Lecture on State Dependent Government Spending Multipliers

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Does the Multiplier Depend on the State of Economy?

Evidence suggests that on average in post-WWII data, it is probably around 1 or below. However, those advocating stimulus spending or the delay of deficit reduction argue that the multiplier is state-dependent and is currently higher than average.

- Traditional Keynesian idea: Multipliers are high when there are many idle resources.
- New Keynesian models: Effects of government spending do not depend on the state of the economy.
 - exception: ZLB or state-dependent monetary policy responses
- Theories: Only two papers (of which I am aware) have tried to link the size of the multiplier to slack in a theoretical model (Michaillat (2014), Michaillat and Saez (2013))

Empirical Literature on Effects of Recessions or Slack

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.

Auerbach and Gorodnichenko (2013, NBER Fiscal Volume)

- Use Jorda local projection method on panel of OECD countries, semiannual data from 1985 on
- Find higher multipliers during recessions.

Other aggregate analyses

 Bachmann and Sims (2012), Fazzari, Morley and Panovska (2012), Baum et al (2012), Mittnik and Semmler (1912)

Cross-sectional analyses

 Most find higher multipliers during periods of slack, but not always statistically different Auerbach and Gorodnichenko (2012, AEJ: Economic Policy)

 One of the first, and most influential, empirical studies finding larger multipliers during recessions.

 Use Blanchard-Peroitti framework, but in a regime-switching model.

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• Find large differences in multipliers across regimes.

AG-12 Econometric Specification

 Use Granger-Terasvirta Smooth Transition Autoregressive Model (STAR), which allows smooth transitions across states

$$X_{t} = [1 - F(z_{t-1})] \prod_{E} (L) X_{t-1}$$

$$+F(z_{t-1}) \Pi_{R}(L) X_{t-1} + \Pi_{Z}(L) z_{t-1} + u_{t},$$

 $u_t \sim N(0, \Omega_t)$

$$\Omega_{t} = \Omega_{E} \left[1 - F \left(z_{t-1} \right) \right] + \Omega_{R} F \left(z_{t-1} \right)$$

$$F(z_t) = rac{exp(-\gamma z_t)}{1 + exp(-\gamma z_t)}, \gamma > 0$$

$$Var(z_t) = 1, E(z_t) = 0.$$

AG-12 Econometric Specification

- z is an index (normalized to have unit variance) of the business cycle.
- Ω_R and Π_R describe behavior during a deep recession (F(Z) near 1).
- Ω_E and Π_E describe behavior during a strong expansion (F(Z) near 0).
- Set z as a 7-quarter MA of output growth. Computer code indicates it is a centered MA!

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- Blanchard-Perotti identification.
- ► X includes G, T, Y.
- Use Monte Carlo Markov Chain methods.
- Calibrate rather than estimate γ .

AG-12 Regimes

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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).

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AG-12 Impulse Response Calculation

Baseline IRFs assume system stays in its current regime. That is:

- There is no feedback from G into the Z.
- If in a recession now, it will last at least 20 quarters.

These assumptions turn the problem into a linear one.

AG-12 Impulse Responses

Black line - linear; Blue - recession; Red - expansion.



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AG-12 Multipliers

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	$max_{h=1}$.	$max_{h=1,,20} \{Y_h\}$		$\sum_{h=1}^{20} Y_h / \sum_{h=1}^{20} G_h$	
	Point estimate	Standard error	Point estimate	Standard error	
Total spending					
Linear	1.00	0.32	0.57	0.25	
Expansion	0.57	0.12	-0.33	0.20	
Recession	2.48	0.28	2.24	0.24	

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TABLE 1-MULTIPLIERS

AG-12 Multipliers with feedback from G to z



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 $\sum_{k=1}^{n} I_k / \sum_{k=1}^{n} G_k$ where time index *h* is in quarters. Blue dashed lines are 90 percent 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.

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Auerbach-Gorodnichenko 2013 Paper

Extend earlier paper to OECD Panel

Semi-annual data, also includes forecasts

Use a direct projection method rather than STAR

Continue to find larger multipliers during recessions

Direct Projection Method (Jorda (2005), Stock-Watson)

► Jorda (2005) local projection method is an alternative method to estimate the impulse response of variable z at horizon t + h.

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► This involves running *h* sets of regressions.

Allows one to easily accommodate state dependence.

$z_{t+h} = \alpha_h + \psi_h(L)y_{t-1} + \beta_h shock_t + \varepsilon_{t+h}$, 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 β_h gives the response of z_{t+h} to the shock at horizon h.

AG-13 State dependent model

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

Advantages of the Jorda method

- Does not impose restrictions on the dynamic pattern of responses like VARs do.
- Does not require assumptions about how long the economy remains in a given state and whether the shock causes it to leave the state.
- The same variables do not have to be used in each equation.

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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.

Comparison of 3 different methods for estimating impulse responses

SVAR

Romer Dynamic

Jorda

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From Ramey discussion of Leduc-Wilson (2012), based on U.S. data 1939q1-2010q4

Owyang-Ramey-Zubairy (2013), Ramey-Zubairy (2013)

Investigate state-dependent multipliers

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.

Different conclusions about state dependence.

Econometric Issues

- Non-linear VARs
- Are the data rich enough?
- Biases in multiplier computation

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Roadmap

- 1. Motivation and Introduction
- 2. Data
- 3. Econometric Framework and Issues

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- 4. State Dependence on Slack
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 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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US Historical Data: 1889-2011

- ▶ 1947 2011 available quarterly from NIPA and CPS.
- 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
 - CPI data back to 1939
 - Balke-Gordon quarterly data for 1890-1938
 - 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.
- Use NBER recession dates for 1890 1929 to interpolate Weir annual series.

Government Spending and GDP Data



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Identifying government spending shocks

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Exogeneity

Anticipation

Narrative method

Roadmap

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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 $unemp_t > 6.5\%$.
- Coefficient β_{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*.

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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:

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

▶ In our historical sample, Y/G varies between 2 and 24. • ratio

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Definition of left hand side variables: z

▶ We use the Hall-Barro-Redlick transformation.

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

$$\frac{G_{t+h} - G_{t-1}}{Y_{t-1}} \approx \left(lnG_{t+h} - lnG_{t-1} \right) \cdot \frac{G_{t-1}}{Y_{t-1}}$$

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Roadmap

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- 5. State Dependence on ZLB
- 6. Conclusion

State Dependence on Slack

Definition of Slack

- Baseline Results
- Robustness
- Comparison to the Literature

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Behavior of Taxes

US Data: 1890-2011



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

Is Military News a Relevant Instrument?

	F-statistic	Number of observations
1891:1 - 2011:4 - All	9.98	484
1891:1 - 2011:4 - Slack	7.38	172
1891:1 - 2011:4 - No slack	7.46	312
1948:1 - 2011:4 - All	19.01	256
1948:1 - 2011:4 - Slack	0.97	74
1948:1 - 2011:4 - No slack	15.73	182

Note: The F-tests are the joint significance of news variables in a regression of log real per capita government spending on its own four lags, four lags of log real per capita GDP and federal receipts, current and four lags of news (scaled by lagged GDP), and a quartic time trend.

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State Dependence on Slack

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Behavior of Taxes

Linear Model



Grey areas are 95% confidence intervals.

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State Dependent Model



Solid lines are responses in high unemployment state, lines with circles are responses in low unemployment state.

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Multipliers

Multipliers account for dynamics of G, and defined as:

$max_{i=120} \{\Delta Y_i\}$	or	$\sum_{i=1}^{M} \Delta Y_i$
$\overline{\max_{i=1\dots 20}\{\Delta G_i\}}$	01	$\overline{\sum_{i=1}^{M} \Delta G_i}$

	Linear	High	Low	P-value for
	Model	Unemp	Unemp	difference
				across states
Peak	0.92	0.82	1.15	
	(0.462)	(0.351)	(0.696)	0.645
2 year integral	0.78	0.79	0.87	
	(0.118)	(0.131)	(0.184)	0.758
4 year integral	0.87	0.80	1.11	
	(0.109)	(0.095)	(0.181)	0.209

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.

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State Dependence on Slack

- Definition of Slack
- Baseline Results

Robustness

Comparison to the Literature

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Behavior of Taxes

Using time-varying unemployment rate threshold: US



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

	Linear	High Unemp	Low Unemp
Peak	0.92	0.87	1.08
2 year integral	0.78	0.89	0.82
4 year integral	0.87	0.82	0.96

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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.

- Post WWII Data
 - F-statistics for news during slack states are below 1.
 - Estimated multipliers across states vary wildly, from -4 to 18.

State Dependence on Slack

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Behavior of Taxes

Estimating AG (2012, AEJ) model using Jordà method



Solid lines are responses in recession, lines with circles are responses in normal times. 📢 🗄 👘 🤶 🔍

Comparison of Multipliers

	Linear Model	Recession	Expansion
AG-12's Estimates			
5 year integral	0.57	2.24	-0.33
Jordà Method			
5 year integral	1.05	0.87	0.53

Why is the Jordà Method Producing Different Results?

Method for calculating impulse responses.

- Uses a different model for each horizon h.
- Computes the conditional expectation directly by generating a forecast at t+h based on the history through t.

- Embeds the historical transition probabilities into the h-period ahead forecast.
- Embeds the historical feedback into the h-period ahead forecast.

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Isolating the Difference

We compute IRFS a third way:

Use AG-12's STVAR parameter estimates.

Compare the effect of a positive shock that raises spending cumulatively by 15 percent: 1991Q1 (recession) vs. 1993Q1 (expansion).

Compute effects allowing endogenous transitions and feedback.

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Jordà Method			
5 year integral	1.05	0.87	0.53
IRFs Allowing Full Feedback		1991q1	1993q1
5 year integral		0.89	0.42

Difference from Auerbach-Gorodnichenko (2013, NBER Fiscal

- 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

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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.
 - 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.

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Responses of taxes and deficits



Solid lines are responses in high unemployment state, lines with circles are responses in low unemployment state.

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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

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- 4. State Dependence on Slack
- 5. State Dependence on ZLB
- 6. Conclusion

Literature on the Size of the Multiplier at the ZLB

Theoretical DSGE Literature

- Eggertsson, Woodford, Christiano, Eichenbaum, Rebelo; Fernandez Villaverde et al.
- Multipliers can be 3X larger at the zero lower bound.

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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Behavior of Interest Rates



Solid lines are responses in ZLB state, lines with circles are responses in normal state.

Taylor Rule vs. Actual Interest Rates



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

Is Military News a Relevant Instrument?

	F-statistic	Number of observations
1891:1 - 2011:4 - All	9.98	484
1891:1 - 2011:4 - ZLB	2.07	89
1891:1 - 2011:4 - Normal	18.22	395

Note: The F-tests are the joint significance of news variables in a regression of log real per capita government spending on its own four lags, four lags of log real per capita GDP and federal receipts, current and four lags of news (scaled by lagged GDP), and a quartic time trend.

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State Dependent Model - ZLB



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Multipliers at the ZLB

Multipliers account for dynamics of G, and defined as:

$$\frac{\max_{i=1\dots 20} \{\Delta Y_i\}}{\max_{i=1\dots 20} \{\Delta G_i\}} \text{ or } \frac{\sum_{i=1}^{M} \Delta Y_i}{\sum_{i=1}^{M} \Delta G_i}$$

	Linear	Near Zero	Normal	P-value for difference
	Model	Lower Bound		in multipliers across
				states
Peak	0.92	0.71	0.80	
2 year integral	0.78	0.78	0.73	
	(0.118)	(0.172)	(0.130)	0.952
4 year integral	0.87	0.73	1.60	
	(0.109)	(0.113)	(0.304)	0.007

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Conclusion

▶ We find no difference in multipliers across slack states- 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 no evidence of higher multipliers when interest rates are at the ZLB.

Ratio of Y/G in US



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Response of Private Activity (Y-G)



Suggests output multiplier of less than 1.

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Ratio of G/Y in US



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