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

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Do Multipliers Depend on the State of Economy?

Traditional Keynesian idea: Multipliers are high when there are many idle resources.

New Keynesian models: Effects of government spending do not depend on the current utilization of resources.

Recent Theories: Only a few papers have tried to link the size of the multiplier to slack in a theoretical model (e.g. Michaillat (2014), Michaillat and Saez (2013), Roulleau-Paseloup (2014)).

Other State Dependent Models

ZLB or state-dependent monetary policy responses (Eggertson and Woodford (2003), Christiano, Eichenbaum, Rebelo (2011)).

Countercyclical spreads (Canzoneri et al (2013)).
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- Gordon and Krenn (2010)
  - Multipliers are larger if they stop the sample in mid-1941.

- Auerbach and Gorodnichenko (2012, AEJ)
  - Use STVAR model on quarterly post-WWII data
  - Find significantly higher multipliers during recessions.

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  - Mertens and Ravn (2014), Kiley (2014) present models with multipliers that are smaller at the ZLB.

- Ramey (2011, QJE)
  - Estimated the model from 1939 through 1949.
  - Estimates a lower multiplier for this period: 0.7.

- Crafts and Mills (2012)
  - Constructed defense news series for Britain.
  - Estimate multiplier from 1922 through 1938.
  - Estimate multipliers below unity even when interest rates near the ZLB.
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Econometric Issues

- Non-linear VARs.
- Information in the data.
- Ex post computation of multipliers.
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

▶ 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.

▶ Alternative estimation method that avoids nonlinear problems.

▶ Alternative method of calculating multipliers.

▶ Result: Different conclusions about state dependence.
Roadmap

1. Motivation and Introduction

2. Data

3. Econometric Framework and Issues

4. State Dependence on Slack

5. State Dependence on ZLB

6. Conclusion
Should we worry about including data with major wars?

“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.”

— Milton Friedman (1951)
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— Milton Friedman (1951)
Data

- 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.
US Historical Data: 1889-2013

- **1947 - 2013** - available quarterly from NIPA and CPS.
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- **1890-1946** - interpolate annual Y,G,T, P from NIPA and Historical Stats with:
  - BEA quarterly data on nominal Y and G going back to 1939
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  - NBER MacroHistory database monthly federal expenditures and receipts.
  - Unemployment rate
    - Use Conference Board, etc. unemployment rates from 1930 - 1947 to interpolate Weir (1992) annual unemployment rates.
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Identifying government spending shocks

- Exogenous.
- Unanticipated.
- Narrative method.
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

\[ z_{t+h} = \alpha_h + \psi_h(L)y_{t-1} + \beta_h shock_t + \epsilon_{t+h}, \text{ for } h = 0, 1, 2, ... \]

where

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

\[ z_{t+h} = I_{t-1} [\alpha_{A,h} + \psi_{A,h}(L)y_{t-1} + \beta_{A,h} \text{shock}_t] \]

\[ + (1 - I_{t-1}) [\alpha_{B,h} + \psi_{B,h}(L)y_{t-1} + \beta_{B,h} \text{shock}_t] + \varepsilon_{t+h}. \]

where

- The dummy variable, \( I_t = 1 \) if \( \text{unemp}_t > 6.5\% \).
- Coefficient \( \beta_{A,h} \) gives the **high unemployment state** response of \( z_{t+h} \) to the shock at horizon \( h \).
- Coefficient \( \beta_{B,h} \) gives the **low unemployment 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.
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.
Pitfalls in Calculating Multipliers from IRs

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

$$\Delta Y \Delta G = \Delta \ln(Y) \div \Delta \ln(G) \times \frac{Y}{G}$$

In our historical sample, $Y/G$ varies between 2 and 24.
Pitfalls in Calculating Multipliers from IRs

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\frac{\Delta Y}{\Delta G} = \frac{\Delta \ln(Y)}{\Delta \ln(G)} \frac{Y}{G}
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Definition of left hand side variables: $z$

- We use the Hall-Barro-Redlick transformation.

\[
\frac{Y_{t+h} - Y_{t-1}}{Y_{t-1}} \approx \ln Y_{t+h} - \ln Y_{t-1}
\]

\[
\frac{G_{t+h} - G_{t-1}}{Y_{t-1}} \approx (\ln G_{t+h} - \ln G_{t-1}) \cdot \frac{G_{t-1}}{Y_{t-1}}
\]
Baseline control variables

- 2 lags of log real per capita GDP.
- 2 lags of log real per capita government purchases.
- 2 lags of news.
- Quartic trend.
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State Dependence on Slack

- Definition of Slack
- Baseline Results
- Robustness
- Comparison to the Literature
- Behavior of Taxes
US Data: 1890-2013

Military news (% of GDP)

Unemployment rate

Shaded areas indicate time periods when the unemployment rate is above 6.5 %
Is Military News a Relevant Instrument?

The lines show the F-statistic on news for each horizon in the baseline model. Statistics are capped at 20.
State Dependence on Slack

- Definition of Slack
- **Baseline Results**
- Robustness
- Comparison to the Literature
- Behavior of Taxes
Grey areas are 95% confidence intervals.
Blue lines are high unemployment state, red lines are low unemployment state.
Multipliers account for dynamics of $G$, and defined as:

$$\frac{\sum_{i=1}^{H} \Delta Y_i}{\sum_{i=1}^{H} \Delta G_i}$$

<table>
<thead>
<tr>
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<th>High Unemp</th>
<th>Low Unemp</th>
<th>P-value for difference across states</th>
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<tbody>
<tr>
<td><strong>2 year integral</strong></td>
<td>0.76</td>
<td>0.69</td>
<td>0.78</td>
<td>0.631</td>
</tr>
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<td></td>
<td>(0.102)</td>
<td>(0.094)</td>
<td>(0.187)</td>
<td></td>
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<td><strong>4 year integral</strong></td>
<td>0.84</td>
<td>0.76</td>
<td>0.96</td>
<td>0.331</td>
</tr>
<tr>
<td></td>
<td>(0.092)</td>
<td>(0.060)</td>
<td>(0.218)</td>
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Blue lines are high unemployment state, red lines are low unemployment state.
Summary of Baseline Results

- Both GDP and government spending have more robust responses during high unemployment states.

- The multipliers are usually less than 1.

- No evidence of larger multipliers during periods of slack in the economy.
State Dependence on Slack

- Definition of Slack
- Baseline Results
- **Robustness**
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Using time-varying unemployment rate threshold: US

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

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Other Robustness Checks

▶ Using linearly interpolated data - slightly lower multipliers than baseline.

▶ Using AG function of 7 quarter moving average of output growth - similar to baseline.

▶ Excluding WWII Rationing - multipliers are 1 - 1.26, but they are lower when unemployment is high.

▶ Post WWII Data
  ▶ Estimated multipliers across states vary wildly, from -5 to 25.
  ▶ F-statistics for news during slack states are low.
State Dependence on Slack

- Definition of Slack
- Baseline Results
- Robustness
- Comparison to the Literature
- Behavior of Taxes
Comparison to Auerbach and Gorodnichenko (2012, AEJ)

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

\[
X_t = \left[1 - F(z_t - 1)\right] \Pi_E(L) X_{t-1} + F(z_t - 1) \Pi_R(L) X_{t-1} + \Pi_Z(L) z_{t-1} + u_t,
\]

Blanchard-Perotti identification. Impulse responses assume that the economy does not leave its current state for at least 20 quarters.
Comparison to Auerbach and Gorodnichenko (2012, AEJ)

- Multipliers of 2.2 in recessions and -0.3 in expansions in the U.S.
- Details of their specification:

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- Blanchard-Perotti identification.
- Impulse responses assume that the economy does not leave its current state for at least 20 quarters.
AG-12 Impulse Responses

Black line - linear; Blue - recession; Red - expansion.
Using Jorda method on AG (2012, AEJ) post-WWII data and threshold

Blue lines are high unemployment state, red lines are low unemployment state.
## Comparison of Multipliers

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<td><strong>AG-12’s Estimates</strong></td>
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<td>5 year integral</td>
<td>2.24 (0.24)</td>
<td>-0.33 (0.20)</td>
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</table>
Why is the Jorda Method Producing Different Results?

- Auerbach-Gorodnichenko method for calculating impulse responses.
  - Compute the impulse responses for each state assuming the economy stays in that state.
  - Their baseline results assume the government spending shock can’t change the state.
  - They compute alternative multipliers allowing partial feedback of government spending on the state.

- Jorda Method
  - Embeds the historical state transition tendencies into the h-period ahead forecast.
  - Embeds the historical effect of government spending shocks into the h-period ahead forecast.
Isolating the Differences

- We use AG-12’s STVAR parameter estimates.

- We compute alternative impulse response functions allowing historical state transitions and/or effects of government spending on the state of the economy.
Alternative Multipliers using AG’s STVAR Estimates

<table>
<thead>
<tr>
<th>Specification</th>
<th>Severe Recession</th>
<th>Severe Expansion</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant State, No Feedback</td>
<td>2.16</td>
<td>-0.31</td>
<td>2.47</td>
</tr>
<tr>
<td>Actual State Dynamics, No Feedback</td>
<td>1.41</td>
<td>0.19</td>
<td>1.22</td>
</tr>
<tr>
<td>AG Partial Feedback</td>
<td>1.36</td>
<td>-0.04</td>
<td>1.40</td>
</tr>
<tr>
<td>Actual State Dynamics, Partial Feedback</td>
<td>1.07</td>
<td>0.14</td>
<td>0.93</td>
</tr>
</tbody>
</table>

The multipliers shown are 5 year integral multipliers.
Comparison to Second AG Paper: AG-13

- Despite using the Jorda method, AG-13 report finding higher multipliers in recessions.

- They calculate multipliers in a non-standard way - relative to initial shock, not cumulative change in government spending.

- Their estimates are also affected by using the ex post conversion factor.

- We show that applying their method to our estimates also results in higher multipliers during recessions.
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.
Taxes

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  - We will modify our baseline model to include tax rates and deficits.
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.
  - 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.
Roadmap

1. Motivation and Introduction
2. Data
3. Econometric Framework and Issues
4. State Dependence on Slack
5. State Dependence on ZLB
6. Conclusion
Behavior of Interest Rates

Military news (% of GDP)

Tbill rate

Shaded areas indicate time periods which we classify as the zero lower bound period.
Taylor Rule vs. Actual Interest Rates

nominal interest rate = $1 + 1.5 \text{ year-over-year inflation rate} + 0.5 \text{ output gap}$
Is Military News a Relevant Instrument?

The lines show the F-statistic on news for each horizon in the baseline model. Statistics are capped at 20.
Blue lines are ZLB state, red lines are normal state.
Multipliers Across Monetary Policy Regimes

Multipliers account for dynamics of $G$, and defined as:

$$
\frac{\sum_{i=1}^{M} \Delta Y_i}{\sum_{i=1}^{M} \Delta G_i}
$$

<table>
<thead>
<tr>
<th></th>
<th>Linear Model</th>
<th>Near Zero Lower Bound</th>
<th>Normal</th>
<th>P-value for difference in multipliers across states</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 year integral</td>
<td>0.76</td>
<td>0.81</td>
<td>0.57</td>
<td>0.356</td>
</tr>
<tr>
<td></td>
<td>(0.102)</td>
<td>(0.139)</td>
<td>(0.191)</td>
<td></td>
</tr>
<tr>
<td>4 year integral</td>
<td>0.84</td>
<td>0.76</td>
<td>0.85</td>
<td>0.860</td>
</tr>
<tr>
<td></td>
<td>(0.092)</td>
<td>(0.073)</td>
<td>(0.501)</td>
<td></td>
</tr>
</tbody>
</table>
Robustness Checks on Full Sample

- Define ZLB as Treasury Bill $< 0.5$ - similar to baseline.
- Blanchard-Perotti identification - similar to baseline.
- Including taxes - similar to baseline.
- Including inflation - similar to baseline.
Robustness Checks on Sample Excluding WWII

<table>
<thead>
<tr>
<th></th>
<th>Linear Model</th>
<th>Near Zero Lower Bound</th>
<th>Normal</th>
<th>P-value for difference in multipliers across states</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 year integral</td>
<td>1.01</td>
<td>1.59</td>
<td>0.57</td>
<td>0.126</td>
</tr>
<tr>
<td></td>
<td>(0.376)</td>
<td>(0.532)</td>
<td>(0.192)</td>
<td></td>
</tr>
<tr>
<td>4 year integral</td>
<td>1.26</td>
<td>1.06</td>
<td>0.85</td>
<td>0.790</td>
</tr>
<tr>
<td></td>
<td>(0.365)</td>
<td>(0.364)</td>
<td>(0.501)</td>
<td></td>
</tr>
</tbody>
</table>

- Differences are larger if use Blanchard-Perotti (1.88 vs. 0.47 for 2-year).
- Differences are smaller if include taxes as controls (1.19 vs. 0.71 for 2-year).
- Differences are similar if include inflation.
Roadmap

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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 difference in multipliers - all multipliers in the linear and state dependent models are estimated to be between 0.8 and 1.1.

- Our results differ from Auerbach-Gorodnichenko because our estimates incorporate the natural propensity of the economy to transition between states.

- We find weak evidence of higher multipliers when interest rates are at the ZLB only if we exclude WWII.
Ratio of Y/G in US
Extra

Response of Private Activity (Y-G)

Suggests output multiplier of less than 1.
Extra

Ratio of G/Y in US