

# Regime Switching in Fiscal Debt Targets and Policy Functions in the United States

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## Describe fiscal policy dynamics

Government expenditures	Deficits
Income tax rate	Debt
Net transfer payments	

## Describe debt service

- 1 How do these fiscal policy variables respond to *debt / GDP*?
- 2 What is the implied target for *debt / GDP*?
- 3 Is there switching in these fiscal policy responses?
- 4 Is there switching in the long-run debt target?

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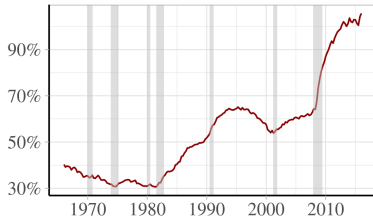
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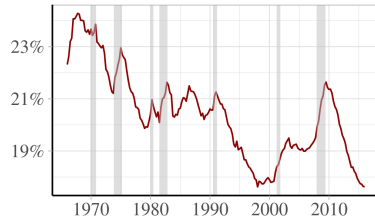
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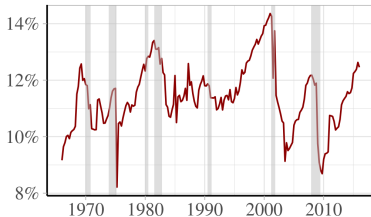
### Debt to GDP Ratio



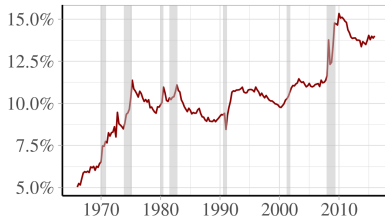
### Government Expenditures Ratio to GDP



### Tax Revenue Ratio to GDP



### Transfer Ratio to GDP



## Debt target and tax response matter

- Expected smaller debt/GDP target and/or expected larger response of taxes to debt,
  - Higher expected income taxes
  - lower consumption, investment, real GDP.
- Richter and Throckmorton (EER, 2015):
  - Unknown debt targets amplify impact of tax shocks
  - Uncertain long-run debt targets reduced impact of ARRA, extensions to Bush tax cut

## Fiscal composition matters

Leeper, Plante, and Traum (JoE, 2010)

- Rich set of fiscal variables responding to debt fits data best
- Magnitude of fiscal shocks depend on composition
- Fiscal multipliers can have unexpected signs, depending on composition

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## Gradual movement toward target

$$G_t = \rho_g \left( \frac{Y_{t-1}}{Y_{t-2}} \right) G_{t-1} + (1 - \rho_g) G_t^*,$$

- $\rho_g \in (0, 1)$  persistence parameter
- $G_t$ : Actual nominal government expenditures
- $G_t^*$ : Target level for government expenditures
- $Y_t$ : Nominal GDP, so  $Y_{t-1}/Y_{t-2}$ , is lagged gross NGDP growth.

Divide by nominal GDP ( $Y_t$ )

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- $g_t \equiv G_t/Y_t$ ,  $g_t^* \equiv G_t^*/Y_t$ : Actual / Target government expenditures to GDP ratio
- $y_t \equiv Y_t/Y_{t-1}$ : Gross growth rate of nominal GDP



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## Target Policy Behavior

- Use government expenditures to stabilize business cycle  
→ **Decrease gov exp** in response to output gap
- **Decrease government expenditures** in response to rising debt

## Structure

$$g_t^* = \bar{g}(s_t) + \psi_g(s_t)x_t + \gamma_g(s_t) [b_{t-1} - \bar{b}(s_t)] + u_{g,t},$$

- $s_t \in \{1, \dots, M\}$ : Fiscal regime... more later
- $\bar{g}(s_t)$ : Long-run government expenditures / GDP goal
- $b_{t-1}$ : Lagged government debt / GDP ratio
- $\bar{b}(s_t)$  Long-run goal debt / GDP ratio
- $\psi_g(s_t) < 0$ : Response to increase in output gap
- $\gamma_g(s_t) < 0$ : Response to increase in government debt
- $u_{g,t}$ : Shock to government expenditures

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## Movement Toward Target

$$\tau_t = \rho_\tau \left( \frac{y_{t-1}}{y_t} \right) \tau_{t-1} + (1 - \rho_\tau) \tau_t^*$$

- $\tau, \tau^*$ : Tax revenue / GDP, short-run target

## Target Policy Behavior

- Use taxes to stabilize business cycle  
→ **Increase taxes** in response to output gap
- **Increase taxes** in response to rising debt

## Target Tax Policy

$$\tau_t^* = \bar{\tau}(s_t) + \psi_\tau(s_t)x_t + \gamma_\tau(s_t) [b_{t-1} - \bar{b}(s_t)] + u_{\tau,t}$$

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$$n_t = \rho_n \left( \frac{y_{t-1}}{y_t} \right) n_{t-1} + (1 - \rho_n) n_t^*$$

- $n, n^*$ : Net transfers / GDP, short-run target

## Target Policy Behavior

- Use transfers to stabilize business cycle  
→ **Decrease transfers** in response to output gap
- **Decrease transfers** in response to rising debt

## Target Transfers Policy

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## Primary Budget Deficit

$$d_t = \tau_t - g_t - n_t + \tilde{d}_t$$

$\tilde{d}_t$ : Deficit residual

(Other expenditure or revenue items I did not include)

## Deficit Residual Behavior

Gradual movement toward target:

$$\tilde{d}_t = \rho_d \left( \frac{y_{t-1}}{y_t} \right) \tilde{d}_{t-1} + (1 - \rho_d) d_t^*$$

Short-run target:

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## Intertemporal government budget constraint

$$B_t = (1 + r_{t-1})B_{t-1} + D_t - (M_t - M_{t-1}),$$

$B_t$ : Nominal government debt     $r_{t-1}$ : interest rate on past-issued debt  
 $D_t$ : Nominal budget deficit     $M_t - M_{t-1}$ : seigniorage

## Empirical government budget constraint

Divide both sides by  $Y_t$  and allow for measurement error ( $v_t$ )

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  - Debt / GDP,  $\bar{b}(s_t)$ , and
  - deficits / GDP,  $\bar{d}(s_t)$
- Evaluate budget constraint at steady state and a constant fiscal regime  $s_{t-1} = s_t = s$ :

$$\bar{d}(s) = \left( \frac{\bar{y} - \bar{r} - 1}{\bar{y}} \right) \bar{b}(s) - \bar{u}_b$$

## Long-run deficit dependencies

Debt target

Long-run nominal interest rate

Long-run nominal GDP growth

Long-run seigniorage

Jointly estimate these long-run targets



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## Regime-dependent variances for fiscal shocks

$$\begin{array}{ll} \sigma_g^2(s_t): \text{Var}(\text{shock to gov exp}) & \sigma_n^2(s_t): \text{Var}(\text{shock to transfers}) \\ \sigma_\tau(s_t): \text{Var}(\text{shock to taxes}) & \sigma_d^2(s_t): \text{Var}(\text{shock to deficits}) \end{array}$$

## Correlations of fiscal shocks

- Fiscal policy decisions are dependent on one another.
- Consider all possible correlations:

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## Long-run Debt Target Regimes

**Regime L:** *Low* long-run target for debt/GDP (low value for  $\bar{b}(s_t)$ )

**Regime H:** *High* long-run target for debt/GDP (high value for  $\bar{b}(s_t)$ )

## Fiscal Financing

- Targets for fiscal components:  $\bar{g}(s_t)$ ,  $\bar{\tau}(s_t)$ ,  $\bar{n}(s_t)$ ,  $\bar{d}(s_t)$
- Behavior toward output gap and debt:  $\psi_f(s_t)$  and  $\gamma_f(s_t)$ , for  $f \in \{g, \tau, n, d\}$

**Regime A:** Fiscal behavior A

**Regime B:** Fiscal behavior B

## Fiscal Volatility

Two regimes to determine variances,  $\sigma_g^2(s_t)$ ,  $\sigma_\tau^2(s_t)$ ,  $\sigma_n^2(s_t)$ , and  $\sigma_d^2(s_t)$ :

**Regime S:** *Stable*, relatively smaller variances

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## Markov regime switching

Regime switches randomly, each source **independently** of other sources

- $p_L = P(s_t = L | s_{t-1} = L)$  be prob policy remains in reg L
- $p_H = P(s_t = H | s_{t-1} = H)$  be prob policy remains in reg H
- $p_A = P(s_t = A | s_{t-1} = A)$  be prob policy remains in reg A
- $p_B = P(s_t = B | s_{t-1} = B)$  be prob policy remains in reg B
- $p_S = P(s_t = S | s_{t-1} = S)$  be prob policy remains in reg S
- $p_V = P(s_t = V | s_{t-1} = V)$  be prob policy remains in reg V

## Rich Set of Regime-Switching Possibilities

- Changes in priorities for taxes, transfers, spending, *without adjusting long-run targets for debt/GDP*
- Changes in debt-targets, *without adjusting purposes and priorities for fiscal components*
- Changes in volatility of fiscal outcomes, *without changing goals or purposes*



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## Loose ends

- Relationship between  $\bar{d}(s_t)$  and  $\bar{b}(s_t)$  depends on...
  - long-run values for nominal GDP growth ( $\bar{y}$ )
  - long-run average interest rate ( $\bar{r}$ )
- Identify effects of output gap on fiscal policy behavior *from effects of fiscal policy actions on output gap.*

## Next steps

- Specify monetary policy
- Specify inter-dependent behavior of macro variables: GDP growth, output gap, and inflation

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## Taylor-like (1993) rule

$$r_t = (1 - \rho_r)\bar{r} + \rho_r r_{t-1} + (1 - \rho_r) [\phi_x x_t + \phi_\pi (\pi_t - \bar{\pi})] + u_{r,t},$$

$\bar{r}$ : long-run nominal interest rate

$\pi_t$ : inflation rate

$\rho_r$ : Monetary policy persistence

$\bar{\pi}$ : target inflation rate

$\phi_x > 0$ : Response to output gap

$x_t$ : output gap

$\phi_\pi > 0$ : Response to inflation

$u_{r,t}$ : shock to monetary policy

## Policy shock

$$u_{r,t} = \alpha_r u_{r,t-1} + e_{r,t}, \quad e_{r,t} \sim \mathcal{N}(0, \sigma_r^2)$$

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## Dependent variables

Augmented vector autoregression for...

- 1 nominal GDP growth,  $y_t$ ,
- 2 output gap,  $x_t$ ,
- 3 inflation,  $\pi_t$

## Explanatory variables

- One lag of all dependent variables:  $y_{t-1}, x_{t-1}, \pi_{t-1}$
- Fiscal policy variables:  $g_t, \tau_t, n_t$
- Monetary policy:  $r_t$

## Estimation Outcomes

- Long-run values for  $\bar{y}$  and  $\bar{r}$
- Predictive model for impact of fiscal policy on macro outcomes,  $y_t, x_t, \pi_t, r_t$

## Dependent variables

Augmented vector autoregression for...

- 1 nominal GDP growth,  $y_t$ ,
- 2 output gap,  $x_t$ ,
- 3 inflation,  $\pi_t$

## Explanatory variables

- One lag of all dependent variables:  $y_{t-1}, x_{t-1}, \pi_{t-1}$
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### Fiscal policy variables

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- 2 Tax revenue: NIPA Table 3.2, Line 3
- 3 Net transfers: Federal current transfer pmts - receipts
  - NIPA Table 3.2, (Line 25 - Line 18)
- 4 Primary budget deficit:
  - (-) net federal government saving - federal interest payments
  - NIPA Table 3.2, Line 36 - Line 32
- 5 Government debt: Federal debt held by the public (U.S. Dept of Treasury)

### Remaining variables

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- 7 Output gap: Difference between NGDP and potential GDP
- 8 Inflation: Growth GDP implicit price deflator (NIPA Table 1.1.9, Line 1)
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- Approximates probability in each regime over sample period, *given parameters, including switching probabilities.*

### Bayesian Estimation

- Metropolis-Hastings Markov-Chain Monte Carlo
- Impose  $(0, 1)$  priors for a number of parameters (persistence, fiscal components ratio to GDP, et al.)
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## Endogeneity problem: two-way causation

- *Ceteris paribus*, an increase in output gap leads to higher taxes (captured by parameter  $\psi_\tau(s_t)$  in fiscal policy equation)
- *Ceteris paribus*, an increase in taxes leads lower aggregate demand and therefore a lower output gap (captured by coef in augmented VAR for  $x_t$ )

## Sign restrictions

- Faust (1998), Canova and De Nicolò (2002), and Uhlig (2005)
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  - Response = time path of response to tax revenue
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## Impulse: Shock to output gap

- Responses = resulting time paths for output gap, tax revenue
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Restrict cumulative response over *2 quarters*, including shock period.

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## Fiscal policy sign restrictions

Response	Impulse Variable				
	Gov Exp	Taxes	Transfers	Deficit	Output gap
Output gap	positive	negative	positive	positive	positive
Output growth	positive	negative	positive	positive	positive
Gov exp	positive	(none)	(none)	(none)	negative
Taxes	(none)	positive	(none)	(none)	positive
Transfers	(none)	(none)	positive	(none)	negative
Deficits	(none)	(none)	(none)	positive	negative

## Monetary policy sign restrictions

Response	Impulse Variable		
	Interest rate	Output gap	Inflation
Output gap	negative	positive	(none)
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Inflation	negative	positive	(none)
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Param.	Description	Fiscal Regime A		Fiscal Regime B	
		Median	90% Bounds	Median	90% Bounds
$\bar{g}$	Long-run gov target	0.19	(0.18, 0.20)	0.31	(0.29, 0.32)
$\psi_g$	Resp to output gap	-0.32	(-0.38, -0.28)	-0.43	(-0.45, -0.39)
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$\bar{\tau}$	Long-run tax target	0.14	(0.13, 0.14)	0.28	(0.25, 0.29)
$\psi_{\tau}$	Resp to output gap	0.69	(0.68, 0.72)	0.47	(0.44, 0.55)
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## Description

- Fiscal Regime A has lower long-run tax target
- Fiscal regime A has taxes more responsive to output gap
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$\bar{n}$	Long-run transfers	0.11	(0.10, 0.13)	0.18	(0.17, 0.20)
$\psi_n$	Resp to output gap	-0.46	(-0.49, -0.41)	-0.50	(-0.54, -0.43)
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## Description

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- Regimes are not different on responsiveness to output gap
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## Description

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## Posterior Parameter Distributions Under Low &amp; High Debt Regimes

Param. Description	Low Debt Regime		High Debt Regime	
	Median	90% Bounds	Median	90% Bounds
$b$ Debt/GDP target	0.37	(0.34, 0.39)	0.60	(0.55, 0.64)

## Debt Regimes

Low debt regime  $\approx$  37% of GDP

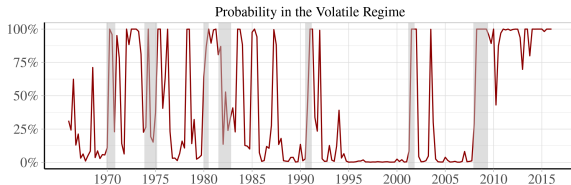
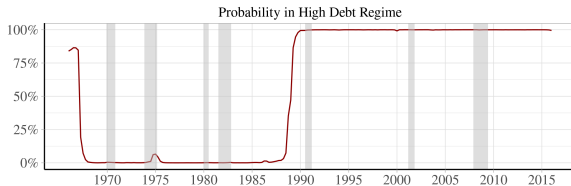
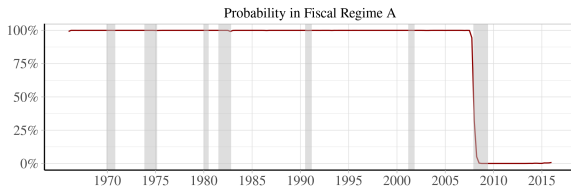
High debt regime  $\approx$  60% of GDP

## Posterior Parameter Distributions Under Stable and Volatile Regimes

Param.	Description	Stable Regime		Volatile Regime	
		Median	90% Bounds	Median	90% Bounds
$\sigma_g$	Gov stdev	0.10	(0.09, 0.11)	0.19	(0.17, 0.22)
$\sigma_\tau$	Tax stdev	0.10	(0.10, 0.11)	0.29	(0.28, 0.30)
$\sigma_n$	Transfers stdev	0.06	(0.06, 0.08)	0.22	(0.19, 0.26)
$\sigma_d$	Deficit stdev	0.08	(0.08, 0.10)	0.20	(0.19, 0.22)

All standard deviations are larger in volatile regime,  
**most more than double.**





## Questions: Compare Differences in Regimes

- Do fiscal policy shocks have different effects on macroeconomic variables in different regimes?
- Do fiscal variables have different interdependent effects in different regimes?
- Do effects of fiscal policy shocks depend on long-run debt target?
- Can we visualize difference of shocks in stable vs. volatile fiscal regimes.

## Left for Future Work

- Long-run effects of moving to a high-debt regime
- Long-run effects of a change in behavior regime in macroeconomic variables.
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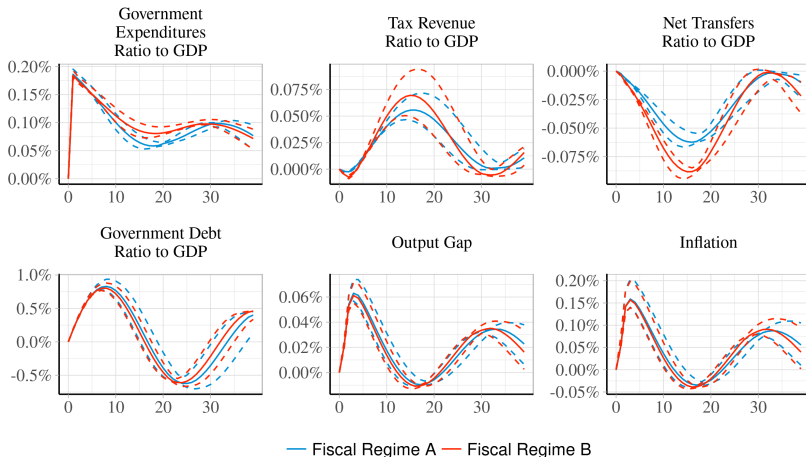
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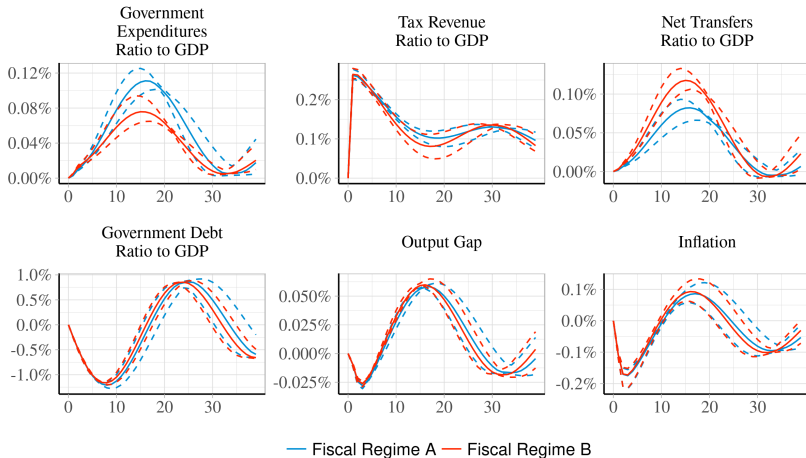


## Government Expenditures Shock



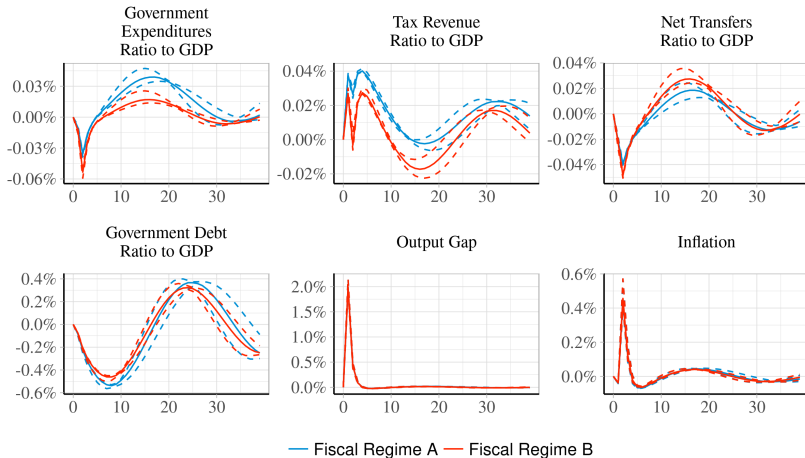
Smaller response to **Transfers** in Fiscal Regime A  
 No differences in macroeconomic dynamics

## Tax Policy Shock



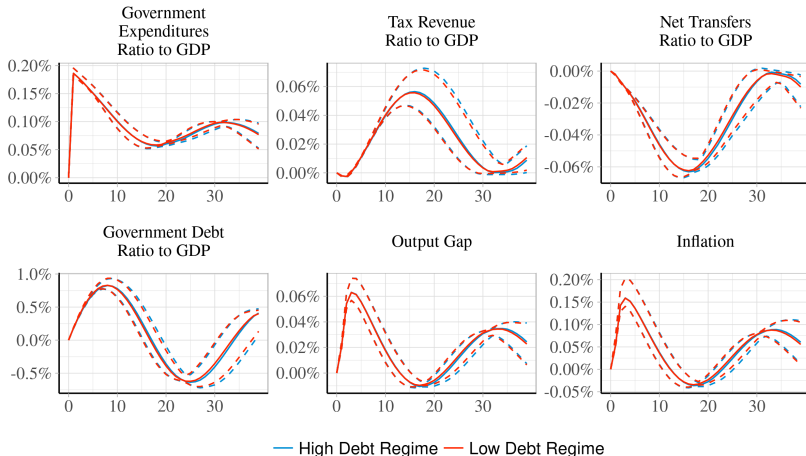
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 Larger response to **Government Expenditures** in Fiscal Regime A  
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## Output Gap Shock



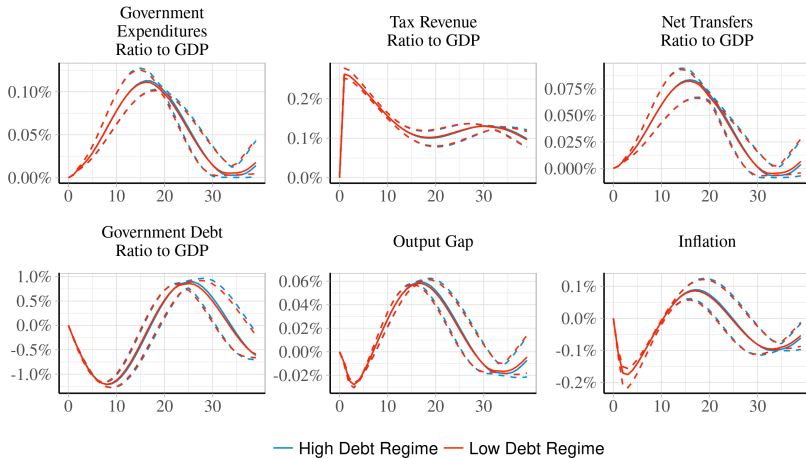
Larger responses to **Gov Exp** and **Taxes** in Fiscal Regime A  
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## Government Expenditures Shock



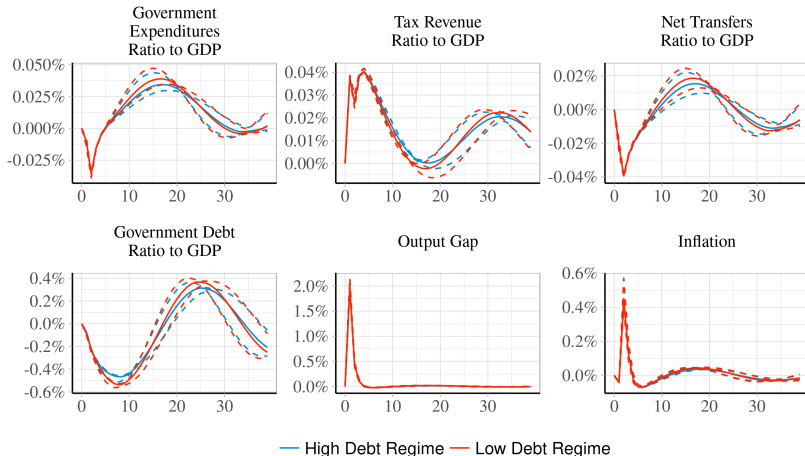
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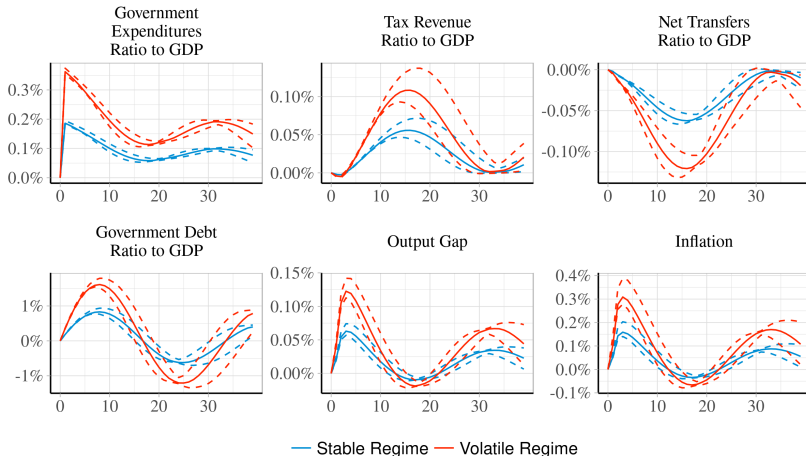
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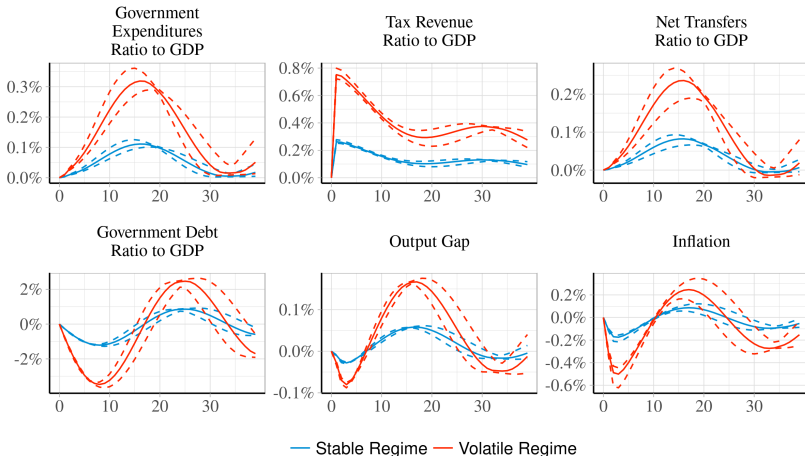


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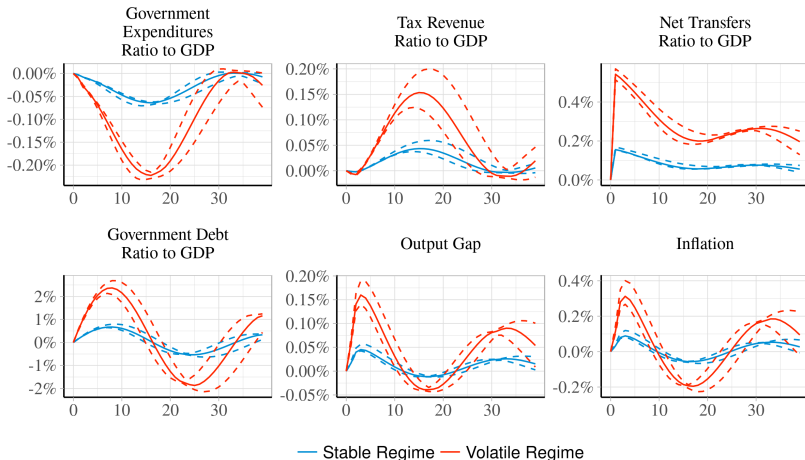
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## Tax Policy Shock



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## Net Transfers Shock



Much larger sized shocks and responses in volatile regime

- Evidence of switching in all three dimensions.
- Switch from low-debt to high-debt regime in 1989.
- Single, permanent, switch in fiscal policy behavior in 2008.
  - Government expenditures playing larger role in macroeconomic stabilization, smaller role in balancing budget.
  - Taxes play smaller role in macroeconomic stabilization, larger role in balancing budget.
- Many switches from stable to volatile fiscal regimes, usually around and following recessions.
- Differences in impulse response functions explained mostly by changing fiscal volatility.

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