Government Spending Multipliers in Good Times and in Bad: Evidence from U.S. Historical Data

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  - Countercyclical spreads (Canzoneri et al (2013))

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- **Other aggregate analyses**
  - e.g. Bachmann and Sims (2012), Fazzari, Morley and Panovska (2012)
- **Cross-sectional analyses**
  - Most find higher multipliers during periods of slack, but not always statistically different

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- **Theoretical DSGE Literature**
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- **Crafts and Mills (2015)**
  - Constructed defense news series for Britain.
  - Estimate multiplier from 1922 through 1938.
  - Estimate multipliers below unity even when interest rates near the ZLB.

Goal of this paper

To investigate whether multipliers are higher when unemployment is higher or when the economy is near the zero lower bound.

Specific contributions of this paper

- Comprehensive investigation of whether government spending multipliers differ in times of slack and at the ZLB.
- Construction and analysis of new historical data for the U.S. encompassing periods with dramatic fluctuations in unemployment and government spending and interest rates near the zero lower bound.
- Innovations in the methodology for estimating and constructing multipliers.
- Result: Different conclusions about state dependence.

Roadmap

1. Motivation and Introduction
2. **Historical Data**
3. Econometric Framework and Issues
4. State Dependence on Slack
5. State Dependence on ZLB
6. Comparison of Methodologies and Results
7. Conclusion

Why Use Historical Data?

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- Concerns:
  - Has the U.S. economy changed too much?
  - Should wars be excluded?

Milton Friedman (1952)

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"The widespread tendency in empirical studies of economic behavior to discard war years as "abnormal," while doubtless often justified, is, on the whole, unfortunate. The major defect of the data on which economists must rely - data generated by experience rather than deliberately contrived experiment - is the small range of variation they encompass. Experience in general proceeds smoothly and continuously. In consequence, it is difficult to disentangle systematic effects from random variation since both are of much the same order of magnitude. From this point of view, data for wartime periods are peculiarly valuable. At such times, violent changes in major economic magnitudes occur over relatively brief periods, thereby providing precisely the kind of evidence that we would like (to) get by "critical" experiments if we could conduct them. Of course, the source of the changes means that the effects in which we are interested are necessarily intertwined with others that we would eliminate from a contrived experiment. But this difficulty applies to all our data, not to data for wartime periods alone."

Data Construction

- Events happen quickly around wars and agents react quickly so we want to use quarterly data.
- Quarterly historical data for early 20th century not readily available.
- General strategy: use various higher frequency series to interpolate existing annual series.

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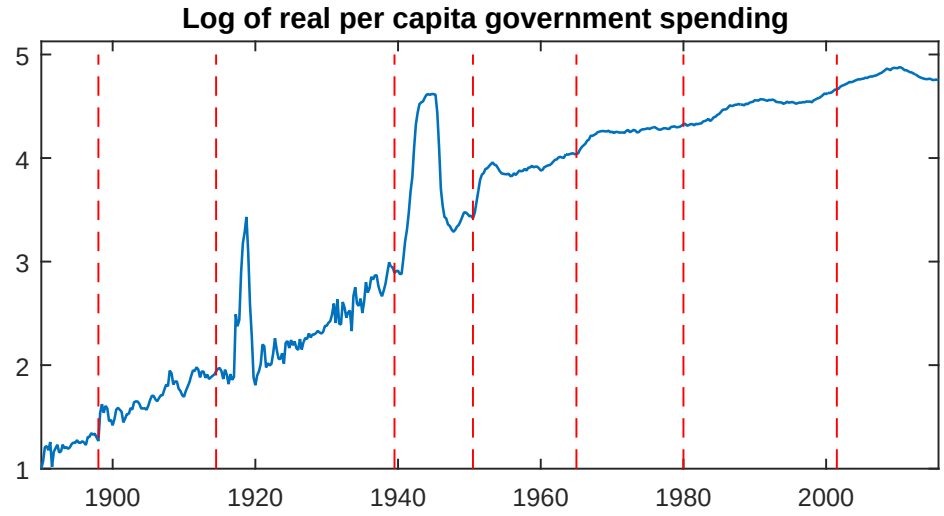
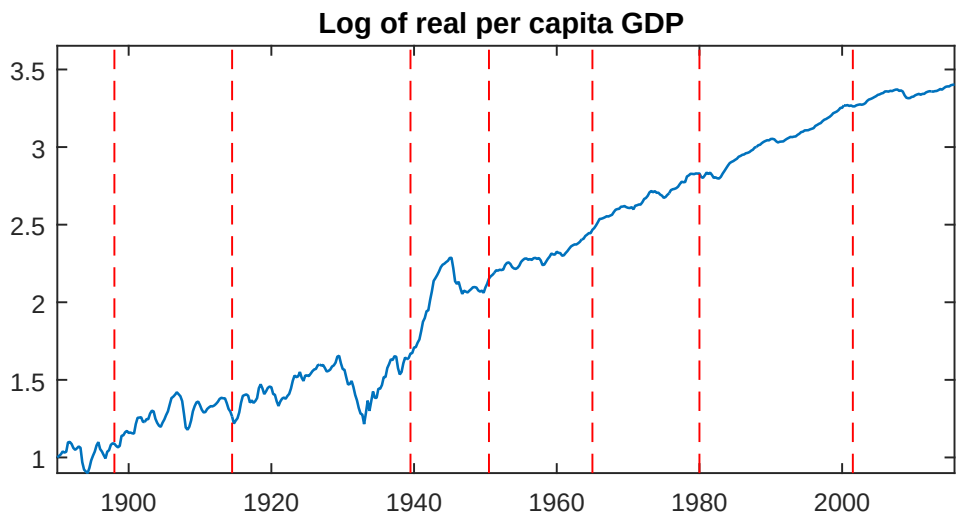
  - Use NBER recession dates for 1890 - 1929 to interpolate Weir annual series.

Identifying government spending shocks

- They should be exogenous and unanticipated.
- Our baseline is military news - narrative based measure of changes in the expected discounted value of government spending.
- We also use Blanchard-Perotti shocks for robustness and because of concerns about local average treatment effects.

Government Spending and GDP Data





Note: The vertical lines indicate major military events.

Roadmap

1. Motivation and Introduction
2. Data
3. **Econometric Framework and Issues**
4. State Dependence on Slack
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Econometric Framework

- We use Jorda (2005) local projection method to estimate the impulse response of variable z at horizon $t + h$.
- This involves running h sets of regressions.
- Allows us to easily accommodate state dependence.
- We allow all coefficients to vary according to whether unemployment is high or low.

Linear model

$$z_{t+h} = \alpha_h + \psi_h(L) y_{t-1} + \beta_h shock_t + \varepsilon_{t+h}, \text{for h} = 0, 1, 2, \ldots$$

where

- y_{t-1} is a vector of control variables
- $\psi_h(L)$ is a polynomial in the lag operator
- Coefficient β_h gives the response of z_{t+h} to the shock at horizon h.

State dependent model

$$z_{t+h} = I_{t-1}\left[\alpha_{A,h} + \psi_{A,h}(L)y_{t-1} + \beta_{A,h}shock_t\right]$$
$$+(1 - I_{t-1})\left[\alpha_{B,h} + \psi_{B,h}(L)y_{t-1} + \beta_{B,h}shock_t\right] + \varepsilon_{t+h}.$$

where

- The dummy variable, $I_t = 1$ if a bad state (high unemployment or ZLB).
- Coefficient $\beta_{A,h}$ gives the **bad state** response of z_{t+h} to the shock at horizon h.
- Coefficient $\beta_{B,h}$ gives the **good state** response of z_{t+h} to the shock at horizon h.

Advantages of the Jorda method

- Does not impose restrictions on the dynamic pattern of responses like VARs do.
- The same variables do not have to be used in each equation.
- Estimates embed the average transitions of the economy from state to state and the tendency of the shock to cause it to leave the state.

Disadvantages of the Jorda method

- Responses are often less precise and more erratic.
- Standard errors need to be corrected for serial correlation.
  - Account for this serial correlation induced in regressions when horizon $h > 0$ by using Newey-West standard errors.
- Long-run responses tend to oscillate.
- Cannot conduct experiments that are counter-factual to the data.

Pitfalls in Calculating Multipliers

- Logs vs. Levels
- Computing Multipliers in a Dynamic Environment

Logs vs. Levels

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- Standard SVARs would use ln(G) and ln(Y) and then multiply by sample average Y/G to get multiplier:

$$\frac{\Delta Y}{\Delta G} = \frac{\Delta \ln(Y)}{\Delta \ln(G)} \cdot \frac{\overline{Y}}{G}$$

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- To avoid this problem, we use the Gordon-Krenn transformation. This transformation divides real GDP and government spending by an estimate of potential or trend GDP, so that they are measured in the same units.

Computing Multipliers in a Dynamic Environment

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- Blanchard-Perotti computed the multiplier as ratio of the *peak* of GDP to *impact* effect on government spending.
- Uhlig and others argue that the proper multiplier is the integral (or PDV) of the output response divided by the integral (or PDV) of the government spending response.
- Policy makers care about the path of output relative to the path of government spending.
- We introduce a new way to estimate these cumulative multipliers:

One-Step IV Estimation of Cumulative Multipliers

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Estimate the following IV regression for each horizon h:

$$\sum_{j=0}^{h} y_{t+j} = \gamma_h + \phi_h(L) z_{t-1} + m_h \sum_{j=0}^{h} g_{t+j} + \omega_{t+h}, \text{ for h} = 0, 1, 2, \ldots$$

using $shock_t$ as an instrument for $\sum_{j=0}^{h} g_{t+j}$.

m_h is the estimate of the cumulative multiplier from t to $t+h$.

Identical to estimated from 3-step method of estimating the Y and G IRFs separately, summing coefficients, forming ratios.

Baseline control variables

- 4 lags of real GDP (divided by trend).
- 4 lags of log real government purchases (divided by trend).
- 4 lags of news.

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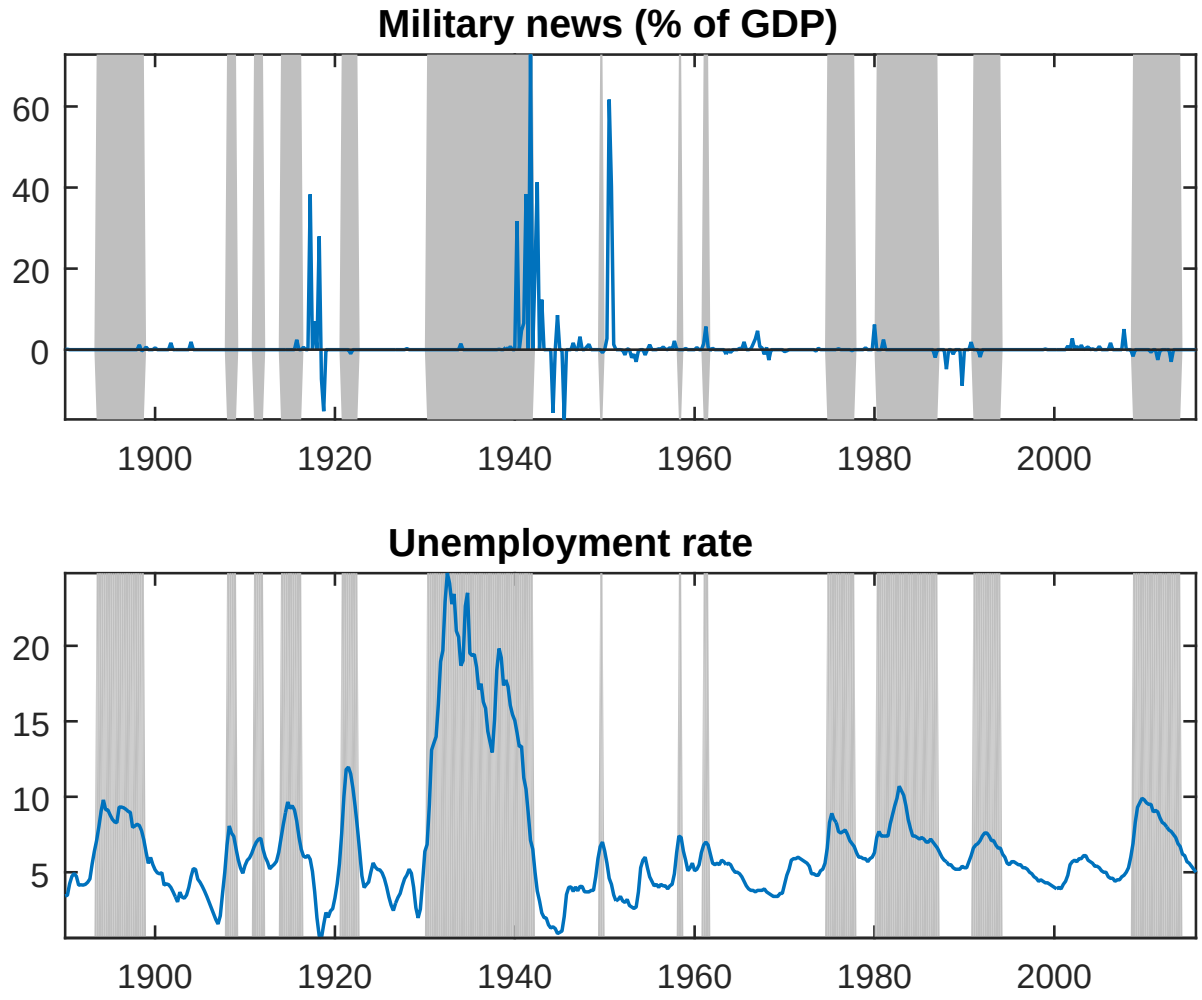
State Dependence on Slack

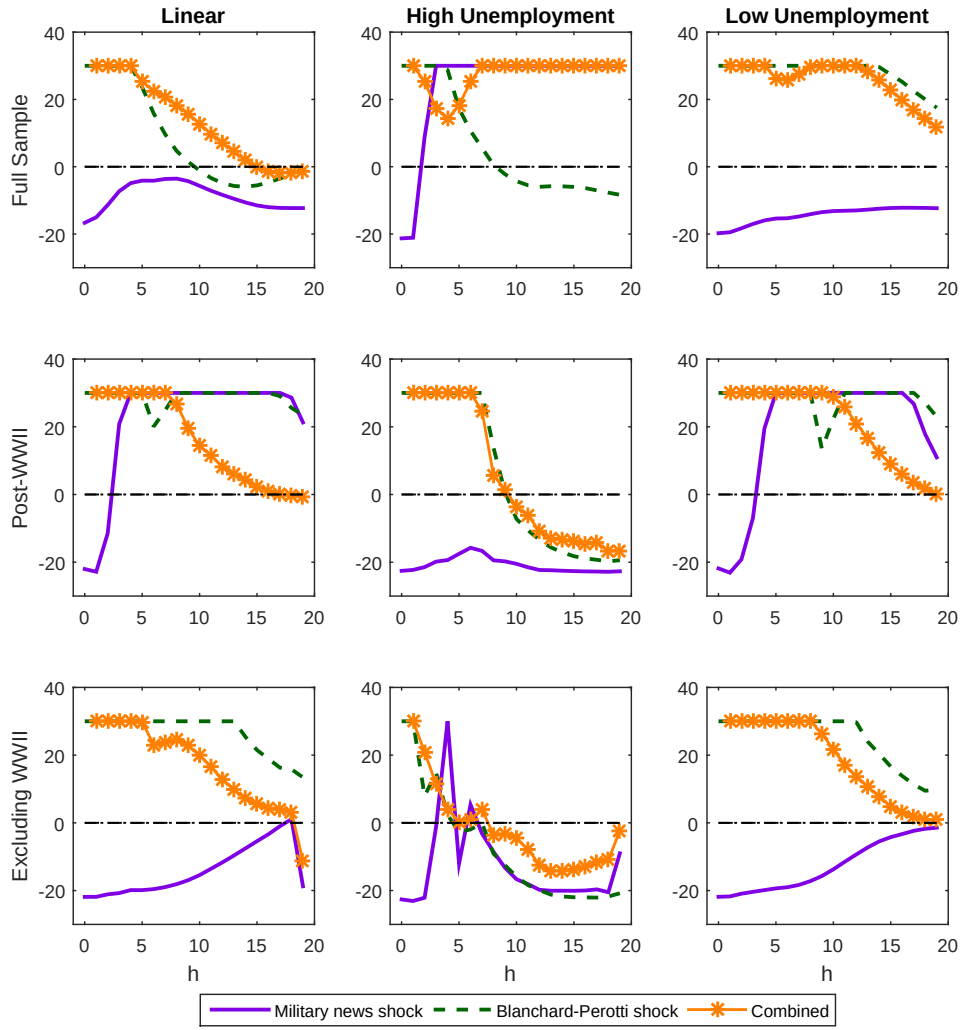
- **Definition of Slack**
- Baseline Results
- Robustness

US Data: 1890-2015



Shaded areas indicate time periods when the unemployment rate is above 6.5 %

Instrument Relevance for Slack States



The lines show the difference between the F-statistic and the 5% threshold for each horizon in the baseline model. Statistics are capped at 30.

State Dependence on Slack

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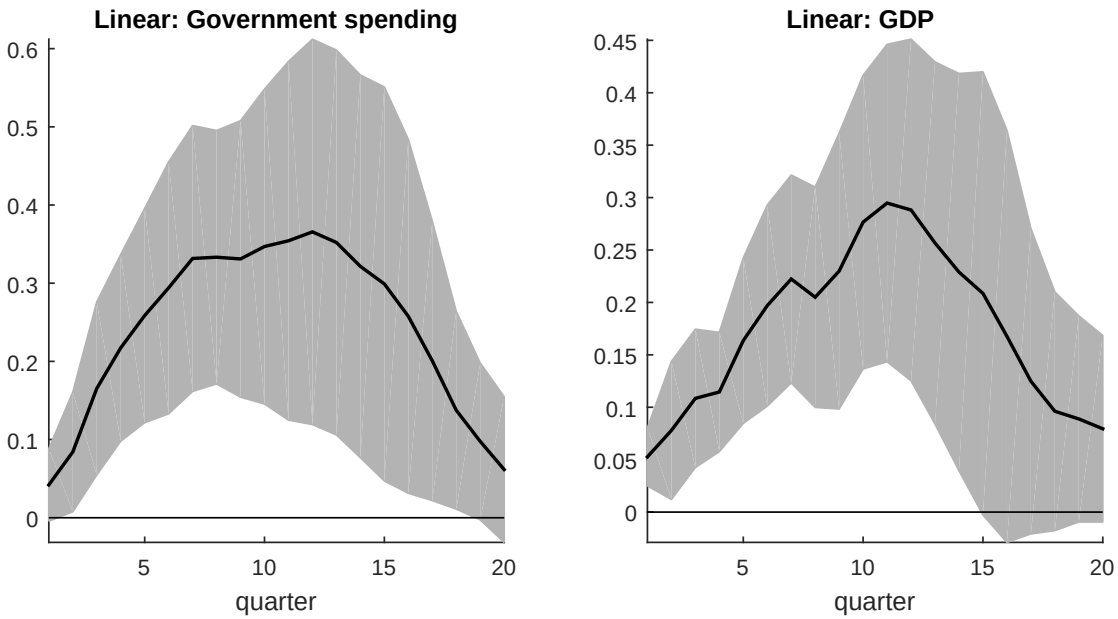
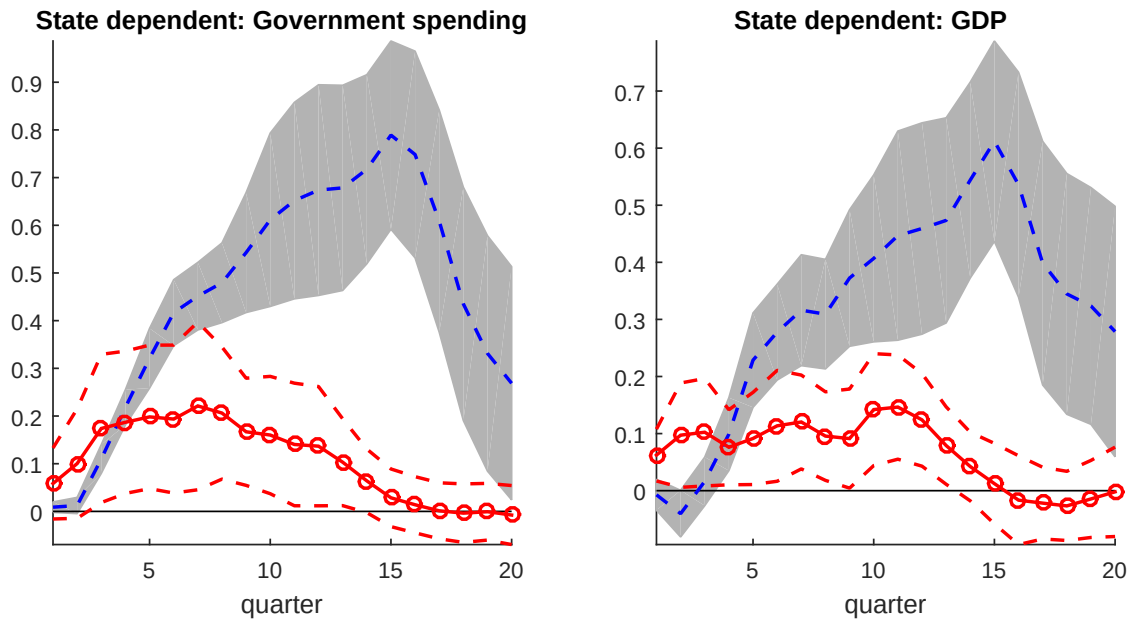
Linear Model



Grey areas are 95% confidence intervals.

State Dependent Model - Slack



Blue lines are high unemployment state, red lines are low unemployment state.

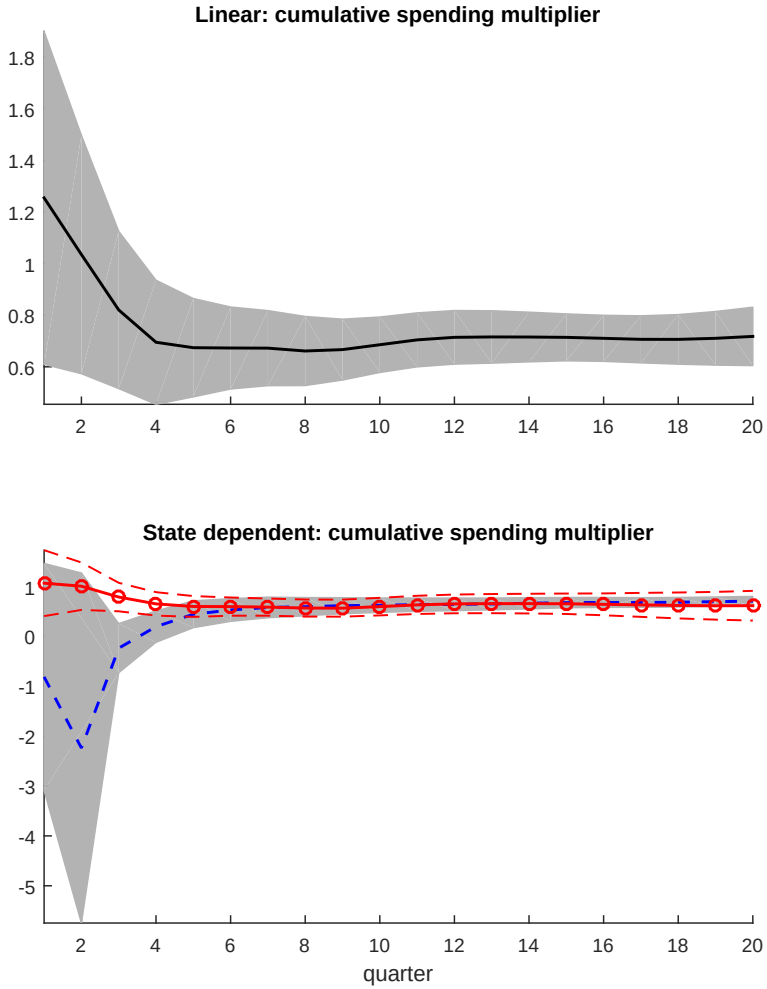
Multipliers: Military News Instrument

Multipliers account for dynamics of G, and defined as:

$$m_h = \frac{\sum_{j=0}^{h} y_{t+j}}{\sum_{j=0}^{h} g_{t+j}}$$

	Linear Model	High Unemp	Low Unemp	P-value for difference across states
2 year integral	0.66	0.59	0.57	
	(0.068)	(0.093)	(0.087)	0.845
4 year integral	0.71	0.68	0.64	
	(0.045)	(0.051)	(0.111)	0.775

Cumulative Multipliers by Horizon: Military News



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Multipliers: Blanchard-Perotti Instrument

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	Linear Model	High Unemp	Low Unemp	P-value for difference across states
2 year integral	0.38	0.65	0.31	
	(0.111)	(0.104)	(0.111)	0.013
4 year integral	0.47	0.75	0.35	
	(0.111)	(0.074)	(0.108)	0.042

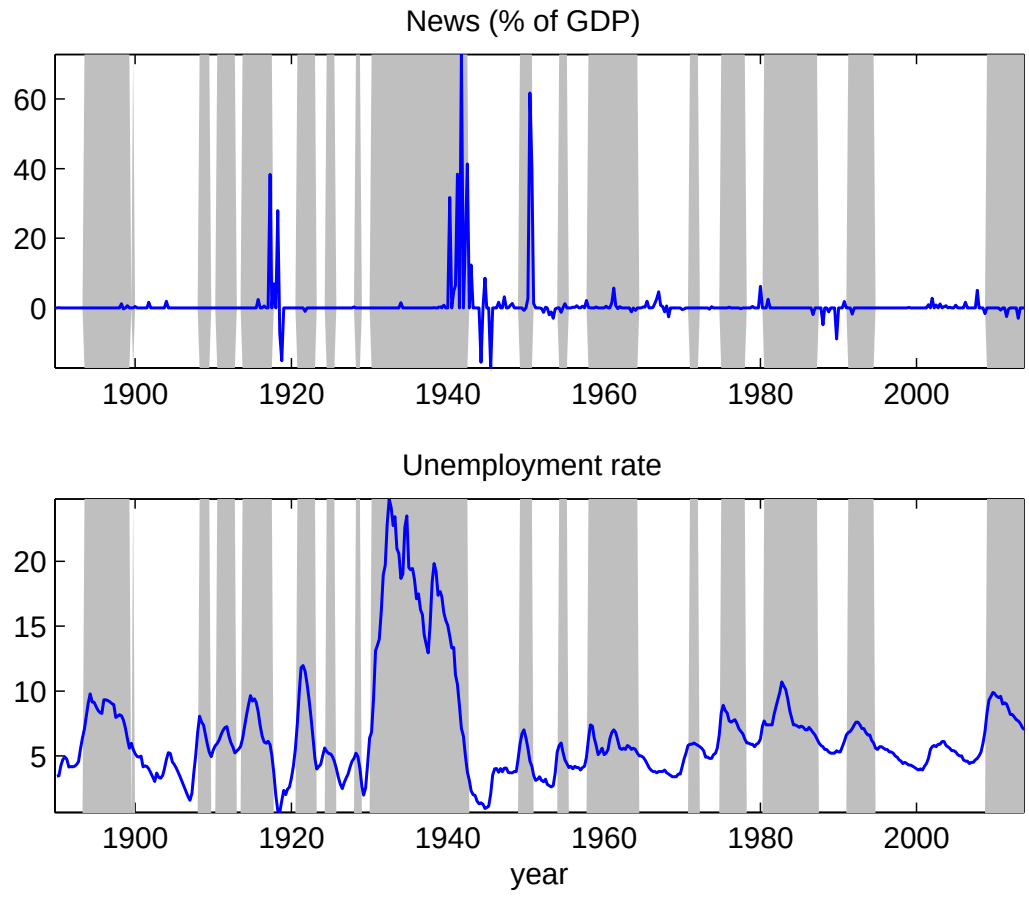
Summary of Baseline Results

- Both GDP and government spending have more robust responses during high unemployment states.
- The multipliers are less than 1 in both states.
- Little evidence of larger multipliers during periods of slack in the economy.

State Dependence on Slack

- Definition of Slack
- Baseline Results
- **Robustness**

Using time-varying unemployment rate threshold



Time varying threshold of HP filtered unemployment with $\lambda = 1,000,000$

	Linear	High Unemp	Low Unemp
2 year integral	0.66	0.53	0.63
4 year integral	0.71	0.57	0.71

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- Using linearly interpolated data - slightly lower multipliers than baseline.
- Excluding WWII
- Post WWII Data - multipliers negative in bad state

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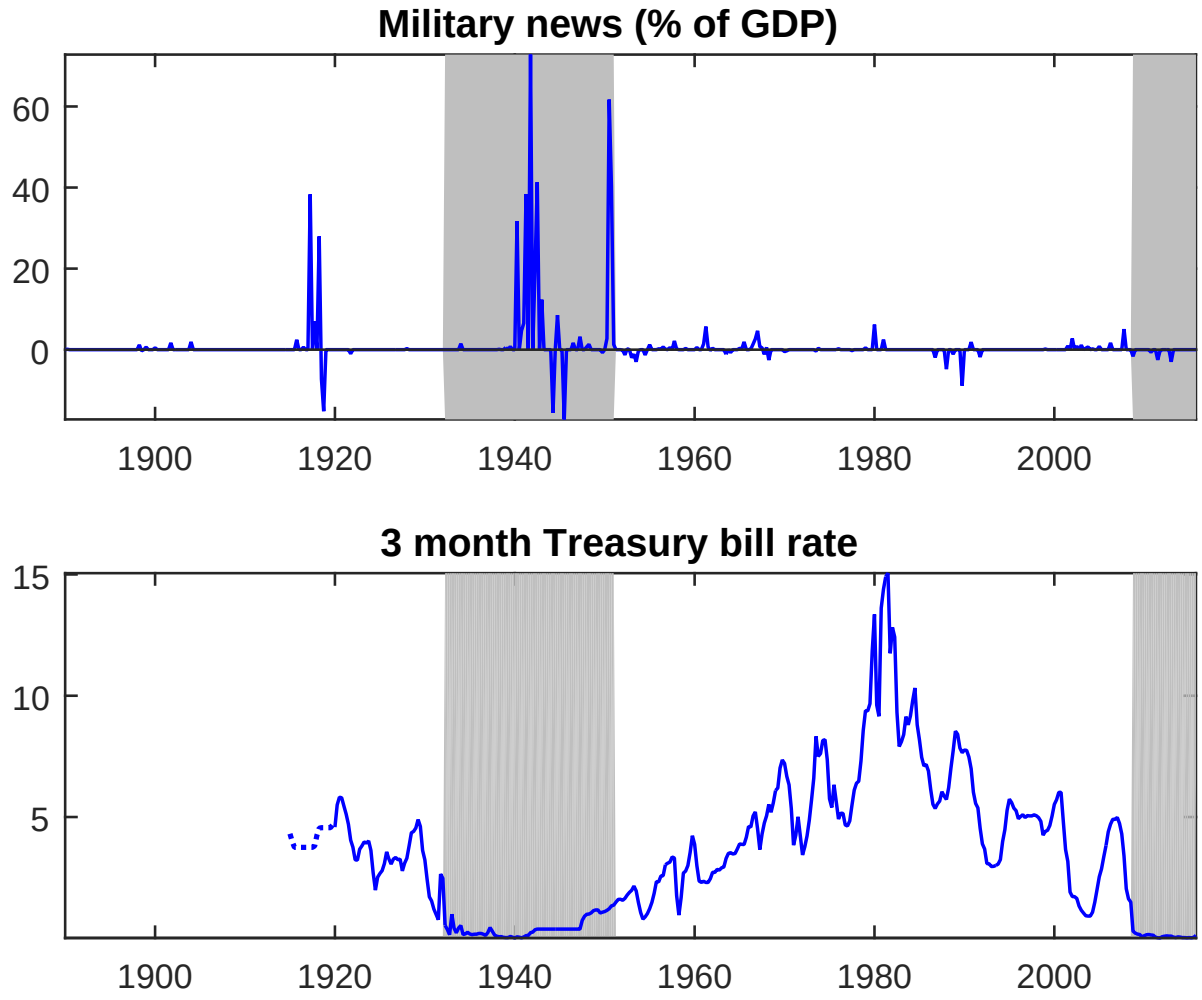
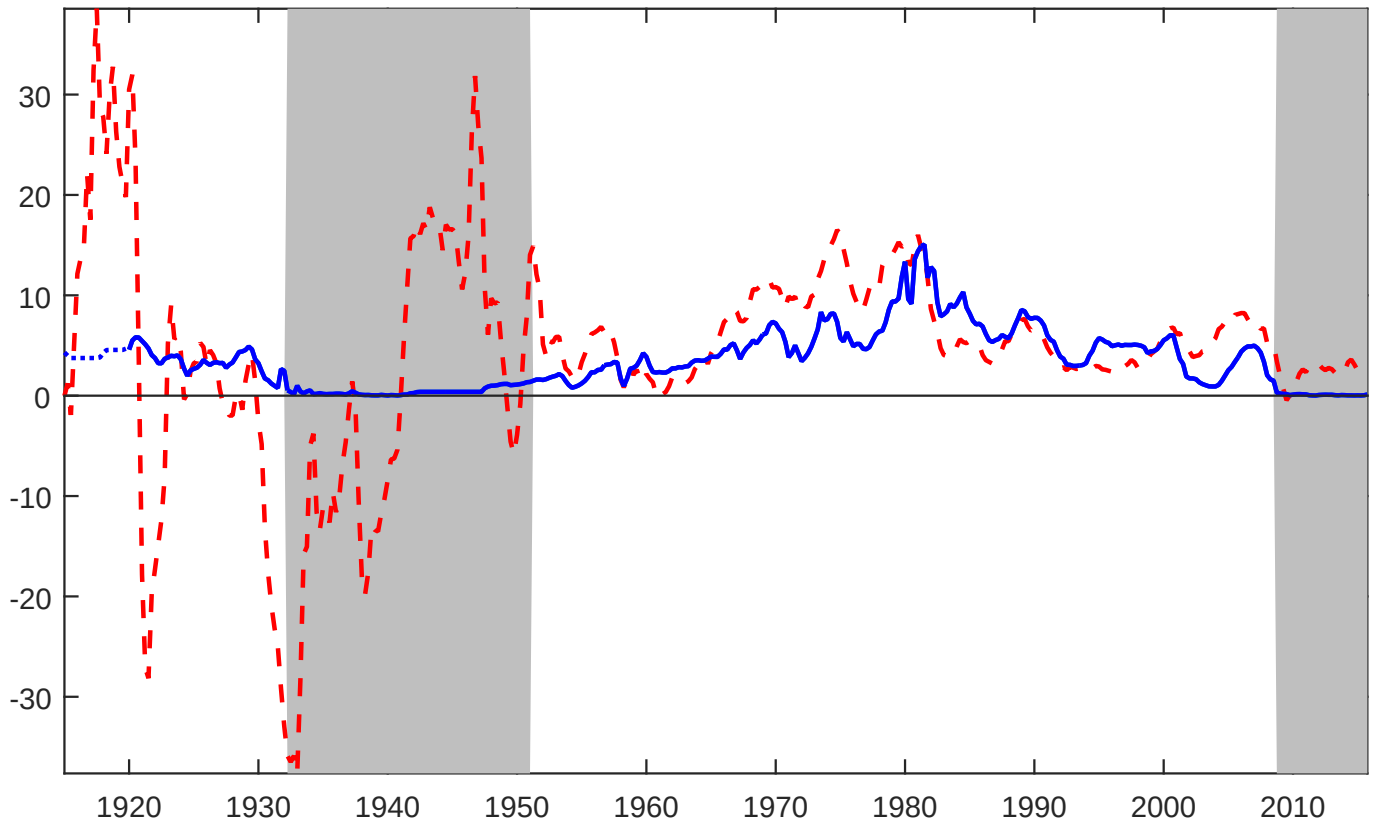
Behavior of Interest Rates



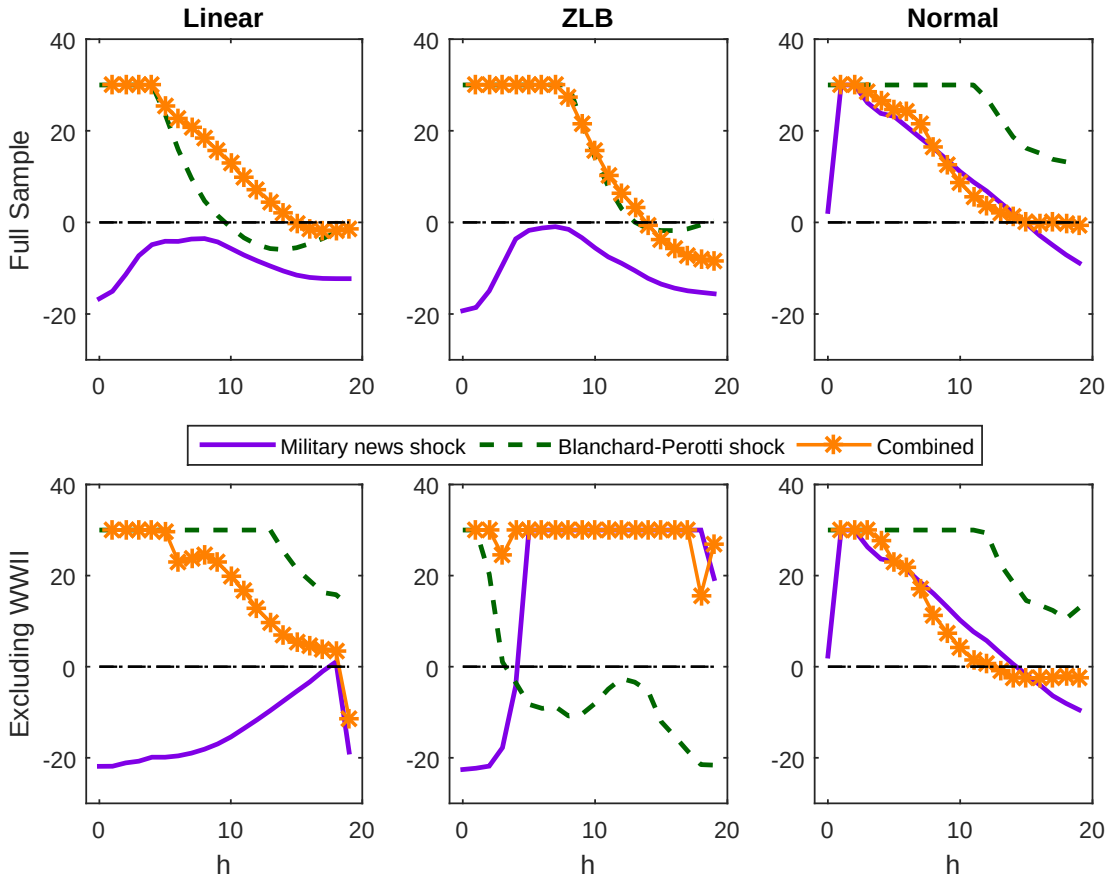
Shaded areas indicate time periods which we classify as the zero lower bound period.

Taylor Rule vs. Actual Interest Rates



nominal interest rate $= 1 + 1.5$ year-over-year inflation rate $+ 0.5$ output gap

Instrument Relevance for ZLB States



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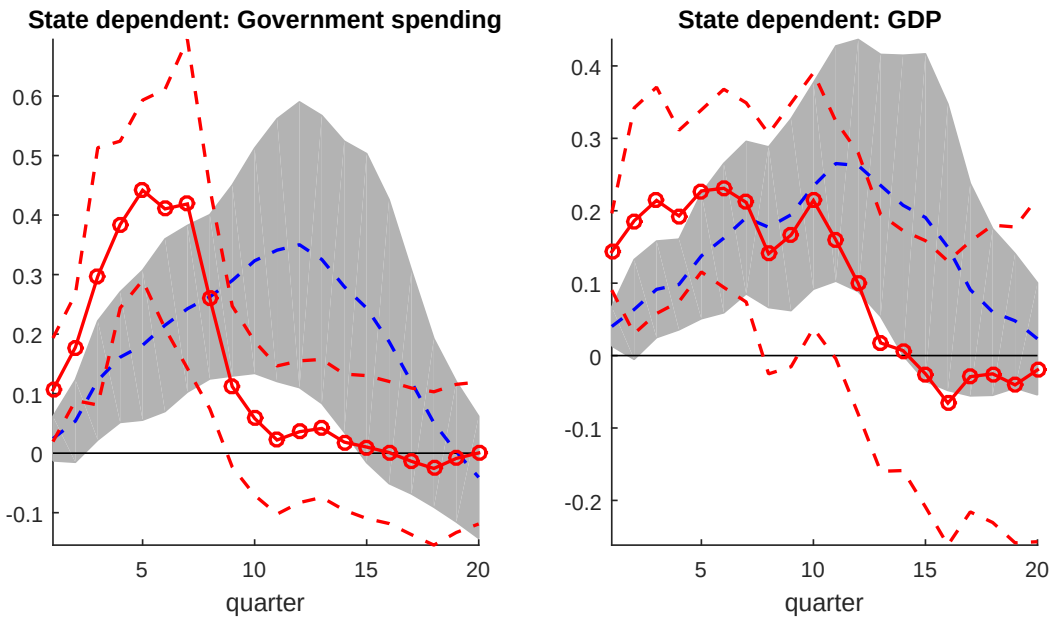

Blue lines are ZLB state, red lines are normal state.

Multipliers Across Monetary Policy Regimes: Military News Instrument

Multipliers account for dynamics of G, and defined as:

$$m_h = \frac{\sum_{j=0}^{h} y_{t+j}}{\sum_{j=0}^{h} g_{t+j}}$$

	Linear Model	Near ZLB	Normal	P-value for difference in multipliers across states
2 year integral	0.66	0.77	0.62	
	(0.068)	(0.106)	(0.149)	0.414
4 year integral	0.71	0.77	0.76	
	(0.045)	(0.058)	(0.367)	0.974

Multipliers Across Monetary Policy Regimes: BP Instrument

Multipliers account for dynamics of G, and defined as:

$$m_h = \frac{\sum_{j=0}^{h} y_{t+j}}{\sum_{j=0}^{h} g_{t+j}}$$

	Linear Model	Near ZLB	Normal	P-value for difference in multipliers across states
2 year integral	0.38	0.64	0.08	
	(0.111)	(0.035)	(0.117)	0.00
4 year integral	0.47	0.71	0.11	
	(0.110)	(0.032)	(0.123)	0.062

Robustness Checks on Full Sample

- Define ZLB as Treasury Bill < 0.5 - similar to baseline.
- Including taxes and inflation - similar to baseline.

Robustness Checks on Sample Excluding WWII

	Linear Model	Near ZLB	Normal	P-value for difference
Military News				
2 year integral	0.78	1.44	0.62	
	(0.202)	(0.147)	(0.151)	0.00
4 year integral	0.75	1.01	0.76	
	(0.163)	(0.109)	(0.365)	0.493
Blanchard-Perotti				
2 year integral	0.11	0.93	0.08	
	(0.090)	(0.784)	(0.112)	0.286
4 year integral	0.14	0.69	0.11	
	(0.099)	(0.785)	(0.124)	0.467

Roadmap

1. Motivation and Introduction
2. Data
3. Econometric Framework and Issues
4. State Dependence on Slack
5. State Dependence on ZLB
6. **Comparison of Methodologies and Results**
7. Conclusion

Calculating Impulse Responses (IRs)

- IRs of G and Y are the building blocks for multipliers in a dynamic model.
- In a linear VAR, IRs are invariant to history, proportional to the size of the shock, and symmetric in the sign of the shock.
- In a nonlinear VAR, the IRs depend on the history of shocks, are not proportional to the size, and are not symmetric in the sign.

Comparison to Auerbach and Gorodnichenko (2012, AEJ)

- Multipliers of 2.2 in recessions and -0.3 in expansions in the U.S.

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- Details of their specification:

$$X_t = \left[1 - F\left(z_{t-1}\right)\right] \Pi_E\left(L\right) X_{t-1}$$

$$+F\left(z_{t-1}\right) \Pi_R\left(L\right) X_{t-1} + \Pi_Z\left(L\right) z_{t-1} + u_t,$$

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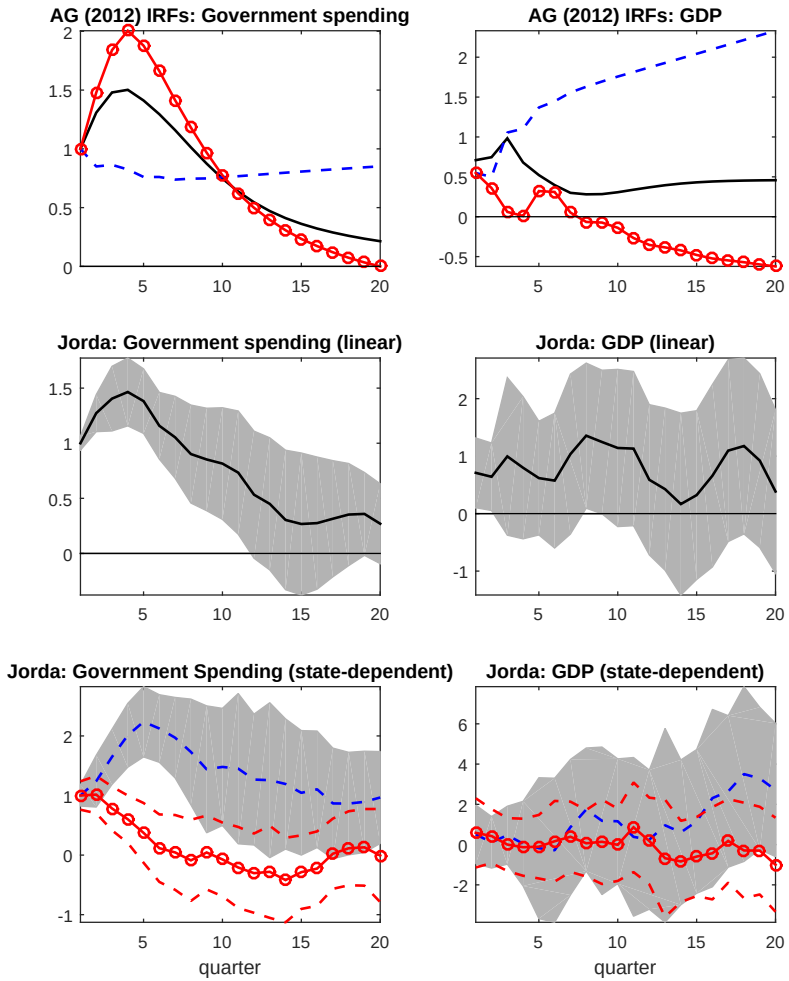
- Blanchard-Perotti identification.
- Impulse responses assume that the economy does not leave its current state for at least 20 quarters.

Using Jorda method on AG (2012, AEJ) post-WWII data and threshold



Black lines are linear, Blue lines are high unemployment state, red lines are low unemployment state.

Recession Multipliers: AG method: 2.24; Jorda method: 0.84.

Why is the Jorda Method Producing Different Results?

Why is the Jorda Method Producing Different Results?

- Jorda Method
  - Natural transitions between states are captured by state-dependent, horizon-dependent coefficients on the control variables.
  - Embeds the historical tendency of government spending shocks to change the state.

Data-Generating Process vs. AG Assumptions

Data-Generating Process vs. AG Assumptions

- Data-Generating Process
  - GDP well-described by regime-switching model, with short-lived recession state and longer-lived expansion state.
  - This means that during a recession, we expect future GDP growth to be higher than the present.
  - The estimated recession parameters probably capture this, as evident from AG-12's IRFs.

AG Assumptions

- Auerbach-Gorodnichenko method for calculating impulse responses.
  - Compute the impulse responses for each state assuming the economy stays in that state for at least 20 quarters.
  - Thus, they do allow the parameters to switch from the recession state to the expansion state.
  - But their recession states last on average only 3 quarters in their sample.
  - Their baseline results also assume the government spending shock can't change the state.

Isolating the Differences

- We use AG-12's STVAR parameter estimates.
- We compute alternative impulse response functions allowing historical state transitions and effects of government spending on the state of the economy.
- When we do this, we estimate recession multipliers of 1.07.

Threshold VARs on the Historical Sample

Threshold VARs on the Historical Sample

- AG-12's assumptions are a better approximation to cases in which each state lasts a long time.
- In the historical sample, ZLB states and normal states each last many years.
- Recession or high unemployment rate states don't last as long, but they are longer in the historical sample.

Threshold VAR Multipliers

ZLB Monetary Policy Regime			
	Linear	Bad	Good
ZLB			
Military news shock			
2 year integral	0.61	0.75	0.43
4 year integral	0.64	0.83	0.32
Blanchard-Perotti shock			
2 year integral	0.36	0.62	0.02
4 year integral	0.40	0.70	0.07
NBER Recession Dates			
Military news shock			
2 year integral	0.61	0.59	0.52
4 year integral	0.64	0.54	0.52
Blanchard-Perotti shock			
2 year integral	0.36	-0.23	0.40
4 year integral	0.40	-0.27	0.41

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Conclusion

- In the full historical sample, we observe that both GDP and government spending respond more to a news shock during slack times.
- However, there is no evidence of multipliers above unity during times of high unemployment.
- We find evidence of higher multipliers (1.4) when interest rates are at the ZLB only if use military news and we exclude WWII.
- Our results differ from Auerbach-Gorodnichenko because our estimates incorporate the natural propensity of the economy to transition between states.

State Dependence on Slack

- Definition of Slack
- Baseline Results
- Robustness
- Comparison to the Literature
- **Behavior of Taxes**

Taxes

- Most increases in government spending are financed partly with deficits and partly with distortionary taxes.
- Romer-Romer find large, negative tax multipliers.
- Thus, it is important to consider how the government spending is financed.

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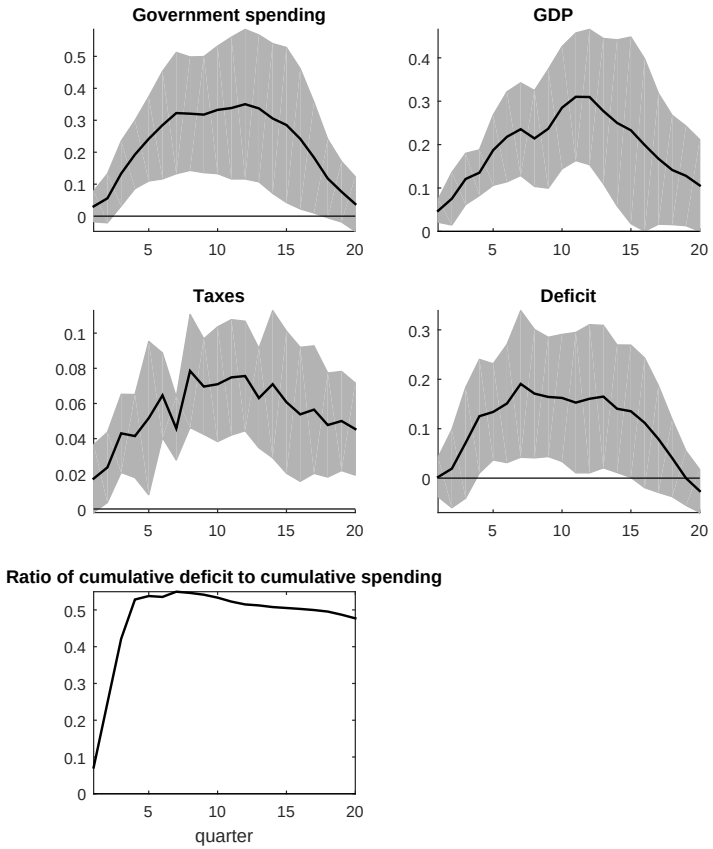
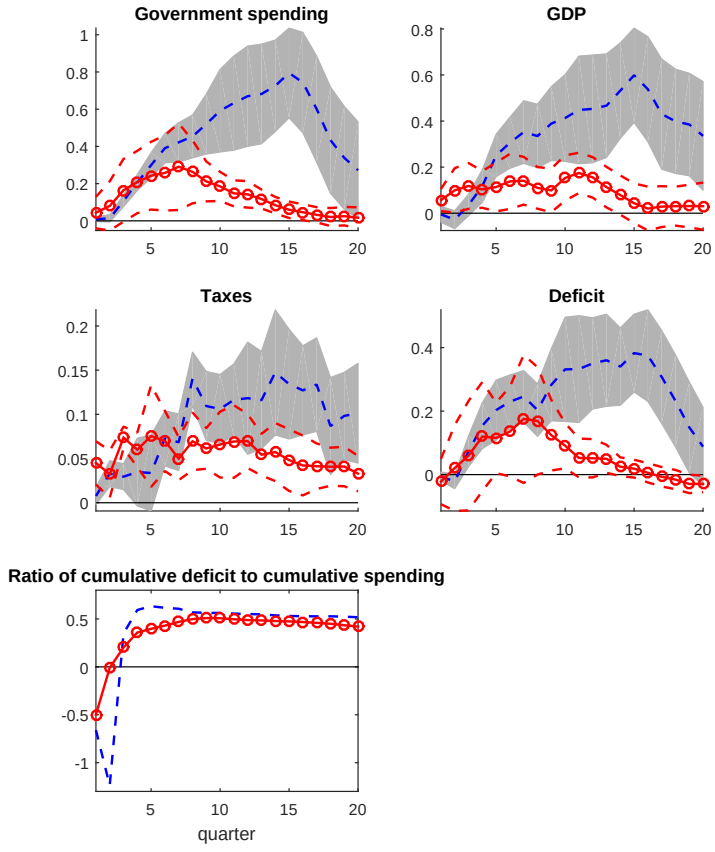
- Romer-Romer find large, negative tax multipliers.
- Thus, it is important to consider how the government spending is financed.
  - We will modify our baseline model to include tax rates and deficits.
  - Tax rates are defined as nominal federal receipts divided by nominal GDP.

Responses of taxes and deficits



Note: These are responses for taxes and deficits in the linear model. The shaded areas indicate 95% confidence bands.

Responses of taxes and deficits

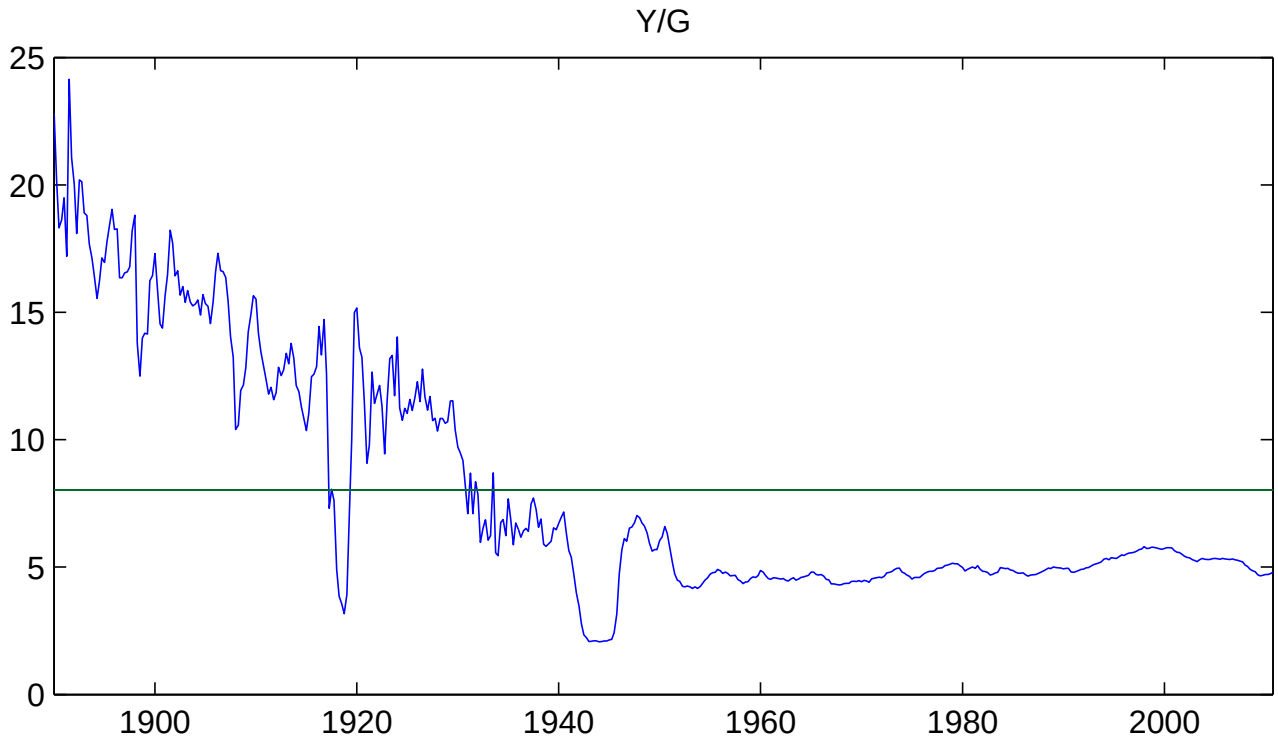


Blue lines are high unemployment state, red lines are low unemployment state.

Observations on the Behavior of Tax Rates and Deficits

- If anything, a higher fraction of expenditures are financed with deficits during slack periods.
- Thus, the behavior of taxes can't seem to explain why multipliers aren't higher during times of slack.
- Tax rates lag the increase in spending. If this is anticipated, then intertemporal substitution effects mean that multipliers are larger than for the lump-sum case.

Ratio of Y/G in US



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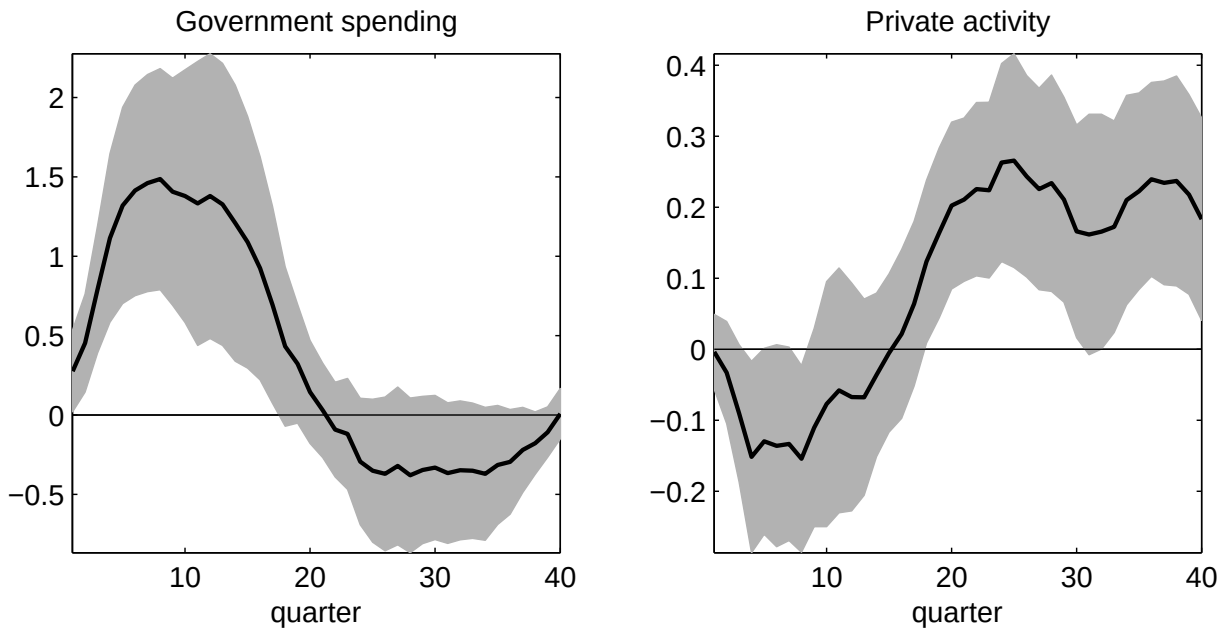
Extra

Response of Private Activity (Y-G)



Suggests output multiplier of less than 1.

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Extra

Ratio of G/Y in US