Lecture 4: Nonlinear SVARs

State dependent SVARs

- Are the effects of the shocks of interests dependent on some relevant "state" variable?
- Interesting questions:
  - Are the effects of policy shocks dependent on the state of the economy, recessions vs booms?
  - Are the effects of fiscal shocks dependent on the level of Debt?
- SVAR models seen so far are unable to provide answer.
- Need to extend the models to introduce state-dependence.
- Focus on Smooth Transition VAR models (Granger and Teravirta, 1993).
- Application to fiscal multipliers, Auerbach and Gorodnichenko (2012).

Smooth Transition SVAR

- The model is

$$(1 - F(z_t))D_1(L)Y_t + F(z_t)D_2(L)Y_t = \varepsilon_t$$

  where
  - Y_t is a vector of time series
  - ε_t is a WN with constant covariance matrix (simplifying assumption can be generalized).
  - $D_1(L) = I - D_1^1 L - ... - D_p^1 L^p$
  - $D_2(L) = I - D_1^2 L - ... - D_p^2 L^p$
  - $F(z_t) = \frac{exp(-\gamma z_t)}{1+exp(-\gamma z_t)}$ is a logistic function in [0 1].
  - z_t is a state variable.

Smooth Transition SVAR

- Two regimes.
  - when $F(z_t) = 1$ the model is

$$D_2(L)Y_t = \varepsilon_t$$

    and the structural MA is

$$Y_t = D_2(L)^{-1} A_0^{-1} u_t$$

  - when $F(z_t) = 0$ the model is

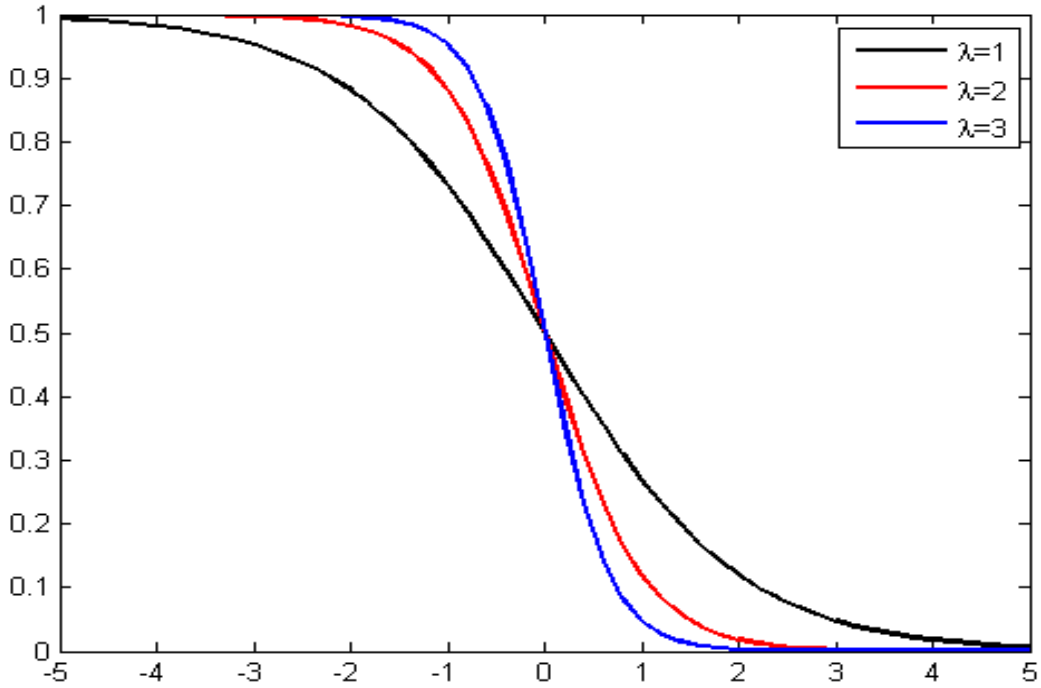
$$D_1(L)Y_t = \varepsilon_t$$

    and the structural MA is

$$Y_t = D_1(L)^{-1} A_0^{-1} u_t$$

- Transition is smooth and governed by the parameter γ.

$F(z_t)$



Estimation

- when γ is known and z_t exogenous then simply construct $F(z_t)$ and estimate using OLS.
- when γ is known and z_t endogenous replace z_t with z_{t-1} and use OLS.
- when γ is not known use a grid for γ and minimize the residuals.
- MCMC methods can be used in the general setting where γ unknown, z_t is endogenous and the variance of ε_t is state dependent.

Endogeneity of z_t

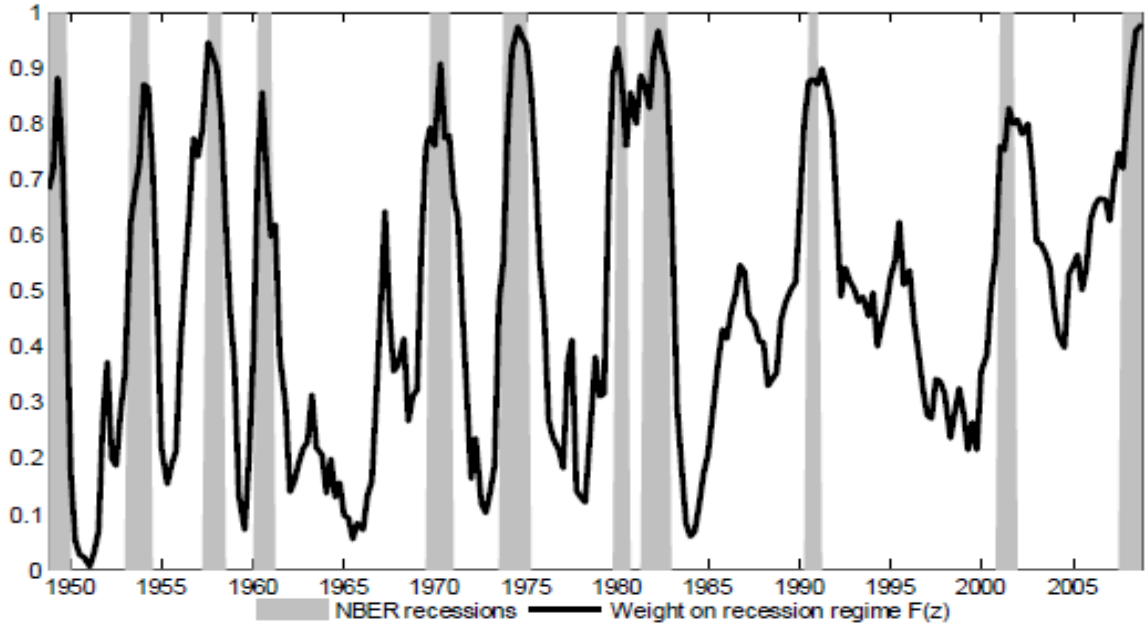
- IRF are computed under the assumption that the regime stays in place
- In principle one could take into account endogenous regime changes using Generalized IRF

Auerbach and Gorodnichenko AEJ:policy 2012.

- the paper studies the effects of government spending shocks in recessions and booms.
- Use the STVAR for US data.
- z_t is a 7-quarter MA of output growth.
- Blanchard-Perotti identification.
- Y_t government spending, taxes and output.
- variance of the shocks is regime dependent (use MCMC methods).
- $\gamma = 1.5$ calibrated.

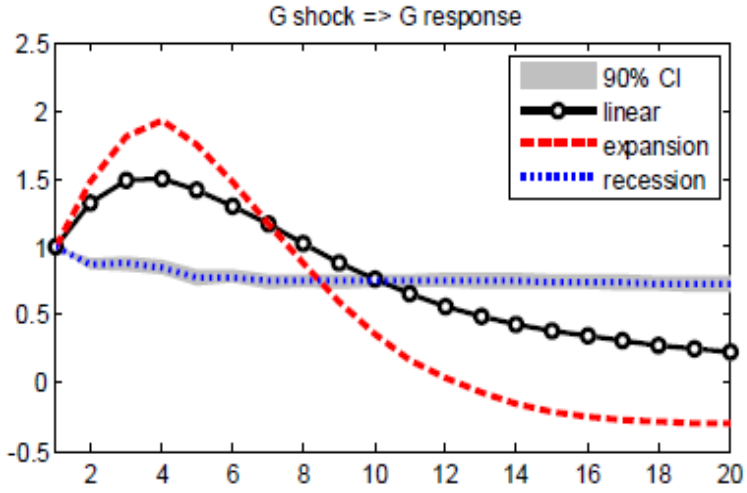
Auerbach and Gorodnichenko AEJ:policy 2012.

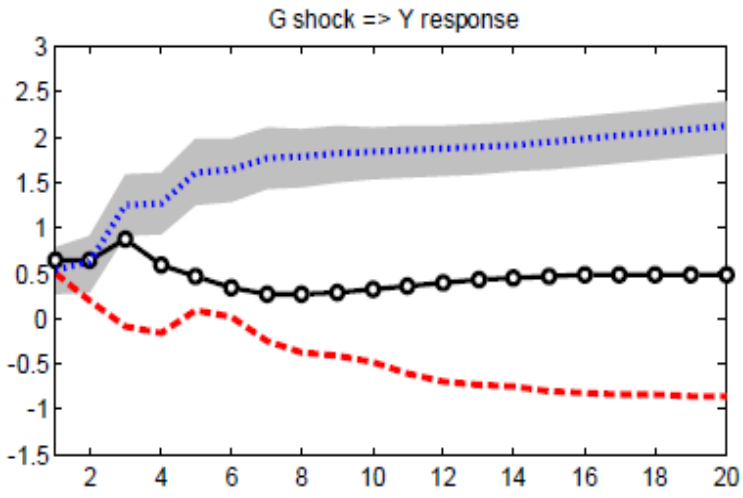
Figure 1. NBER dates and weight on recession regime $F(z)$



Notes: The shaded region shows recessions as defined by the NBER. The solid black line shows the weight on recession regime $F(z)$.

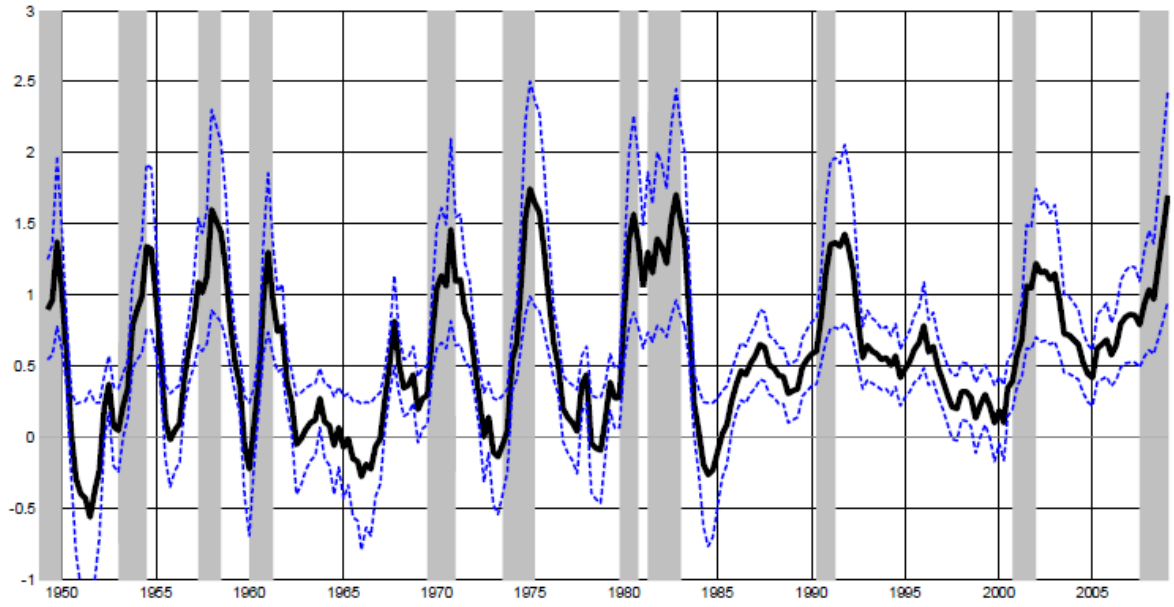
Auerbach and Gorodnichenko AEJ:policy 2012.





Auerbach and Gorodnichenko AEJ:policy 2012.

Figure 3. Historical multiplier for total government spending



Notes: shaded regions are recessions defined by the NBER. The solid black line is the cumulative multiplier computed as $\sum_{h=1}^{20} Y_h / \sum_{h=1}^{20} G_h$, where time index h is in quarters. Blue dashed lines are 90% confidence interval. The multiplier incorporates the feedback from G shock to the business cycle indicator z. In each instance, the shock is one percent increase in government spending.

Owyang, Ramey and Zubairy AER 2013.

- Longer span: 1890-2010.
- Threshold VAR (TVAR), special case
- Direct projection method
- $F(z_t)$ is either 0 or 1.
- Measure of slack is the unemployment rate: 6.5% is the threshold
- Identification using the news variable.

Owyang, Ramey and Zubairy AER 2013.

- Model

$$w_{t+h} = I_t \left[\alpha_{Ah} + \psi_{Ah}(L) y_{t-1} + \Omega_{Ah}(L) g_{t-1} + \beta_{Ah} \frac{news_t}{Y_{t-1}} \right] +$$
$$+(1 - I_t) \left[\alpha_{Bh} + \psi_{Bh}(L) y_{t-1} + \Omega_{Bh}(L) g_{t-1} + \beta_{Bh} \frac{news_t}{Y_{t-1}} \right]$$

where

  - Y_t is GDP.
  - $_t$ and g_t are the logs of GDP and government spending.
  - $news_t$ is an extension of the Ramey (2011)'s military news variable
  - $I_t = 1$ if unemployment > 6.5
  - w_t is $\frac{Y_{t+4} - Y_t}{Y_t}$ and $\frac{G_{t+4} - G_t}{Y_t}$.
  - The multiplier is derived from the estimates of the two equations (ration of the IRF).

Owyang, Ramey and Zubairy AER 2013.

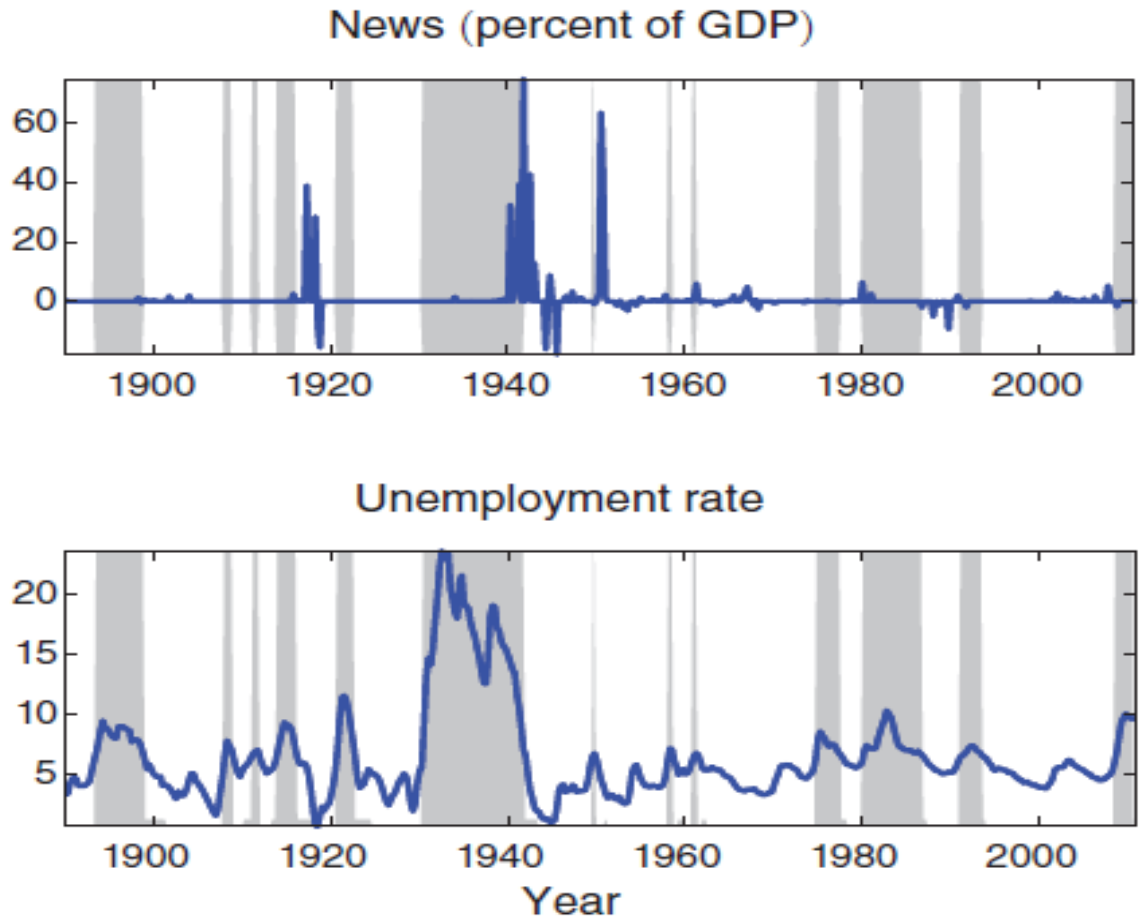


FIGURE 1. US UNEMPLOYMENT AND MILITARY SPENDING NEWS

Owyang, Ramey and Zubairy AER 2013.

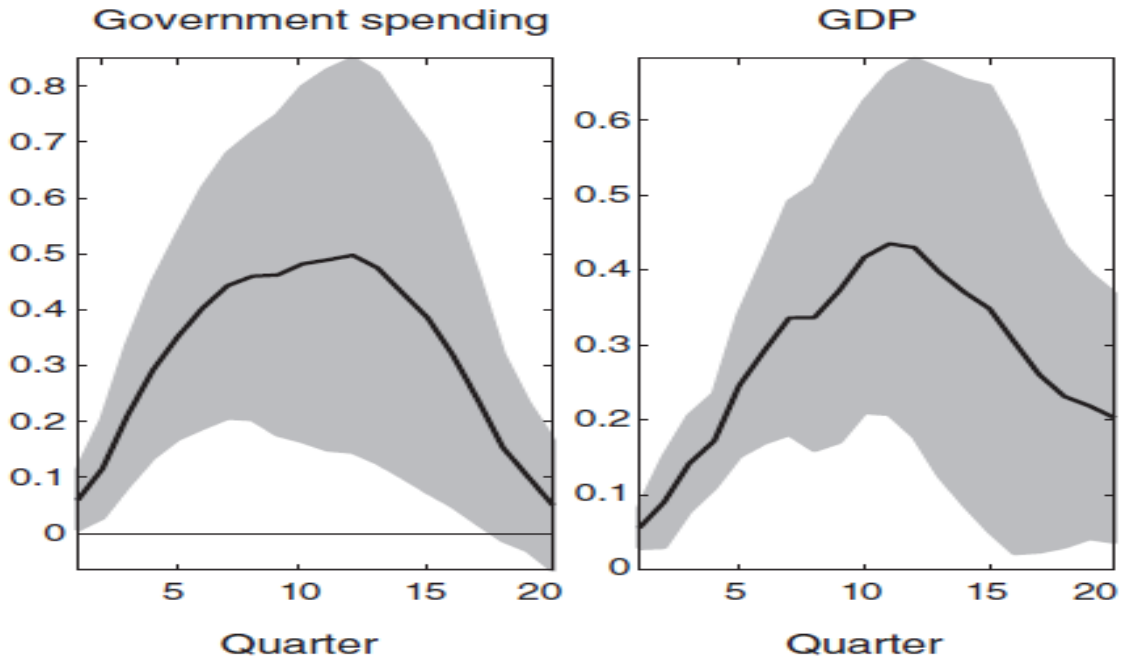


FIGURE 3. US RESPONSE OF GOVERNMENT SPENDING AND GDP TO A NEWS SHOCK EQUAL TO 1 PERCENT OF GDP, LINEAR MODEL

Owyang, Ramey and Zubairy AER 2013.

TABLE 1—ESTIMATED MULTIPLIERS

	Linear model	High unemployment	Low unemployment
	(1)	(2)	(3)
United States			
2 year integral	0.72	0.76	0.72
4 year integral	0.81	0.78	0.88
Peak	0.88	0.83	0.93
Canada			
2 year integral	0.67	1.60	0.44
4 year integral	0.79	1.16	0.46
Peak	0.57	0.65	0.49

Owyang, Ramey and Zubairy AER 2013.

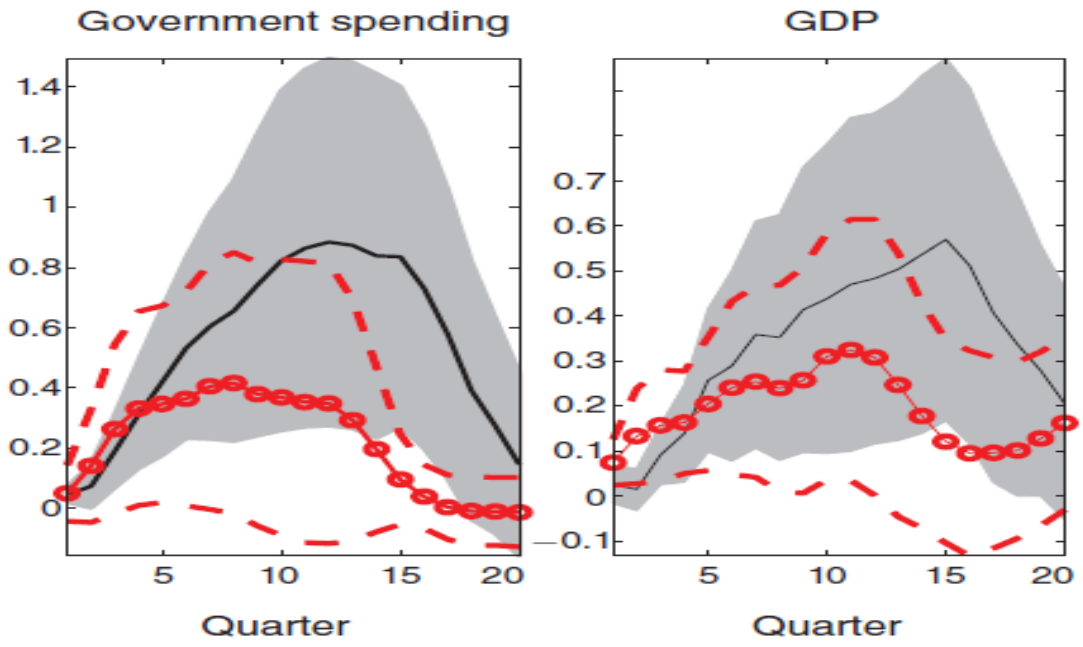


FIGURE 4. US RESPONSE OF GOVERNMENT SPENDING AND GDP TO A NEWS SHOCK EQUAL TO 1 PERCENT OF GDP, STATE-DEPENDENT MODEL

Caggiano, Castelnuovo, Colombo and Nodari EJ forthcoming.

- Same model as in AG.
- Different identification
- Use the measure proposed in Forni and Gambetti (2014). The forecast revision

$$E_t g_{t+h} - E_{t-1} g_{t+h}$$

- This solves the problem of fiscal anticipation.
- Results:
  - Fiscal multipliers larger than one in recessions
  - Fiscal multipliers larger in deeper recession like the 2007-09 one.

Caggiano, Castelnuovo, Colombo and Nodari EJ forthcoming.

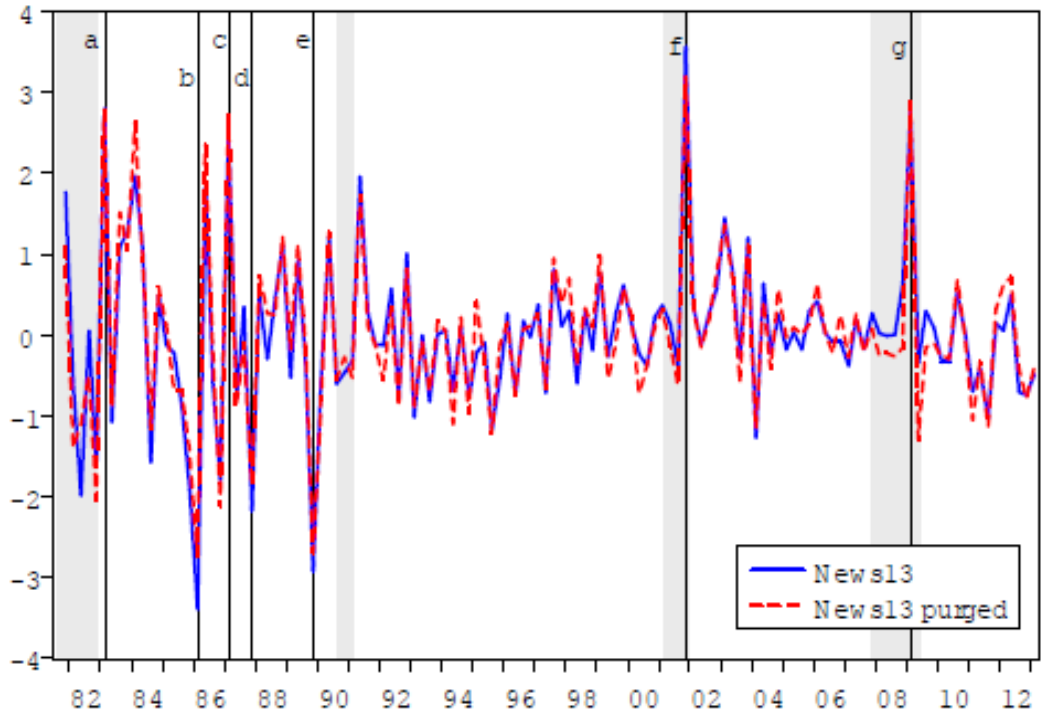


Figure 10: **News13 vs. News13 purged**. Blue, solid line: News variable constructed by considering the sum of Survey of Professional Forecasters' forecast revisions regarding future public spending from one to three period-ahead. Red, dashed line: News variable constructed by regressing News13 over a constant and the sums of the forecasts revisions of real GDP growth, unemployment, GDP deflator inflation, the three-month Treasury bill rate, and the 10-year Treasury bond rate. Extreme values, interpretation: (a) 1983Q1: Reagan's "Evil Empire" and "Star Wars" speeches; (b) 1986Q1: Perestrojka; (c) 1987Q1: Senate elections won by the Democrats a quarter before; (d) 1987Q4: Spending cuts as for the Pentagon; (e) 1989Q4: Berlin wall; (f) 2001Q4: War in Afghanistan; (g) 2009Q1: Obama's stimulus package. Both news measures in this Figure are standardized.

Caggiano, Castelnuovo, Colombo and Nodari EJ forthcoming.

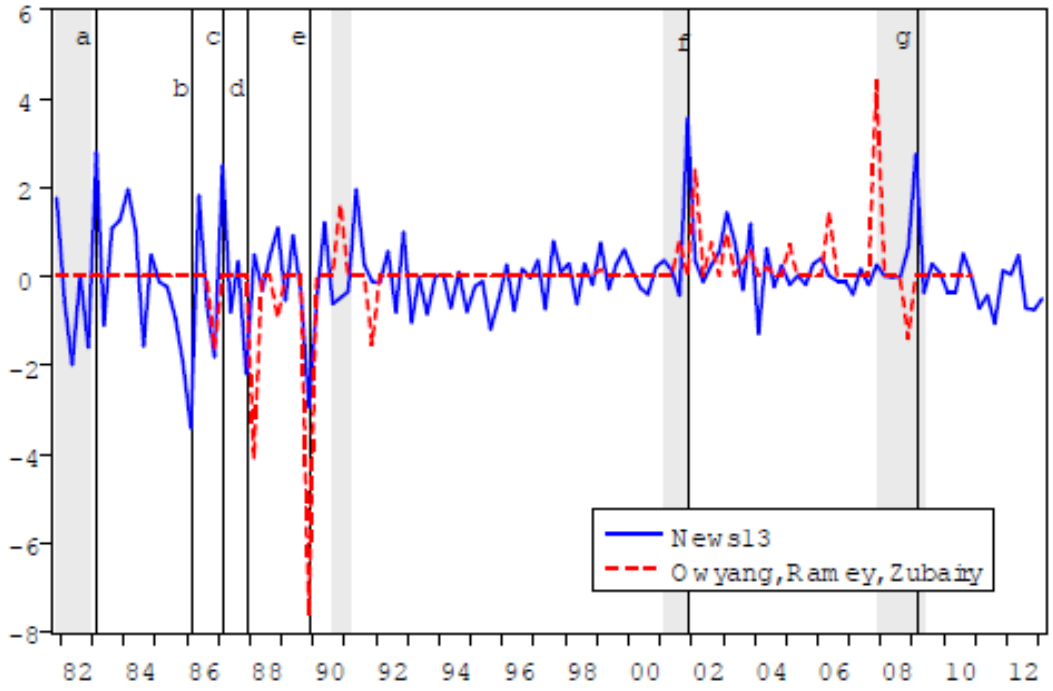


Figure 1: **News13 (this paper) vs. Owyang, Ramey, and Zubairy's (2013) news variable.** Blue, solid line: News variable constructed by considering the sum of Survey of Professional Forecasters' forecast revisions regarding future public spending from one-to-three quarter-ahead. Extreme values, interpretation: (a) 1983Q1: Reagan's "Evil Empire" and "Star Wars" speeches; (b) 1986Q1: Perestrojka; (c) 1987Q1: Senate elections won by the Democrats a quarter before; (d) 1987Q4: Spending cuts as for the Pentagon; (e) 1989Q4: Berlin wall; (f) 2001Q4: War in Afghanistan; (g) 2009Q1: Obama's stimulus package. Red, dashed line: News variable constructed by Owyang, Ramey, and Zubairy (2013), who extended Ramey's (2011) news variable up to 2010Q4. Ramey's (2011) variable is constructed by considering the present discounted value of expected changes in defense spending (nominal spending divided by nominal GDP one period before). Both news measures in this Figure are standardized.

Caggiano, Castelnuovo, Colombo and Nodari EJ forthcoming.

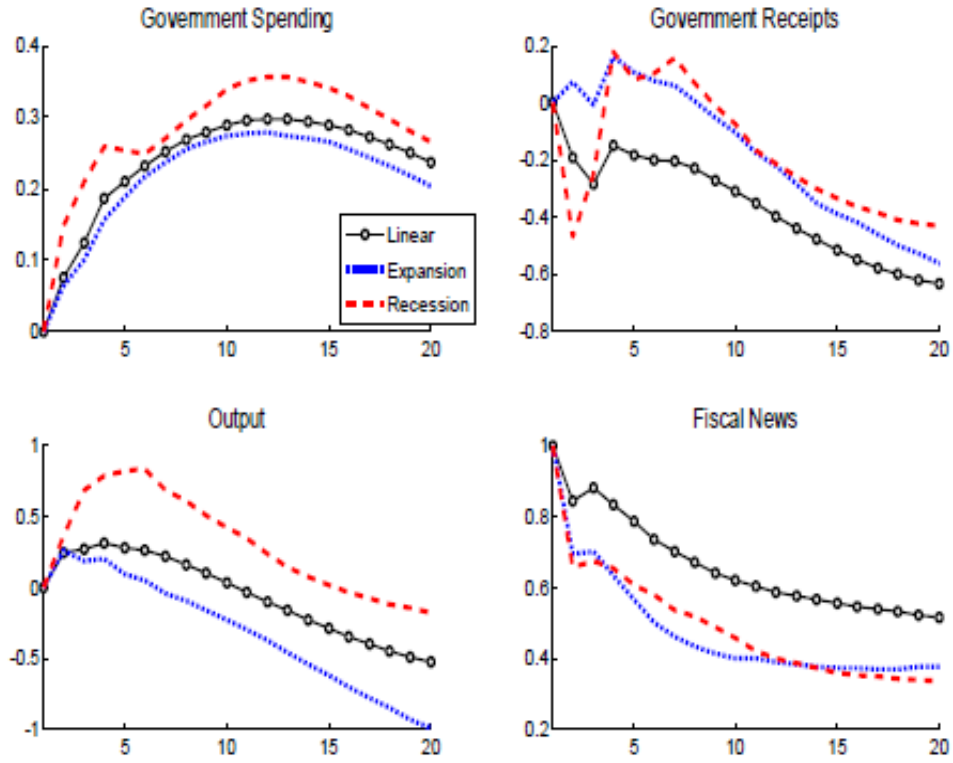


Figure 3: **Generalized impulse responses to a fiscal news (anticipated) spending shock: Linear model, recessions, expansions.** Median responses to a fiscal news shock normalized to one. News variable constructed as the sum of the revisions of the one, two, and three step-ahead expectation values over future fiscal spending growth. News variable expressed in cumulated terms to have the same order of integration as the one of the log-real variables in the vector. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.

Caggiano, Castelnuovo, Colombo and Nodari EJ forthcoming.

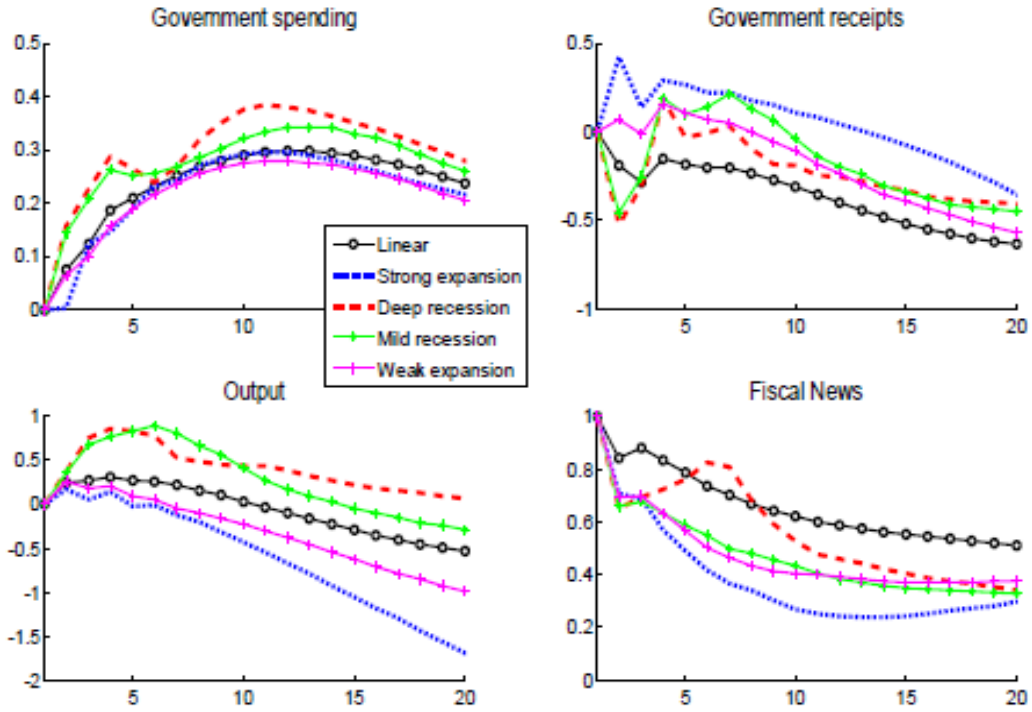


Figure 7: **Generalized impulse responses to a fiscal news (anticipated) spending shock: Linear model, deep vs. mild recessions, strong vs. weak expansions.** Deep recessions/strong expansions associated to histories consistent with realizations of our transition variable which are below/above two standard deviations. Mild recessions/weak expansions associated to histories consistent with realizations of our transition variable below/above -0.75 but within the range [-2,2]. Median responses to a fiscal news shock normalized to one. News variable constructed as the sum of the revisions of the one, two, and three step-ahead expectation values over future fiscal spending growth. News variable expressed in cumulated terms to have the same order of integration as the one of the log-real variables in the vector. VAR models estimated with a constant and three lags. Log-values of the impulse response of output rescaled by the sample mean of output over public spending (both taken in levels) to convert percent changes in dollars.