A New Identification Of Fiscal Shocks Based On The Information Flow

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London Business School

ESSIM 2015
Tarragona – 26th May 2015

The Information Flow on Fiscal Spending

Before

The Obama administration's plan to reduce the number of U.S. troops in Iraq and Afghanistan will cut the Pentagon's war budget by $42 billion - a 26 percent decrease from this year's level, according to government officials. [Bloomberg News, 21 Jan 2011]

Upon

Lawmakers voted last night by wide margins to pass legislation ending the shutdown. Obama signed the bill just after midnight. The measure suspends the debt limit, puts government workers back on the job starting today and permits the U.S. to pay its debts, benefits and salaries. [Bloomberg News, 17 Oct 2013]

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The economy in the U.S. expanded more than forecast in the third quarter, capping its strongest six months in more than a decade, as gains in government spending and a shrinking trade deficit made up for a slowdown in household purchases. [Bloomberg News, 30 Oct 2014]

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A New Identification

Based on the Information Flow

Identification of **fiscal spending** shocks:

- *Imperfect information* & *fiscal foresight*
- New measures of the information flow: *before*, *upon* and *after*
- Three orthogonal shocks :

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     agents identify *upon* impact
  3. **Misexpected Fiscal Changes***
     agents learn *after* the impact

* names borrowed from the Psychological literature `more...`

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A New Identification

Delayed-information – e.g., Mankiw and Reis (2002)
...or **Noisy-information** – e.g., Woodford (2001)

- Information slowly absorbed
  ⟶ Forecast errors: current and past shocks
- Correlated expectations revisions
  ⟶ Proxies for shocks (conditional on their past)
- Imperfect knowledge of the state of the Economy
  ⟶ Nowcast errors ("misexpectations")
- Heterogenous beliefs
  ⟶ Aggregation bias

More...

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A New Identification

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More...

A New Identification

▶ Use a **large information** set exceeding agents' one...

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- Use a **large information** set exceeding agents' one...
- and **individual forecasts** (aggregation bias) to extract...

A New Identification

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- ▶ and **individual forecasts** (aggregation bias) to extract...
- ▶ ..."**news**" (expectation revisions) at different horizons...

A New Identification

The approach of this paper

- Use a **large information** set exceeding agents' one...
- and **individual forecasts** (aggregation bias) to extract...
- ..."**news**" (expectation revisions) at different horizons...
- ... and "**misexpectations**" (nowcast errors)...

A New Identification

- Use a **large information** set exceeding agents' one...
- and **individual forecasts** (aggregation bias) to extract...
- ..."**news**" (expectation revisions) at different horizons...
- ... and "**misexpectations**" (nowcast errors)...
- ...and to identify **expected**, **unexpected** and **misexpected** fiscal spending changes

A New Identification

- **Information matters** in shock identification
- Expected/Unexpected fiscal expansion:
    - **Large output effects**

        The multiplier for government spending is probably between 0.8 and 1.5 [Ramey JEL (2011)]

    - **Investment accelerator**, not consumption
    - Prices increase, **real exchange rate appreciates**
- Misexpected: **reconciliation previous results**

A New Identification

	Previous Contrib.	This Paper
Output Mult.		
Investiment		
Gov't Spend		
REE		
CPI		

A New Identification

	Previous Contrib.	This Paper
	SVAR/EVAR	
Output Mult.	≤ 1	
Investiment	$\Downarrow$	
Gov't Spend	not persistent	
REE	$\Downarrow$	
CPI	$=$	

A New Identification

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A New Identification

	Previous Contrib.	This Paper	
	SVAR/EVAR	Misexp.	Unexp.
Output Mult.	≤ 1	≤ 1	> 1
Investiment	$\Downarrow$	$\Downarrow$	$\Uparrow$
Gov't Spend	not persistent	not persistent	persistent
REE	$\Downarrow$	$\Downarrow$	$\Uparrow$
CPI	$=$	$=$	$\Uparrow$

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A New Identification

Contributions

	Previous Contrib.	This Paper	
	SVAR/EVAR	Misexp.	Unexp./Exp.
Output Mult.	≤ 1	≤ 1	> 1
Investiment	$\Downarrow$	$\Downarrow$	$\Uparrow$
Gov't Spend	not persistent	not persistent	persistent
REE	$\Downarrow$	$\Downarrow$	$\Uparrow$
CPI	$=$	$=$	$\Uparrow$

A New Identification

	Previous Contrib.	This Paper	
	SVAR/EVAR	Misexp.	Unexp./Exp.
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A New Identification

The effects of fiscal spending shocks: output

Output Effects of Fiscal Changes

A New Identification

The effects of fiscal spending shocks: output

Output Effects of Fiscal Changes

A New Identification

- **Fiscal Policy:** Ramey (2011), Perotti (2011), Leeper et al. (2013), Leeper et al. (2012), Monacelli et al (2010); Caldara and Kamps (2012), Mertens and Ravn (2010,2012), Alesina et al. (2012), Corsetti et al (2012), Born et al (2013), Forni and Gambetti (2014), Zeev and Pappa (2014) More...

- **Imperfect Information:** Woodford (2001), Mankiw and Reis (2002), Reis (2006a,b), Sims (2003), Mackowiak and Wiederholt (2009), Coibion and Gorodnichenko (2010, 2012), Andrade and Le Bihan (2013)

- **News and Imperfect Information:** Beaudry and Portier (2006), Barsky and Sims (2012), Blanchard et al. (2013), Leduc and Sill (2010), Schmitt-Grohe and Uribe (2008), Jaimovich and Rebelo (2009), Scheinkman and Xiong (2003), Burnside et al. (2011), Forni et al (2014)
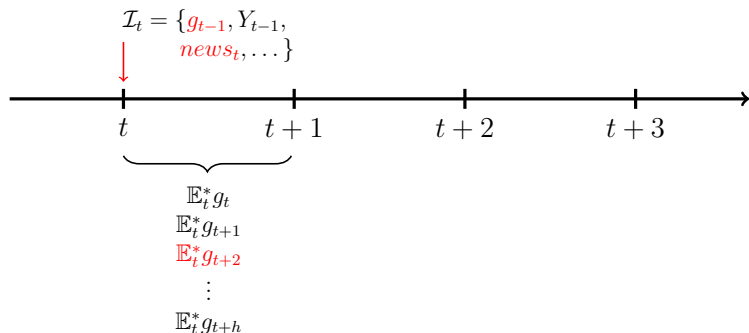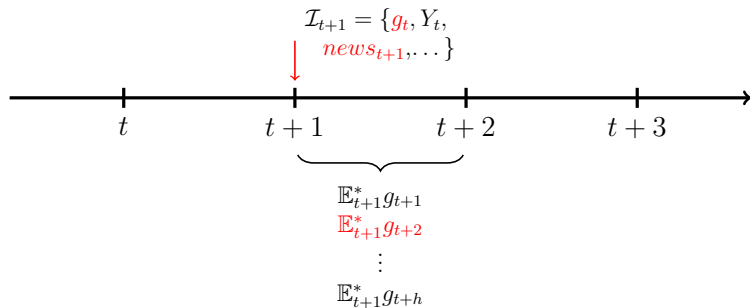
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The Information Flow

The Information Flow

The Information Flow

$\mathcal{I}_{t+1} = \{g_t, Y_t, news_{t+1}, \dots\}$

$\mathbb{E}^*_{t+1} g_{t+1}$
$\mathbb{E}^*_{t+1} g_{t+2}$
$\vdots$
$\mathbb{E}^*_{t+1} g_{t+h}$

The Information Flow

The Information Flow

$$\mathcal{I}_{t+3} = \{g_{t+2}, Y_{t+2},\ news_{t+3}, \ldots\}$$
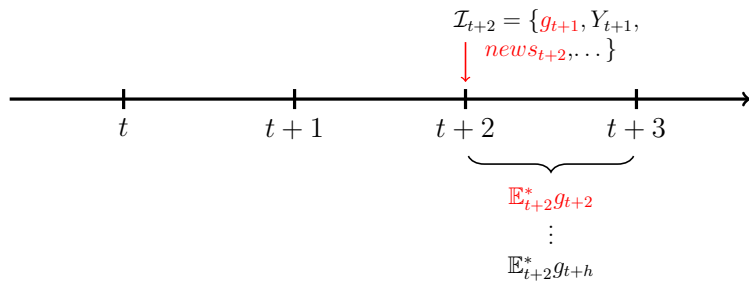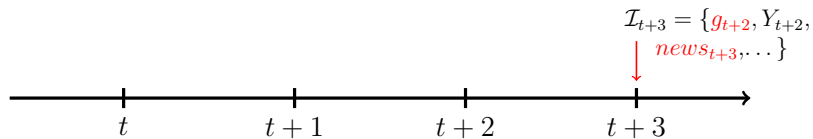
The Information Flow

$$\underbrace{g_t - \mathbb{E}^*_{t-2}g_t}_{\substack{\text{forecast error} \\ \text{2 periods ahead}}} \quad = \quad \underbrace{\left(g_t - \mathbb{E}^*_t g_t\right)}_{\substack{\text{nowcast error} \\ \notin \mathcal{I}_t}} \quad +$$

$$+ \quad \underbrace{\left(\mathbb{E}^*_t g_t - \mathbb{E}^*_{t-1}g_t\right)}_{\substack{\text{nowcast revision} \\ \text{(news at t)} \in \mathcal{I}_t}} \quad +$$

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The Information Flow

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- Measure of misexpectations
- Modify agents' information set at t+h (*after*)
- Dominate VAR residuals, difficult to interpret

The Information Flow

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- ► Measure of fiscal news on the current quarter
- ► Modify agents' information set at t (*upon*)
- ► Have predictive power and are easy to interpret

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The Information Flow

$$\underbrace{g_t - \mathbb{E}^*_{t-2}g_t}_{\substack{\text{forecast error} \\ \text{2 periods ahead}}} \quad = \quad \underbrace{\left(g_t - \mathbb{E}^*_t g_t\right)}_{\substack{\text{nowcast error} \\ \notin \mathcal{I}_t}} \quad +$$

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- ▶ Measure of fiscal foresight
- ▶ Modify agents' information set at t-h (*before*)
- ▶ Have predictive power and are easy to interpret

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Fiscal Changes

	Unanticipated	Anticipated
Misperceived on impact	*Misexpected Fiscal Changes* $\notin \mathcal{I}_t$ $\underset{\sim}{}$ *proxy: nowcast errors* $g_t - \mathbb{E}_t^* g_t$	
Perceived on impact	*Unexpected Fiscal Changes* $\in \mathcal{I}_t$ $\underset{\sim}{}$ *proxy: nowcast revisions* $\mathbb{E}_t^* g_t - \mathbb{E}_{t-1}^* g_t$	*Expected Fiscal Changes* $\in \mathcal{I}_t$ $\underset{\sim}{}$ *proxy: forecast revisions* $\mathbb{E}_t^* g_{t+h} - \mathbb{E}_{t-1}^* g_{t+h}$

New Measures of Expectations

U.S. Survey of Professional Forecasters Data

Survey Date	History[1]		Quarterly Forecast			
	Q_{-1}	Q_0	Q_{+1}	Q_{+2}	Q_{+3}	Q_{+4}
. . .	. . .	. . .	. . .	. . .	. . .	. . .
2012Q2	G_{2012Q1}	G_{2012Q2}	G_{2012Q3}	G_{2012Q4}	G_{2013Q1}	G_{2013Q2}
2012Q3	G_{2012Q2}	G_{2012Q3}	G_{2012Q4}	G_{2013Q1}	G_{2013Q2}	G_{2013Q3}
2012Q4	G_{2012Q3}	G_{2012Q4}	G_{2013Q1}	G_{2013Q2}	G_{2013Q3}	G_{2013Q4}
. . .	. . .	. . .	. . .	. . .	. . .	. . .

Quarterly SPF forecasts:

- **current** quarter and **four quarters ahead**
- information sets: **previous quarter GDP** and components (advance estimate)
- deadline: **third week of the middle month**
- U.S. Fed Spending from 1981:Q3 to 2012:Q4 More...

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[1]BEA advance estimate

SPF Forecast & Actual Government Growth

SPF Expected Government Spending Growth Rate

SPF Nowcast – Current Quarter

SPF Forecasts – Four Quarters Ahead

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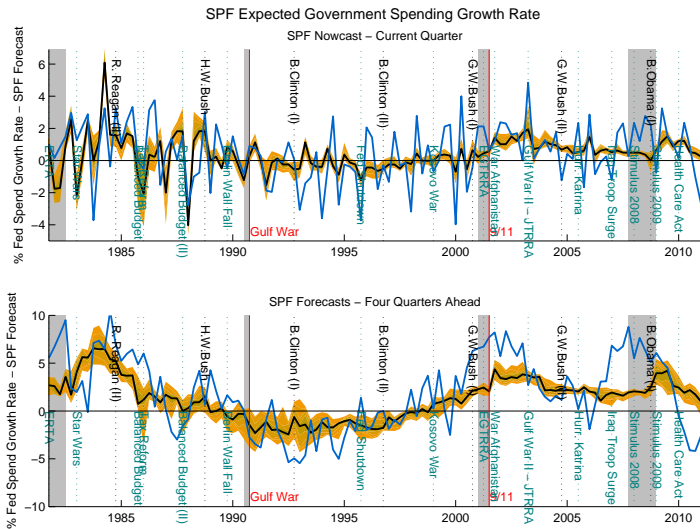
Do Agents Have Full Information?

Granger causation test with factors from a large dataset # 128

	Factor1		Factor2		Factor3		Factor4	
	Fstat	*p-value*	*Fstat*	*p-value*	*Fstat*	*p-value*	*Fstat*	*p-value*
Forecast Err.	2.99**	(0.05)	0.57	(0.64)	3.95***	(0.01)	2.97	(0.04)
Nowcast Err.	1.07	(0.35)	0.00	(1.00)	6.21***	(0.00)	1.24	(0.29)

- ▶ Forecast and nowcast errors are **forecastable**
- ▶ Forecast revisions ('news') and forecast errors are **correlated**

Presence of information rigidities! [Coibion and Gorodnichenko (2010, 2012), Andrade and Le Bihan (2012)]

Empirical Measures of Fiscal News

Aggregate economy

Nowcast Errors

$$\widehat{n.c.err}_t = \text{Median}(g_t - \mathbb{E}^{*i}_t g_t)$$

Fiscal News on the current quarter

$$\widehat{news}_t(0) = \text{Median}(\mathbb{E}^{*i}_t g_t - \mathbb{E}^{*i}_{t-1} g_t)$$

Fiscal News three quarters ahead

$$\widehat{news}_t(1,3) = \text{Median}\left(\sum_{h=1}^{3}(\mathbb{E}^{*i}_t g_{t+h} - \mathbb{E}^{*i}_{t-1} g_{t+h})\right)$$

Spectra... | Other Macro Shocks... | Individual vs Aggregated...

SPF Implied News and Nowcast Errors

Current quarter
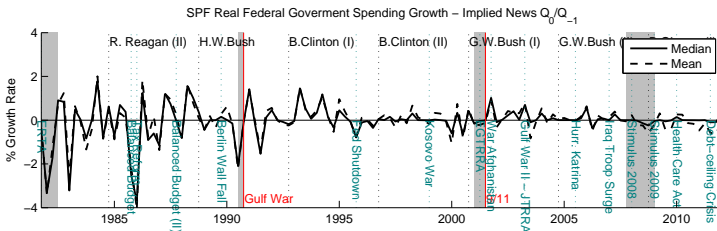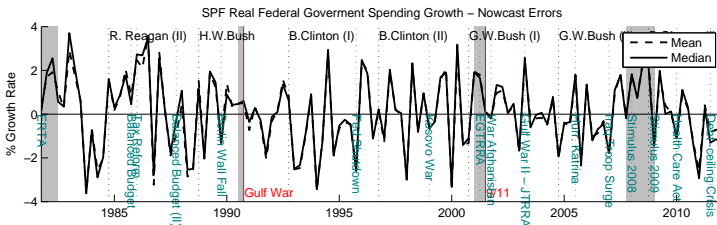
SPF Real Federal Goverment Spending Growth – Nowcast Errors

SPF Real Federal Goverment Spending Growth – Implied News Q_0/Q_{-1}

SPF Implied News

Current and future quarters

SPF Implied News

SPF Forecasts Revisions Current Quarter

SPF Forecasts Revisions One Year Head

SPF Implied News

Current and future quarters

SPF Implied News

SPF Forecasts Revisions Current Quarter

SPF Forecasts Revisions One Year Head
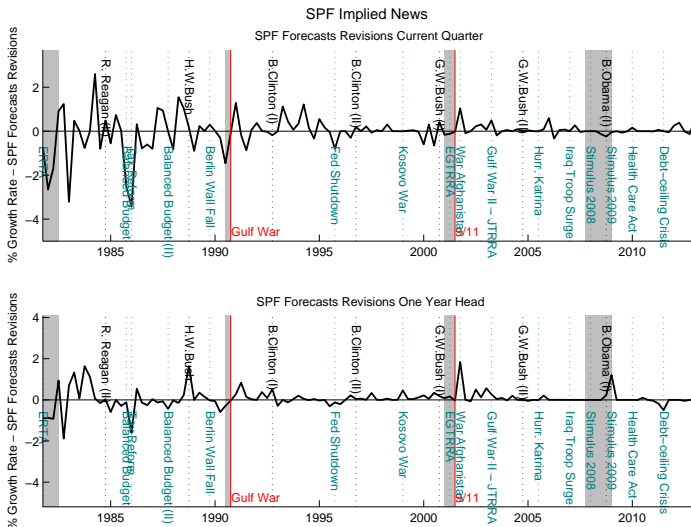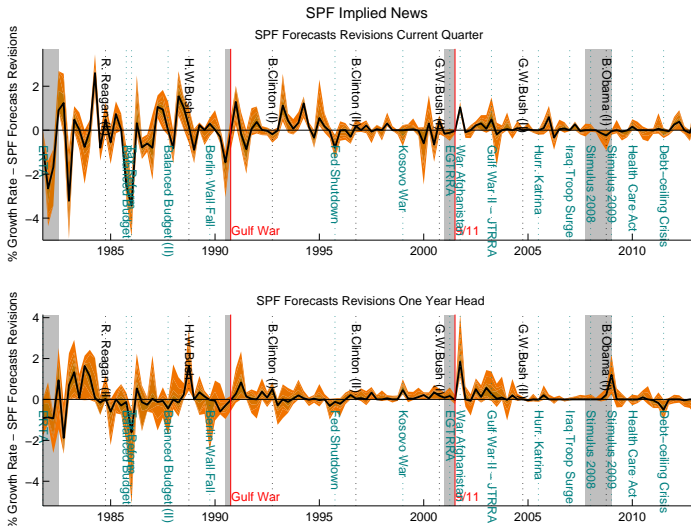
The Empirical Model: Large Bayesian EVAR

Large EVAR

- [ ] *Expectational Variables 1:* News & Nowcast Errors
- [ ] *Expectational Variables 2:* Forecasts for GDP and Unemployment
- [ ] *Expectational Variables 3:* Forward looking variables: prices, inventories, CEO confidence, consumer confidence, . . .
- [ ] *Macroeconomic variables:* Federal spending, S&L spending, Barro-Redlick tax rate, GPD, wages, durables, nondurables and services consumption, investment, real rates, 10-y rates, real exchange rates, . . .

Large VAR [Banbura et al. (2010)] with Litterman priors and sum-of-coefficients priors. Hyperpriors [Giannone, Lenza, Primiceri (2012)]

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Identification of Fiscal Changes

A last spin

Structural Identification – Assumptions

1. fiscal policy doesn't respond to contemporaneous macro-shocks
2. new information *before*, *upon* and *after* actual change
3. new information slowly absorbed
4. spending forecasts incorporate systematic policy responses
5. three shocks are orthogonal

Recursive identification

$$\left(\widehat{news}_t(0) \quad \widehat{n.c.err}_t \quad \hat{\mathbb{E}}_t^* \mathrm{GDP}_t \quad \hat{\mathbb{E}}_t^* \mathrm{U}_t \quad \widehat{news}_t(1,3) \quad Y_t' \right)'$$

Empirical Results

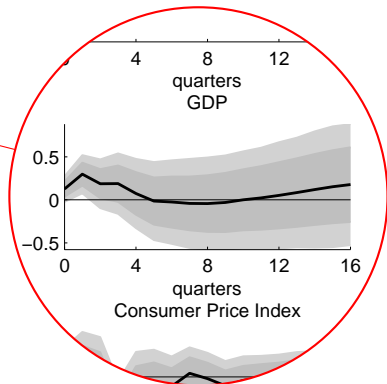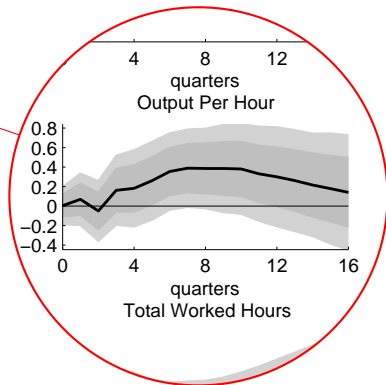# Unexpected Fiscal Changes

Unexpected Federal Fiscal Change
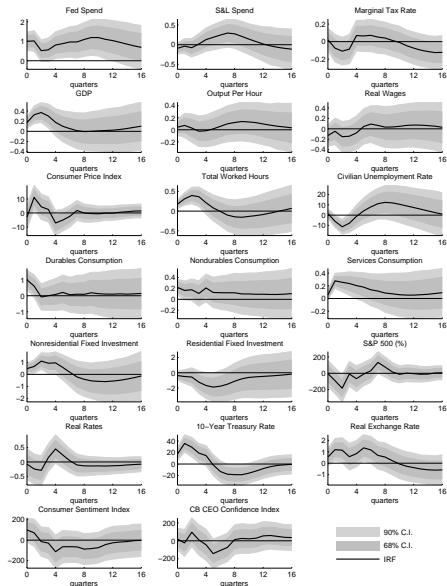
Unexpected Fiscal Changes: Gov't Spending
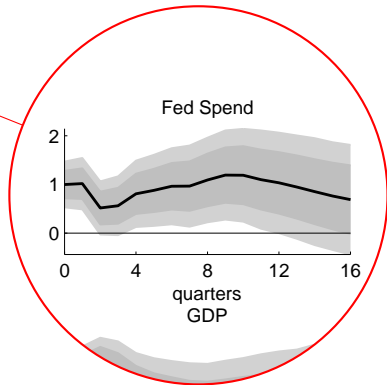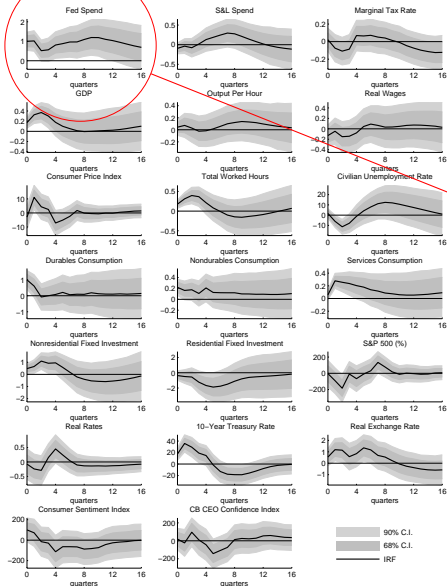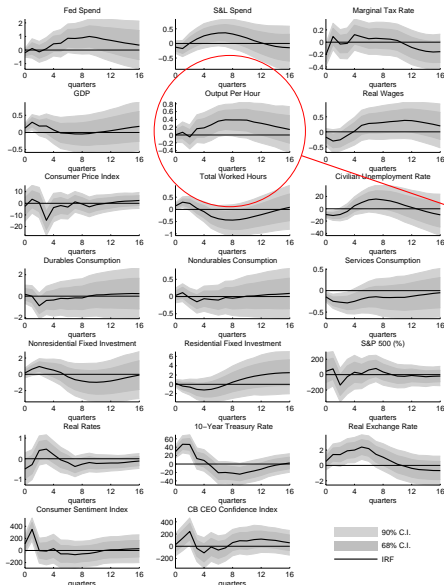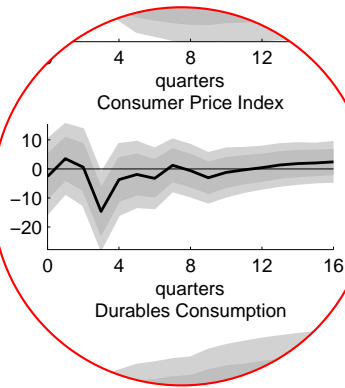
Unexpected Fiscal Changes: GDP
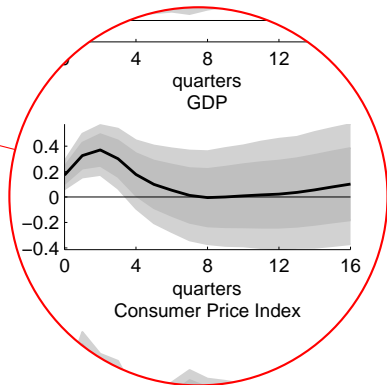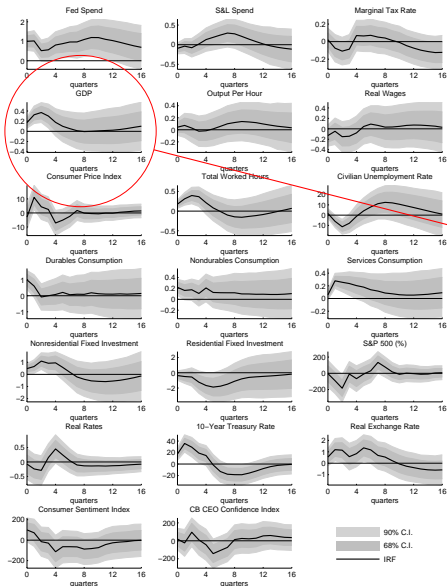
Unexpected Fiscal Changes: CPI Inflation
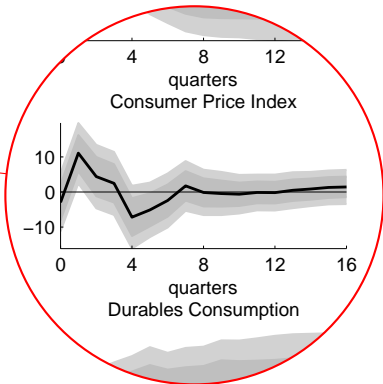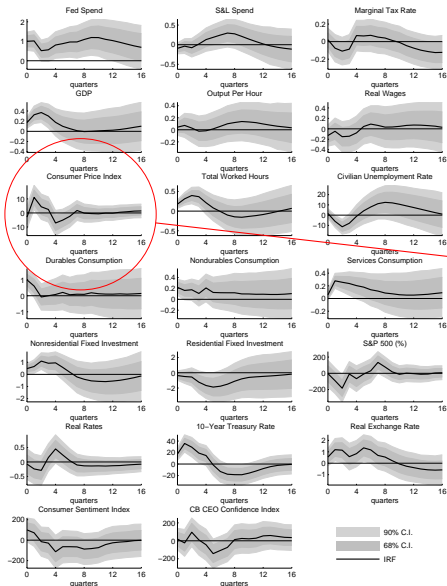
Unexpected Fiscal Changes: Worked Hours

Unexpected Fiscal Changes: Consumption

Unexpected Fiscal Changes: Consumption

Unexpected Fiscal Changes: Consumption
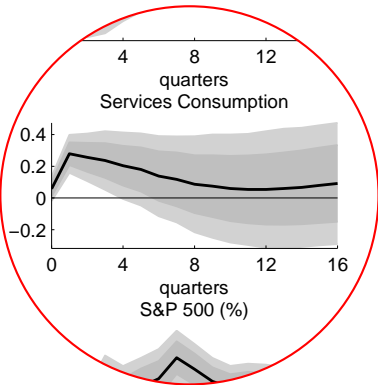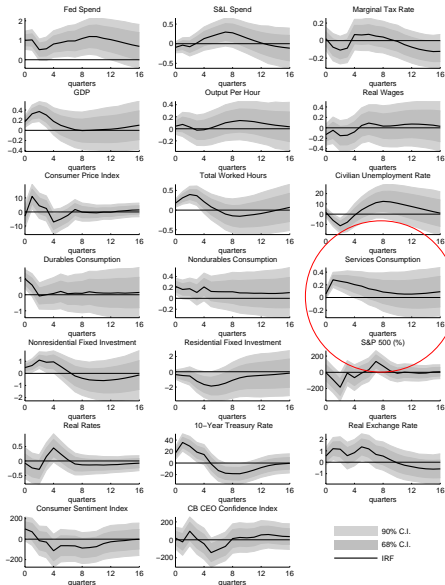
Unexpected Fiscal Changes: Investment
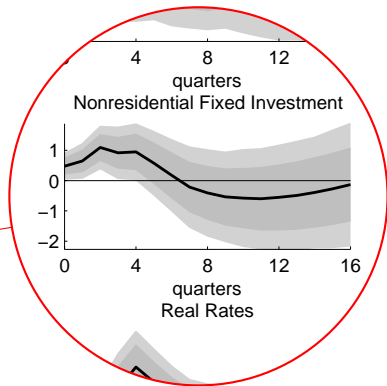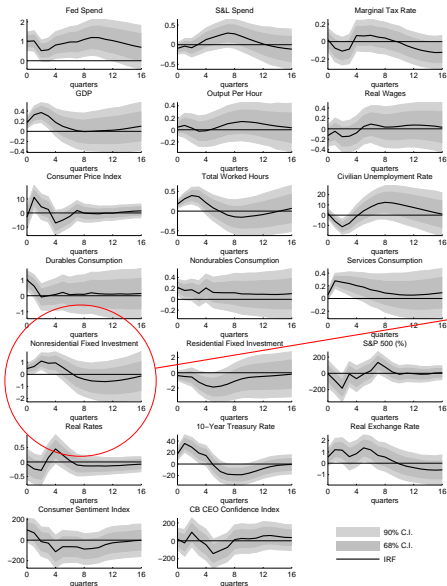
Unexpected Fiscal Changes: 10-Year Rate
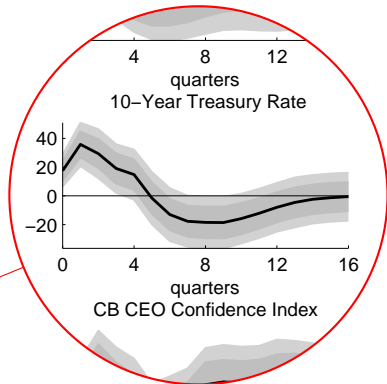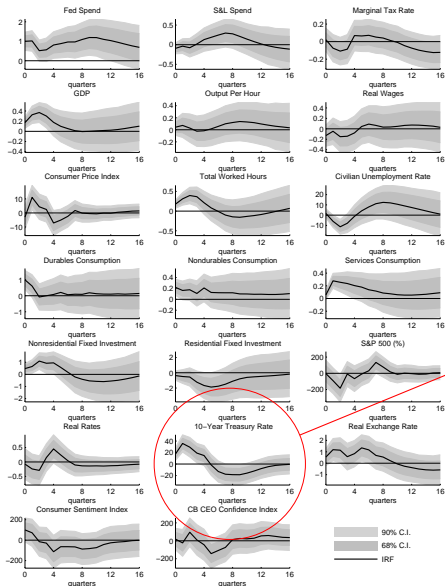
Unexpected Fiscal Changes: Real Exchange Rate

Unexpected Fiscal Changes: Consumers Confidence

Unexpected Federal Fiscal Change
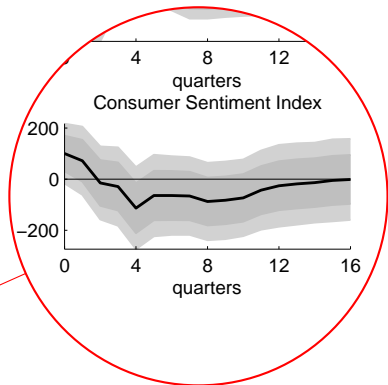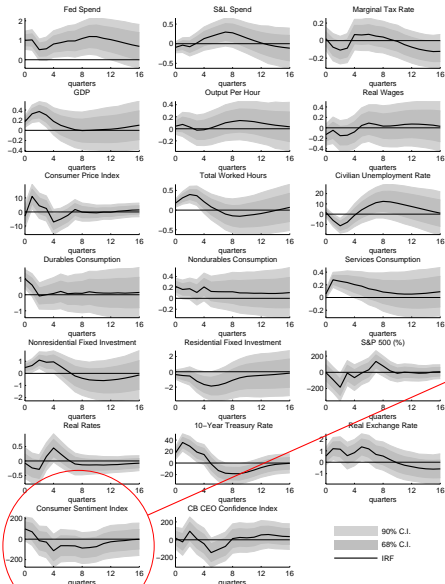
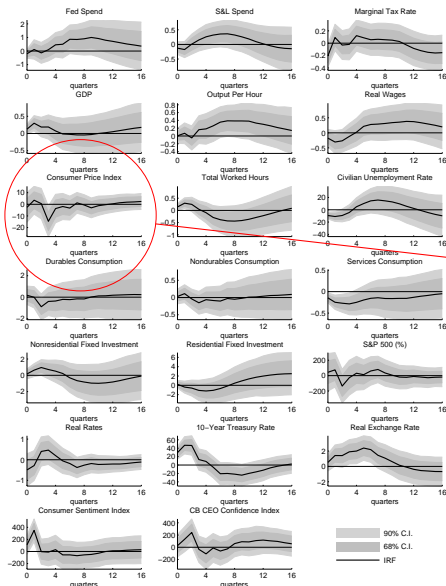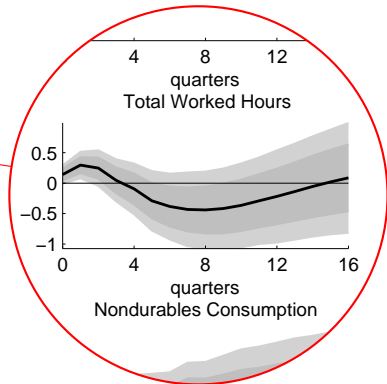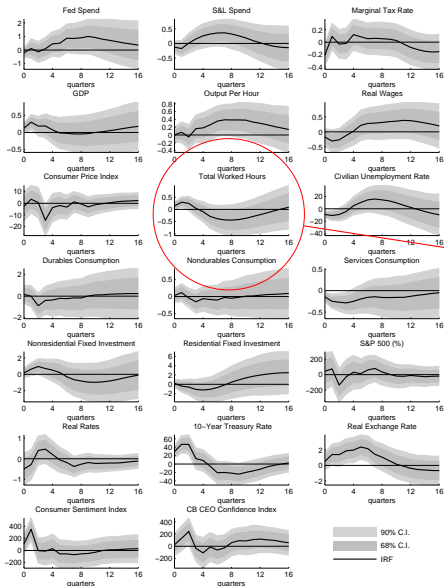# Expected Fiscal Changes

Expected Federal Fiscal Change
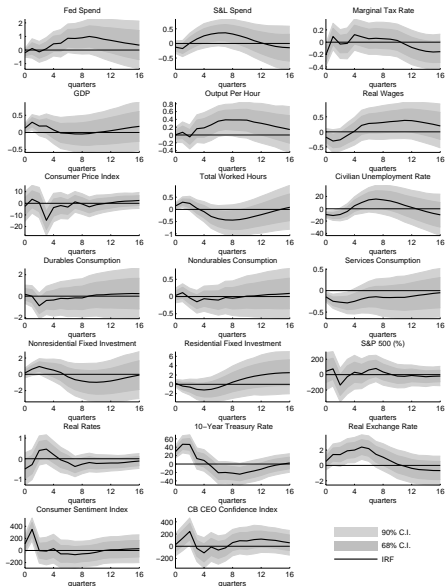
Expected Fiscal Changes: Gov't Spending
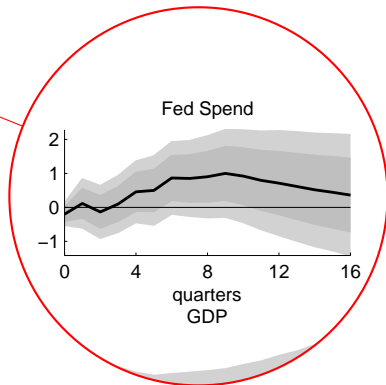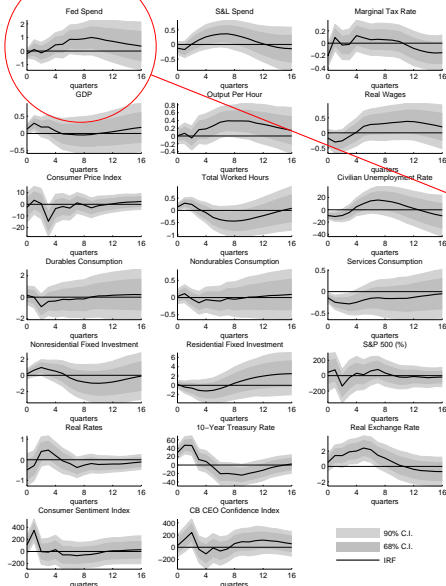
Expected Fiscal Changes: GDP
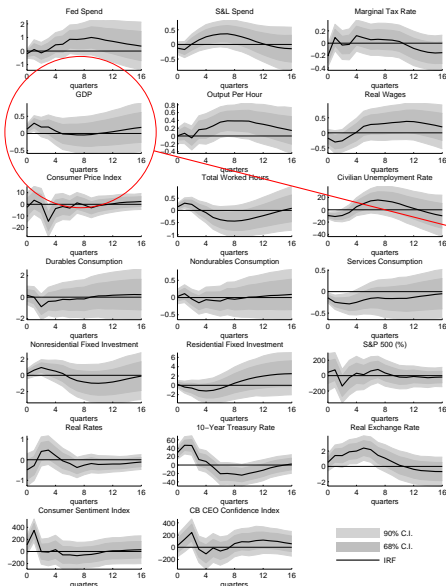
Expected Fiscal Changes: Output per Hour

Expected Fiscal Changes: CPI Inflation
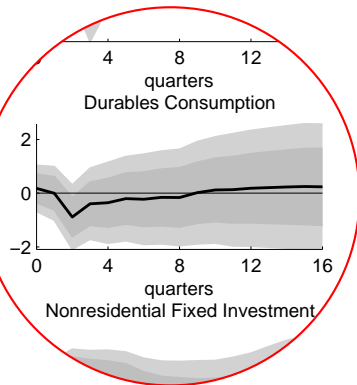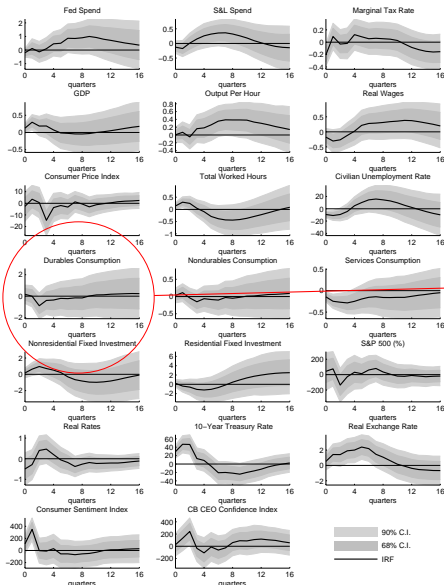
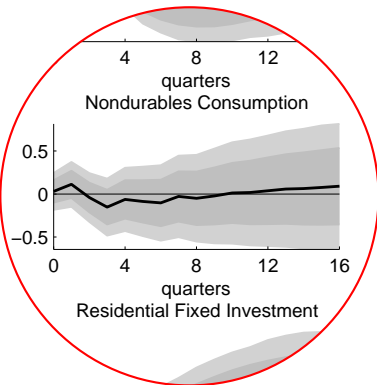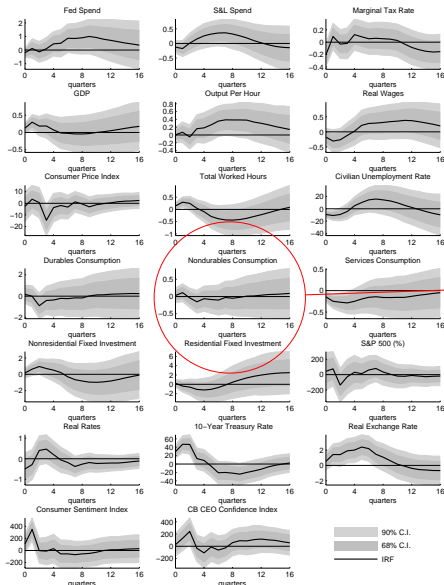# Expected Fiscal Changes: Consumption

Expected Fiscal Changes: Consumption

Expected Federal Fiscal Change

Expected Fiscal Changes: Consumption
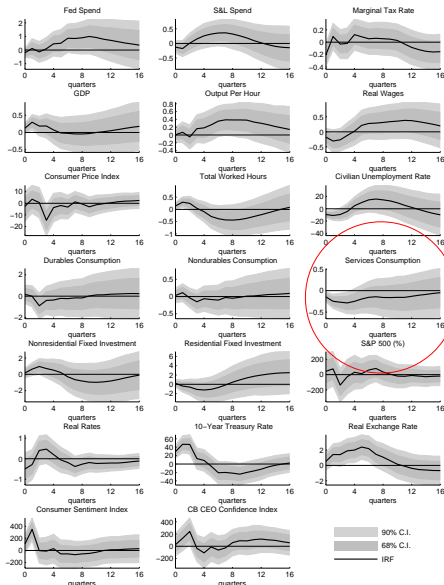
Expected Fiscal Changes: Investment
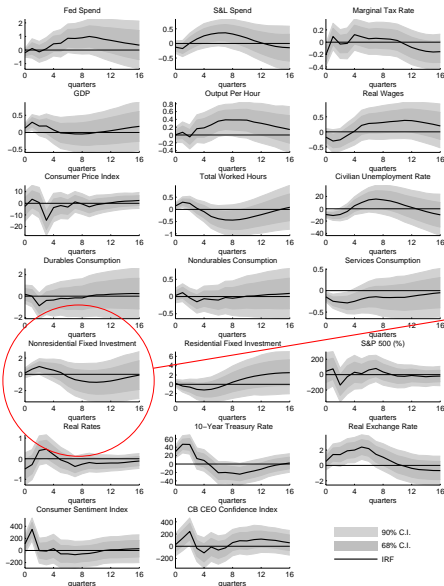
Expected Fiscal Changes: 10-Year Rate

Expected Fiscal Changes: Real Exchange Rate

Expected Fiscal Changes: Consumers Confidence
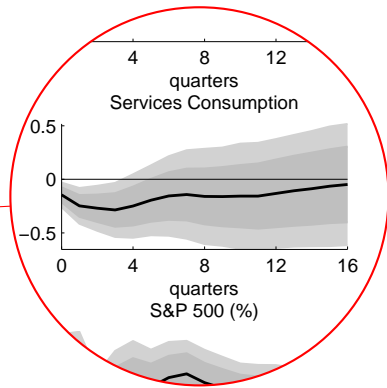
Expected Fiscal Changes: CEO Confidence

Expected Federal Fiscal Change

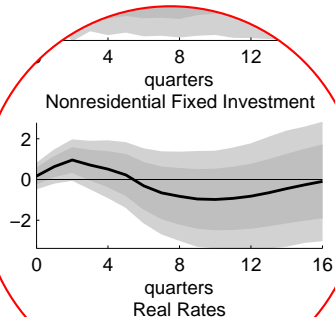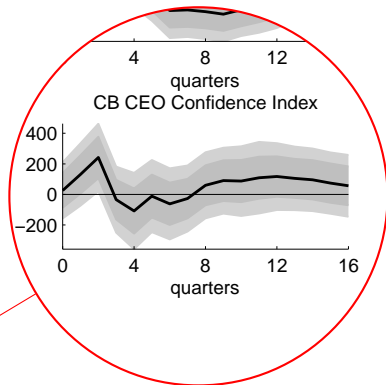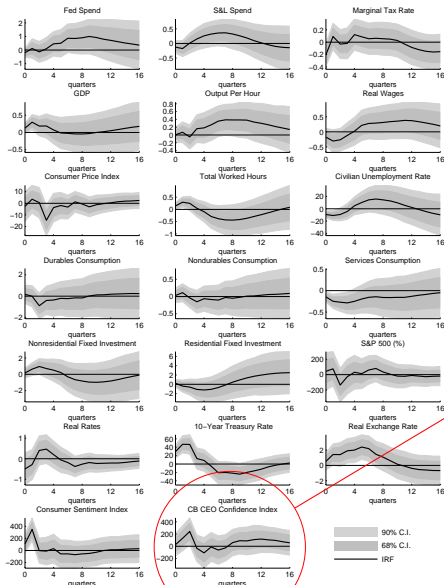# Misexpected Fiscal Changes

Federal Misexpected Fiscal Change

Misexpected Fiscal Changes vs Large SVAR & Ramey
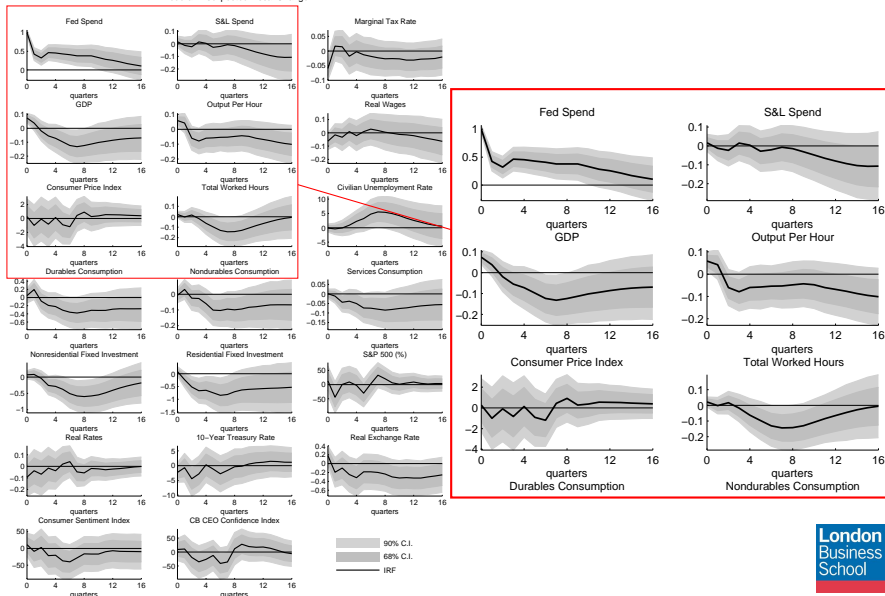
Misexpected Fiscal Changes vs Large SVAR & Ramey

Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes
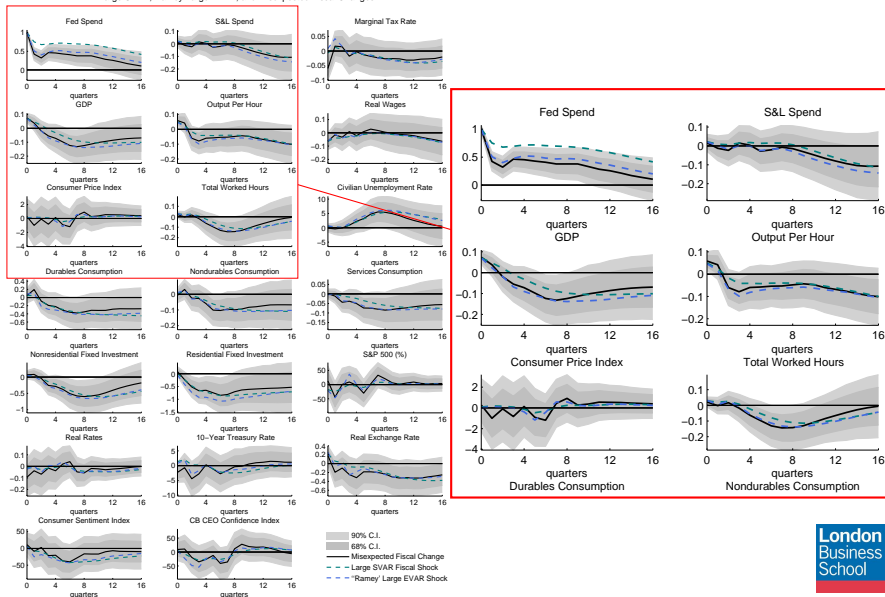
Misexpected Fiscal Changes: Gov't Spending

Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes

Legend:
- 90% C.I.
- 68% C.I.
- Misexpected Fiscal Change
- - - Large SVAR Fiscal Shock
- - - "Ramey' Large EVAR Shock

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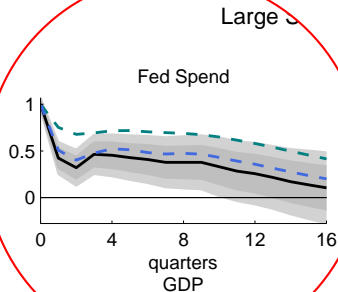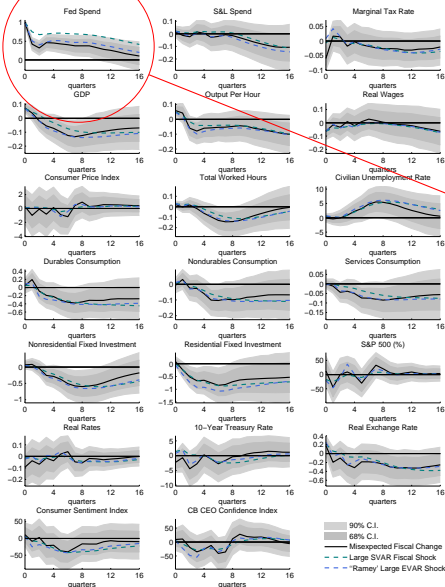
Misexpected Fiscal Changes: GDP

Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes
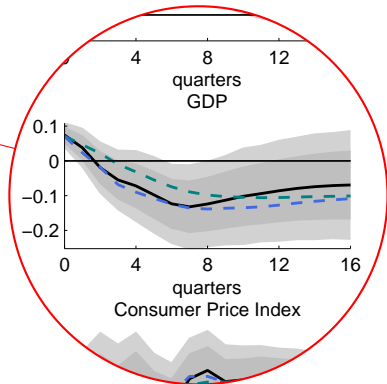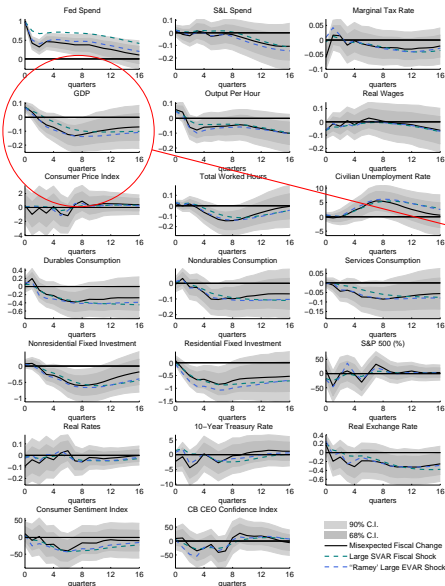
Misexpected Fiscal Changes: CPI Inflation

Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes
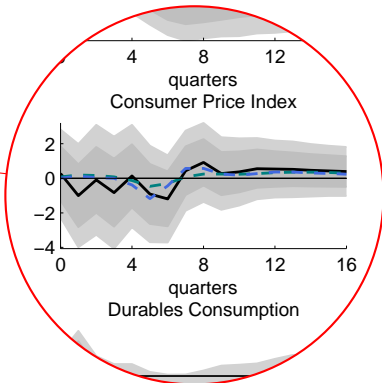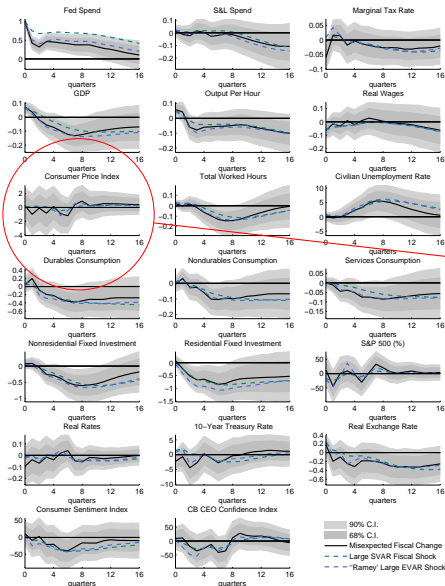
Misexpected Fiscal Changes: Worked Hours

Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes
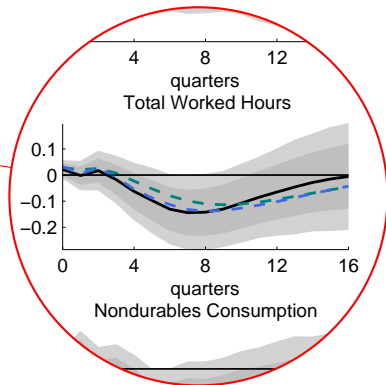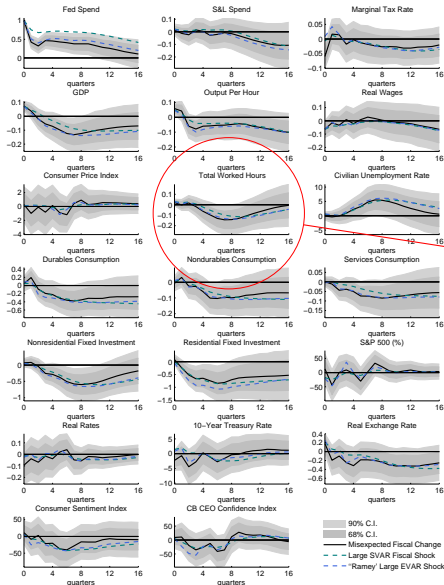
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Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes

Misexpected Fiscal Changes: Consumption

Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes

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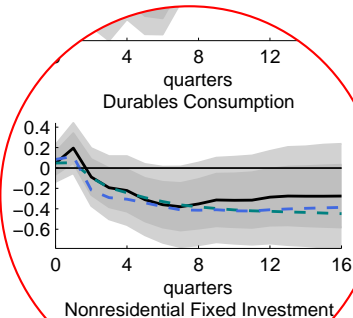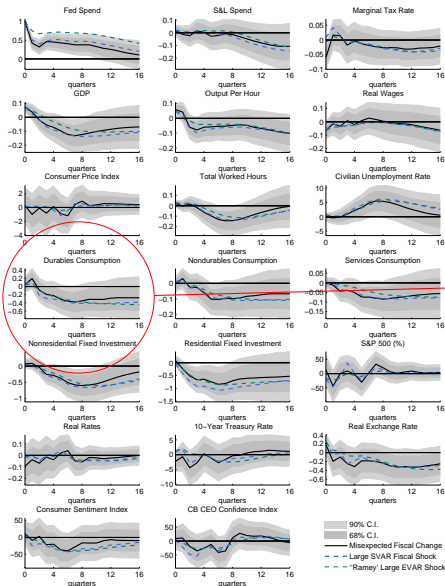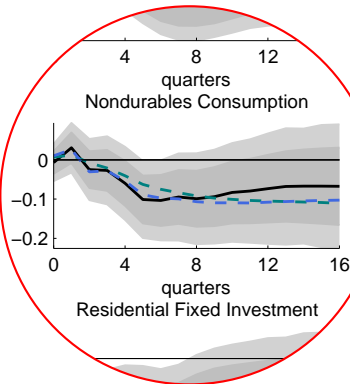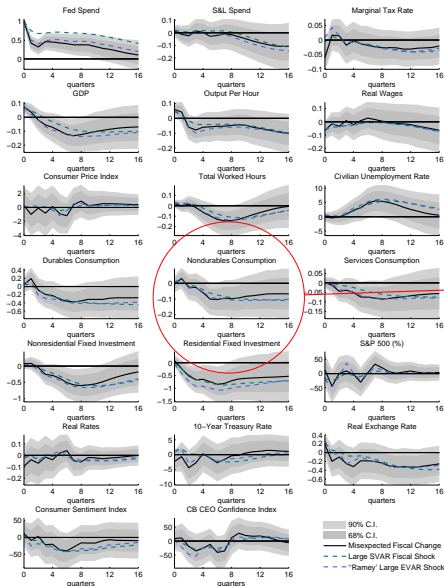
Misexpected Fiscal Changes: Consumption

Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes
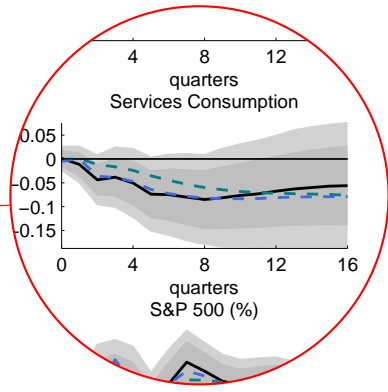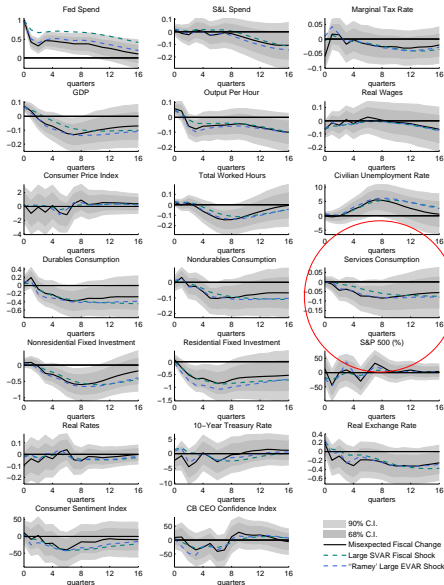
Misexpected Fiscal Changes: Investment

Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes
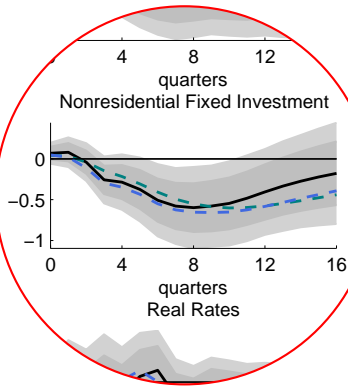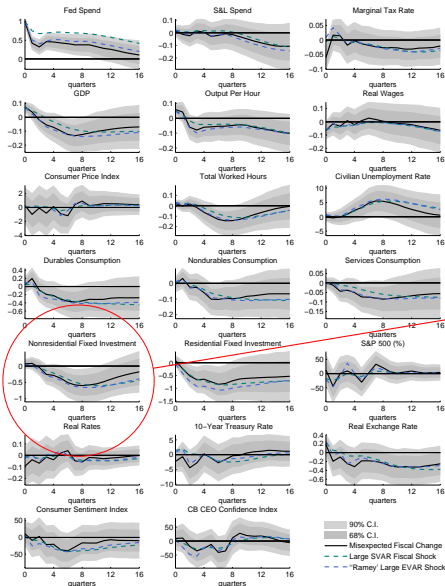
Misexpected Fiscal Changes: 10-Year Rate

Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes
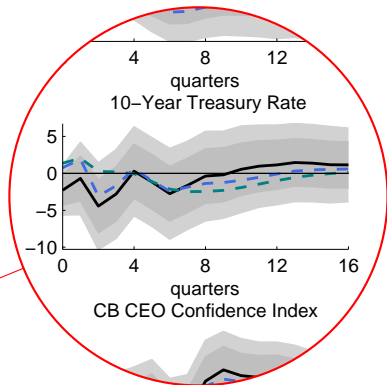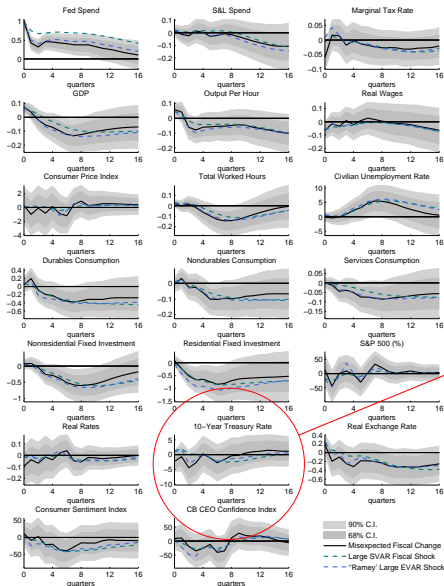
Misexpected Fiscal Changes: Real Exchange Rate

Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes
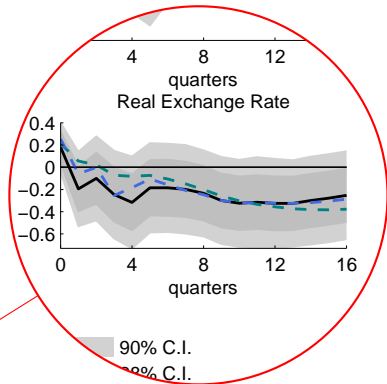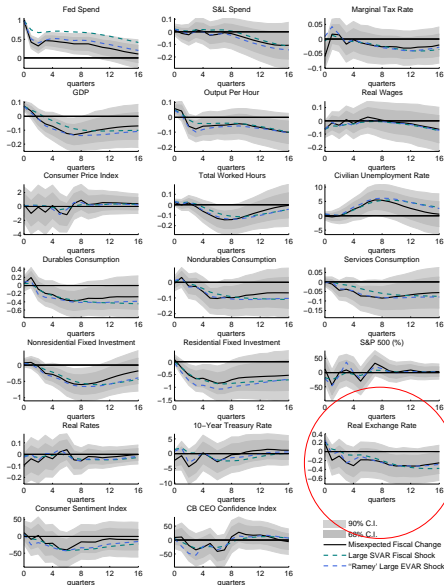
Misexpected Fiscal Changes: Consumers Confidence

Large SVAR, Ramey Large EVAR, and Misexpected Fiscal Changes

What are the Nowcast Errors?

▶ Slow absorption of information

▶ Data revisions

▶ Model mispecifications/Higher order terms

▶ Forecasters' aggregate bias

▶ Accounting issues

▶ Deviations from rational expectations

▶ Optimism or pessimism? [Enders et al (2013)]

▶ ...

▶ ...

▶ "Misexpected" structural shocks

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Fiscal Cumulated Multipliers

Government Spending Cumulative Multipliers
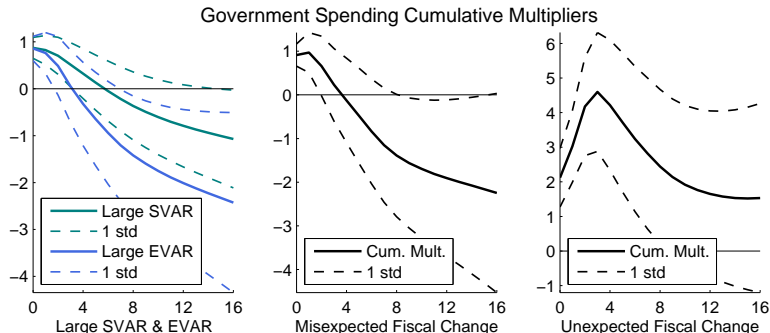
- Cumulative output multiplier for Expected Fiscal Changes around 1.5
- Multipliers adjusted to take into account the direct effect of Fed spending only S&L Adjusted Multipliers

Conclusions

- Identification in the presence of **foresight** and **imperfect information**
- Novel empirical **measures fiscal information flow** at different horizons
- Fiscal spending have **large effect**
- **Investment accelerator**
- Other applications: **monetary policy**, forward guidance

Appendix

Expected, Unexpected & Misexpected Events

Ekman, Frisen - "Unmasking the Face" Back...

*If you have time to **anticipate** an event and do so correctly, then you cannot be surprised. [...] **Surprise** is triggered both by **unexpected** and **misexpected** events. [...]*

*An **unexpected** surprise is triggered by an unexpected event, that is an event that happens at the moment the surprised person was not expecting anything in particular to happen.*

*A **misexpected** surprise is triggered by an event that happens in contrast to some specific anticipation for something different to happen at that moment.*

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Expected, Unexpected & Misexpected Events

Ekman, Frisen - "Unmasking the Face" `Back...`

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The Identification of Fiscal Spending Shocks

The Identification of Fiscal Spending Shocks (I)

The "classic" identification of fiscal shocks

Blanchard, Perotti (2002):

$$\Delta g_t - \widehat{\mathbb{P}}[\Delta g_t | Y_{t-1}, Y_{t-2}, \ldots] = \hat{\varepsilon}_t \propto \text{fiscal shock}_t$$

Assumptions:

- ▶ "Little information" on future government spending
- ▶ Discretionary policy does not respond to output within a quarter

Surprises informative of discretionary measures effects

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The Identification of Fiscal Spending Shocks (II)

The fiscal foresight issue [Leeper et al. (2013)]

Ramey (2011): (professional) forecast errors as proxy for fiscal shocks

$$\underbrace{\Delta g_t - \mathbb{E}^*_{t-1} \Delta g_t}_{\text{forecast error}} = \hat{\varepsilon}_t \propto \text{fiscal shock}_t$$

Assumptions:

- Rational Expectations
- Full Information
- Discretionary policy does not respond to output within a quarter

Surprises informative of discretionary measures effects

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The Identification of Fiscal Spending Shocks (III)

The "classic" identification strikes back

Decomposition of the one-step-ahead forecast error into

$$\underbrace{\Delta g_t - \mathbb{E}^*_{t-1}\Delta g_t}_{\text{forecast error}} = \underbrace{(\Delta g_t - \mathbb{E}^*_t\Delta g_t)}_{\text{surprise}} + \underbrace{(\mathbb{E}^*_t\Delta g_t - \mathbb{E}^*_{t-1}\Delta g_t)}_{\text{revision of expectations (noise)}}$$

Perotti (2012): *Government spending forecasts convey little information on future government spending, and so does their revision.*

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The Identification of Fiscal Spending Shocks (III)

Imperfect information & fiscal foresight

Decomposition of the two-step-ahead forecast error into

$$\underbrace{\Delta g_t - \mathbb{E}^*_{t-2}\Delta g_t}_{\text{forecast error}} = \underbrace{(\Delta g_t - \mathbb{E}^*_t \Delta g_t)}_{\text{nowcast error}} + \underbrace{(\mathbb{E}^*_t \Delta g_t - \mathbb{E}^*_{t-1}\Delta g_t)}_{\text{revision of expectations (news)}} +$$

$$+ \underbrace{(\mathbb{E}^*_{t-1}\Delta g_t - \mathbb{E}^*_{t-2}\Delta g_t)}_{\text{revision of expectations (news)}}$$

- ▶ Information frictions modify the agents' decision problem
- ▶ ... and the econometric identification problem
- ▶ Forecast revisions are informative: "news"
- ▶ Nowcast errors: "misexpectations"

Back...

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The Survey of Professional Forecasters

Survey of Professional Forecasters Data

Number of Respondents

ASA/NBER SPF   Philadelphia Fed SPF   SPF Tighter Timing

Legend:
— Number of Resp. in Two Consecutive Quarters
-- Total Respondents

y-axis: # Respondents (0 to 60)
x-axis: 1985, 1990, 1995, 2000, 2005, 2010
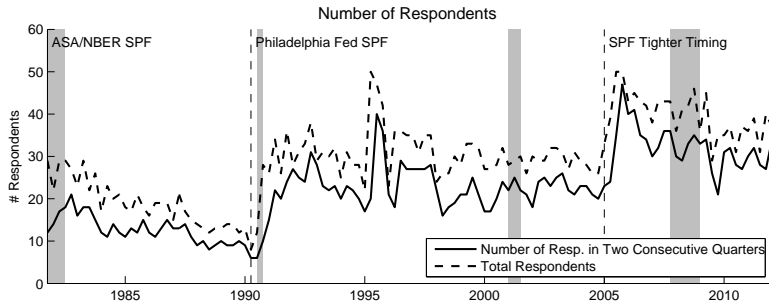
Back...

SPF Implied News

SPF News & Ramey military spending news

Individual Median News One Year Ahead and Ramey Military News
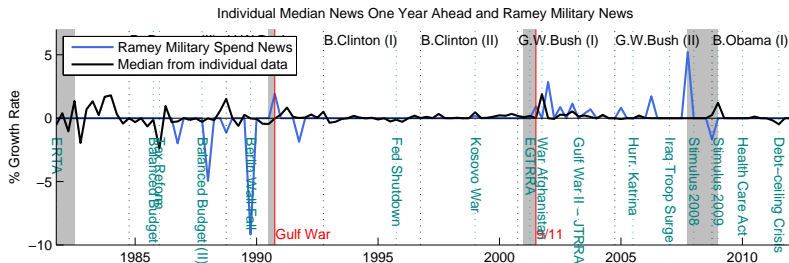
Back...

Other Macro Shocks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Nowcast Errors (median)	0.77	0.00	0.06	-0.10	-0.09	-0.04	0.11	-0.04	-0.07
News Q0 (median)	0.33	0.01	-0.01	0.15	0.03	-0.08	0.02	-0.06	-0.19
News Q1-Q3 (median)	-0.02	-0.01	0.02	-0.02	0.07	0.00	0.07	0.06	-0.16

Correlations of News and Nowcast Errors with Other Proxy Variables: (1)
Ramey (2011) Federal Spending SPF Forecast Errors, (2) Ramey (2011)
Present Discounted Value of Military Spending - PDVMIL, (3) Romer & Romer
(2010) Endogenous Tax Changes, (4) Romer& Romer Exogenous Tax Changes,
(5) Romer & Romer (2004) Monetary Policy Shocks, (6) Baker et al (2013)
Uncertainty Index, (7) Baker et al (2013) Uncertainty Index - Monetary Policy,
(8) Baker et al (2013) Uncertainty Index - Taxes, (9) Baker et al (2013)
Uncertainty Index - Government Spending Back...

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SPF Implied News and Nowcast Errors

Spectra

Nowcast Errors and News Spectral Density

Back...
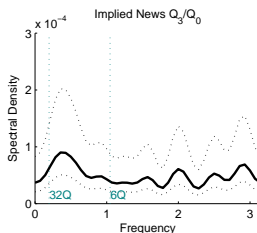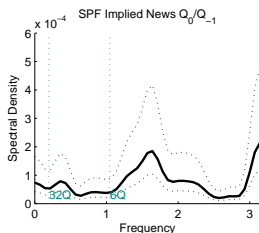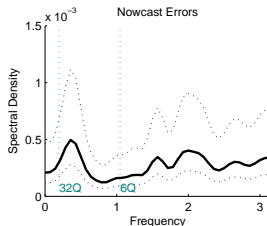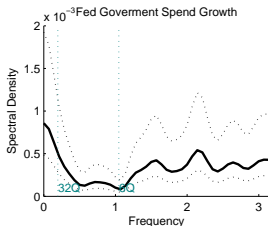
SPF Implied News

Informational content

Independent Variable	F-stat	Prob > F	reg. coeff.	t-stat
$\widehat{news}(0)$	7.54	0.007	0.620	2.75
$\widehat{news}(0)$ (aggr. data)	3.50	0.064	0.448	1.87
$\widehat{news}(1,3)$	6.76	0.011	0.783	2.60
$\widehat{news}(1,3)$ (aggr. data)	3.57	0.062	0.457	1.89

Individual vs Aggregated...

Heterogenous Beliefs and Aggregation Bias

Heterogenous Beliefs and Aggregation Bias

SPF news from individual and aggregated data

Median News One Year Ahead from Individual and Aggregated Data

Legend:
- Median from aggregated data
- Median from individual data
- SPF News Skwness

Back…

Heterogenous Beliefs and Aggregation Bias
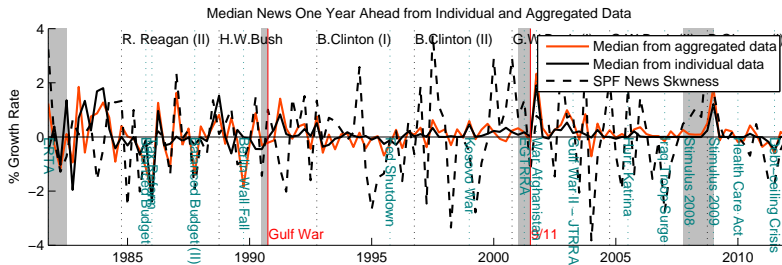
SPF news from individual and aggregated data

Aggregated and Individual SPF Data Median News
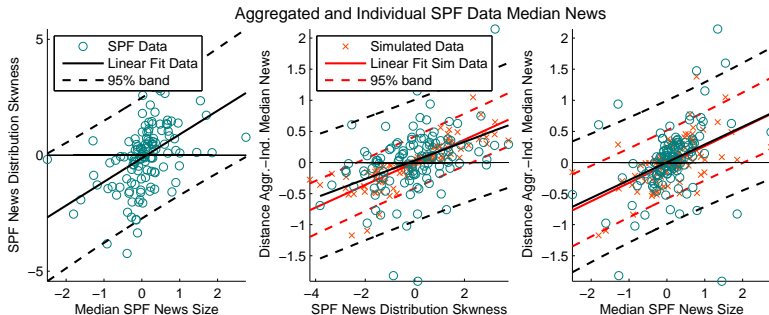
MC Simulations   Military News   Back...

Heterogenous Beliefs and Aggregation Bias

	(1)	(2)	(3)	(4)	SPF data
Correlation Ind.–Aggr. Data Median News	1.000	1.00	0.87	0.86	0.82
Mean Abs Dist. Ind.–Aggr. Data Median News	0.00	0.01	0.21	0.20	0.36
Corr. of Av. Dist. Ind.–Aggr. News w/ Dist. Mean	-0.04	0.09	0.52	0.51	0.37
Corr. of Av. Dist. Ind.–Aggr. News w/ Dist. Std	0.02	-0.12	0.14	0.15	0.31
Corr. of Av. Dist. Ind.–Aggr. News w/ Dist. Skew.	0.04	-0.07	0.77	0.77	0.41
Corr. of Av. Dist. Ind.–Aggr. News w/ Dist. Kurt.	0.04	0.04	0.01	0.01	0.13

Statistics of SPF and MC Simulated Forecast Data on Future Quarters.
Statistics on the median news from individual and aggregated SPF data and
from SPF Monte Carlo simulated data ($n_{sim} = 10,000$). (1) Monte Carlo
simulated data with news sampled from a Pearson distribution with skewness
equal to zero and the time-varying kurtosis implied by SPF data. (2) Monte
Carlo simulated data from an unbalanced panel in which 6 out of the 29
simulated forecasters are dropped from one period to the following. The news
is sampled from a Pearson distribution with skewness equal to zero and the
time-varying kurtosis implied by SPF data. (3) Monte Carlo simulated data
with news sampled from a Pearson distribution with the time-varying skewness
and kurtosis implied by SPF data. (4) Adds an unbalanced panel composition
as specified for column (2) to the specification in column (3) Back...

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Full Information vs Imperfect Information

Full Information Rational Expectations Back...

- ▶ Agents have a complete information set $\mathcal{I}_{t-h}$

$$\mathbb{E}[g_t|\mathcal{I}_{t-h}] + u_t + u_{t-1} + \cdots + u_{t-h+1} = \Delta g_t$$

$\longrightarrow$ Align the econometric information set to the agents' one

- ▶ Agents' forecast errors are combinations of structural shocks

$$g_t - \mathbb{E}[g_t|\mathcal{I}_{t-1}] = u_t$$

$\longrightarrow$ Agents' forecast errors are proxy for structural shocks

- ▶ Agents have perfect knowledge of the state of the world

$$g_t - \mathbb{E}[g_t|\mathcal{I}_t] = 0$$

$\longrightarrow$ No additional information in nowcast errors

- ▶ Agents have the same information set
  $\longrightarrow$ No aggregation issue

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Imperfect Information Rational Expectations

Two classes of models:

- **Delayed-information models** – agents update their information set infrequently but arrive at perfect information once they do [Mankiw and Reis (2002) and Reis (2006a,b)]

- **Noisy-information models** – agents continuously update their information but observe only noisy signals about the true state [Woodford (2001), Sims (2003) and Mackowiak and Wiederholt (2009)]

incorporate deviations from full information

Back...

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Identification with Imperfect Information Back...

▶ The new information is only partially absorbed over time

$$g_t - \mathbb{E}^*_{t-h} g_t = \frac{1-\kappa}{\kappa} \left(\mathbb{E}^*_{t-h} g_t - \mathbb{E}^*_{t-h-1} g_t \right) + u_{t-h+1,t}$$

⟶ Forecast errors combine current and past shocks

▶ Expectations revisions may be correlated

$$\left(\mathbb{E}^*_t g_t - \mathbb{E}^*_{t-1} g_t \right) = (1-\kappa) \left(\mathbb{E}^*_{t-1} g_t - \mathbb{E}^*_{t-2} g_t \right) + \kappa u_t$$

⟶ but are good proxies for shocks (conditional on their past)

▶ Nowcast errors ("misexpectations")

$$g_t - \mathbb{E}^*_t g_t = \frac{1-\kappa}{\kappa} \left(\mathbb{E}^*_t g_t - \mathbb{E}^*_{t-1} g_t \right)$$

⟶ May contain additional information

▶ Agents have heterogenous beliefs
⟶ Potential aggregation bias

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Identification with Imperfect Information Back...

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$$g_t - \mathbb{E}^*_{t-h} g_t = \frac{1 - \kappa}{\kappa} \left(\mathbb{E}^*_{t-h} g_t - \mathbb{E}^*_{t-h-1} g_t \right) + u_{t-h+1,t}$$

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Identification with Imperfect Information Back...

▶ The new information is only partially absorbed over time

$$g_t - \mathbb{E}_{t-h}^* g_t = \frac{1-\kappa}{\kappa} \left(\mathbb{E}_{t-h}^* g_t - \mathbb{E}_{t-h-1}^* g_t \right) + u_{t-h+1,t}$$

⟶ Forecast errors combine current and past shocks

▶ Expectations revisions may be correlated

$$\left(\mathbb{E}_t^* g_t - \mathbb{E}_{t-1}^* g_t \right) = (1-\kappa) \left(\mathbb{E}_{t-1}^* g_t - \mathbb{E}_{t-2}^* g_t \right) + \kappa u_t$$

⟶ but are good proxies for shocks (conditional on their past)

▶ Nowcast errors ("misexpectations")

$$g_t - \mathbb{E}_t^* g_t = \frac{1-\kappa}{\kappa} \left(\mathbb{E}_t^* g_t - \mathbb{E}_{t-1}^* g_t \right)$$

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Identification with Imperfect Information \boxed{\text{Back...}}

- The new information is only partially absorbed over time

$$g_t - \mathbb{E}^*_{t-h} g_t = \frac{1-\kappa}{\kappa} \left(\mathbb{E}^*_{t-h} g_t - \mathbb{E}^*_{t-h-1} g_t \right) + u_{t-h+1,t}$$

  $\longrightarrow$ Forecast errors combine current and past shocks

- Expectations revisions may be correlated

$$\left(\mathbb{E}^*_t g_t - \mathbb{E}^*_{t-1} g_t \right) = \left(1 - \kappa \right) \left(\mathbb{E}^*_{t-1} g_t - \mathbb{E}^*_{t-2} g_t \right) + \kappa u_t$$

  $\longrightarrow$ but are good proxies for shocks (conditional on their past)

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Multipliers

Fiscal (S&L Adjusted) Multipliers

	Fiscal Multipliers (impact/peak)					
	Unexpected		**Misexpected**		**Expected**	
GDP	1.28	(0.63)	0.98	(0.29)	3.06	(1.24)
D Cons	0.54	(0.2)	0.17	(0.13)	0.21	(0.31)
ND Cons	0.28	(0.12)	0.07	(0.08)	0.19	(0.21)
S Cons	0.21	(0.18)	0.04	(0.09)	-0.28	(1.44)
NRes Inv	0.34	(0.19)	0.12	(0.14)	0.89	(0.49)
Res Inv	-0.15	(0.15)	0.08	(0.07)	0.90	(1.12)

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Adjusted Fiscal Multipliers

The impulse response function of a variable, e.g, output, to the news shock $\mathcal{N}_t$ can be expressed as follow

$$\frac{d \log Y_{t+h}}{d\mathcal{N}_t} = \frac{G_{t+h}^{Fed}}{Y_{t+h}} \left[\frac{\partial Y_{t+h}}{\partial G_{t+h}^{Fed}} + \frac{\partial Y_{t+h}}{\partial G_{t+h}^{S\&L}} \frac{\partial G_{t+h}^{S\&L}}{\partial G_{t+h}^{Fed}} \right] \frac{d \log G_{t+h}^{Fed}}{d\mathcal{N}_t}$$

Rearranging (and approximating)

$$\mathcal{M}^{peak} \equiv \frac{\frac{\bar{Y}}{\bar{G}^{Fed}} \mathrm{IRF}^{peak}(Y)}{1 + \frac{\bar{G}^{S\&L}}{\bar{G}^{Fed}} \mathrm{IRF}^{peak}(G^{S\&L})}$$

Back...

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