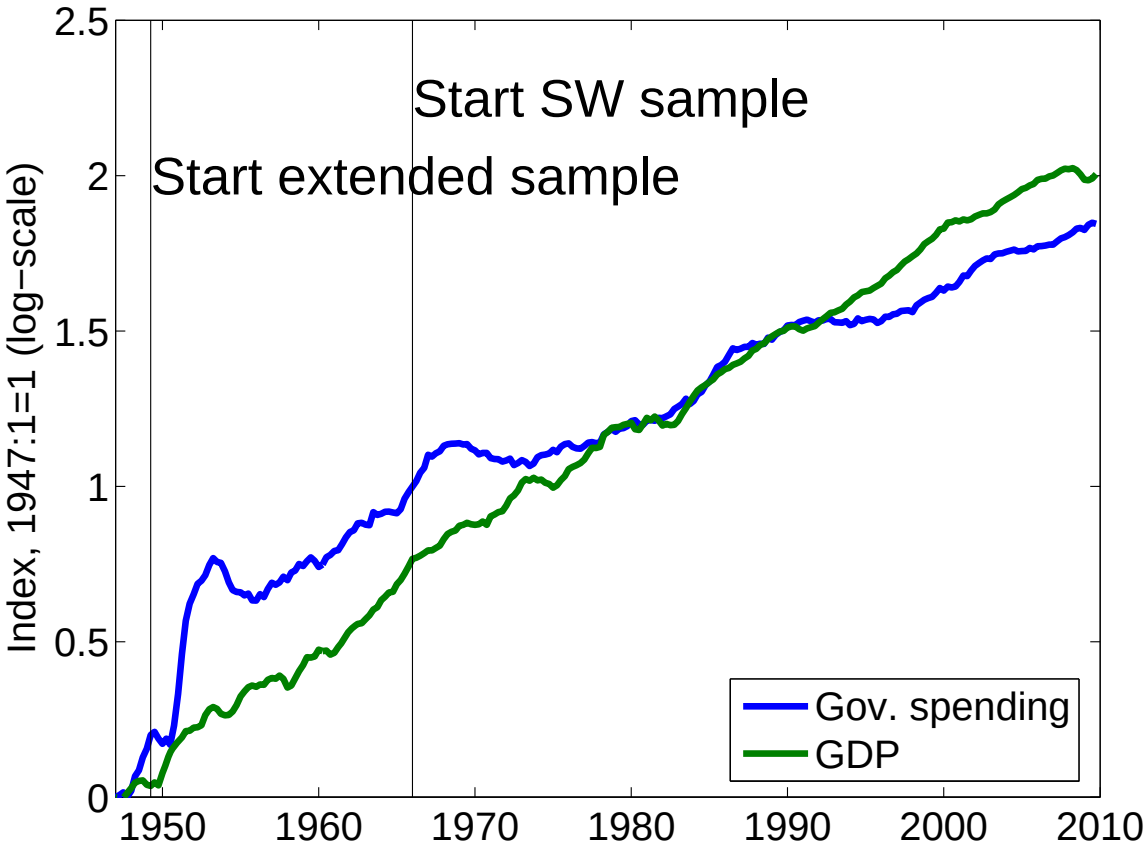
Categorizing the stimulus – Transfers

Item	Amount (bn USD)	Share
Assistance for the unemployed	0.88	0.11
Economic Recovery Programs, TANF, Child support	18.04	2.34
Health Insurance Assistance	25.07	3.25
Health Insurance Assistance	-0.39	-0.05
Low Income Housing Program	0.14	0.02
Military Construction and Veteran Affairs	4.25	0.55
Other housing assistance	9	1.17
Other Tax Provisions	4.81	0.62
Public housing capital fund	4	0.52
Refundable Tax Credits	68.96	8.95
Student financial assistance	16.56	2.15
Supplemental Nutrition Assistance Program	19.99	2.59
Tax Provisions	214.56	27.84
Unemployment Compensation	39.23	5.09
Transfers and Tax cuts	425.09	55.15

Which sample? Barro, Ramey.



Postwar GDP and government spending



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Estimation and Calculation.

Shocks: AR(1).

1. Technology.
2. Bond shock: wedge between FFR and gov't bonds.
3. Bond shock: wedge between gov't bond returns and returns on capital.
4. Gov. spending plus net export. Co-varies with technology.
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

1. Output: Chained 2005 real GDP, growth rates.
2. Consumption: Private consumption expenditure, growth rates.
3. Investment: private fixed investment, growth rates.
4. Government investment: growth rates.
5. Hours worked: Civilian employment index $\times$ average nonfarm business weekly hours worked index. Demeaned log.
6. Inflation: GDP deflator, quarterly growth rates.
7. Wages: Nonfarm Business, hourly compensation index. Growth rates.
8. FFR: Converted to quarterly rates.
9. Corporate-Treasury bond yield spread: Moody's Baa index – 10 yr Treasury bond at quarterly rates, demeaned.
10. Dallas Fed gross federal debt series at par value. Demeaned log.

Observations: Comments

- Time series: Updated SW dataset, 1948:2-2009:4. Quarterly. 4 Period pre-sample.
- Sources: NIPA, FRED 2, BLS.
- Nominal series for wages, consumption, government and private investment deflated with general GDP deflator.
- Differences to Smets-Wouters dataset: Use civilian non-institutionalized population throughout, although not seasonally adjusted before 1976. Base year for real GDP: 2005 instead of 1996.
- 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 $\frac{\bar{x}}{\bar{k}} = 0.0076$.

	SW 66:1–04:4	Extension 48:2–08:4
Depreciation δ	0.025	0.0145
Wage mark-up λ_w	0.5	0.5
Kimball curvature goods mkt. $\hat{\eta}_p$	10	10
Kimball curvature labor mkt. $\hat{\eta}_w$	10	10
Capital tax τ^k	n/a	0.36
Consumption tax τ^c	n/a	0.05
Labor tax τ^n	n/a	0.28
Share credit constrained ϕ	n/a	0.25
Gov. spending, net exports-GDP $\frac{\bar{g}}{\bar{y}}$	0.18	0.153
Gov. investment-GDP $\frac{\bar{x}^g}{\bar{y}}$	n/a	0.04
Debt-GDP $\frac{\bar{b}}{\bar{y}}$	n/a	$4\times$ 0.63

Estimates – Extended Model

	Prior	Prior mean (s.d.)	SW Model 66:1-08:4	New investment 66:1-08:4	Debt & Gov. Capital 49:2-08:4
Adj. cost $S''(\mu)$	norm	4.000 (1.500)	5.93 (1.1)	5.38 (1.03)	4.57 (0.82)
Risk aversion σ	norm	1.500 (0.375)	1.42 (0.11)	1.31 (0.1)	1.18 (0.07)
Habit h	beta	0.700 (0.100)	0.7 (0.04)	0.8 (0.03)	0.85 (0.02)
Calvo wage ζ_w	beta	0.500 (0.100)	0.77 (0.05)	0.77 (0.05)	0.84 (0.03)
Inv. labor sup. ela. ν	norm	2.000 (0.750)	1.96 (0.54)	2.14 (0.47)	2.33 (0.56)
Calvo prices ζ_p	beta	0.500 (0.100)	0.69 (0.05)	0.73 (0.06)	0.81 (0.04)
Wage indexation ι_w	beta	0.500 (0.150)	0.62 (0.1)	0.61 (0.12)	0.44 (0.09)
Price indexation ι_p	beta	0.500 (0.150)	0.26 (0.08)	0.29 (0.1)	0.3 (0.09)
Capacity util.	beta	0.500 (0.150)	0.59 (0.1)	0.54 (0.1)	0.45 (0.08)
$1+\frac{\text{Fix. cost}}{Y} = 1+\lambda_p$	norm	1.250 (0.125)	1.64 (0.08)	1.63 (0.08)	1.93 (0.06)
Taylor rule infl. ψ_1	norm	1.500 (0.250)	2 (0.17)	2.1 (0.17)	1.64 (0.19)
same, smoothing ρ_R	beta	0.750 (0.100)	0.82 (0.02)	0.83 (0.02)	0.92 (0.01)
same, LR gap ψ_2	norm	0.125 (0.050)	0.09 (0.02)	0.12 (0.03)	0.13 (0.03)
same, SR gap ψ_3	norm	0.125 (0.050)	0.24 (0.03)	0.26 (0.03)	0.2 (0.02)
Mean inflation (data)	gamm	0.625 (0.100)	0.76 (0.09)	0.73 (0.12)	0.56 (0.08)
$100\times$time pref.	gamm	0.250 (0.100)	0.16 (0.05)	0.14 (0.04)	0.11 (0.04)
Mean hours (data)	norm	0.000 (2.000)	1.07 (0.95)	1.07 (1.16)	-0.25 (0.67)
Trend $(\mu-1)*100$	norm	0.400 (0.100)	0.43 (0.02)	0.44 (0.01)	0.48 (0.01)
Capital share α	norm	0.300 (0.050)	0.19 (0.02)	0.21 (0.01)	0.24 (0.01)
Gov. adj. cost $S_g''(\mu)$	norm	0.000 (0.500)	n/a	n/a	6.85 (1.03)
Budget bal speed $\frac{\psi_\tau-0.025}{0.175}$	beta	0.30 (0.20)	n/a	n/a	0.07 (0.05)
Implied ψ_τ	n/a	0.078 (0.035)	n/a	n/a	0.0373 (0.01)
Mean gov. debt	norm	0.000 (0.500)	n/a	n/a	0 (0.49)
Mean bond spread	gamm	0.500 (0.100)	n/a	n/a	0.45 (0.05)

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

Estimates – Shock processes

	Prior	Prior mean (s.d.)	SW Model 66:1-08:4	New investment 66:1-08:4	Debt & Gov. Capital 49:2-08:4
s.d. tech.	invg	0.100 (2.000)	0.46 (0.03)	0.46 (0.03)	0.46 (0.02)
AR(1) tech.	beta	0.500 (0.200)	0.95 (0.01)	0.94 (0.01)	0.94 (0.01)
s.d. bond	invg	0.100 (2.000)	0.24 (0.03)	0.17 (0.02)	0.97 (0.05)
AR(1) bond ρ_q	beta	0.500 (0.200)	0.27 (0.1)	0.26 (0.07)	0.68 (0.03)
s.d. gov't	invg	0.100 (2.000)	0.54 (0.03)	0.3 (0.01)	0.35 (0.02)
AR(1) gov't	beta	0.500 (0.200)	0.98 (0.01)	0.99 (0.01)	0.98 (0.01)
Cov(gov't, tech.)	norm	0.500 (0.250)	0.53 (0.09)	0.36 (0.05)	0.3 (0.05)
s.d. inv. price	invg	0.100 (2.000)	0.43 (0.04)	1.17 (0.11)	1.26 (0.11)
AR(1) inv. price	beta	0.500 (0.200)	0.73 (0.06)	0.43 (0.07)	0.55 (0.06)
s.d. mon. pol.	invg	0.100 (2.000)	0.24 (0.02)	0.24 (0.01)	0.23 (0.01)
AR(1) mon. pol.	beta	0.500 (0.200)	0.16 (0.07)	0.14 (0.05)	0.22 (0.06)
s.d. goods m-up	invg	0.100 (2.000)	0.14 (0.01)	0.14 (0.01)	0.31 (0.02)
AR(1) goods m-up	beta	0.500 (0.200)	0.89 (0.04)	0.89 (0.05)	0.91 (0.05)
MA(1) goods m-up	beta	0.500 (0.200)	0.73 (0.08)	0.77 (0.07)	0.96 (0.02)
s.d. wage m-up	invg	0.100 (2.000)	0.26 (0.02)	0.26 (0.02)	0.23 (0.02)
AR(1) wage m-up	beta	0.500 (0.200)	0.97 (0.01)	0.97 (0.01)	0.96 (0.02)
MA(1) wage m-up	beta	0.500 (0.200)	0.91 (0.03)	0.91 (0.03)	0.91 (0.04)
s.d. Tax shock	invg	0.100 (2.000)	n/a	n/a	1.42 (0.07)
AR(1) tax shock	beta	0.500 (0.200)	n/a	n/a	0.97 (0.01)
s.d. gov. inv. price	invg	0.100 (2.000)	n/a	n/a	0.79 (0.09)
AR(1) gov. inv. price	beta	0.500 (0.200)	n/a	n/a	0.97 (0.01)
s.d. bond spread	invg	0.100 (2.000)	n/a	n/a	0.08 (0)
AR(1) bond spread	beta	0.500 (0.200)	n/a	n/a	0.91 (0.02)

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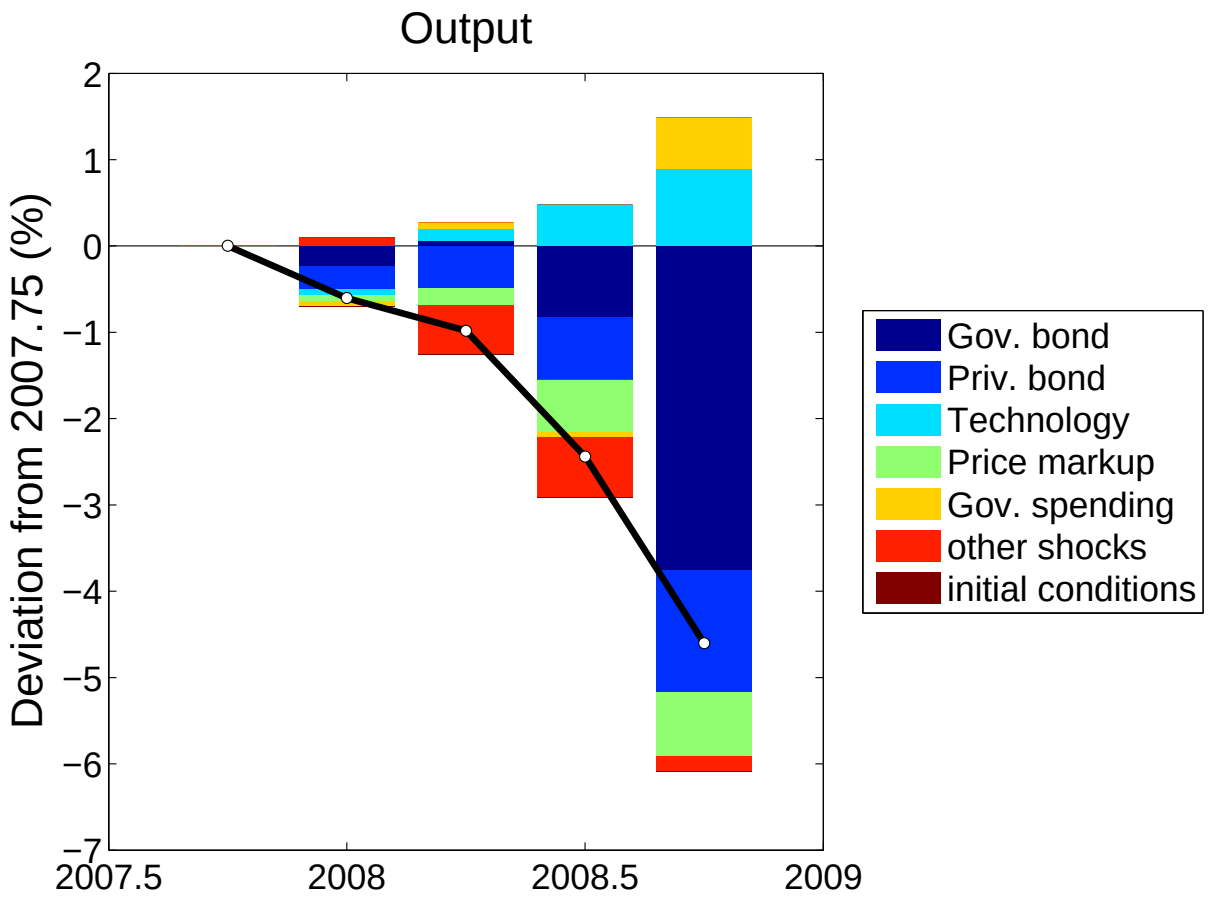
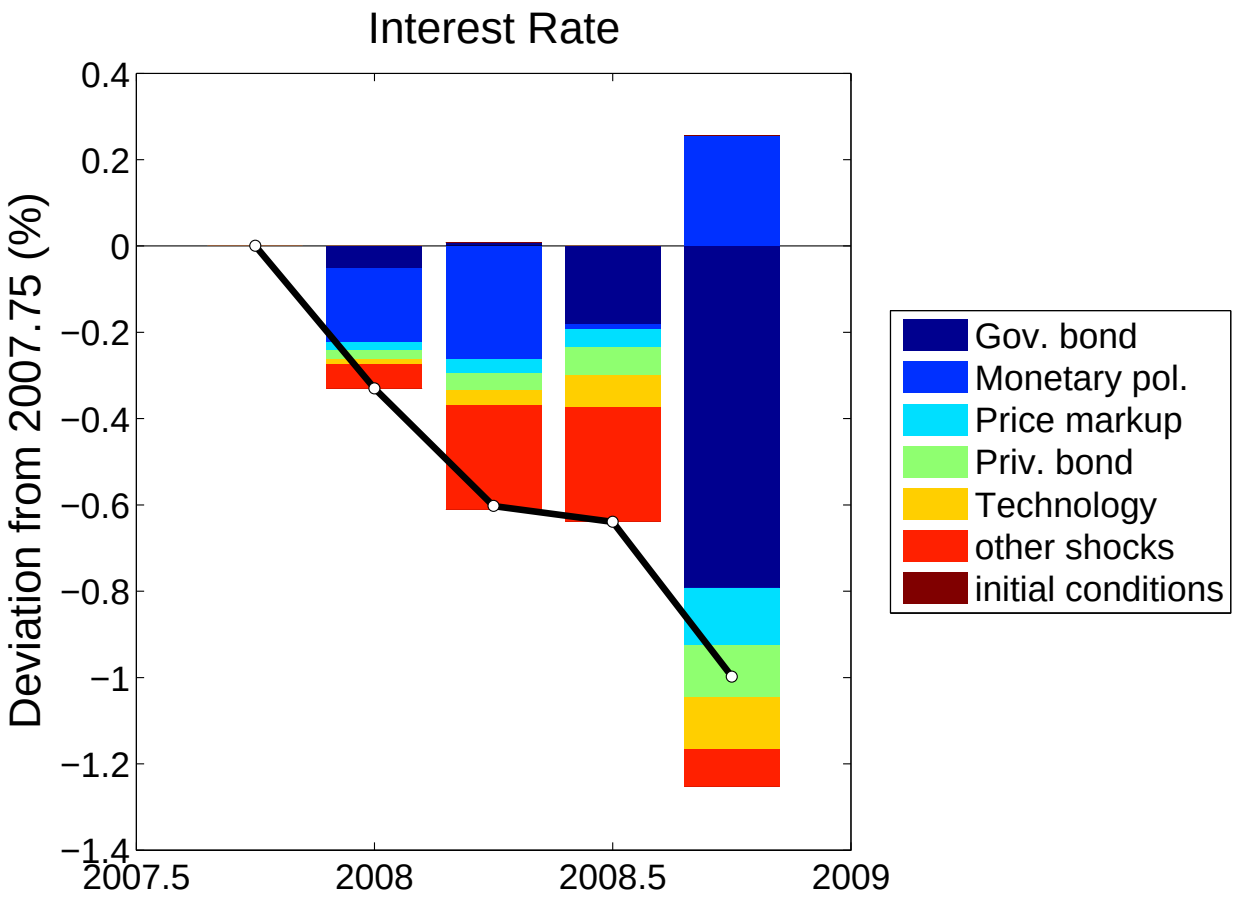
Historical Shock Decomposition: Output



Note: At posterior mean. 2007:4 is the NBER recession date.

Historical Shock Decomposition: Interest rates

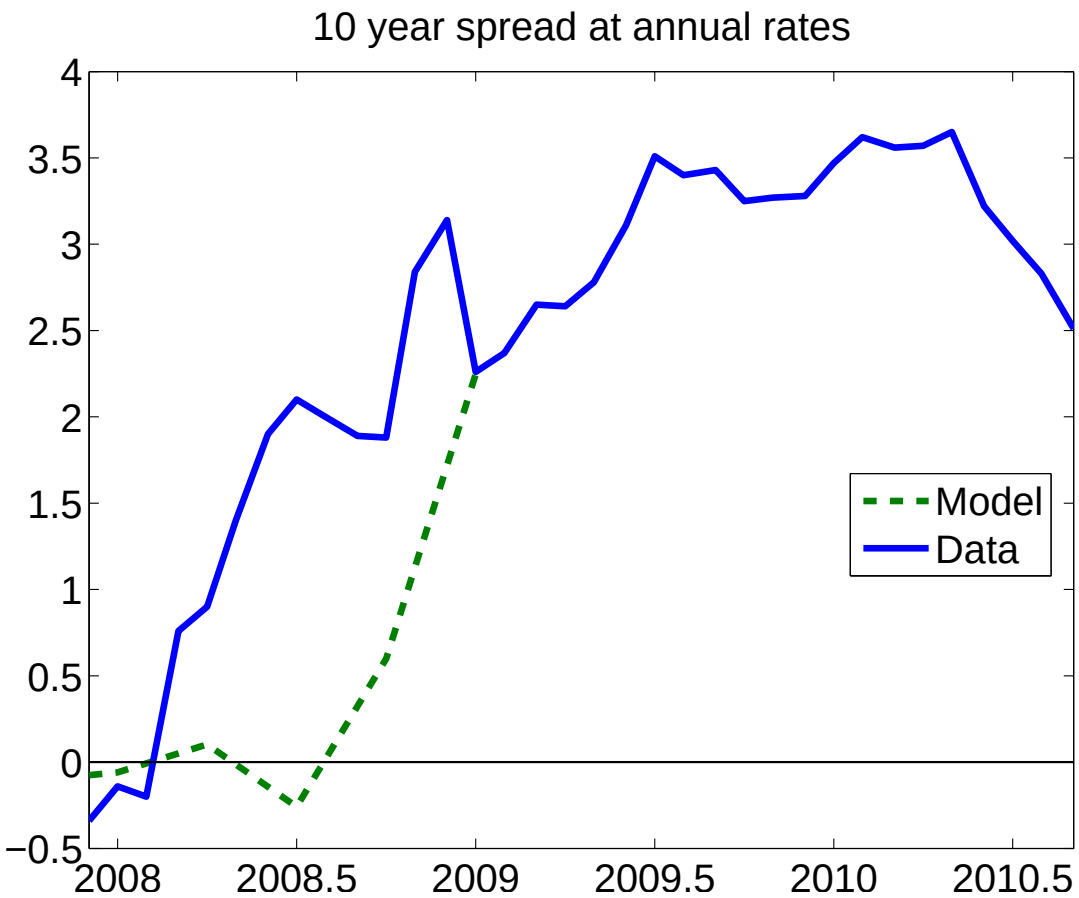


Note: At posterior mean. 2007:4 is the NBER recession date.

Decomposing the recession vs variance decomposition

	2008:4 vs. 2007:4 Historical decomposition		Total Sample Variance decomposition
Shock	%	%	
Gov. bond	-3.75	81.52	6.50
Priv. bond	-1.42	30.81	1.63
Technology	0.90	-19.53	19.21
Price markup	-0.73	15.86	8.59
Gov. spending	0.60	-12.98	4.14
Priv. inv.	-0.30	6.53	16.78
Labor tax	-0.27	5.91	9.20
Monetary pol.	0.20	-4.44	20.88
Wage Markup	0.15	-3.18	8.16
Gov. inv.	0.03	-0.73	4.92
Initial Values	-0.01	0.22	n/a
Sum	-4.60	100.00	100.01

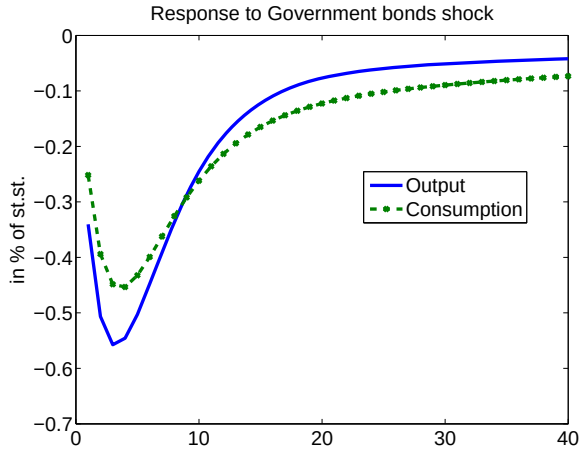
Implied interest rate spread: Gov. bonds vs. FFR



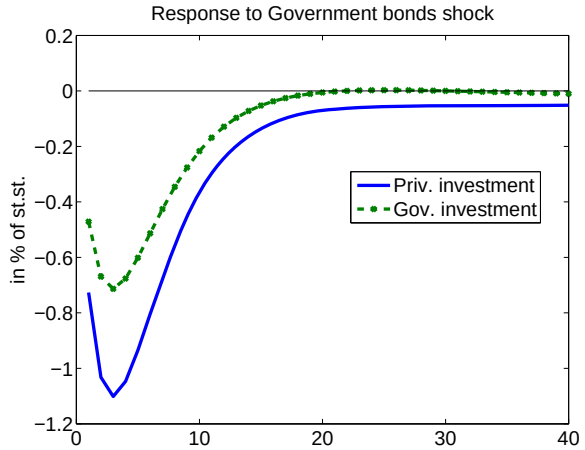
Note: At posterior mean. 2007:4 is the NBER recession date.

Government Bond Shock

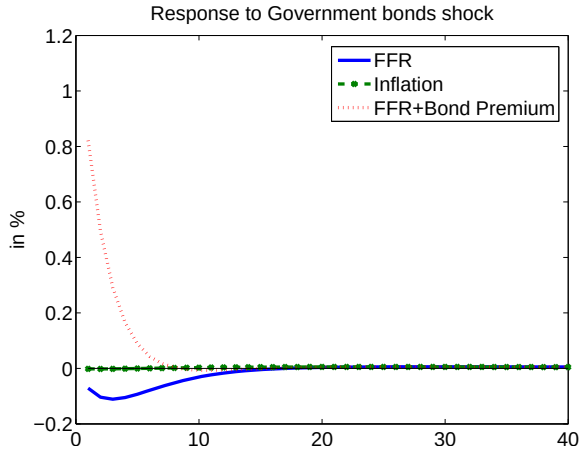
Output & Consumption



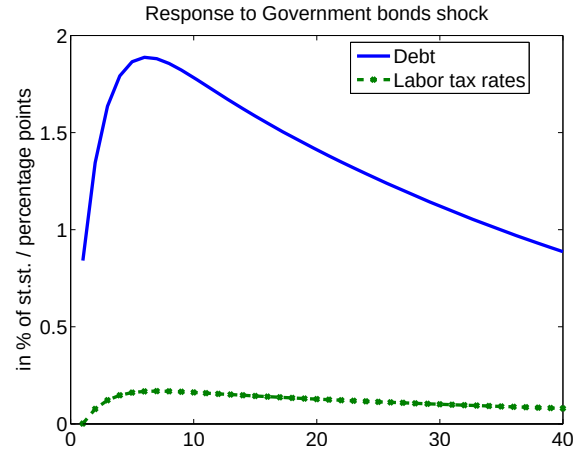
Investment



FFR & Inflation



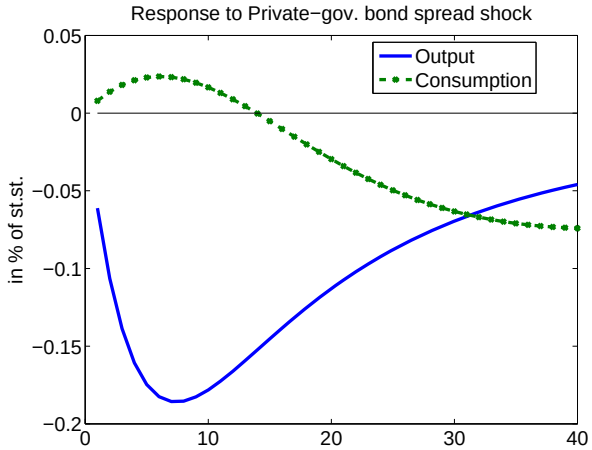
Debt & Labor tax



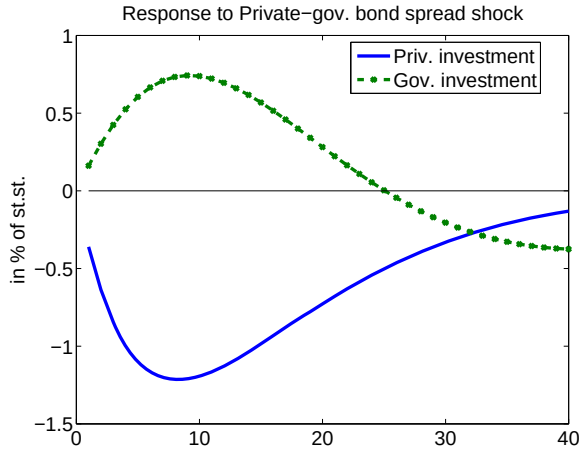
Note: Response to a one standard deviation shock.

Private-Government Bond Spread Shock

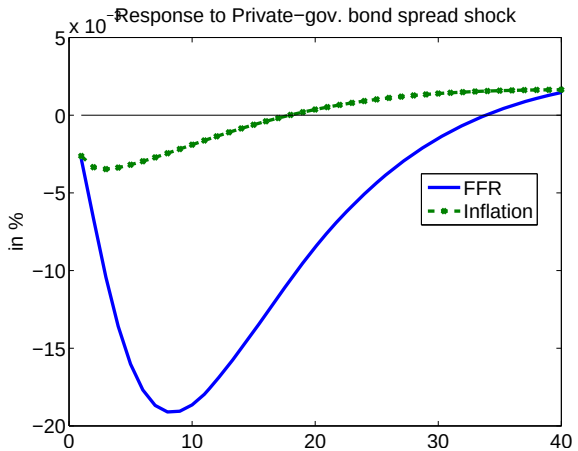
Output & Consumption



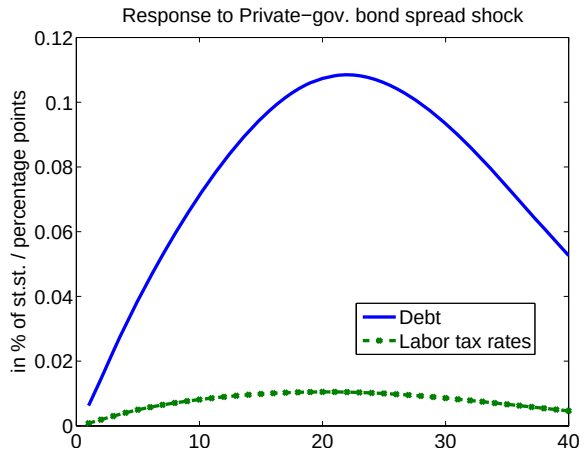
Investment



FFR & Inflation



Debt & Labor tax



Note: Response to a one standard deviation shock.

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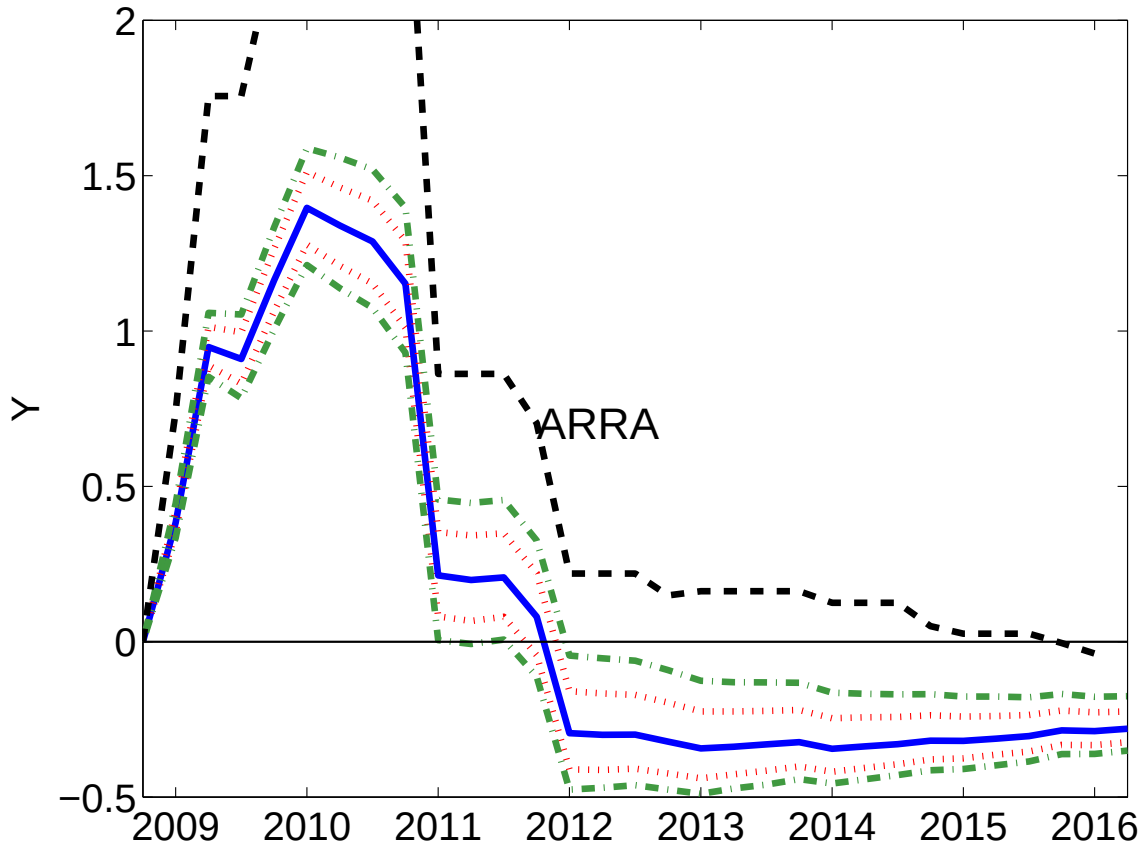
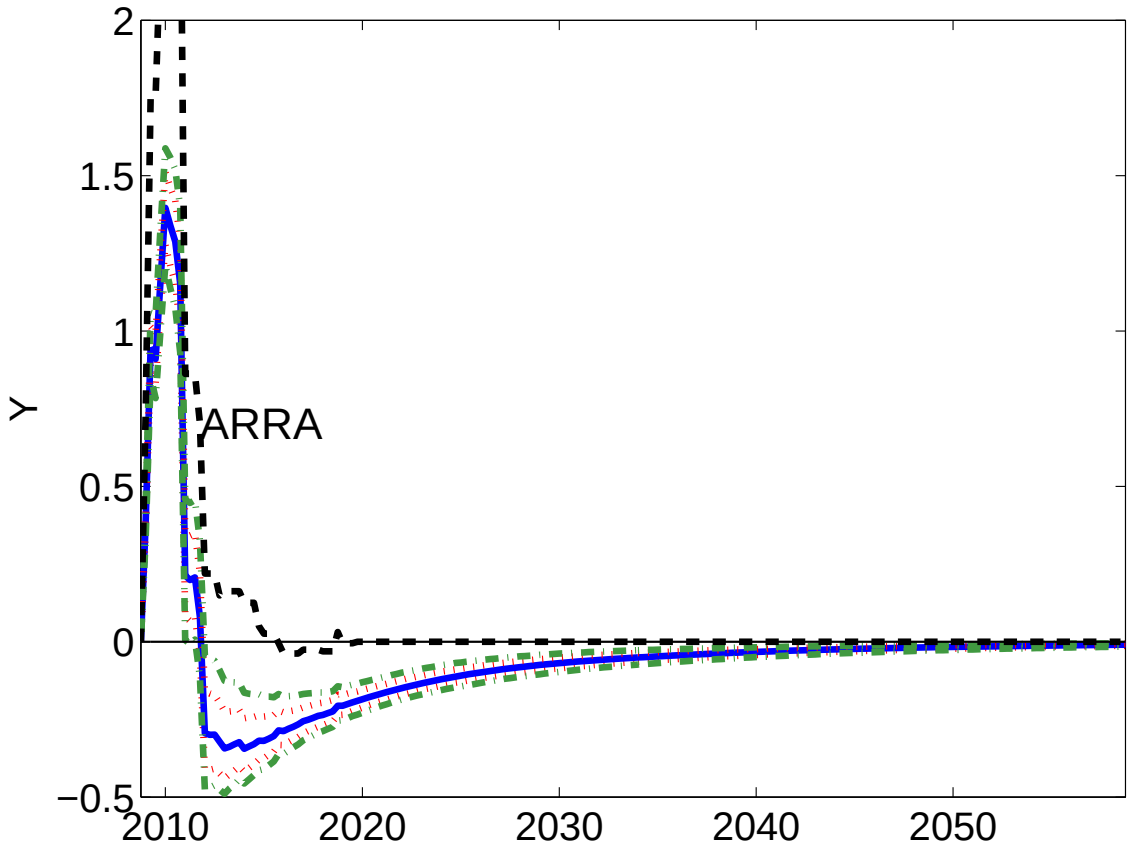
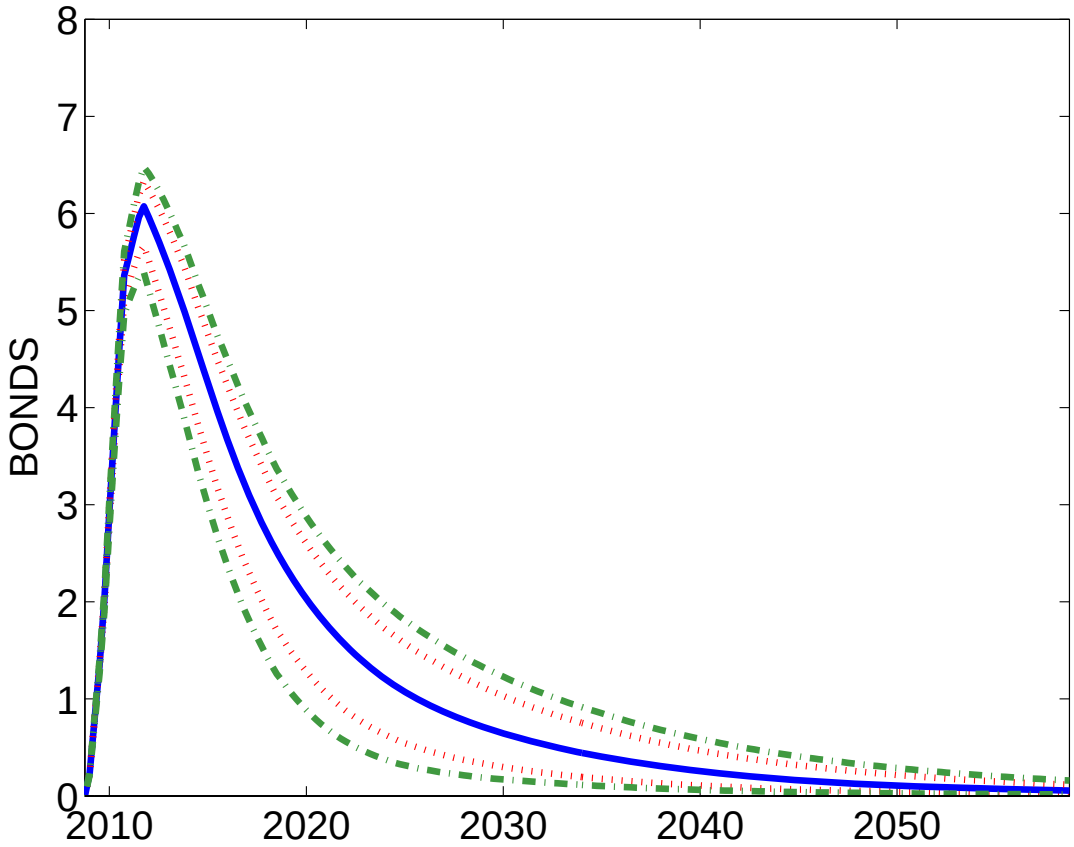
ARRA impact on output: short-run ...



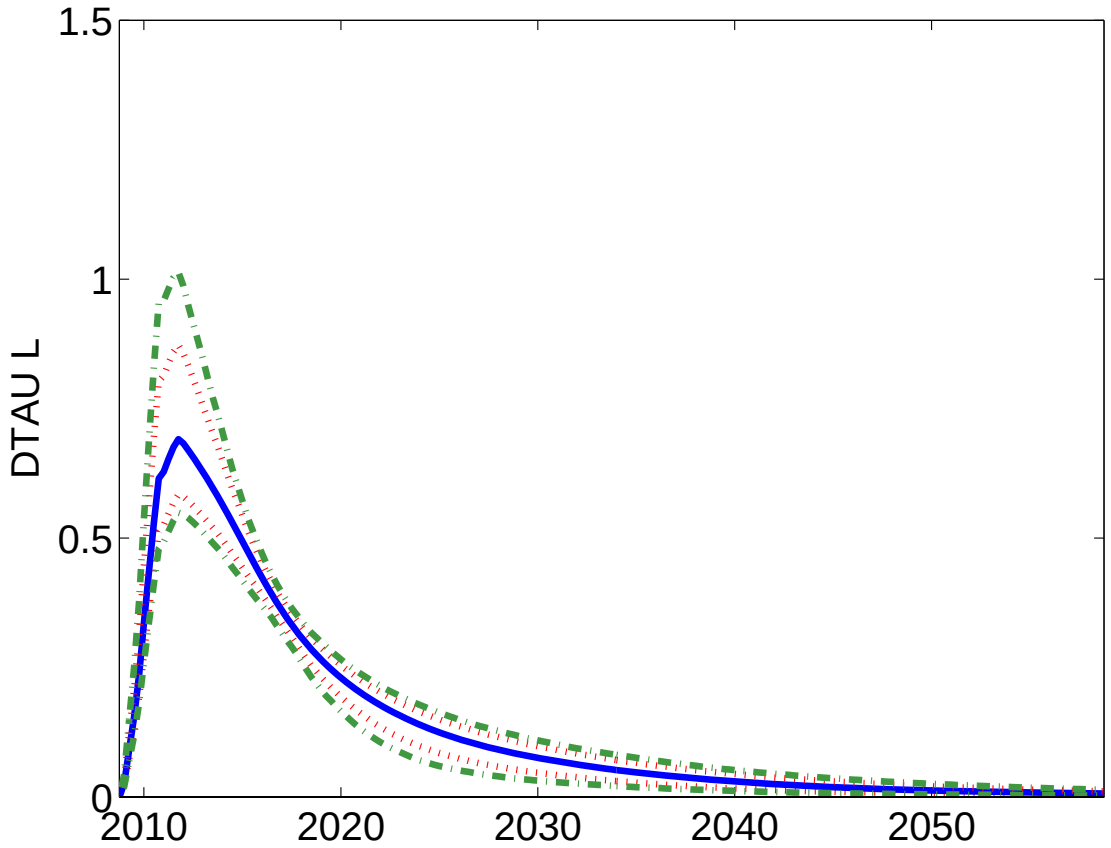
ARRA impact on output: ... and long-run



Debt: long-run

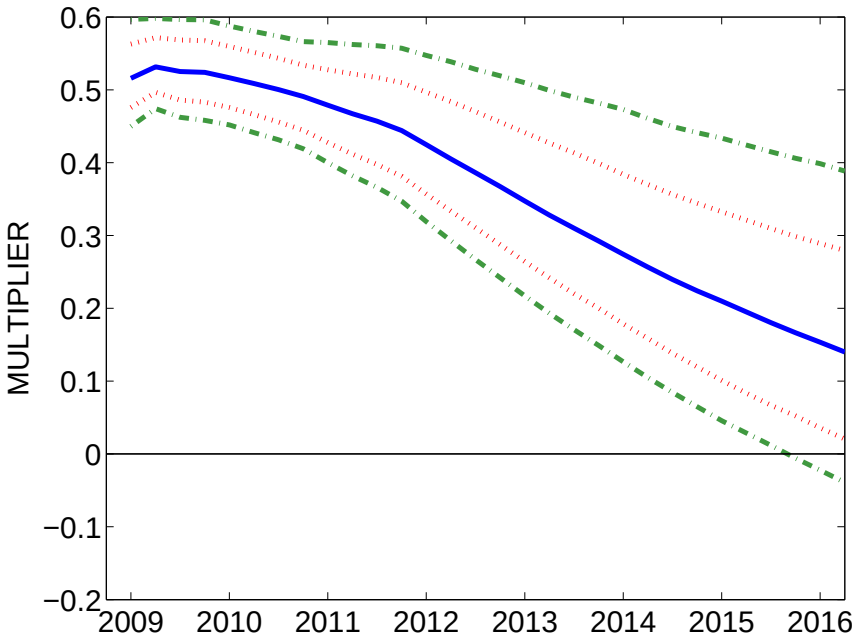


Labor tax rates: long run

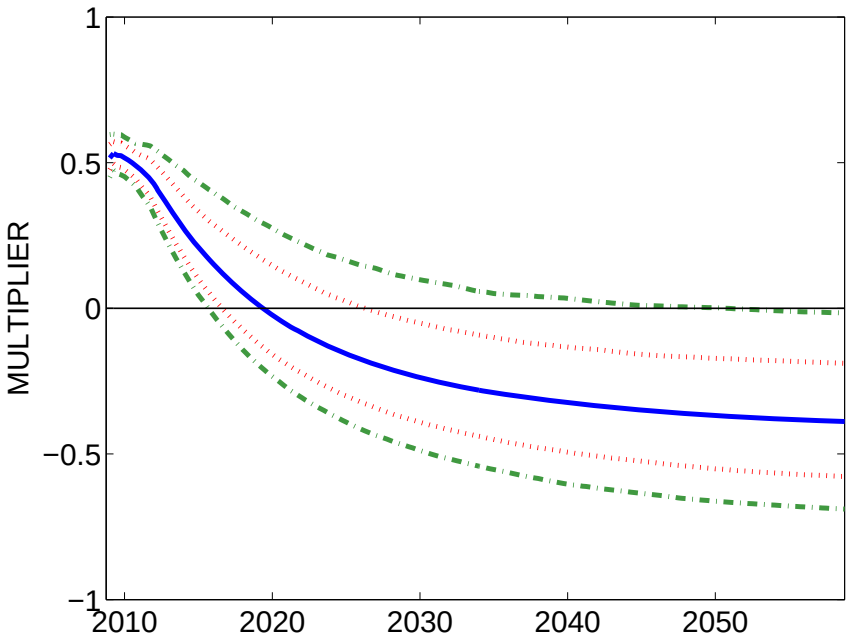


Fiscal Multiplier: short and long run

short run



long run



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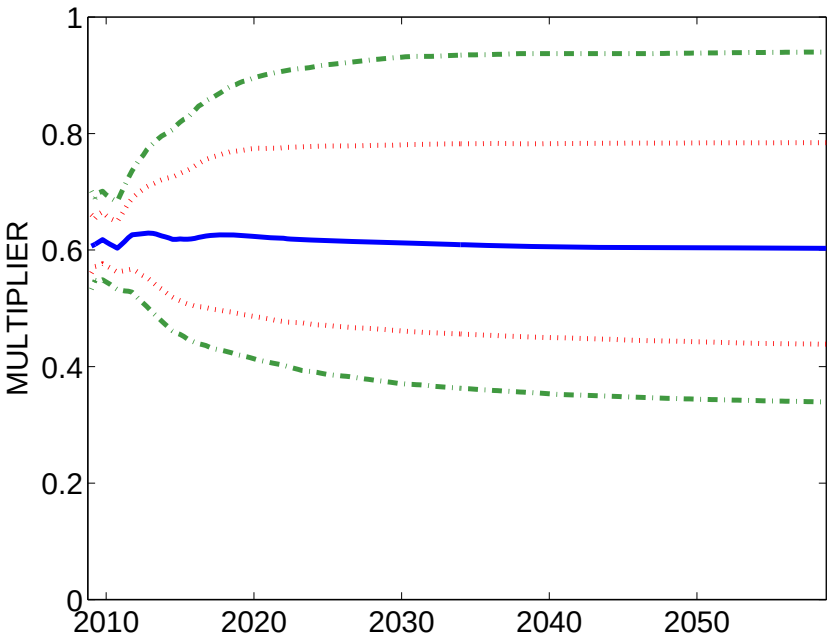
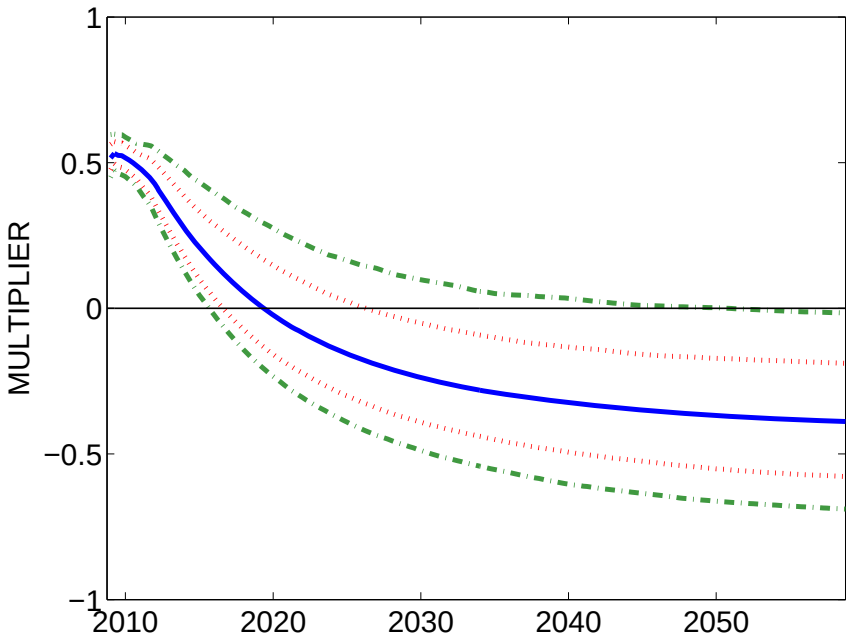
Lump sum vs distortionary taxation.

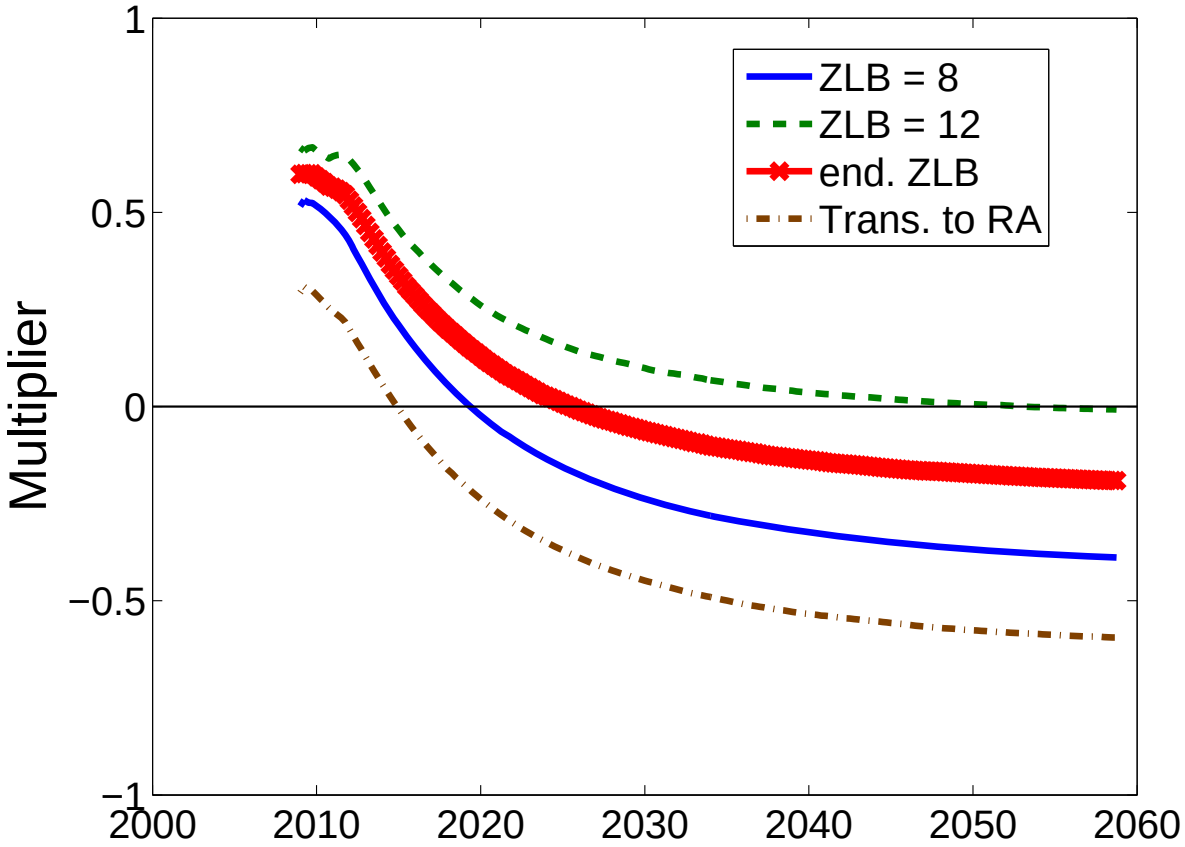
Lump-sum



Distortionary

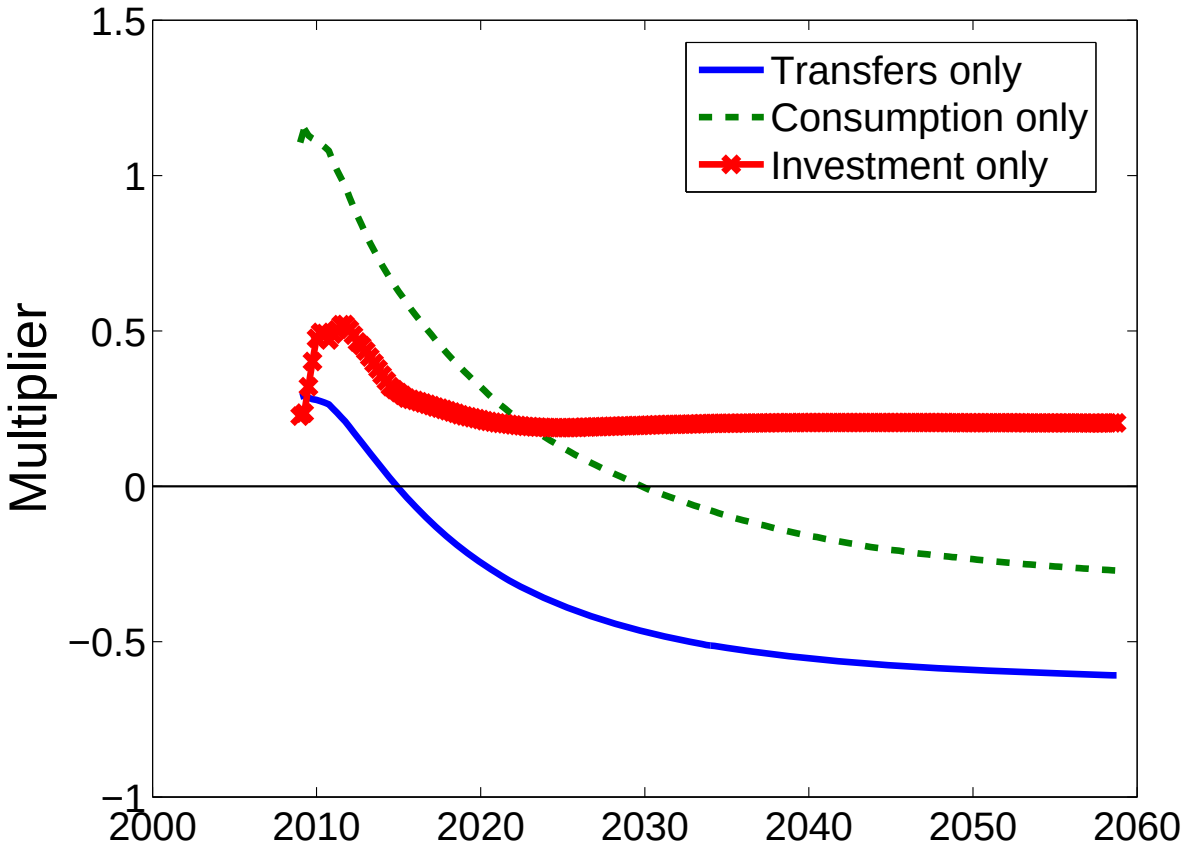


Multiplier: Sensitivity Analysis



(Note: DU stimulus, posterior medians)

Multiplier: Components



(Note: Components of DU stimulus, posterior medians, ZLB=8 qtrs.)

One-year fiscal multipliers: sensitivity

Scenario	5 %	16.5 %	median	83.5 %	95 %
Benchmark	0.46	0.48	0.52	0.57	0.60
lump-sum taxes	0.55	0.57	0.61	0.66	0.70
consumption taxes	0.48	0.50	0.54	0.58	0.61
ZLB: 0 Quart.	0.17	0.20	0.23	0.27	0.30
ZLB: 12 Quart.	0.75	0.78	0.84	0.93	1.02
ZLB: Endogenous	0.51	0.54	0.60	0.69	0.78
RoT=0.15	0.39	0.42	0.46	0.49	0.52
RoT=0.35	0.47	0.54	0.59	0.64	0.69
Share transfers to RoT= 0%	0.25	0.26	0.29	0.31	0.33
Share transfers to RoT= 50%	0.65	0.69	0.75	0.81	0.85
Share transfers to RoT= 100%	1.05	1.11	1.21	1.32	1.39
Priv. capital share=0.35	0.44	0.47	0.52	0.57	0.61
price/wage-stickiness=10% of estim.	0.05	0.07	0.11	0.14	0.16
price/wage-stickiness=50% of estim.	0.35	0.38	0.42	0.47	0.50
price/wage-stickiness=115% of estim.	0.44	0.46	0.50	0.53	0.56
Budget balance: $\psi_\tau = 0.025$	0.48	0.51	0.54	0.58	0.61
Budget balance: $\psi_\tau = 0.05$	0.43	0.46	0.49	0.53	0.56

Long run fiscal multipliers as $t \to \infty$: sensitivity

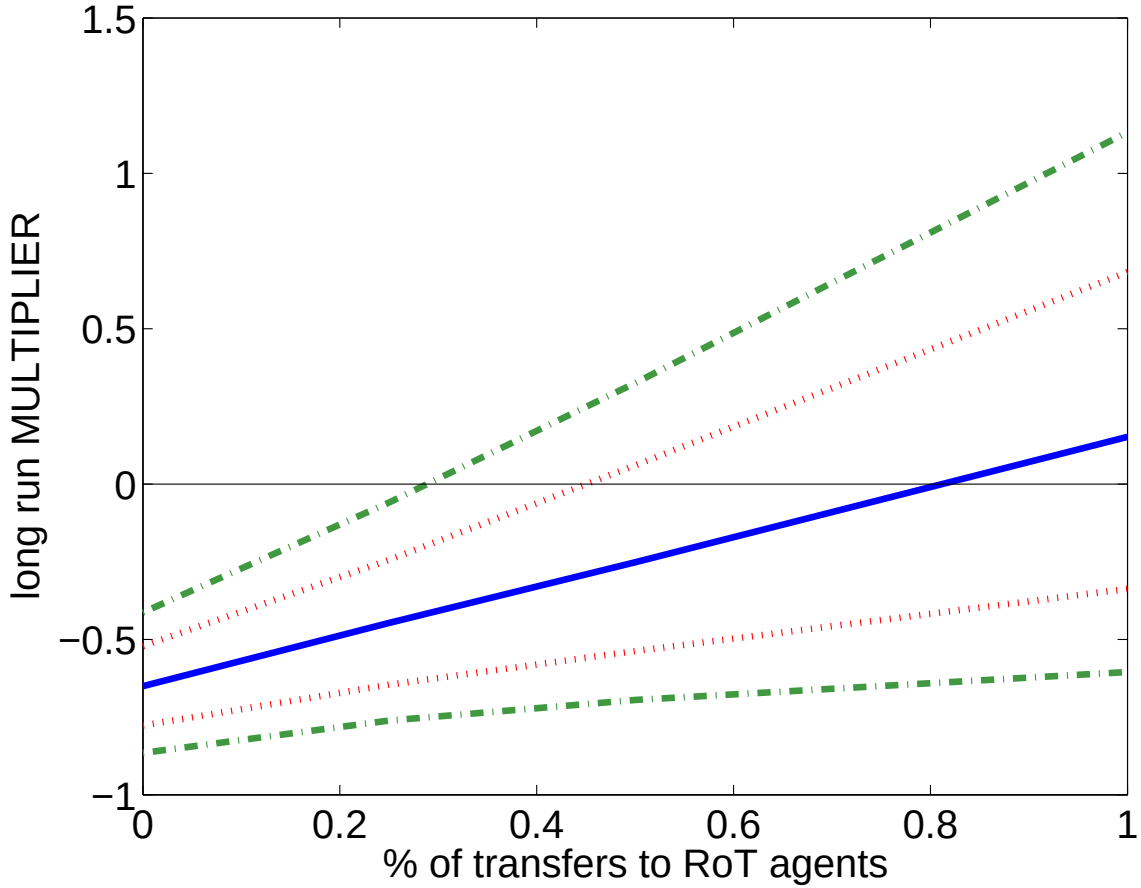
Scenario	5 %	16.5 %	median	83.5 %	95 %
Benchmark	-0.72	-0.61	-0.42	-0.22	-0.04
lump-sum taxes	0.34	0.44	0.60	0.78	0.94
consumption taxes	-0.48	-0.38	-0.20	-0.02	0.14
ZLB: 0 Quart.	-1.30	-1.18	-1.03	-0.87	-0.73
ZLB: 12 Quart.	-0.45	-0.31	-0.03	0.27	0.52
ZLB: Endogenous	-0.56	-0.43	-0.19	0.14	0.57
RoT=0.15	-0.91	-0.79	-0.63	-0.43	-0.26
RoT=0.35	-0.59	-0.44	-0.24	-0.04	0.18
Share transfers to RoT= 0%	-0.86	-0.77	-0.65	-0.52	-0.42
Share transfers to RoT= 50%	-0.64	-0.50	-0.24	0.03	0.29
Share transfers to RoT= 100%	-0.50	-0.28	0.16	0.64	1.05
Priv. capital share=0.35	-1.13	-0.98	-0.76	-0.51	-0.27
price/wage-stickiness=10% of estim.	-0.96	-0.87	-0.75	-0.62	-0.52
price/wage-stickiness=50% of estim.	-0.78	-0.69	-0.58	-0.46	-0.37
price/wage-stickiness=115% of estim.	-0.91	-0.76	-0.56	-0.33	-0.12
Budget balance: $\psi_\tau = 0.025$	-0.70	-0.58	-0.40	-0.21	-0.04
Budget balance: $\psi_\tau = 0.05$	-0.77	-0.66	-0.49	-0.30	-0.13

Sensitivity to RoTs and Transfers

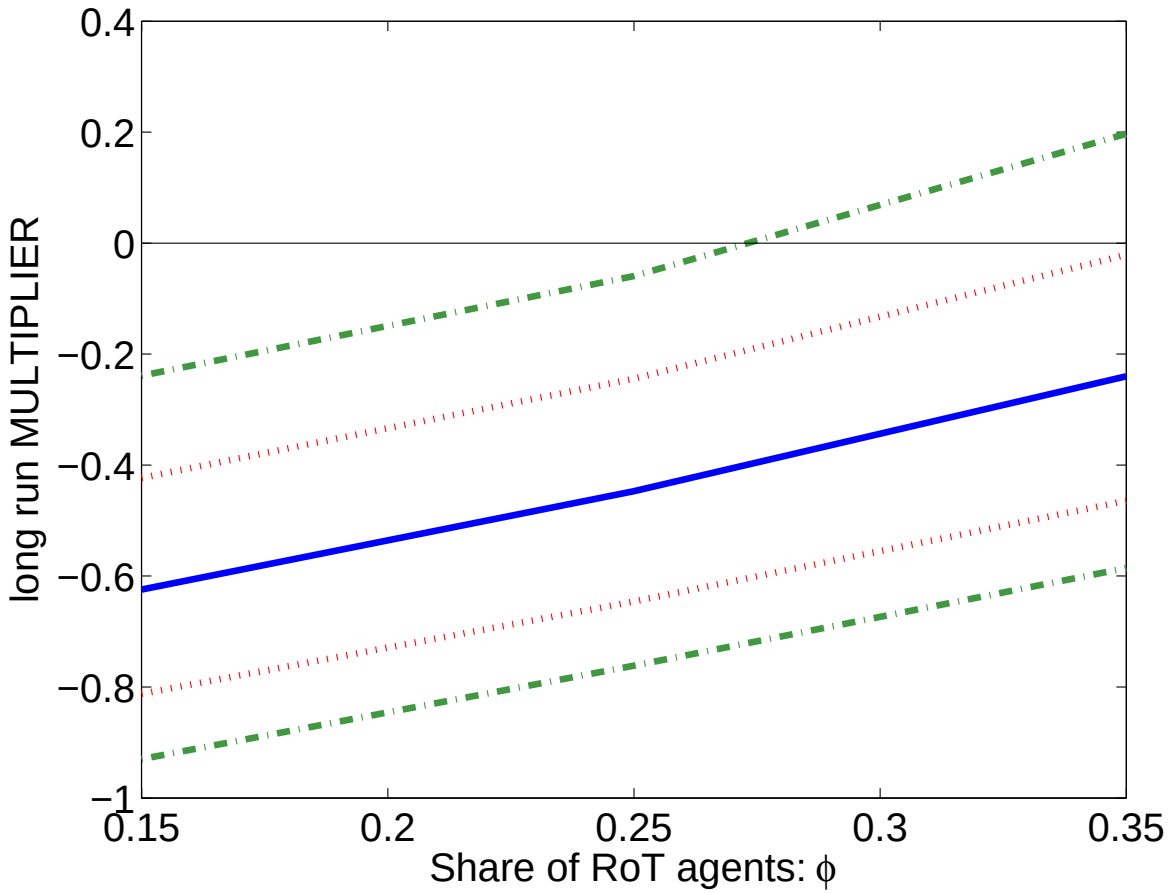
	one year mult.			long-run mult.		
Transfers = RoT fraction =	0.10	0.25	0.40	0.10	0.25	0.40
Const. transfers/household:	0.33	0.54	0.82	-0.62	-0.31	0.12
Transfers =0.25, RoT fraction =	0.10	0.25	0.40	0.10	0.25	0.40
Fixed absolute transfers	0.45	0.54	0.66	-0.53	-0.31	-0.03
RoT Share =0.25, Transfers =	0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

Note: Multiplier not discounted with historical interest rate.

Sensitivity to RoT share of transfers

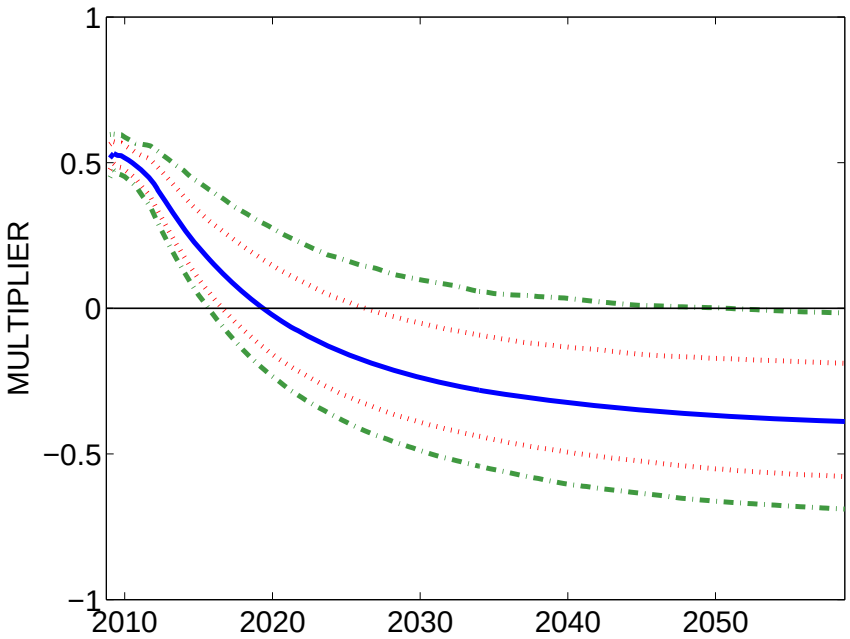


Sensitivity to RoT share of population

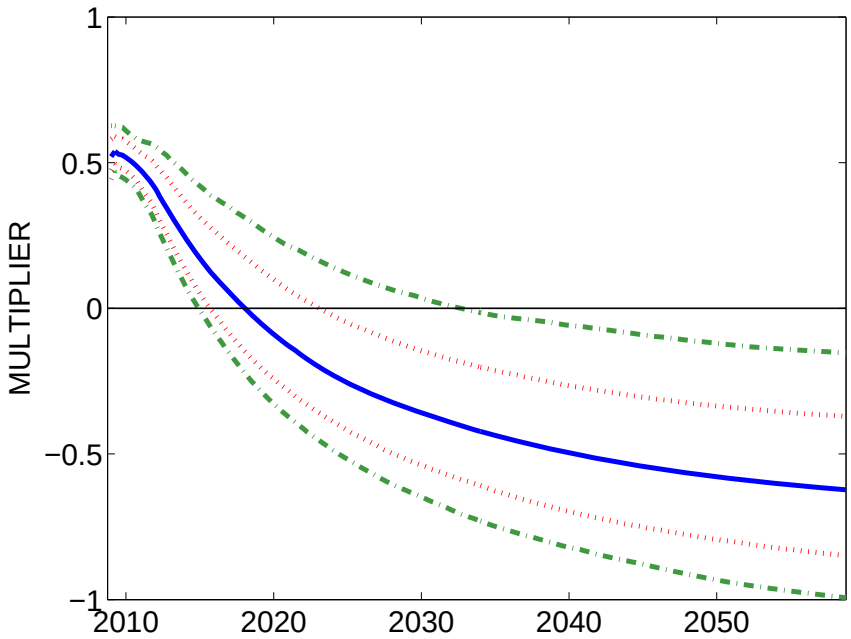


Sensitivity to capital share: 0.24 vs 0.35.

Estimated: ≈ 0.24

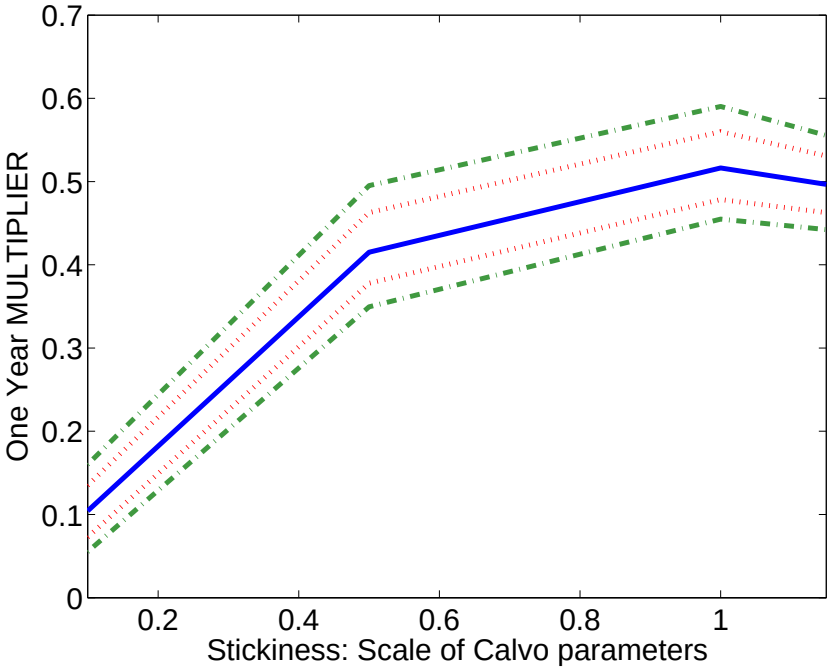


Calibrated: 0.35

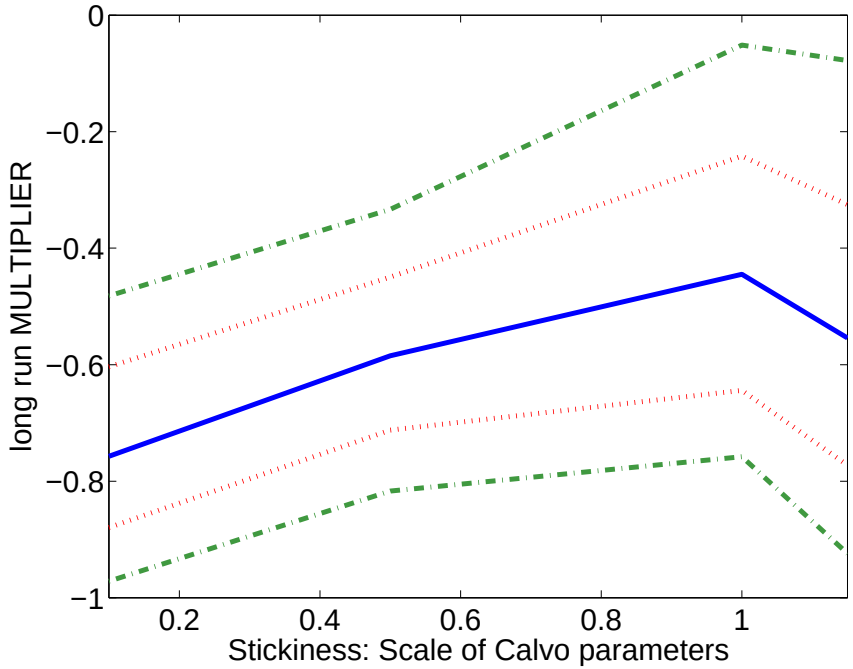


Sensitivity to price stickiness: scaling Calvo

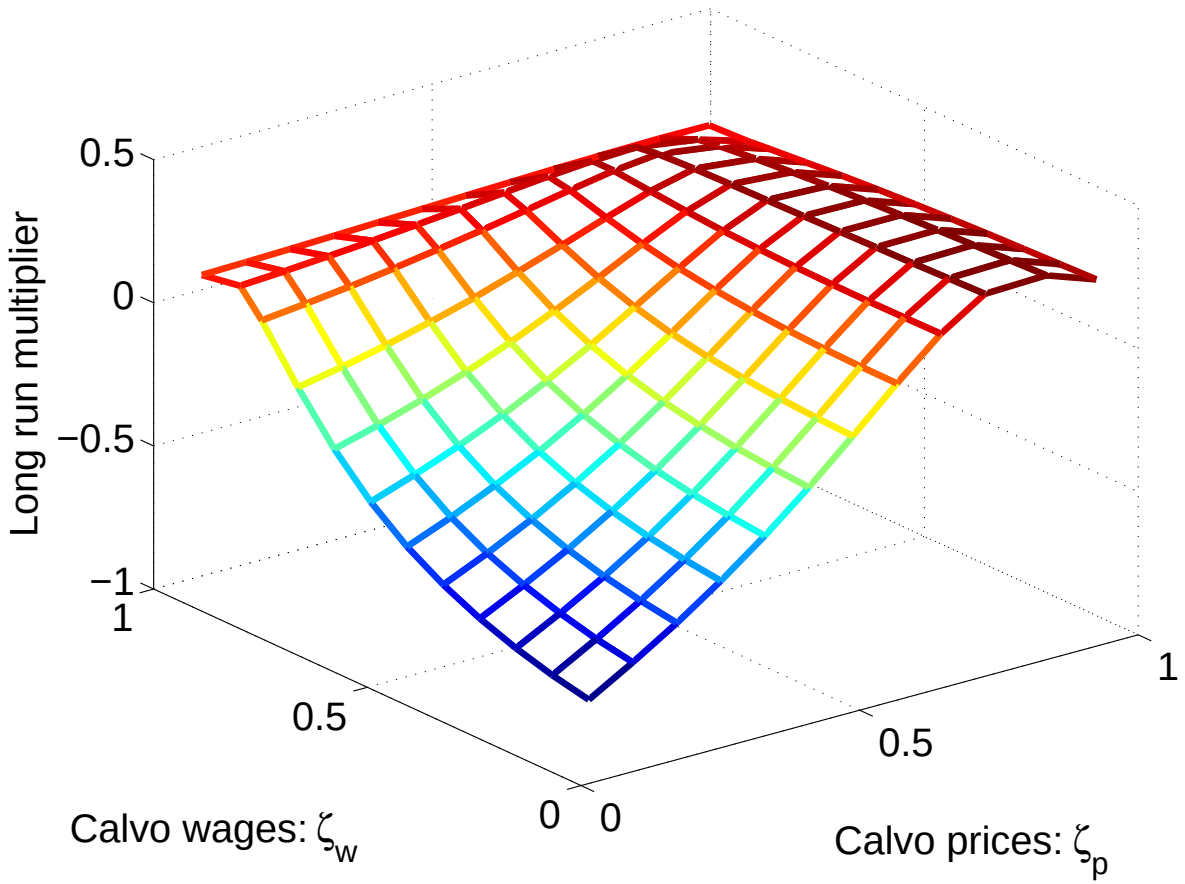
One Year



Long-run



Sensitivity of long-run fiscal multiplier.



Note: Multiplier not discounted with historical interest rate.

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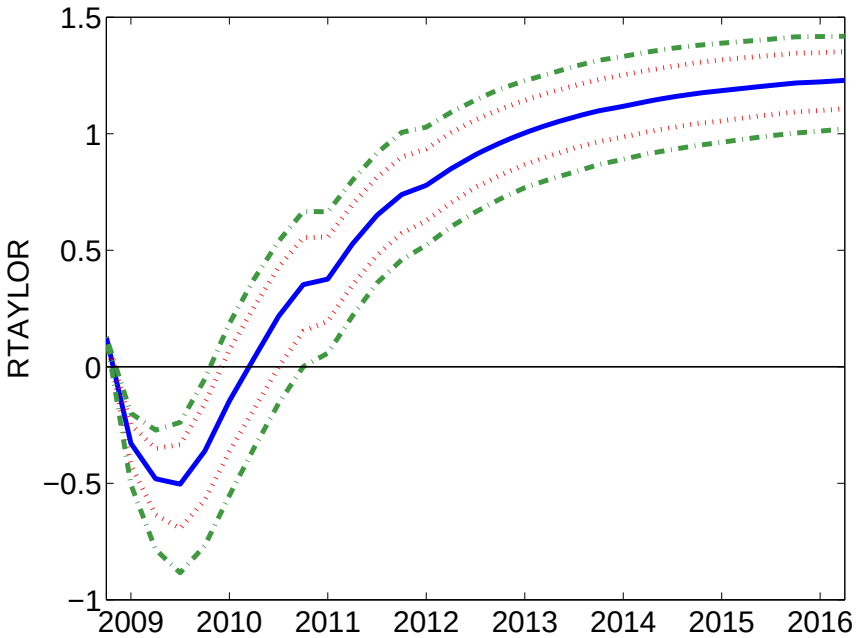
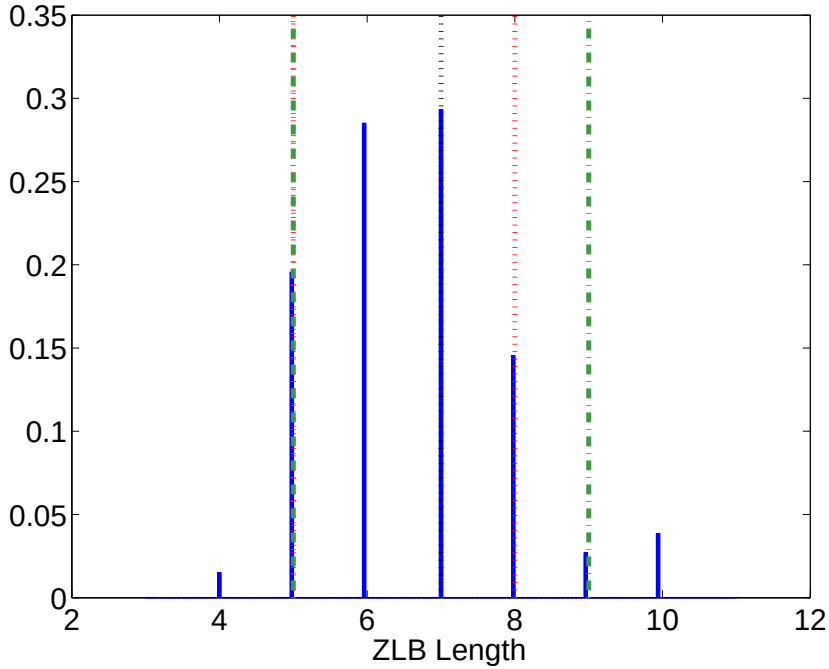
The shadow Taylor rule

Implied FFR

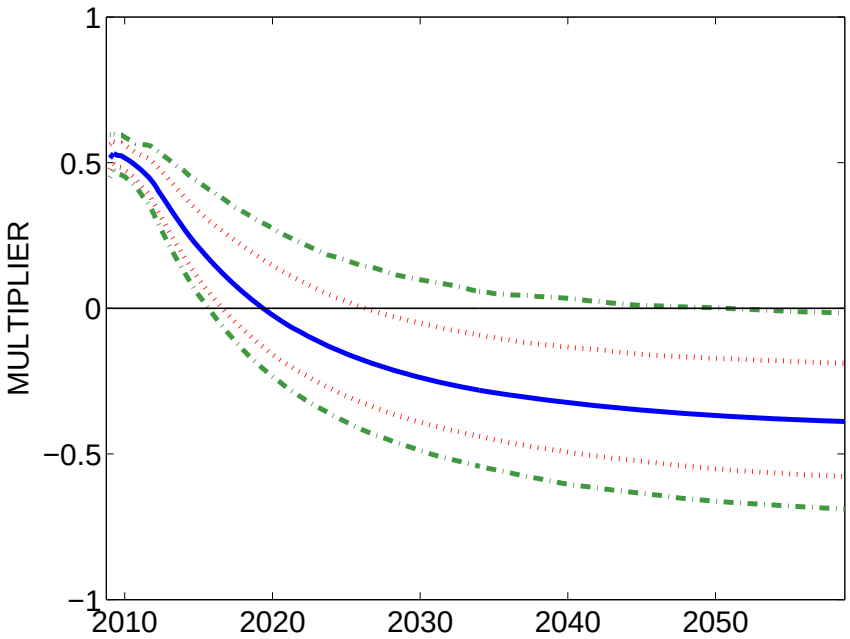


Implied ZLB Length

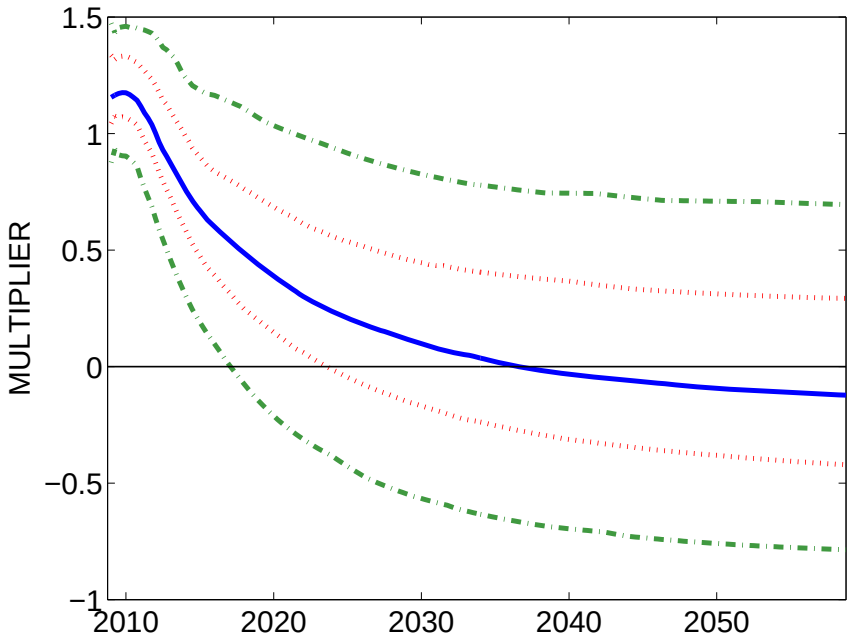


Sensitivity to ZLB: 8 quart. vs endog.

8 Quarters

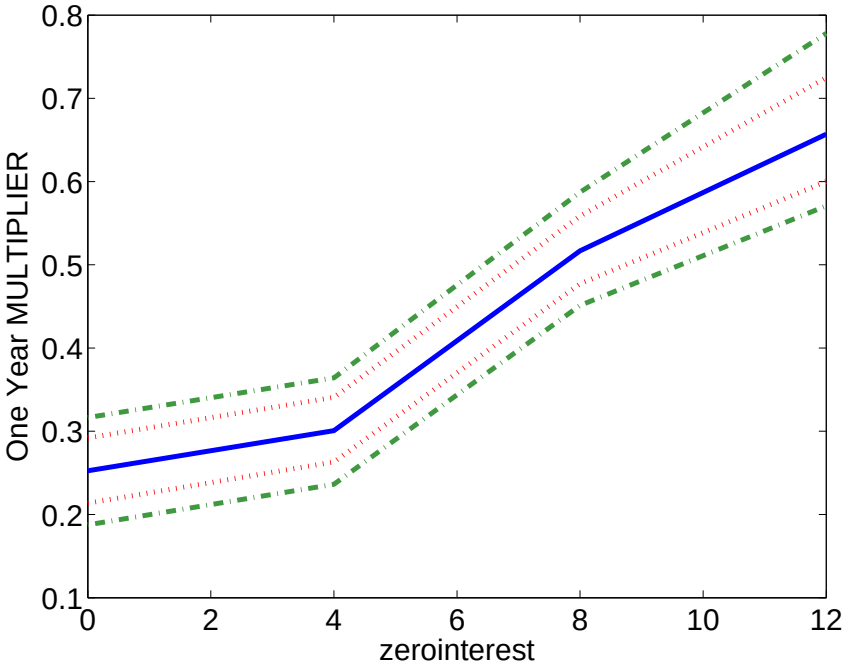


Endogenous

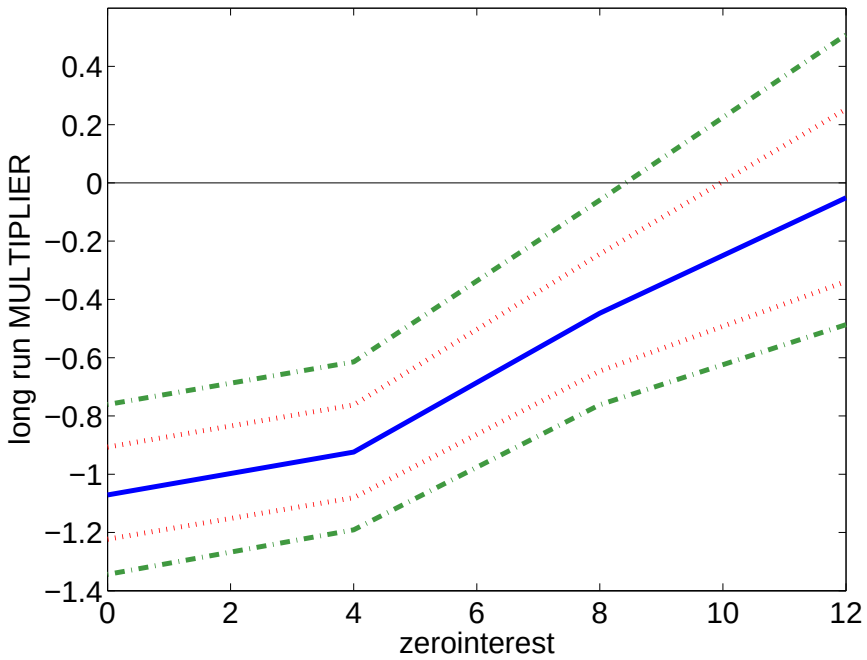


Sensitivity to length of ZLB

One Year



Long-run



Changing ZLB length from 0 to k. No ARRA.

	Output change (in %)			Inflation change (in %)	
ZLB imposed for ...	1 yr	5 yr's	NPV	1 yr	5 yr's
$k = 4$ quarters	-0.52	-0.05	-6.54	0.11	0.03
$k = 8$ quarters	-0.81	-0.07	-9.68	0.06	-0.05
$k = 12$ quarters	0.87	0.26	26.87	0.03	-0.01

Note: Posterior medians.

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Challenges going forward

1. Ramsey-Mirrlees and New Public Finance **versus** Quantitative Macro Public Finance. **Rules of the Game?**
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?

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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!