

Policy Shocks and Wage Rigidities: Evidence from the Regional Impact of National Shocks¹

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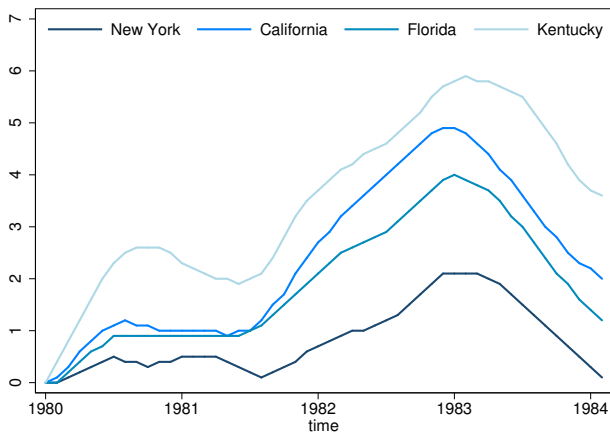
¹The views expressed in this paper are those of the authors and do not reflect those of the Federal Reserve Board.

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Motivation

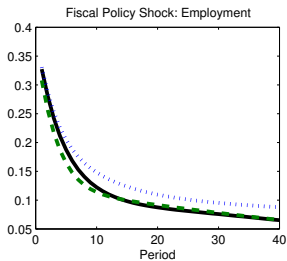
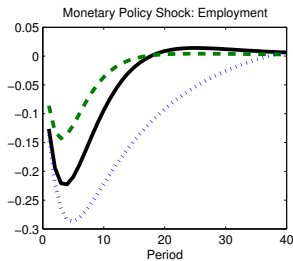
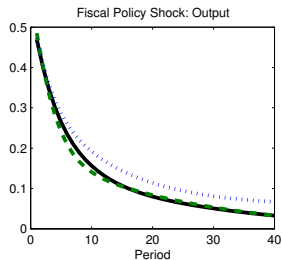
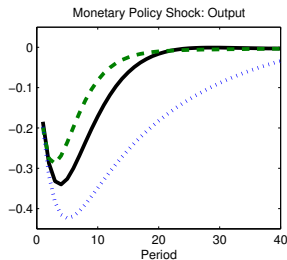
Figure: Unemployment after Volcker Disinflation



Motivation

- Question
 - ▶ Do states with high wage rigidity experience deeper impact of policy shocks?
 - ▶ \Rightarrow wage rigidity prevents price/cost reduction which amplifies the effect of demand shocks
- Strategy:
 - ▶ Calculate *downward* wage rigidity by state and year from micro data
 - ▶ Obtain national shocks in monetary and fiscal policy
 - ▶ Explain variation in state-level impact of policy shocks using rigidity measures

Theory: IRFs to MP Shock, Smets and Wouters (2007)



Motivation

- Our focus on the United States:
 - ▶ Fiscal and monetary union: regional impact of nationally-generated shocks.
 - ▶ Monetary union: exchange rates do not form a channel of automatic stabilization within the union.
 - ▶ States are relatively homogeneous: for instance in a legislative and institutional sense \implies less sensitive to omitted variable bias than cross-country.
 - ▶ Data on wage rigidities collected in exactly the same way.

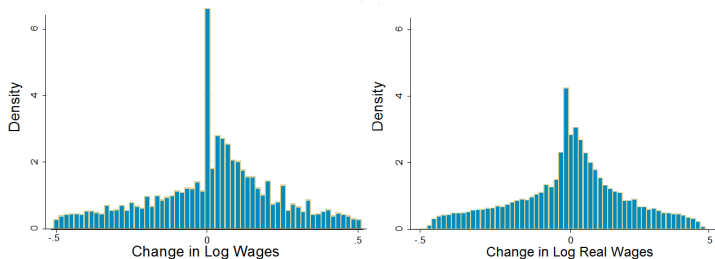
Micro Data on Wages

- Micro data from the Current Population Survey (CPS) between 1979 and 2014.
- Wage-change data for approximately 1.37 million Americans: an average of 838 observations per state per year.
- Randomly selected.
- Legally required to respond for 8 months.
- Applying Madrian and Lefgren (1999) procedure to validate panel matches.

CPS Structure

Distribution of Wage Changes 1980-2014

Figure: Distribution of Wage Changes in CPS micro data 1980-2014



- Define wage hourly (wage or salary/hours)
- Calculate log change: $\Delta wage_{i,s,t} = \ln(wage_{i,s,t}) - \ln(wage_{i,s,t-1})$

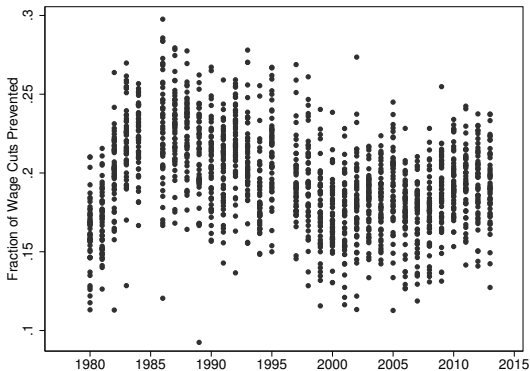
Measures of Downward Rigidity

- Measures for rigidity by Dickens et al. (2007), developed as part of the IWFP
- Fraction of Wage Cuts Prevented (FWCP)
- The FWCP compares the number of nominal wage freezes to the number of nominal wage cuts:

$$FWCP_{t,s}^n = \frac{f_{t,s}^n}{f_{t,s}^n + c_{t,s}^n}$$

Downward Real Wage Rigidities

Figure: Distribution of Downward Nominal Wage Rigidities, 1980-2014

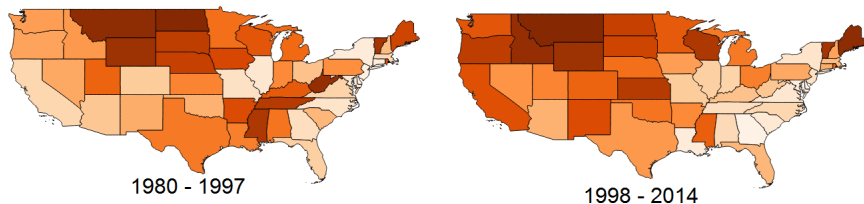


Note: 1985 and 1996 are dropped due to missing panel identifiers.

Average DNWR by States

Regions Don't Drive Rigidity

Figure: Relative Downward Nominal Rigidity Across States



Light: lowest rigidity in year. Dark: highest rigidity in year.

Table: Estimations Labor Market Institutions and Wage Rigidity

	(1)	(2)	(3)	(4)
Δ Mobility	-0.063*** (0.015)		-0.078*** (0.017)	(0.016)
Δ Firm Size	-0.002 (0.002)		0.001 (0.001)	-0.001 (0.002)
Minimum Wage	0.141*** (0.024)		0.077*** (0.022)	0.138*** (0.024)
Unionization	0.071*** (0.025)			0.067*** (0.025)
Union Power	0.010*** (0.002)			0.010*** (0.002)
Δ % Empl. Serv.		0.202*** (0.039)	0.225*** (0.040)	0.023 (0.044)
Δ % Empl. Gov.		0.187** (0.08)	0.186** (0.082)	0.008 (0.082)
Δ Education		-0.012 (0.009)	-0.012 (0.010)	-0.047*** (0.010)
Constant	0.116*** (0.011)	0.196*** (0.001)	0.163*** (0.009)	0.118*** (0.010)
Observations	1,122	1,581	1,479	1,122
R^2	0.071	0.018	0.042	0.084

Note: *, **, *** denote significance at the 10, 5, and 1%, respectively. Clustered standard errors (by state) in parentheses.

Estimates obtained using Fixed Effects estimators.

Non-stationary variables estimated in first difference.

Sample: 1980-2013.

Estimation Equation

- Use rigidity estimates to explain variation in impact of monetary policy shocks.
- Standardize rigidity measure: lowest value per year = 0, highest value = 1.
- Main estimations: Local Projection Method (Jordá, 2005) in a panel STLPM:

$$y_{s,t+h} = F(z_{s,t})(\alpha_h^R + \beta_h^{R'} x_{s,t} + \gamma_h^R i_{s,t}) + (1 - F(z_{s,t}))(\alpha_h^F + \beta_h^{F'} x_{s,t} + \gamma_h^F i_{s,t}) + \phi_h' c_{s,t} + \eta_{s,t+h}, \quad (1)$$

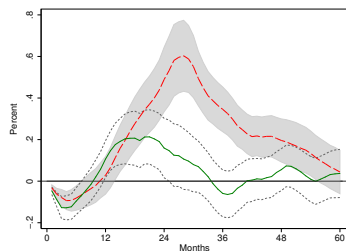
- $y_{s,t}$ = measure of economic activity (unemployment, coincident, GDP). CI
- $F(z_{s,t})$ = probability of being in rigid state $\in [0, 1]$.
- $i_{s,t}$ = Romer and Romer (2004) monetary policy shocks, monthly.
- $x_{s,t}$ = controls: lags of $i_{s,t}$, $y_{s,t}$, FFR, labor market controls.

Romer and Romer (2004) Shocks

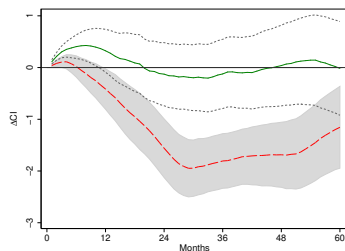
- Derive intended FFR changes from narrative minutes of FOMC meetings between 1981 and 2008
- Regress intended changes on changes in internal (Greenbook) forecasts
- Shocks: defined as divergence from standard response (errors in regressions)
- Robustness: Announcement shocks from Gertler and Karadi (2015) and Gorodnichenko and Weber (2016).
- Robustness: Exclude Volcker Disinflation

Results: Standardized Rigidity Measures

Figure: Monetary policy shocks in Rigid and Flexible States, 1980–2008



(a) Unemployment Rate



(b) Coincident Index

Note: Rigid state in red dashed line; Flexible state in green solid line. 90% intervals.

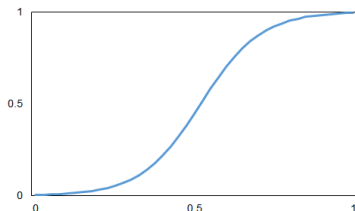
Unconditional IRFs

Outlier Treatment: Logistic Transformation Rigidity

- Follows Auerbach and Gorodnichenko 2012, Ramey and Zubairy, 2014:

$$F(z_{s,t-1}) = \frac{\exp\left[\xi \frac{z_{s,t-1} - c_z}{\sigma_z}\right]}{1 + \exp\left[\xi \frac{z_{s,t-1} - c_z}{\sigma_z}\right]}$$

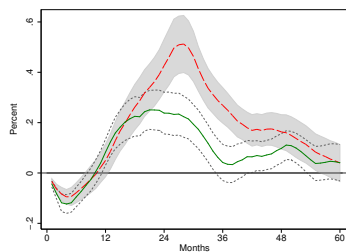
Figure: Shape of $F(z)$ in baseline, $c = \text{mean rigidity}$



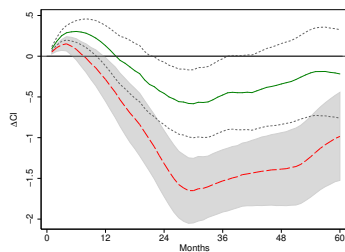
x axis: input rigidity. y axis: $F(z)$

Results: Logistic Transformation Rigidity

Figure: Monetary policy shocks in Rigid and Flexible States, 1980 -2008



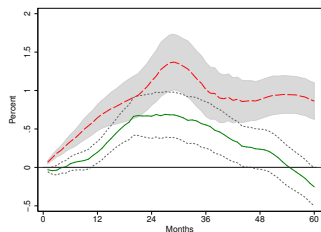
(a) Unemployment Rate



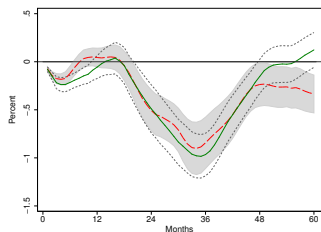
(b) Coincident Index

Note: Rigid state in red dashed line; Flexible state in green solid line. 90% intervals.

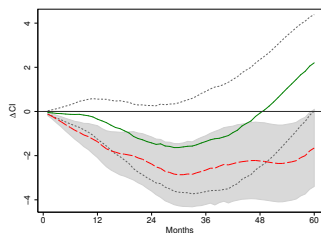
Results: Expansionary vs Contractionary Shocks, Logit



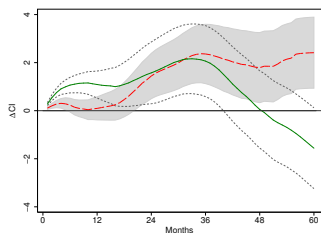
(c) Contractionary, UR



(d) Expansionary, UR

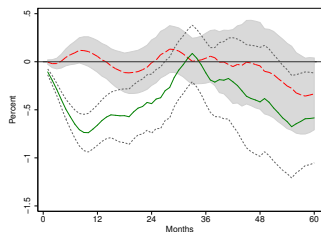


(e) Contractionary, CI

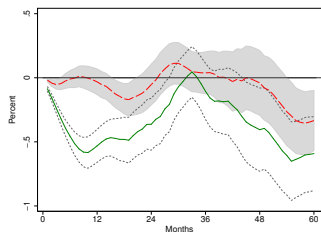


(f) Expansionary, CI

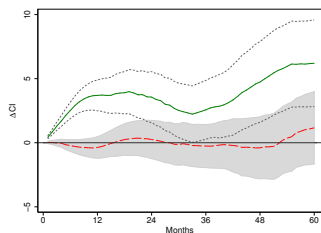
Results: Excluding Volcker Disinflation



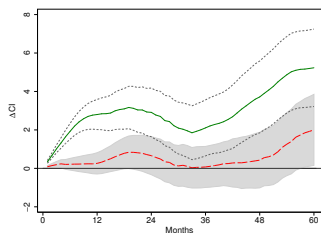
(g) Standard transformation, UR



(h) Logit transformation, UR



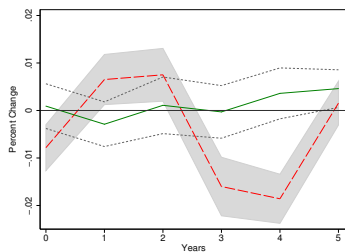
(i) Standard transformation, CI



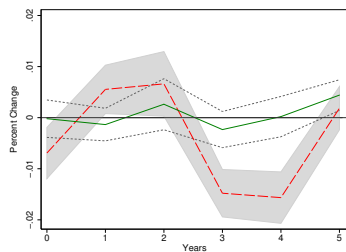
(j) Logit transformation, CI

IRFs of State GDP

Figure: Monetary policy shocks in Rigid and Flexible States: GDP, 1980–2006



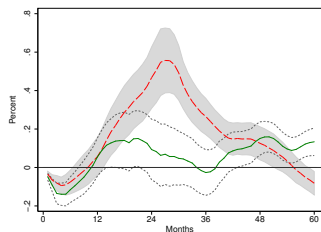
(a) Standard transformation



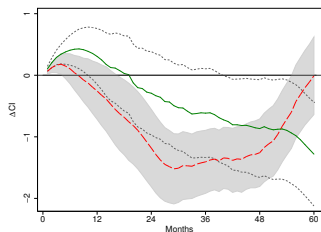
(b) Logit transformation

Note: Rigid state in red dashed line; Flexible state in green solid line. 90% intervals.

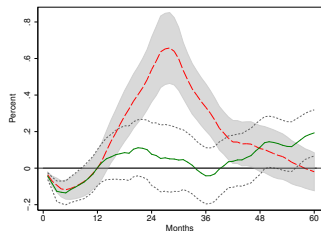
Results: Additional Controls



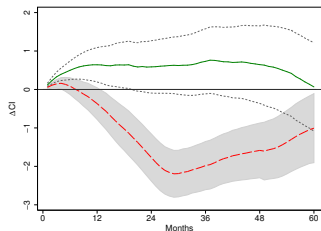
(c) Recursivness controls, UR



(d) Recursivness controls, CI

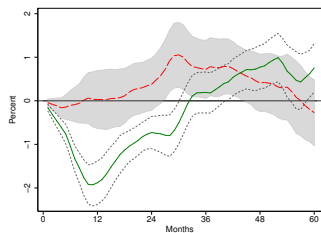


(e) Mortgage rate controls, UR

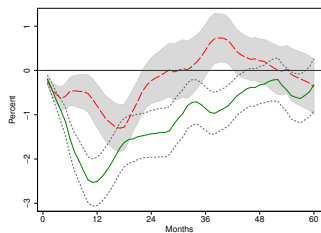


(f) Mortgage rate controls, CI

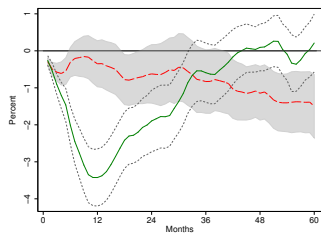
Results: Announcement shocks



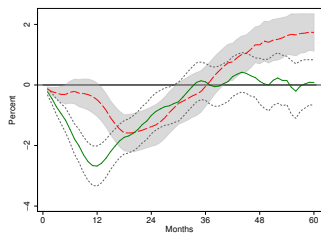
(g) GW (2016), tight interval, 94-07



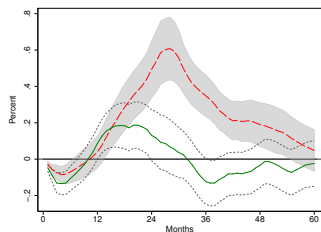
(h) GK (2015), FFR fut., 88-07



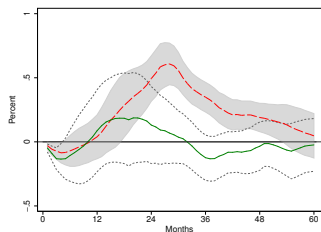
(i) GK (2015), 3-month FFR fut., (j) GK (2015), 1yf Eurodollar dep.,



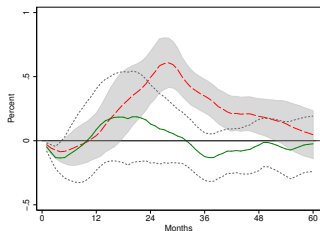
Results: Standard Errors



(k) SURE est., cl. by state



(l) SURE est., cl. by time



(m) SURE est., cl. by state and time

Fiscal Shocks

- State-level spending: Endogenous!
- Instrument spending à la Nakamura and Steinsson (2014)
- 1st stage:

$$\Delta\mu_{s,t} = \phi_s + \beta_2\Delta\mu_t^{nat} + \beta_3\phi_s \cdot \Delta\mu_t^{nat} + \nu_{s,t} \quad (2)$$

- 2nd stage: estimate multipliers conditional on wage rigidity:

$$\Delta y_{s,t} = F(z_{s,t})\left(\alpha_h^R + \beta_h^{R'} x_{s,t} + \gamma_h^R \Delta\hat{\mu}_{s,t}\right) + \\ (1 - F(z_{s,t}))\left(\alpha_h^F + \beta_h^{F'} x_{s,t} + \gamma_h^F \Delta\hat{\mu}_{s,t}\right) + \phi_h' c_{s,t} + \eta_{s,t}, \quad (3)$$

- Calculate Open Economy Relative Multiplier conditional on DWR

Results: Fiscal Shocks

Table: 2SLS Estimates of Military Expenditure Multiplier and Wage Rigidity

	(1)	(2)	(3)	(4)	(5)
Prime Spending					
High Multiplier	2.151** (0.842)	2.102*** (0.783)	2.387*** (0.887)	2.865*** (1.102)	2.352*** (0.822)
Low Multiplier	-0.761 (0.964)	-0.426 (0.892)	-0.560 (0.818)	0.342 (0.830)	-0.185 (0.816)
Controls for Sector, Institutions	No	No	No	No	Yes
Controls for Military Sector	No	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
State FE	No	Yes	No	Yes	Yes
Observations	1,223	1,223	1,223	1,223	1,172
R-squared	0.229	0.381	0.225	0.360	0.404

Note: *, **, *** denote significance at the 10, 5 and 1% level, respectively.

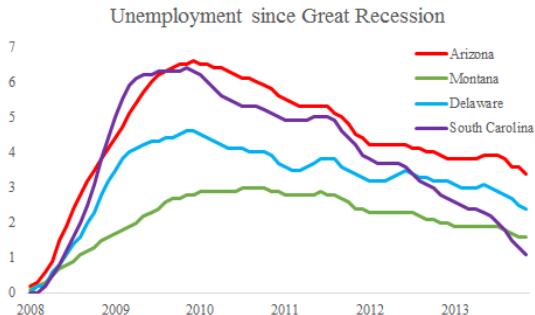
Estimates obtained using 2SLS. Standard errors are in parentheses, clustered by state. Dependent variable is two-year growth in state GDP.

Concluding remarks

- We calculate yearly measures of DNWR for U.S. states and study regional impact of national shocks.
- Significant differences in state-level rigidity, shifts over time.
- States that have higher DNWR face greater unemployment and economic activity effects of policy shocks.
- In line with role of wages in New Keynesian DSGE models.
- Flexible state: multiplier < 0 , Rigid state: multiplier > 2 .

Motivation

Figure: Unemployment since Great Recession



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Related Literature

- Wage rigidity and amplitude of business cycles:
 - ▶ Blanchard and Wolfers (2000): Interaction between common shocks and labor market institutions explains European unemployment 1960-1996.
 - ▶ Bauer et al. (2007): Real wage rigidity in West Germany accelerates unemployment growth between 1975 and 2001.
 - ▶ Gnocchi et al. (2015): Episodes of labor market reform reduce business cycle amplitude in OECD countries.
- Evidence of wage rigidity in wages: Dickens et al. (2007), Card and Hyslop (1999), Altonji and Devereux (1999), Lebow, Saks, Wilson (2003), Fehr and Goette (2007), Kahn (2007), Fallick, Lettau, Wascher (2016).
- Papers studying variation in economic behavior across states: Blanchard and Katz (1992), Driscoll (2004), Nakamura and Steinsson (2014).

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Current Population Survey

Table: Panel Dimension CPS

	Group A		Group B, etc.	
	Year 1	Year2	Year 1	Year 2
Jan			Start Cycle 1	Start Cycle 2
Feb	Start Cycle 1	Start Cycle 2	Included	Included
Mar	Included	Included	Included	Included
Apr	Included	Included	ORG Cycle 1	ORG Cycle 2
May	ORG Cycle 1	ORG Cycle 2		
Jun				
Jul				
Aug				
Sep				
Oct				
Nov				
Dec				

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DNWR by State

<i>Average</i>	0.1949	KY	0.1954	OH	0.1967
AL	0.1918	LA	0.1865	OK	0.1965
AK	0.1992	ME	0.2153***	OR	0.2025
AZ	0.1915	MD	0.1717***	PA	0.1954
AR	0.2031	MA	0.1886	RI	0.2046*
CA	0.1963	MI	0.2031	SC	0.1858*
CO	0.1969	MN	0.2034	SD	0.2063**
CT	0.1832**	MS	0.2056**	TN	0.1944
DE	0.1636***	MO	0.1851*	TX	0.1972
DC	0.1512***	MT	0.2200***	UT	0.2027
FL	0.1899	NE	0.2055**	VT	0.2107***
GA	0.1743***	NV	0.1945	VA	0.1834**
HI	0.1981	NH	0.1929	WA	0.1992
ID	0.2080**	NJ	0.1740***	WV	0.2009
IL	0.1824**	NM	0.1998	WI	0.2087**
IN	0.1911	NY	0.1749***	WY	0.2117***
IA	0.2001	NC	0.1831**		
KS	0.2029	ND	0.2128***		

*Note: *, ** and *** denote significance from average at the 10, 5, and 1% significance level, respectively. Estimates obtained using a mean-comparison t-test, two-sided.*

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Table: Monetary Policy Shock and Fiscal Policy Shock Data Summary Statistics

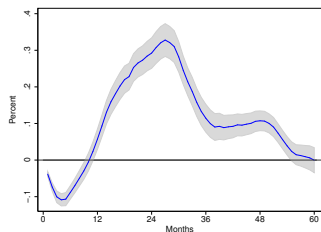
	Mean	SD	Obs.	Min.	Max.	Source	Type
<i>Dependent Variables</i>							
Unemployment Rate	5.832	5.832	17,136	2.1	18.8	BLS	
Coincident Index	110.625	110.625	16,800	57.527	232.740	Phil. Fed	
Biannual State GDP Growth	5.384	5.148	1478	-12.82	33.50	BEA	
<i>Monetary policy shocks</i>							
Narrative: Monetary policy shocks	0.013	0.297	384	-3.259	1.885	RR (2004)	
Anncmt: tight window	-0.010	0.068	191	-0.438	0.163	GW (2016)	
Anncmt: wide window	-0.010	0.069	191	-0.463	0.152	GW (2016)	
Anncmt: current FFR futures	-0.017	0.062	257	-0.423	0.146	GK (2015)	
Anncmt: 3-month ahead FFR futures	-0.015	0.051	243	-0.290	0.092	GK (2015)	
Anncmt: year-ahead fut. Eurodollar dep.	-0.011	0.058	315	-0.381	0.213	GK (2015)	
<i>Fiscal policy shocks</i>							
Growth in Prime Military Sp. - State	0.024	0.023	1478	-5.111	3.979	NS (2014)	
Growth in Broad Military Sp. - State	0.027	0.026	1478	-5.092	3.991	NS (2014)	
Growth in Prime Military Sp. - National	0.004	0.003	29	-0.449	0.687	NS (2014)	
Growth in Broad Military Sp. - National	0.009	0.008	29	-0.534	0.808	NS (2014)	
<i>Control Variables</i>							
Mobility	0.287	0.046	1836	0.184	0.694	CBS	I(1)
Firm Size	18.75	3.240	1836	10.36	29.32	CBS	I(1)
Minimum Wage	0.424	0.062	1683	0.257	0.670	BLS	I(0)
Unionization	0.144	0.064	1224	0.008	0.348	CPS	I(0)
Union Power	0.562	0.496	1938	0	1	C (2014)	I(0)
% Services	0.684	0.051	1734	0.543	0.822	CPS	I(1)
% Government	0.056	0.027	1734	0.024	0.233	CPS	I(1)
Education	4.058	0.226	1734	3.000	4.547	CPS	I(1)

Coincident Index

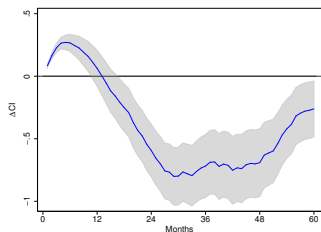
- Only monthly indicator of state-level activity, from Philadelphia Fed (see, Crone and Clayton-Matthews, 2005)
- Seasonally adjusted
- Combines 4 components in 1 index:
 - ▶ Nonfarm payroll employment
 - ▶ Avg. hours worked in manufacturing
 - ▶ Unemployment rate
 - ▶ Real salary disbursements
- Highly correlated with BEA quarterly state GDP > 2004

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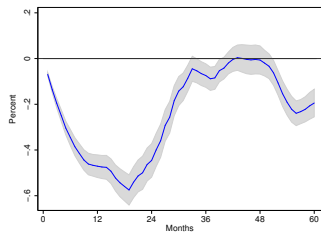
Monetary Policy Shocks, Unconditional response



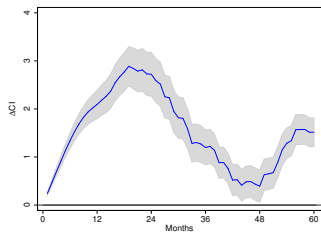
(a) Standard transformation, 1980-2007 UR



(b) Standard transformation, 1980-2007 CI

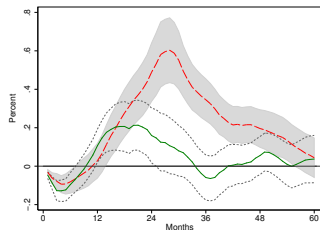


(c) Standard transformation, 1980-2007 UR

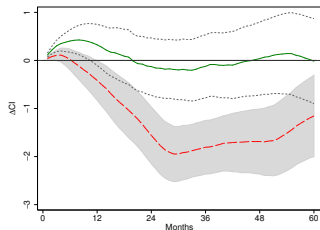


(d) Standard transformation, 1980-2007 CI

Monetary Policy Shocks, Bootstrap SE



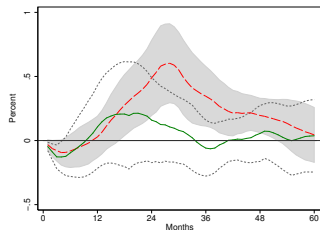
(e) Standard
1980–2007 UR



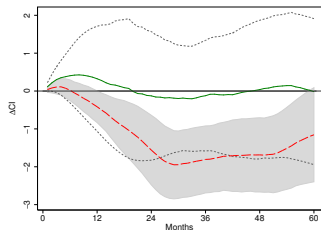
(f) Standard
1980–2007 CI

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Monetary Policy Shocks, Driscoll-Kraay SE



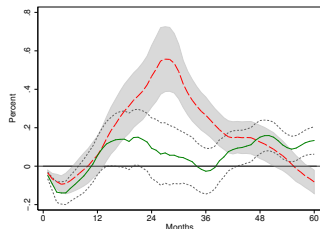
(g) Standard
1980–2007 UR



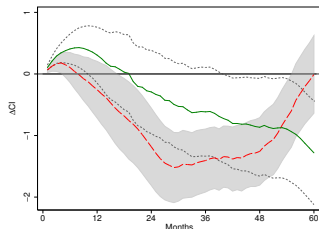
(h) Standard
1980–2007 CI

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Monetary Policy Shocks, House prices and CPI



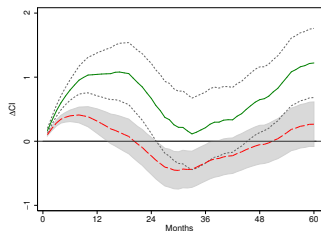
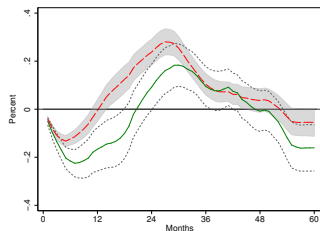
(i) Standard transformation, 1980–2007 UR



(j) Standard transformation, 1980–2007 CI

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Monetary Policy Shocks, Ratio between minimum wages and median wages by state



(k) Minimum wages, 1980–2007 (l) Minimum wages, 1980–2007 CI
UR

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Downward Real Wage rigidities

- Real counterpart:

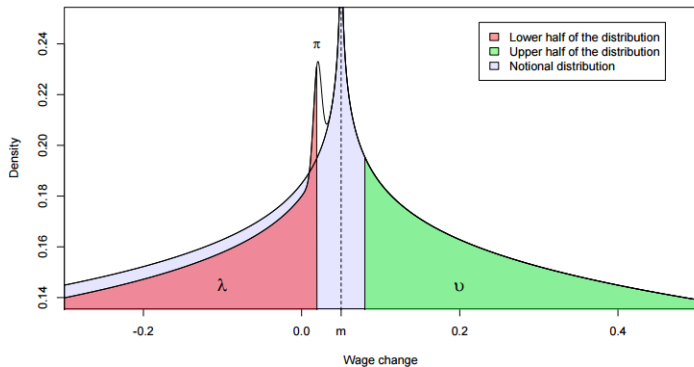
$$FWCP_{t,s}^r = \frac{2(h_{t,s} - c_{t,s}^r)}{h_{t,s}}, \quad h_{t,s} = \Delta M_{t,s} + (\Delta M_{t,s} - \pi_t^e)$$

- Inflation expectations from Michigan Survey

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Measures of Downward Rigidity

Figure: Measure of Real Rigidity (Illustration: CPB, 2014)



DNWR and DRWR by State

	$FWCP^n$	$FWCP^r$		$FWCP^n$	$FWCP^r$		$FWCP^n$	$FWCP^r$
Avg.	0.1949	-0.0691	KY	0.1954	-0.1021	OH	0.1967	-0.0922
AL	0.1918	-0.1963***	LA	0.1865	-0.1918**	OK	0.1965	-0.1213
AK	0.1992	-0.1296	ME	0.2153***	-0.0218	OR	0.2025	0.0250
AZ	0.1915	0.0080**	MD	0.1717***	0.0152*	PA	0.1954	-0.0966
AR	0.2031	-0.1098	MA	0.1886	0.0081	RI	0.2046*	-0.0049
CA	0.1963	-0.0465**	MI	0.2031	-0.0806	SC	0.1858*	-0.1608*
CO	0.1969	-0.0013***	MN	0.2034	0.0656***	SD	0.2063**	-0.0235
CT	0.1832**	-0.0191	MS	0.2056**	-0.3255***	TN	0.1944	-0.2001***
DE	0.1636***	-0.0255	MO	0.1851*	-0.0359	TX	0.1972	-0.1154
DC	0.1512***	0.0485**	MT	0.2200***	-0.1162	UT	0.2027	0.0767***
FL	0.1899	-0.0235	NE	0.2055**	-0.0182	VT	0.2107***	0.0283**
GA	0.1743***	-0.1902	NV	0.1945	-0.1678**	VA	0.1834**	-0.0525
HI	0.1981	-0.2365	NH	0.1929	-0.0025	WA	0.1992	-0.0506
ID	0.2080**	-0.0368	NJ	0.1740***	-0.0099	WV	0.2009	-0.1893**
IL	0.1824**	-0.0744	NM	0.1998	0.0180*	WI	0.2087**	-0.0203
IN	0.1911	-0.0919	NY	0.1749***	-0.0546	WY	0.2117***	-0.1309
IA	0.2001	-0.0836	NC	0.1831**	-0.1208**			
KS	0.2029	0.0185*	ND	0.2128***	-0.0670			

*, ** and *** denote $p < 0.10$, 0.05 and 0.001% , respectively.

Estimates obtained using a mean-comparison t-test, two-sided.

Results: Fiscal Shocks, Including direct compensation

Table: 2SLS Estimates of Military Expenditure Multiplier and Wage Rigidity

	(1)	(2)	(3)	(4)	(5)
Incl. Direct Comp.					
High Multiplier	1.663** (0.680)	2.275*** (0.685)	1.761** (0.703)	2.841*** (1.028)	2.282*** (0.710)
Low Multiplier	-0.612 (0.857)	0.106 (0.805)	-0.519 (0.730)	0.792 (0.882)	0.221 (0.819)
Controls for Sector, Institutions	No	No	No	No	Yes
Controls for Military Sector	No	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
State FE	No	Yes	No	Yes	Yes
Observations	1,223	1,223	1,223	1,223	1,172
R-squared	0.229	0.381	0.225	0.360	0.404

Note: *, **, *** denote significance at the 10, 5 and 1% level, respectively.

Estimates obtained using 2SLS. Standard errors are in parentheses, clustered by state. Dependent variable is two-year growth in state GDP.

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