Gimme a Break! Identification and Estimation of the Macroeconomic Effects of Monetary Policy Shocks in the U.S.

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4th International Conference in memory of Carlo Giannini
Università degli Studi, Pavia – March 25-26, 2014

Monetary policy shocks and VARs

- SVARs: Employed to establish stylized facts, perform model selection
- A lot of attention devoted to the effects of monetary policy shocks
- Benchmark: *Recursive identification scheme, fixed coefficients* (Christiano et al. 1999, 2005)
- Pros: No need to identify other shocks
- Cons: *Zero restrictions at odds with most DSGE models* (e.g. Smets and Wouters 2007), *evidence against such restrictions* (Faust et al. 2004, Del Negro et al. 2007)
- **Non-recursive schemes: Unfeasible**

This paper's approach

- This paper: **Novel identification scheme to identify shocks in VARs – "SVAR-WB"**
- How: Information coming from **break in the reduced-form VCV matrix**, **contemporaneous coefficients**
- Application: 7-VAR, post-WWII U.S. data
- Empirical exercises:

i) **IRFs in pre-mid 1980s, Great Moderation**

ii) **estimation of DSGE model with the cost-channel via IRF matching**

This paper's results

- Evidence of **instability in the U.S. post-WWII IRFs to a monetary policy shock**
- **Post-WWII fixed coefficient-VAR evidence de facto driven by the Great Inflation phase** (e.g., price puzzle)
- Evidence robust to alternative assumptions underlying the processes at hand (stationary, non-stationary and cointegrated)
- **Recursive- vs. non-recursive SVAR-WB imply quite similar dynamics pre-1984**, not quite so during the Great Moderation (entity of the response, size, sign)
- **IRF matching approach** with non-recursive SVAR-WB suggests **instabilities in the structural parameters, in particular as for the cost-channel**

Plan of the presentation

- Literature review
- SVAR-WB: Theory
- SVAR-WB vs. alternatives: Evidence
- DSGE estimation with IRF matching
- Conclusions

State of the art

- Identification through heteroskedasticity: Rigobon (2003), Rigobon and Sack (2003, 2004), Lanne and Lütkepohl (2008, 2010), Lanne, Lütkepohl, and Maciejowska (2010), Bacchiocchi and Fanelli (2013)
- Time-dependence of the VAR coefficients: Cogley and Sargent (2005a,b), Primiceri (2005), Canova, Gambetti, and Pappa (2008); Canova and Forero (2012)
- Instabilities in DSGE model parameters: Canova (2009), Castelnuovo (2012), Canova and Ferroni (2012), Inoue and Rossi (2013)
- Relevance of the cost-channel: Ravenna and Walsh (2006), Rabanal (2007), Tillmannn (2009)

VAR

- Consider the following VAR model:

$$\begin{aligned} \mathbf{z}_t &= \mathbf{\Pi} \mathbf{w}_t + \mathbf{u}_t \quad , \mathbf{u}_t = \mathbf{C}\mathbf{e}_t \\ \mathbf{e}_t &\sim \mathrm{WN}(\mathbf{0}_n \ , \ \mathbf{I}_n) \\ \mathbf{\Sigma}_u &= E(\mathbf{u}_t \mathbf{u}_t') \end{aligned}$$

- Fixed-coefficient model: Not enough information to identify the n^2 elements of the $\mathbf{C}$ matrix
- Break(s) in the covariance-structure of the data are of help for the econometrician!

The role of the break

- Assume a break at time $t = T_B$ occurs, and consider the following VAR structure:

$$\begin{aligned} \mathbf{z}_t &= \mathbf{\Pi}(t)\mathbf{w}_t + \mathbf{u}_t \ , \ \mathbf{u}_t = \mathbf{C}(t)\mathbf{e}_t \\ \mathbf{e}_t &\sim \mathrm{WN}(\mathbf{0}_n \ , \ \mathbf{I}_n) \\ \mathbf{\Pi}(t) &= \mathbf{\Pi_1} \times \mathbf{1}(t < T_B) + \mathbf{\Pi_2} \times \mathbf{1}(t \geq T_B) \\ \mathbf{\Sigma}_u(t) &= \mathbf{\Sigma}_{u,1} \times \mathbf{1}(t < T_B) + \mathbf{\Sigma}_{u,2} \times \mathbf{1}(t \geq T_B) \end{aligned}$$

- Key assumption: $\mathbf{\Sigma}_{u,1} \neq \mathbf{\Sigma}_{u,2}$, i.e. that there are two volatility regimes in the data

The role of the break (cont'd)

- Crucial assumption in the literature: Changes in $\mathbf{\Sigma}_u$ not associated with a change in $\mathbf{C}$, which is **fixed**
- Identification of $\mathbf{C}$: $\mathbf{\Sigma}_{u,1} = \mathbf{CC}'$, $\mathbf{\Sigma}_{u,2} = \mathbf{CVC}'$
- Our kick: **We do allow for a time-dependent C**

$$\mathbf{C}(t) = \mathbf{C} + \mathbf{Q} \times \mathbf{1}\left(t \geq T_B\right)$$

Changes in C: Identification

- Identifying restrictions:

$$\begin{aligned} \boldsymbol{\Sigma}_{u,1} &= \mathbf{C}\mathbf{C}' \\ \boldsymbol{\Sigma}_{u,2} &= (\mathbf{C}+\mathbf{Q})(\mathbf{C}+\mathbf{Q})' \end{aligned}$$

- Additional restrictions (needed):

$$\begin{pmatrix} vec(\mathbf{C}) \\ vec(\mathbf{Q}) \end{pmatrix} = \begin{pmatrix} \mathbf{S}_C & \mathbf{S}_I \\ \mathbf{0}_{n^2 \times a_C} & \mathbf{S}_Q \end{pmatrix} \begin{pmatrix} \boldsymbol{\varphi} \\ \mathbf{q} \end{pmatrix} + \begin{pmatrix} \mathbf{s}_C \\ \mathbf{s}_Q \end{pmatrix}$$

- Under these restrictions, NS rank condition + N order condition (see proof in the paper)

The very general model

- The previous model can be seen as a particular case of the more general model:

$$
\begin{aligned}
\boldsymbol{\Sigma}_{u,1} &= \mathbf{C}\mathbf{C}' \\
\boldsymbol{\Sigma}_{u,2} &= (\mathbf{C}+\mathbf{Q})\boldsymbol{\Lambda}(\mathbf{C}+\mathbf{Q})'
\end{aligned}
$$

  that nests the Rigobon (2003) and Lanne and Lütkepohl (2008) specifications

- Additional restrictions (needed):

$$
\begin{pmatrix} vec(\mathbf{C}) \\ vec(\mathbf{Q}) \\ w(\boldsymbol{\Lambda}) \end{pmatrix} = \begin{pmatrix} \mathbf{S}_C & \mathbf{S}_I & \mathbf{0} \\ \mathbf{0} & \mathbf{S}_Q & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{S}_\Lambda \end{pmatrix} \begin{pmatrix} \boldsymbol{\varphi} \\ \mathbf{q} \\ \boldsymbol{\lambda} \end{pmatrix} + \begin{pmatrix} \mathbf{s}_C \\ \mathbf{s}_Q \\ \mathbf{s}_\Lambda \end{pmatrix}
$$

- Under these restrictions, NS rank condition + N order condition (see Bacchiocchi and Fanelli, 2013)

Empirical application: SVAR-WB

- Estimation of a seven variable VAR, U.S. quarterly data, 1954Q3-2008Q2
- Sample edges: Data availability, no ZLB
- $\mathbf{z}_t = (NDCONS_t, DCONS_t, INVEST_t, GDP_t, INFL_t, FFR_t, 10YR_t)'$, constants, four lags
- Break T_B=1984Q1, LR Chow-type test rejects the null of stability
  - 1954Q3-1983Q4 = 'Great inflation' period
  - 1984Q1-2008Q2 = 'Great Moderation' period
- Recursive- vs. non-recursive SVAR-WB

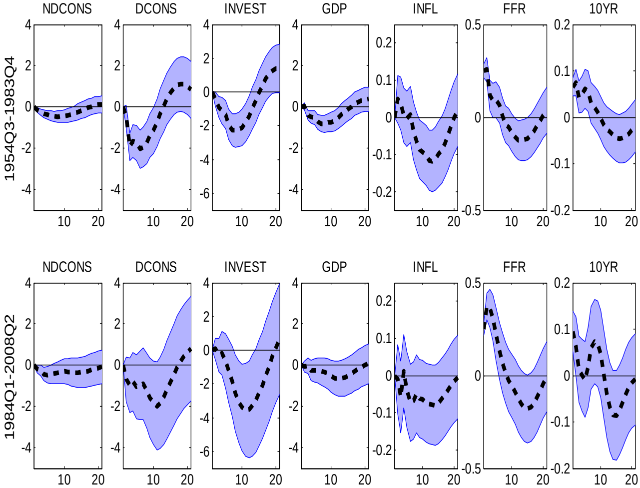
Recursive- vs. non-recursive SVAR-WB

- Mapping structural shocks $\mathbf{e}_t$ – reduced-form residuals $\mathbf{u}_t$:

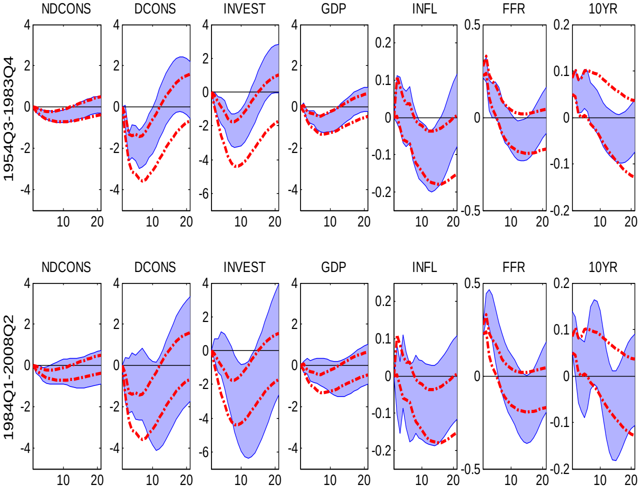
$$\begin{aligned} \mathbf{u}_t &= \mathbf{C}(t)\mathbf{e}_t \\ &= \mathbf{C} + \mathbf{Q} \times \mathbf{1}\left(t \geq T_B\right)\mathbf{e}_t \end{aligned}$$

- Recursive SVAR-WB: $\mathbf{C}$ lower triangular, $\mathbf{Q}$ lower triangular
- Non-recursive SVAR-WB: $\mathbf{C}$ full, $\mathbf{Q}$ diagonal

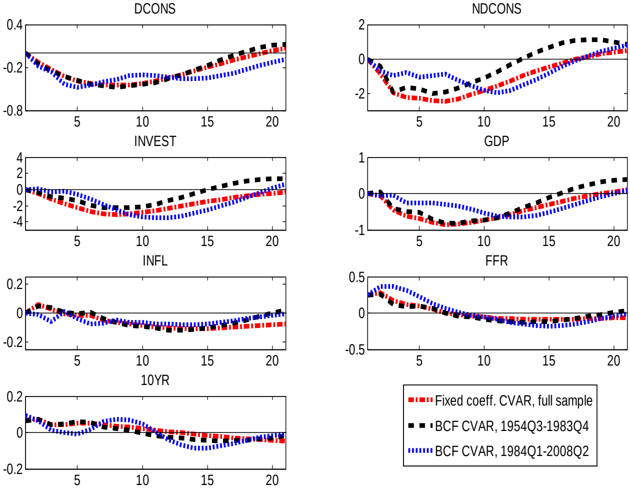
Recursive SVAR-WB: Pre- vs. post-1984



Recursive SVAR-WB vs. fixed-coeff. SVAR



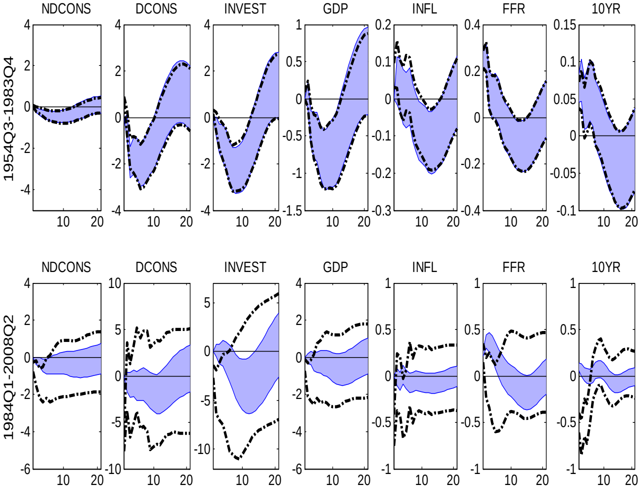
Recursive SVAR-WB vs. fixed-coeff. SVAR (cont'd)



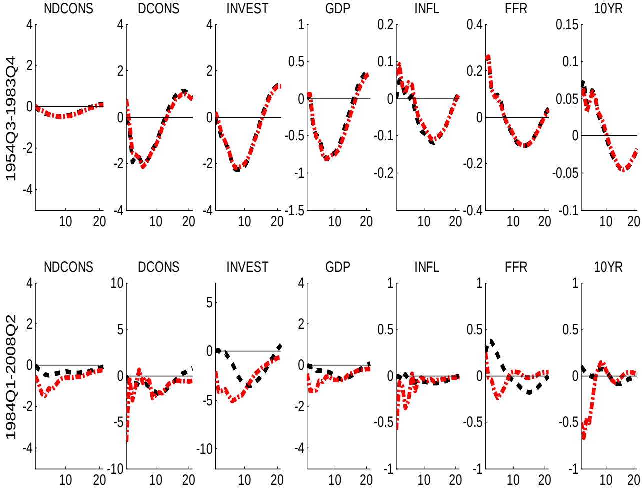
Recursive models

- Clear **recessionary effects in the Great inflation sample, price puzzle**
- Much **larger uncertainty in the post-1984 period**, no price puzzle
- **Fixed-coefficient VARs** estimated with post-WWII data: **Dynamics fully driven by pre-1984 period**
- **What if data analyzed with non-recursive SVAR-WB?**

Recursive- vs. non-recursive SVAR-WB



Recursive- vs. non-recursive SVAR-WB (cont'd)



Recursive- vs- non-recursive SVAR-WB

- **Pre-break period: Quite similar dynamics**, contemporaneous zero-restrictions not so problematic
- **Post-break sample**: Non-recursive SVAR-WB predicts **significantly negative responses of real variables and the long-term policy rate, deflation**
- Can we **discriminate between the two frameworks**? No, if we stick to the unconstrained formulations (just-identified models)
- Coefficients of **C** and **Q** not all significant! **Constrained formulations, best fitting model** (LR tests, likelihood)
    - constrained recursive VAR-WB: Log-lik = 1540.12, $\chi(23)$=33.36, p-value=0.08
    - constrained non-recursive VAR-WB: Log-lik = 1550.25, $\chi(22)$=13.10, p-value=0.94
- **Non-recursive SVAR-WB favored by the data**

SVAR-WB for IRF matching estimates

- IRFs to a monetary policy shock often used to estimate DSGE models via IRF matching procedure (Rotember and Woodford 1997, Boivin and Giannoni 2006, Christiano et al. 2005, Altig et al. 2011)
- Approach based on **fixed-coefficient recursive VAR, recursive DSGE models**
- **Most microfounded DSGE models not-recursive, though**
- **SVAR-WB can be employed to estimate non-recursive DSGE models**, detect structural parameter instabilities
- Application: Small-scale **cost-channel model** à la Ravenna and Walsh (2006), Surico (2008)

DSGE model with the cost-channel

$$
\begin{aligned}
\pi_t &= \beta[\xi_\pi E_t \pi_{t+1} + (1-\xi_\pi)\pi_{t-1}] + \kappa x_t + \kappa\alpha R_t + \varepsilon_t^\pi \\
x_t &= \xi_x E_t x_{t+1} + (1-\xi_x)x_{t-1} - \tau(R_t - E_t\pi_{t+1}) + \varepsilon_t^x \\
R_t &= (1-\phi_i)(\phi_\pi \pi_t + \phi_x x_t) + \phi_i R_{t-1} + \varepsilon_t^i
\end{aligned}
$$

DSGE model: IRF matching estimates

	Estimates		
Parameter	*1954Q3-1983Q4*	*1954Q3-1983Q4*	*1984Q1-2008Q2*
ξ_x	0.50 (0.01)	0.42 (0.02)	0.09 (0.16)
τ	0.03 (0.001)	0.09 (0.01)	0.73 (0.22)
ξ_π	0.53 (0.02)	0.27 (0.05)	1.00 (0.18)
κ	0.01 (0.01)	0.01 (0.01)	0.11 (0.02)
α	3.08 (2.07)	0^*	0.00 (1.80)
Distance	133.39	137.82	20.09

Time-varying role of the cost-channel

- **Cost-channel: Time-dependence detected**
- Result which comes from time-dependence of the price puzzle
- Interpretation: Financial liberalization in the early 1980s.

Conclusions

- Evidence of **instability in the U.S. post-WWII IRFs to a monetary policy shock**
- **Post-WWII fixed coefficient-VAR evidence de facto driven by the Great Inflation phase** (e.g., price puzzle)
- **Recursive- vs. non-recursive SVAR-WB imply quite similar dynamics pre-1984**, not quite so during the Great Moderation (entity of the response, size, sign)
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Thank you!