Estimating Fiscal Multipliers: News From a Non-linear World

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Assessment of fiscal spending multiplier

- **How large is the fiscal multiplier?** Key for policy decisions in **normal** and **extraordinary** times
- Empirical studies, status quo: *Linear* VAR model, fiscal spending shocks assumed to exert an immediate impact on output (Blanchard and Perotti 2002)
- Parker (2011): Fiscal spending shocks likely to be **countercyclical**
- Leeper, Walker, Yang (2013): **Fiscal foresight** ("fiscal news") as **key-element** to consider to correctly assess fiscal shocks (rel.: Beaudry and Portier 2013)
- This paper's goal: **Quantification of fiscal spending multipliers in a non-linear world featuring fiscal news**

This paper's approach

- **Non-linear VAR models for the US** that jointly **i) allow for countercyclical fiscal multipliers** and **ii) deal with fiscal foresights**
- **Non-linearity**: **STVAR** (Teräsvirta et al. 2010), allows us to explore **recessions and expansions**
- **Fiscal foresight**: **Sum of revisions of expectations** over future fiscal spending (Gambetti 2012a, 2012b), theoretically and empirically **more powerful predictors than contemporaneous revisions**
- **Fiscal multipliers** computed via **GIRFs** (Koop, Pesaran, Potter 1996, Ehrmann et al 2003), which account for the **interactions between output and the states of the economic system**

This paper's results

- **Anticipated fiscal spending shocks** trigger a **significant reaction of output**
- Such reaction is **not significantly different between states** when **randomizing over all initial conditions** (recessions/expansions)
- Such reaction is **statistically different when focusing on "extreme events"** (randomization over **deep recessions/strong expansions**)
- **Fiscal multipliers in recessions are larger than one**
- **Spending news shocks** in recession **induce economic stabilization**

State of the art

- Linear VARs and standard identification strategies: Blanchard and Perotti (2002)
- VARMA representations: Mertens and Ravn (2010), Kriwoluzky (2012)
- Excess returns of large military contractors: Fisher and Peters (2010)
- Defense spending news: Ramey (2011), Ben Zeev and Pappa (2014)
- Revisions of one-step-ahead forecasts: Perotti (2007, 2011), Ramey (2011), Barro and Redlick (2011), Ricco (2014)

State of the art (cont'd)

- *DSGE-based investigations*: Eggertsson (2009), Christiano et al (2011), Woodford (2011), Canzoneri et al (2011)
- *State-contingent investigations*: Tagkalakis (2008), Corsetti et al (2012), Canova and Pappa (2011), Perotti (1999), Cantore et al (2013)
- **Revisions of n-step-ahead forecasts**: Gambetti (2012a, 2012b)
- **Non-linear VARs**: Auerbach and Gorodnichenko (2012a, 2013), Bachmann and Sims (2012), Batini et al (2013), Fazzari et al (2013), Berger and Vavra (2014)
- *Non-linear local projections*: Auerbach and Gorodnichenko (2012b), Ramey et al (2013), Ramey and Zubairy (2013)

Fiscal foresight

- **Fundamental-VAR**: VAR-econometrician **able to recover the relevant structural shocks from current and past realizations only** (Hansen and Sargent, 1991)
- Issue with fiscal shocks: **Fiscal foresight**. Quite likely, **VAR is non-fundamental!**
- Stylized model: forward-looking process for output and a potentially **"news-rich" process for fiscal spending**:

$$y_t = \delta E_t y_{t+1} + g_t + \omega_t \quad (1)$$

$$g_t = \varepsilon_{t-h} + \phi_{h+1}\varepsilon_{t-h-1} + \ldots + \phi_{h+q}\varepsilon_{t-q} = \phi(L)\varepsilon_t \quad (2)$$

- Some roots of the polynomial $\phi(L)$ inside the unit circle $\Longrightarrow$ **shocks not recoverable from past and current realizations** of g_t only

Fiscal foresight

- To fix ideas, $h = q = 1$:

$$g_t = \varepsilon_{t-1}$$

- Solving (1) forward:

$$\begin{bmatrix} y_t \\ g_t \end{bmatrix} = \underbrace{\begin{bmatrix} \delta & 1 \\ 0 & 0 \end{bmatrix}}_{A_0} \begin{bmatrix} \varepsilon_t \\ \omega_t \end{bmatrix} + \underbrace{\begin{bmatrix} 1 & 0 \\ 1 & 0 \end{bmatrix}}_{A_1} \begin{bmatrix} \varepsilon_{t-1} \\ \omega_{t-1} \end{bmatrix}. \quad (3)$$

- Roots of $\left|\sum_{i=0}^{q} A_i z^i\right|$ inside the unit circle $\Longrightarrow$ non-fundamentalness (Fève at al. 2009)

Expectations

- How to identify fiscal news shocks? Source of the problem (LWY, 2013): the econometrician's information set lags the agents' $\Longrightarrow$ Add **relevant information** to the system
  $(1) - (2) \Longrightarrow$ some measure of expectations
- Consider the VMA representation for the vector $(y_t, E_t g_{t+1})$:

$$\begin{bmatrix} y_t \\ E_t g_{t+1} \end{bmatrix} = \underbrace{\begin{bmatrix} \delta & 1 \\ 1 & 0 \end{bmatrix}}_{A_0} \begin{bmatrix} \varepsilon_t \\ \omega_t \end{bmatrix} + \underbrace{\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}}_{A_1} \begin{bmatrix} \varepsilon_{t-1} \\ \omega_{t-1} \end{bmatrix}. \quad (4)$$

- (4) is fundamental!
- $E_t g_{t+1}$ does the trick

Expectations (cont'd)

- Do expectations work well in general?
- Assume $h = 1, q = 2$:

$$g_t = \varepsilon_{t-1} + \phi_2 \varepsilon_{t-2}$$

- The one-step-ahead expected value of g is:

$$E_t g_{t+1} = \varepsilon_t + \phi_2 \varepsilon_{t-1}$$

- If $|\phi_2| > 1$, process still non-fundamental!

Expectation revisions

- **Expectation revisions** possibly more informative than expectations *per se*
- Revision:

$$E_t g_{t+1} - E_{t-1} g_{t+1} = \varepsilon_t$$

- In general, revision exactly proportional to the shock:

$$E_t g_{t+h} - E_{t-1} g_{t+h} = \phi_h \varepsilon_t$$

- Issue: h typically unknown. If selected forecast horizon too short ($< h$) or too long ($> q$), revision does not recover the shock $\Longrightarrow$ non-fundamentalness still there

Sum of expectations revisions

- Gambetti's (2012a, 2012b) proposal: **Sum of expectations revisions**

$$\eta_J^g = \sum_{j=1}^{J} \left(E_t g_{t+j} - E_{t-1} g_{t+j} \right)$$

  With J large enough to ensure that $J \geq h$.

- Suppose

$$g_t = \varepsilon_{t-2} + \phi_3 \varepsilon_{t-3} \tag{5}$$

- VMA representation of (y_t, g_t) non-fundamental
- Augment VAR with $\eta_3^g = \sum_{j=1}^{3} \left(E_t g_{t+j} - E_{t-1} g_{t+j} \right) = \left(1 + \phi_3 \right) \varepsilon_t$

Sum of expectations revisions (cont'd)

- The VMA representation for (y_t, η_3^g) is:

$$\begin{bmatrix} y_t \\ \eta_3^g \end{bmatrix} = \underbrace{\begin{bmatrix} \delta^2(1+\delta\phi_3) & 1 \\ 1+\phi_3 & 0 \end{bmatrix}}_{A_0} \begin{bmatrix} \varepsilon_t \\ \omega_t \end{bmatrix} + \underbrace{\begin{bmatrix} \delta(1+\delta\phi_3) & 0 \\ 0 & 0 \end{bmatrix}}_{A_1} \begin{bmatrix} \varepsilon_{t-1} \\ \omega_{t-1} \end{bmatrix} + \underbrace{\begin{bmatrix} 1+\delta\phi_3 & 0 \\ 0 & 0 \end{bmatrix}}_{A_2} \begin{bmatrix} \varepsilon_{t-2} \\ \omega_{t-2} \end{bmatrix} + \underbrace{\begin{bmatrix} \phi_3 & 0 \\ 0 & 0 \end{bmatrix}}_{A_3} \begin{bmatrix} \varepsilon_{t-3} \\ \omega_{t-3} \end{bmatrix},$$

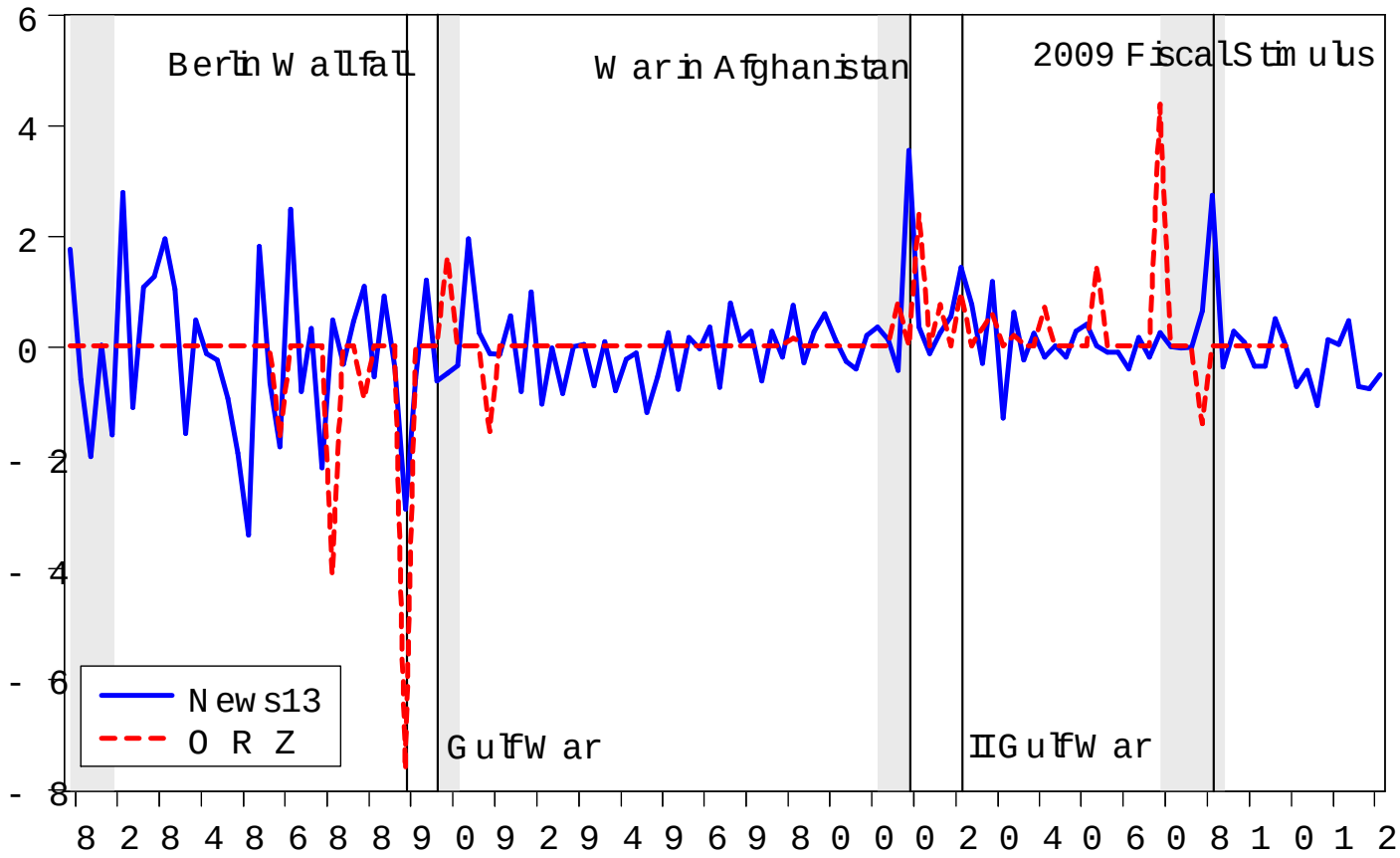
which is fundamental.

News13 variable

- SPF data on expectations over future fiscal spending growth rates: 1981Q3-2013Q1, from $E_{t-1}g_{t+1}$ to $E_{t-1}g_{t+3}$ available
- Allow to construct a $News_{13}$ fiscal spending news variable
- News13 variable:

$$News_{13} = \sum_{j=1}^{3} (E_t g_{t+j} - E_{t-1} g_{t+j})$$

News13


Berlin Wall fall
War in Afghanistan
2009 Fiscal Stimulus
Gulf War
II Gulf War
News13
ORZ
6
4
2
0
-2
-4
-6
-8
82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 12

Predictive power of News13

- Fiscal spending regressed on its own lags, lags of fiscal receipts and output, and a lagged value of $News_{13}$
- Exclusion restriction, t-test:

News	$(1,3)$	$(1,1)$	$(2,2)$	$(3,3)$	$(0,0)$
$p-value$	**0.00**	**0.00**	**0.00**	**0.00**	0.11

News13 vs. Ramey's (2011)/ORZ's (2013)

- Granger-causality test involving $News_{13}$ vs. Ramey's (2011)/Owyang, Ramey, and Zubairy's (2013) news variable

Sample	*Ramey*	$News_{13}$	*ORZ*	$News_{13}$
1981:III-2008:IV	0.44	**0.06**		
1986:IV-2008:IV	0.28	**0.02**		
1981:III-2010:IV			0.71	**0.06**
1986:IV-2010:IV			0.59	**0.02**

STVAR model

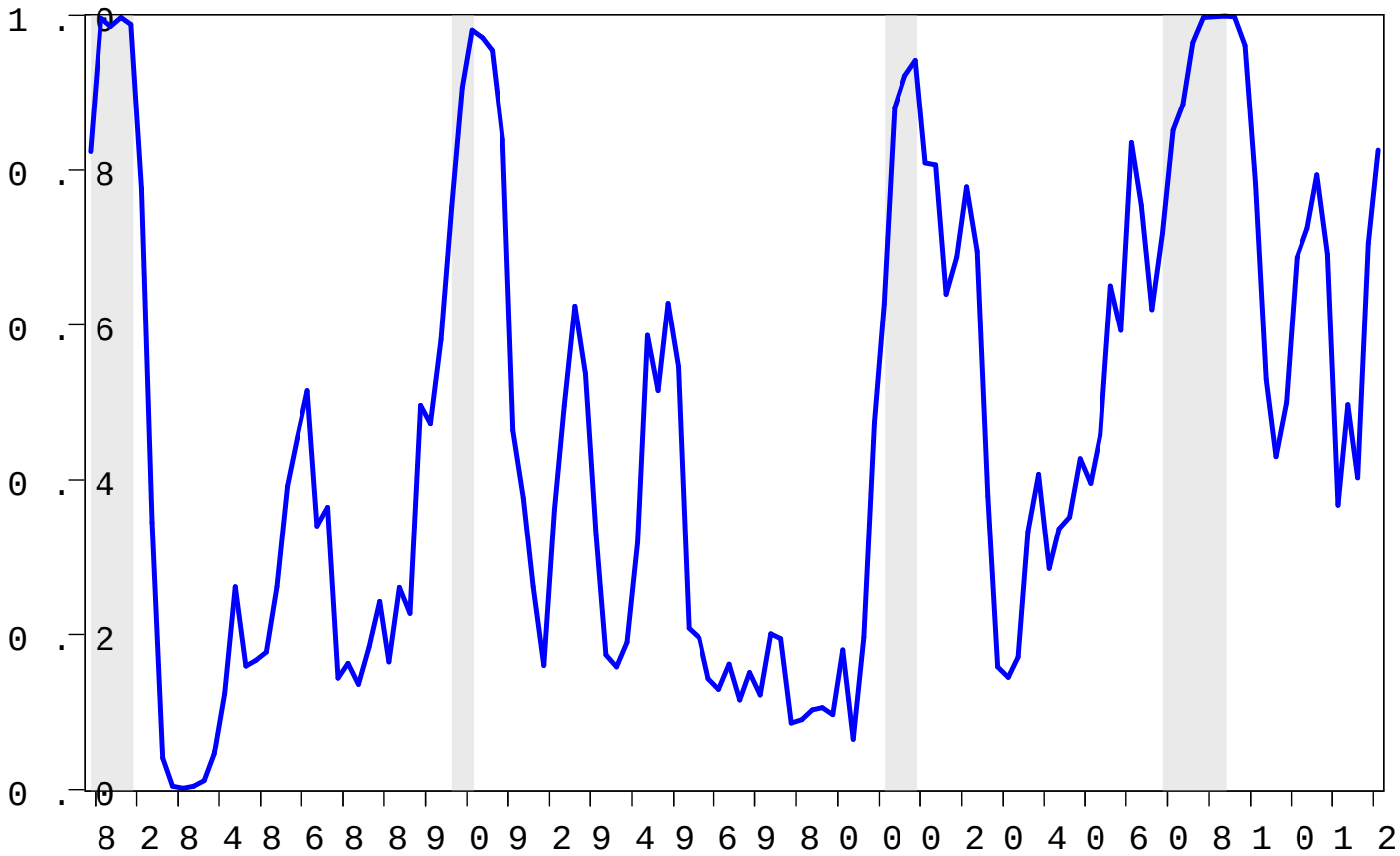
$$
\begin{aligned}
\mathbf{X}_t &= F(z_{t-1})\mathbf{\Pi}_R(L)\mathbf{X}_t + (1 - F(z_{t-1}))\mathbf{\Pi}_E(L)\mathbf{X}_t + \varepsilon_t, \\
\varepsilon_t &\sim N(0, \mathbf{\Omega}_t), \\
\mathbf{\Omega}_t &= F(z_{t-1})\mathbf{\Omega}_R + (1 - F(z_{t-1}))\mathbf{\Omega}_E, \\
F(z_t) &= \exp(-\gamma z_t)/(1 + \exp(-\gamma z_t)), \gamma > 0, z_t \sim N(0, 1).
\end{aligned}
$$

- $F(z_t)$: probability of being in a recession
- Linear model: $\mathbf{\Pi}_R(L) = \mathbf{\Pi}_E(L)$, $\mathbf{\Omega}_R = \mathbf{\Omega}_E$

Transition function

- Transition objects similar to Auerbach and Gorodnichenko (2012), Bachmann and Sims (2012):
  - z_t: Real GDP growth rate, back-look. MA, 4 terms
  - γ: **Calibrated** to get $\Pr(F(z_t) \geqslant 0.85) \approx 0.15$ (15% NBER recessions in the post-WWII period)
- Calibration: $\gamma = 2.3$, slightly larger than in Bachmann and Sims (2012), Auerbach and Gorodnichenko (2012), Berger and Vavra (2014)
- High prob. of recession correlated with NBER dating

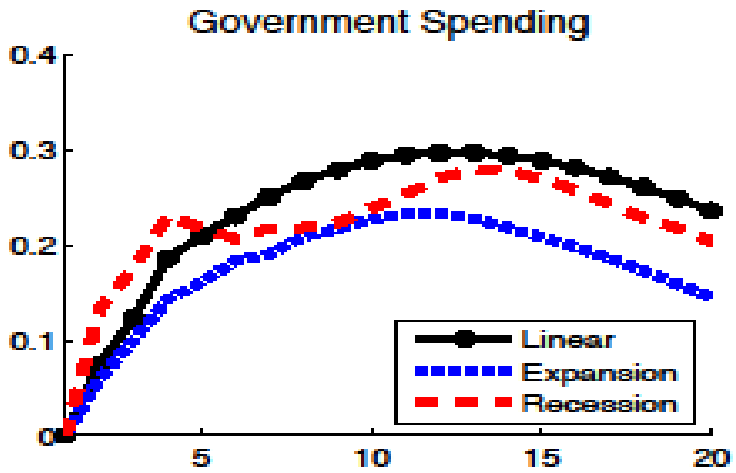
Transition function

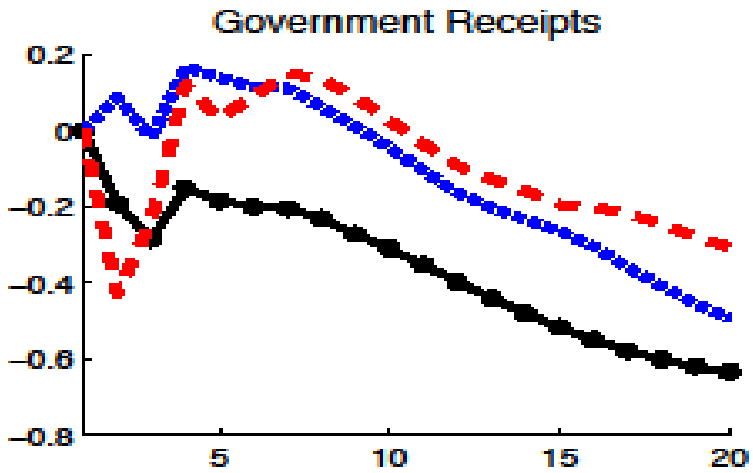


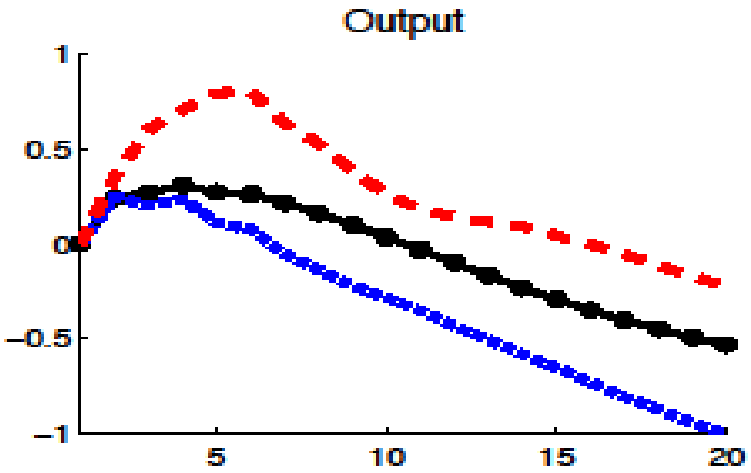
Modeled vector and IRFs computation

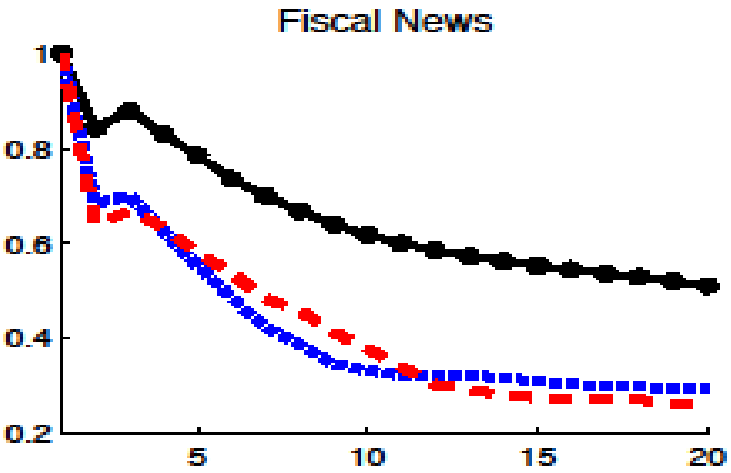
- Vector $\mathbf{X}_t = [G_t, T_t, Y_t, News_{13t}]'$
- Estimation of VAR(p) models via ML-MCMC (Chernozhukov and Hong, 2003)
- News shocks purged via **Cholesky decomposition** of Ω_R, Ω_E
- Sample: 1981Q3-2013Q1
- Computation of the GIRFs to allow for interactions between $\mathbf{X}_t$ and z_t (Koop, Pesaran, Potter 1996, Ehrmann et al 2003)
- Note: Null of linearity rejected by Teräsvirta-Yang (2013)

Baseline VAR - IRFs

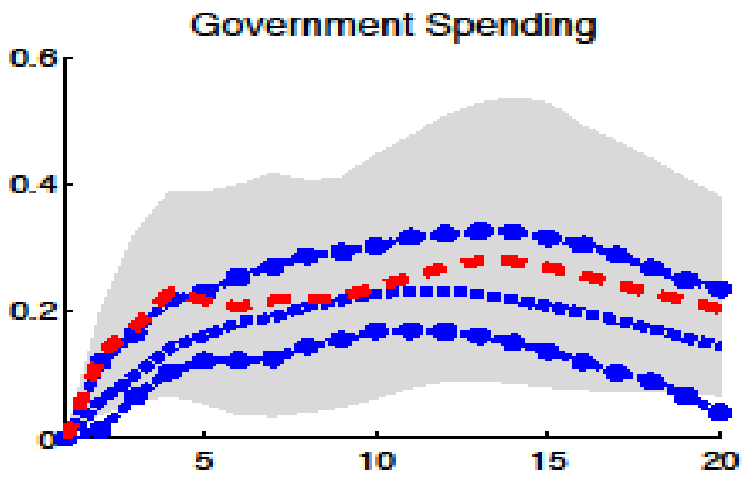


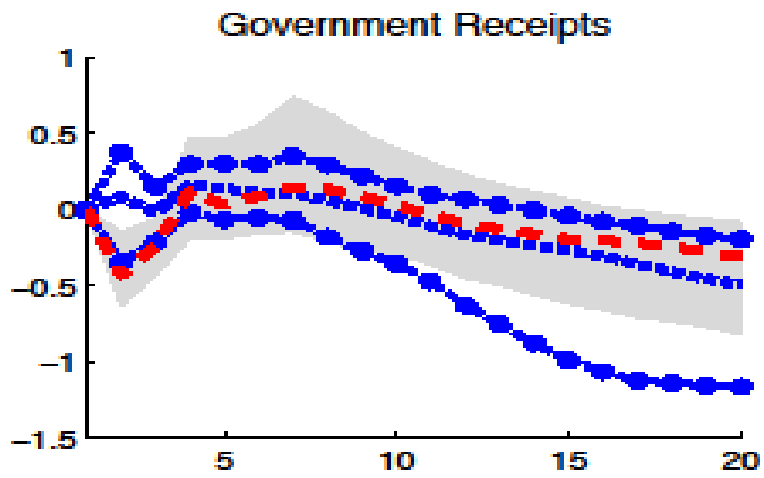


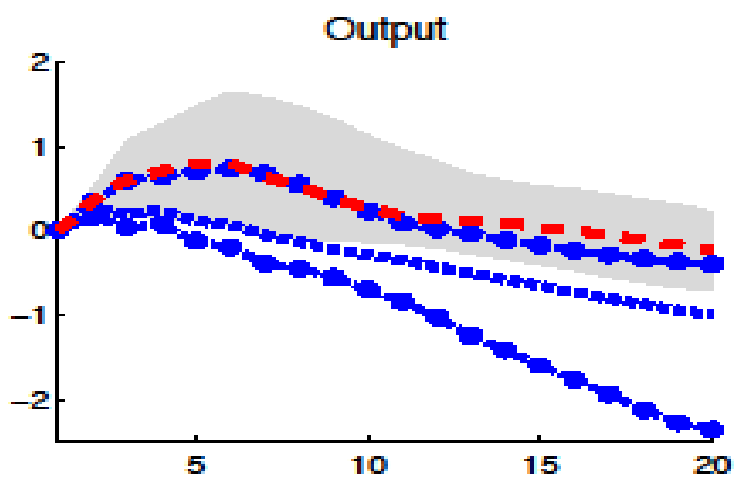


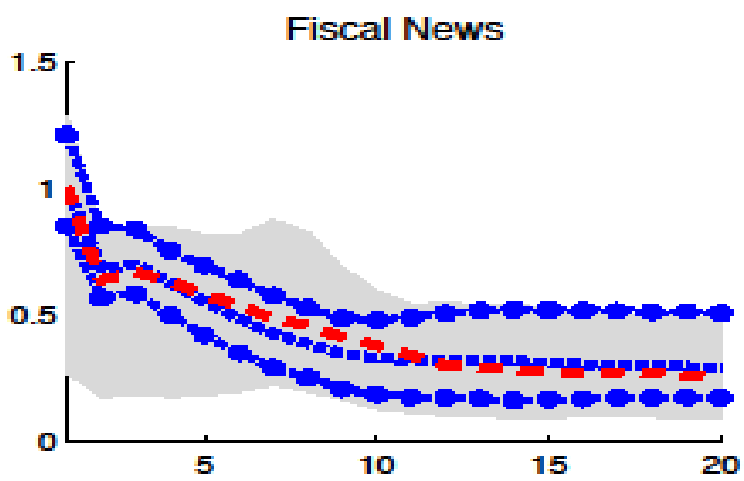


GIRFs


Government Spending
0.6
0.4
0.2
0
5
10
15
20


Government Receipts
1
0.5
0
−0.5
−1
−1.5
5
10
15
20

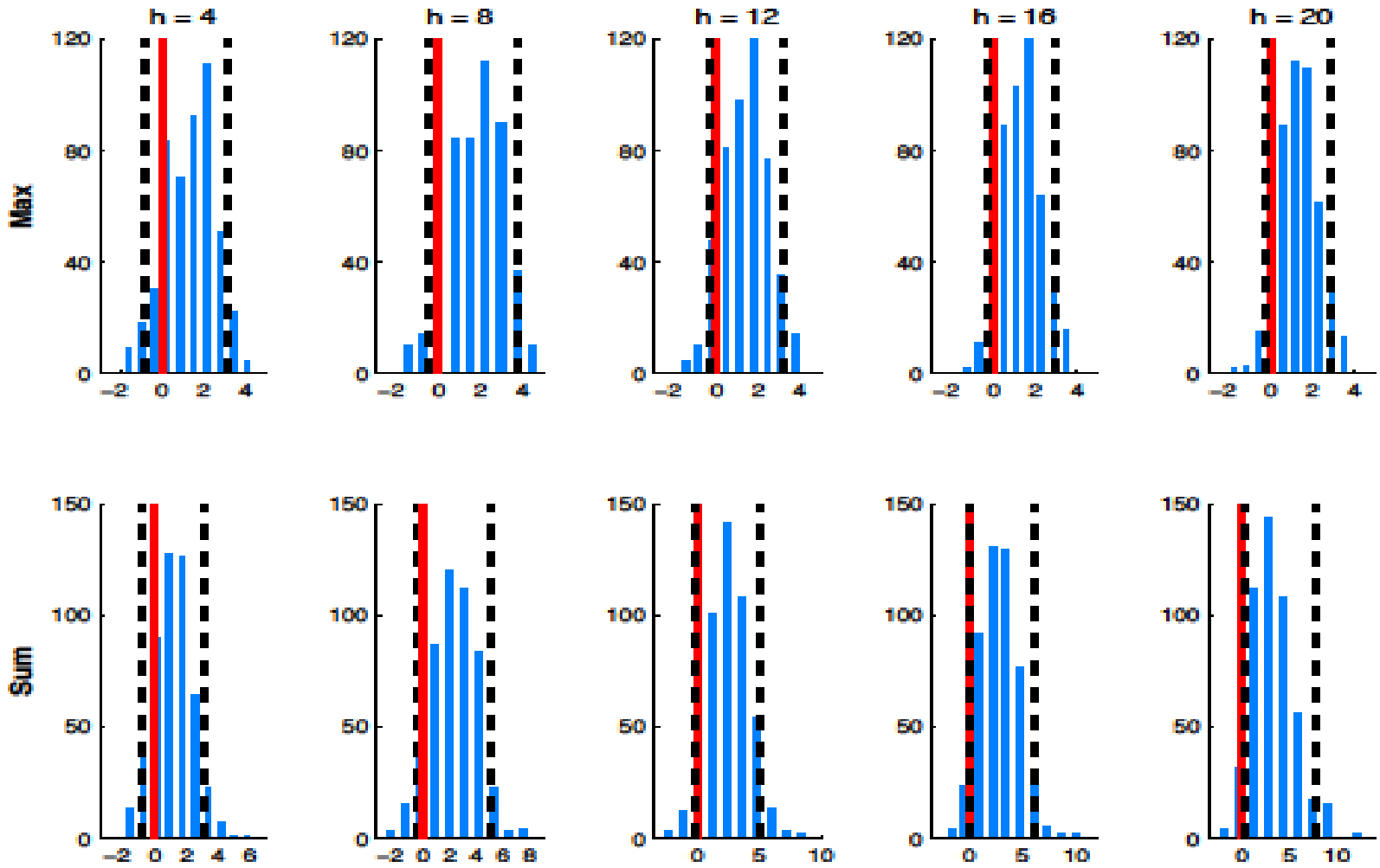

Output
2
1
0
−1
−2
5
10
15
20


Fiscal News
1.5
1
0.5
0
5
10
15
20

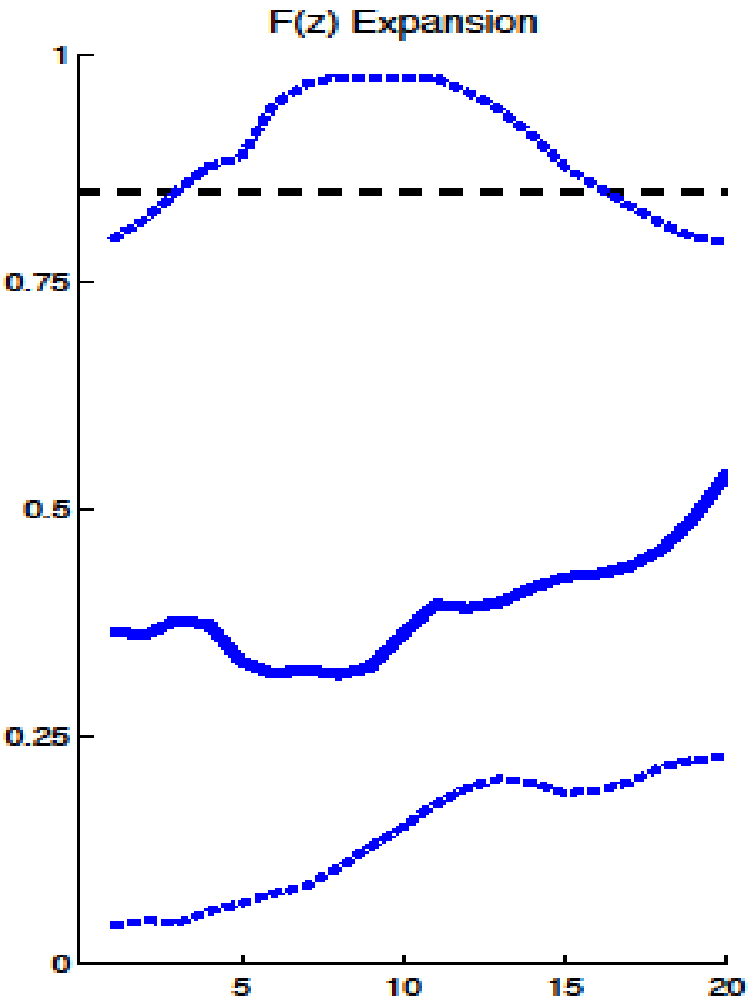
Fiscal multipliers

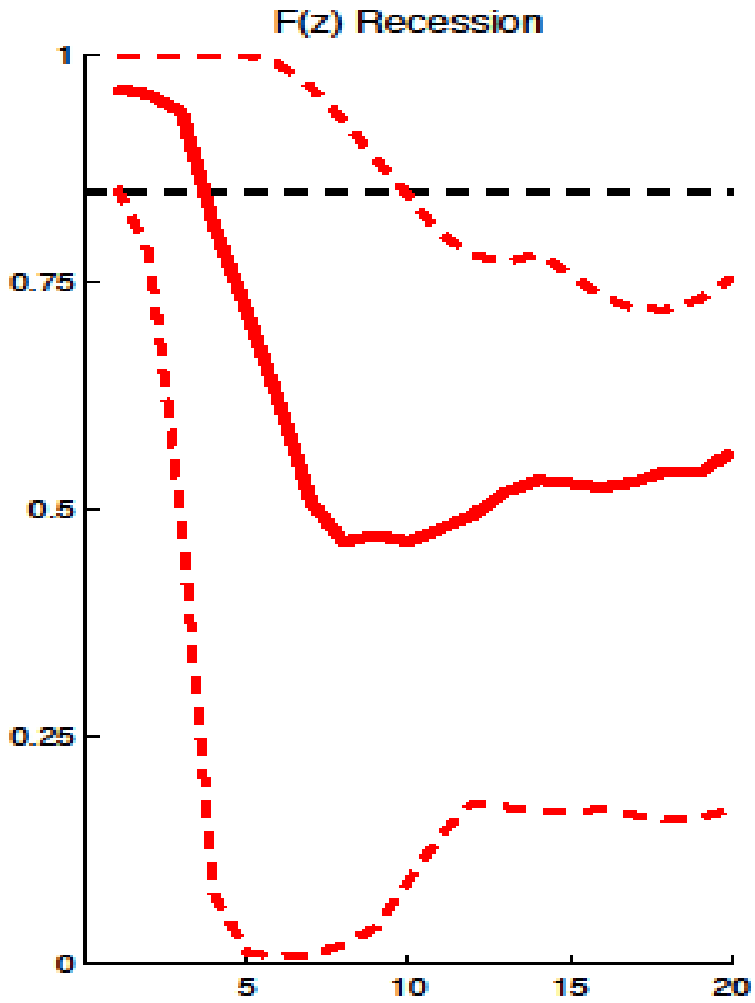
	Peak		*Sum*	
Horizon / State	*Expansion*	*Recession*	*Expansion*	*Recession*
4	1.44 [0.95,3.19]	3.02 [1.64,4.22]	1.45 [0.26,3.22]	2.90 [1.14,3.94]
8	0.94 [0.65,2.42]	2.62 [1.07,4.21]	0.24 [−0.77,2.56]	2.50 [0.25,4.24]
12	0.86 [0.54,1.78]	2.23 [1.02,3.49]	−0.41 [−1.72,1.32]	1.74 [−0.16,3.31]
16	0.83 [0.47,1.64]	2.10 [1.01,3.24]	−1.03 [−2.68,0.49]	1.20 [−0.52,2.58]
20	0.82 [0.44,1.61]	2.09 [1.00,3.14]	−1.65 [−3.84,−0.15]	0.80 [−0.87,2.11]

Multipliers: Recessions vs. Expansions



Probability of recession





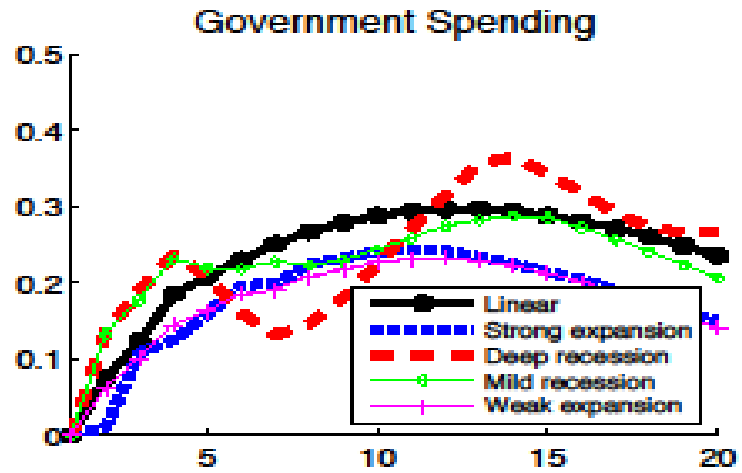
Results conditional on all histories

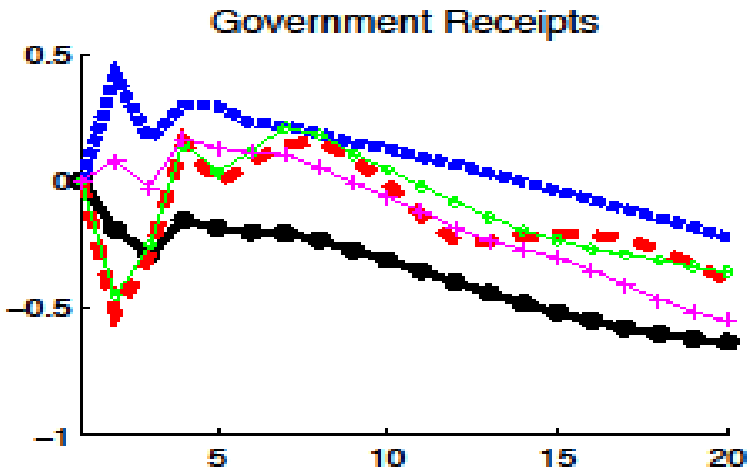
- Responses of output **not necessarily stronger under recession** [rel.: Ramey et al (2013), Ramey and Zubairy (2013)]
- Multipliers **not necessarily larger under recession**
- Transition probabilities **quite uncertain**
- Multipliers under recessions **larger than one**

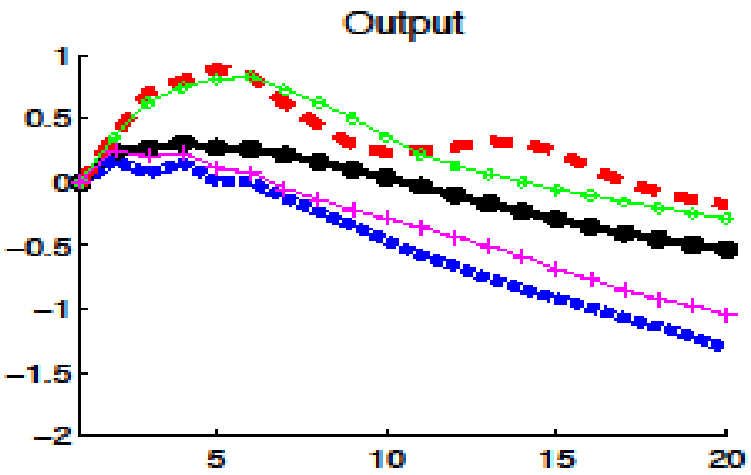
Extreme events

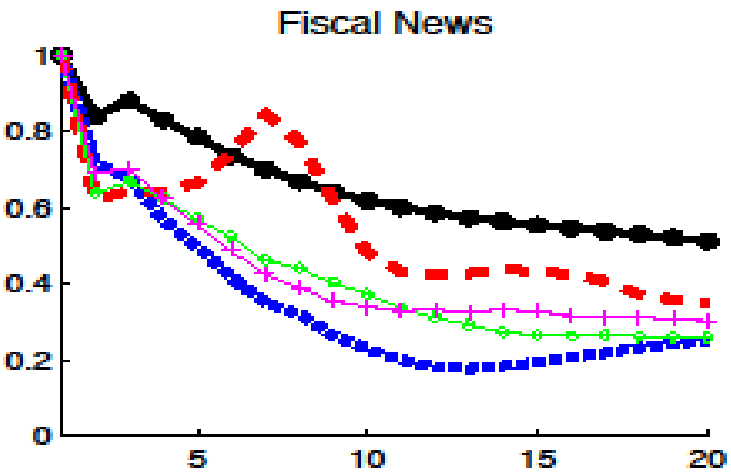
- Results obtained so far: Randomization over all histories
- Are recessions (expansions) alike?
- Effects of fiscal shocks may very well be stronger when economic conditions quite severe!
- Randomize over **"extreme events"**:
- **"deep recessions"** $(z < -2\%)$: 1982Q1, 1982Q3, 2008Q4-2009Q3
- **"strong expansions"** $(z > 2\%)$: 1983Q4-1984Q2

GIRFs: Extreme events









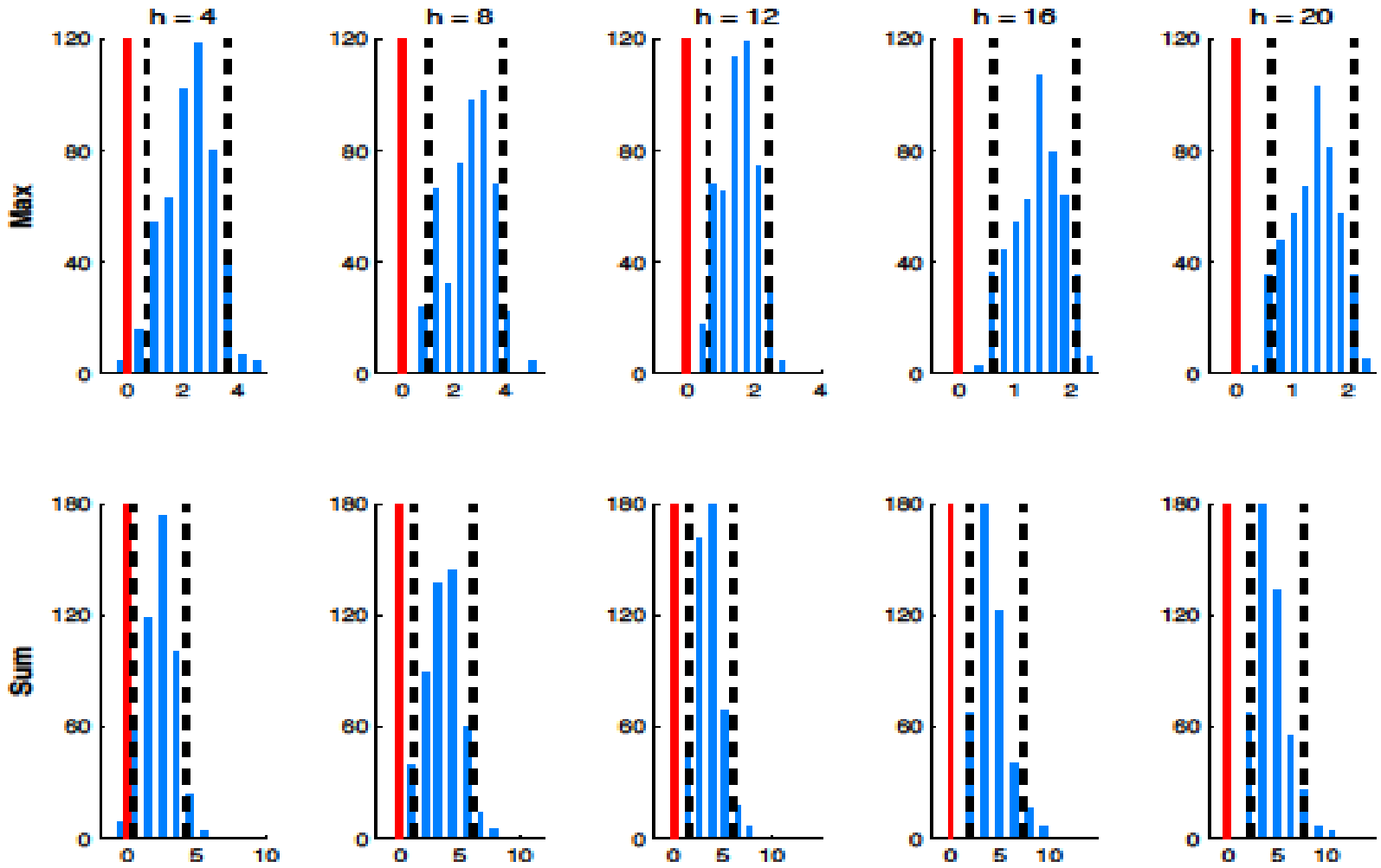
Multipliers: Extreme events

	Peak			
Hor./State	*Strong exp.*	*Deep rec.*	*Weak exp.*	*Mild rec.*
4	0.98 [0.67,1.55]	2.95 [2.04,4.00]	1.44 [0.96,3.19]	3.02 [1.63,4.03]
8	0.63 [0.46,0.96]	2.49 [1.52,3.47]	0.95 [−0.66,2.42]	2.74 [1.05,4.58]
12	0.56 [0.40,0.83]	2.17 [1.43,2.87]	0.87 [0.54,1.78]	2.28 [1.01,3.83]
16	0.52 [0.34,0.77]	2.15 [1.41,2.84]	0.84 [0.48,1.64]	2.16 [0.99,3.53]
20	0.48 [0.28,0.74]	2.14 [1.40,2.84]	0.83 [0.45,1.61]	2.12 [0.98,3.36]

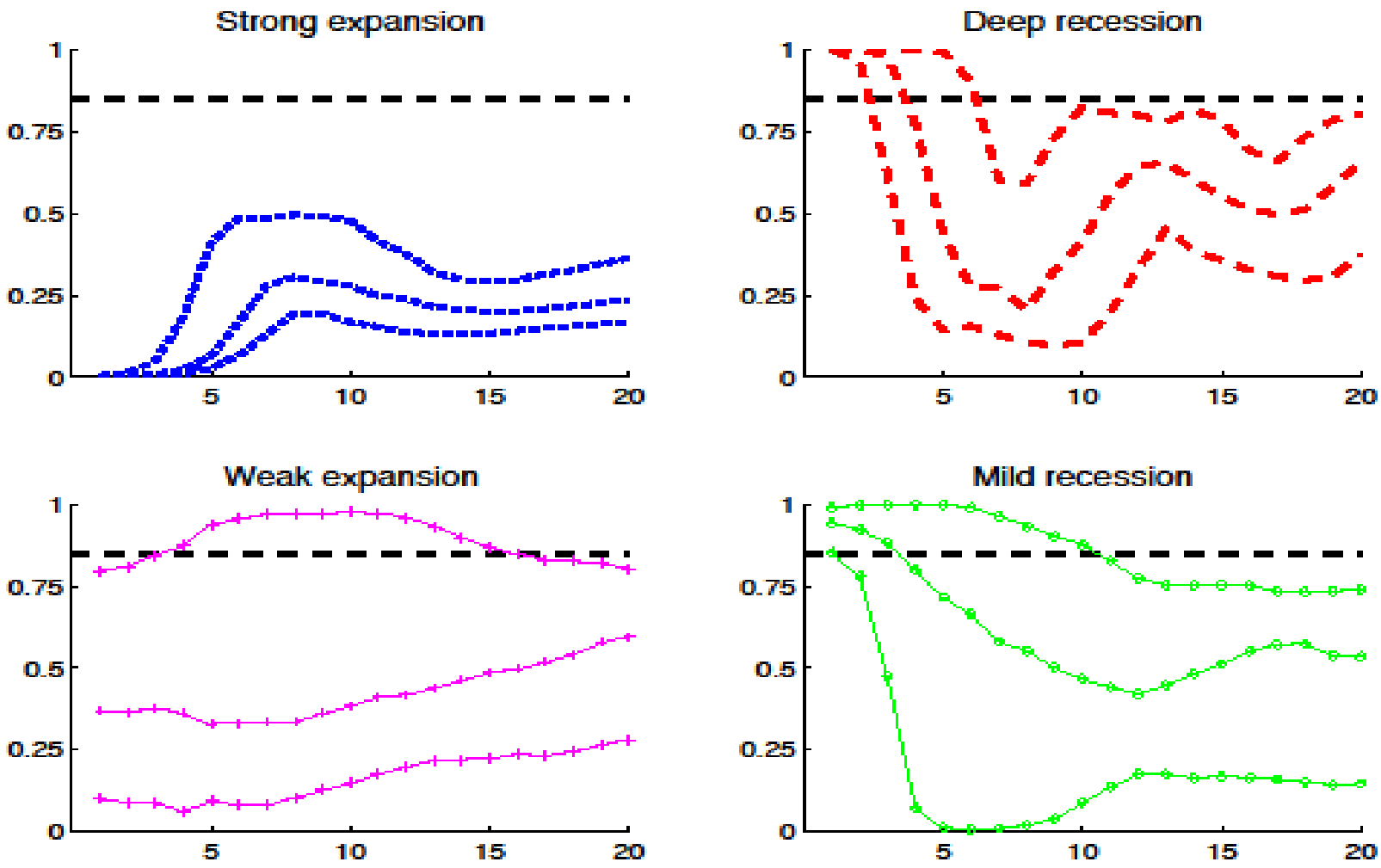
Multipliers: Extreme events (cont'd)

	Sum			
Hor./State	*Strong exp.*	*Deep rec.*	*Weak exp.*	*Mild rec.*
4	0.78 [−0.92,1.76]	2.87 [1.86,3.73]	1.45 [0.33,3.22]	2.89 [1.12,3.97]
8	−0.23 [−1.83,0.69]	2.31 [1.06,3.39]	0.25 [−0.74,2.56]	2.63 [0.25,4.57]
12	−1.05 [−2.77,−0.10]	1.74 [0.67,2.53]	−0.4 [−1.62,1.32]	1.77 [−0.17,3.64]
16	−1.96 [−4.05,−0.75]	1.39 [0.39,2.17]	−1.02 [−2.63,0.49]	1.17 [−0.52,2.85]
20	−3.03 [−5.60,−1.44]	1.16 [0.15,1.98]	−1.64 [−3.80,−0.15]	0.68 [−0.87,2.37]

Multipliers: Deep recessions vs. Strong expansions



Probability of recession: Extreme events



Results conditional on extreme events

- Responses of output **stronger under recession** [Auerbach and Gorodnichenko (2012a, 2013)]
- Multipliers **larger under recession**
- Transition probabilities **quite precisely estimated**
- Multipliers under recessions **larger than under expansions**

Conclusions

- **Anticipated fiscal spending shocks** trigger a **significant reaction of output**
- Such reaction is **not significantly different between states** when **randomizing over all initial conditions** (recessions/expansions)
- Such reaction is **statistically different when focusing on "extreme events"** (randomization over **deep recessions/strong expansions**)
- **Fiscal multipliers in recessions are larger than one**
- **Spending news shocks** in recession **induce economic stabilization**

To come

- FAVAR
- Business confidence (Bachmann and Sims, 2012), real interest rate (Canova and Pappa, 2011)
- Impact on consumption and real wages to discriminate between RBC and NK mechanisms (Pappa, 2009)
- Impact on subcomponents of GDP, e.g. durable private spending (Berger and Vavra, 2012, 2014)

Thank you!

Data

- U.S. quarterly data, 1981Q3-2013Q1
- G: Fiscal expenditures – sum of Federal, state, and local consumption expenditures and gross government investments minus consumption of fixed capital. Source: NIPA's Table 3.1.
- T: Current tax recepits – difference between Federal, state, and local current recepits and government social benefits. Source: NIPA's Table 3.1.
- Y: Real GDP (billions of chained 2009 dollars). Source: Federal Reserve Bank of St. Louis.
- $News_{13}$: Constructed by employing forecast revisions regarding mean predictions over future fiscal real fiscal Federal spending expressed in growth rates. Source: Survey of Professional Forecasters.