Uncertainty, Real Activity, and Risk Aversion during the Great Recession

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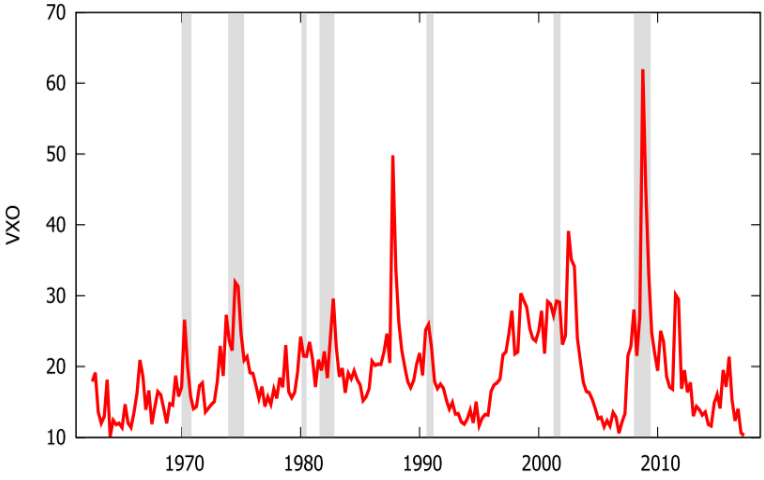
Financial uncertainty and the business cycle



- Uncertainty during the Great Recession: Concern for policymakers ▸ Blanchard

Financial uncertainty and the Great Recession

- "But while policymakers clearly think uncertainty has played a central role in driving the Great Recession and slow recovery, **the econometric evidence is really no more than suggestive**." (Bloom, 2014)
- "An assumption of linearity may be adequate for estimating average relationships, but **few expect that an economy will respond linearly to every aberration**." (Greenspan, 29 August 2003)

Research questions

- **Q1: Real effects of uncertainty shocks: State-dependent? Great Recession vs. normal times?**
  - identification of new facts regarding the real effects of uncertainty shocks during the Great Recession
  - focus on financial uncertainty shocks, drivers of the business cycle (Ludvigson, Ma, and Ng 2019; Angelini, Bacchiocchi, Caggiano, and Fanelli 2019)
- **Q2: Structural interpretation of asymmetric effects of uncertainty shocks during the Great Recession?**
  - identification of structural drivers
  - calibration/estimation macro models for policy analysis

$\Rightarrow$Need nonlinear models

This paper

- **Estimate IVARs with post-WWII U.S. data**, GDP growth as conditioning indicator
  - Aim: State-dependent GIRFs to detect/quantify nonlinearities
- **Estimate nonlinear DSGE model à la Basu and Bundick (2017)** via Bayesian direct inference approach (Christiano et al., 2011)
  - Able to generate comovements to financial uncertainty shocks
  - Aim: Unveil whether/which structural instabilities in key parameters are needed to replicate the facts
- **Analyze Great Recession**
  - Output loss & implications for calibrating models for policy analysis, counterfactual on role of monetary policy

Main findings

- **Responses of real activity indicators to uncertainty shocks: Stronger during Great Recession**
  - Larger than predicted by a linear VAR
- **Nonlinear effects of uncertainty shocks explained by counter-cyclical risk aversion**
  - Good fit of the DSGE model in both states (normal times/GR) thanks to parameter instability
  - High risk aversion crucial to replicate IVAR Great Recession responses
- **Great recession: Role of nonlinearities...**
  - DSGE model estimated conditional on nonlinear IVAR explains about 60% of the output loss in the 2008Q4-2014Q3 period; only 40% if a linear VAR is employed
- **Great recession: ... and policy counterfactual**
  - Fed's immediate and aggresive response helped to prevent a deeper recession

Plan of the presentation

- Literature review
- IVAR model: Specification, estimation, evidence
- DSGE model: Review, estimation, evidence
- Great recession
- Conclusions

Literature review

- **State-dependent effects of uncertainty shocks**: Caggiano, Castelnuovo, and Groshenny (2014), Caggiano, Castelnuovo, Nodari (2017), Caggiano, Castelnuovo, Figueres (2017); Alessandri and Mumtaz (2018); Chatterjee (2018a)
- **Interacted-VAR**: Mittnik (1990); Towbin and Weber (2013), Sáet al. (2014), Aastveit et al. (2017), Pellegrino (2017a,b), Caggiano, Castelnuovo, Pellegrino (2017)
- **Structural analysis of uncertainty-driven comovements**: Basu and Bundick (2017)
- **Bayesian IRF matching**: Christiano et al. (2011); Castelnuovo and Pellegrino (2018)
- **Estimation of III-order approx. DSGE frameworks**: Fernández-Villaverde et al. (2011, 2015), Rudebusch and Swanson (2012), Born and Pfeifer (2014), Andreasen, Fernández-Villaverde, Rubio-Ramírez (2017), Ruge-Murcia (2017); Chatterjee (2018b); Mumtaz and Theodoridis (2019)

Interacted VAR

Interacted VAR

- IVAR à la Pellegrino (2017a,b), Caggiano, Castelnuovo, and Pellegrino (2017):

$$\mathbf{Y}_t = \boldsymbol{\alpha} + \sum_{j=1}^{L} \mathbf{A}_j \mathbf{Y}_{t-j} + \left[\sum_{j=1}^{L} \mathbf{c}_j \ln VXO_{t-j} \times \Delta \ln GDP_{t-j} \right] + \boldsymbol{\eta}_t$$

$$E(\boldsymbol{\eta}_t \boldsymbol{\eta}_t') = \boldsymbol{\Omega}$$

- $\mathbf{Y}_t = [\ln VXO_t, \ln GDP_t, \ln C_t, \ln I_t, \ln Hours_t, \ln P_t, R_t]'$
- Nonlinear effects of shocks to $\ln VXO_t$ conditional on realizations of $\Delta \ln GDP_{t-j}$
- Advantages of IVAR: Parsimonious framework, full sample estimation, resambles nonlineary decision rules of III-order model while preserving stability [results robust to IVAR with higher order terms]
- [Shadow rate consistent with a negative policy rate in DSGE model (Wu and Zhang 2017; Mouabbi and Sahuc 2017)]

Interacted-VAR (cont'd)

- Uncertainty can be (both) a cause and a consequence of business cycle fluctuations
- Uncertainty shocks identified using **narrative sign restrictions** as in Ludvigson et al. (LMN):
  - $\eta_t = \mathbf{B}\mathbf{e}_t,\ E(\mathbf{e}_t\mathbf{e}_t^{'}) = \mathbf{I}_n \ \Rightarrow \boldsymbol{\Omega} = \mathbf{B}\mathbf{B}^{'}\ ;\ \mathbf{B} = [\mathbf{b}_1\ , ...,\ \mathbf{b}_n]$
  - Infinitely many solutions:
    $\mathcal{B} = \left\{\mathbf{B} = \mathbf{P}\mathbf{Q} : \mathbf{Q} \in \mathcal{O}_{\underline{n}}, diag(\mathbf{B}) \geqslant 0, \boldsymbol{\Omega} = \mathbf{B}\mathbf{B}'\right\}$
    - $\mathbf{Q}\mathbf{Q}' = \mathbf{I_n},\ \boldsymbol{\Omega} = \mathbf{P}\mathbf{P}'$
  - $\rightarrow$Impose restrict. to get the set of admissible solutions $\bar{\mathcal{B}}$
- Constraints on $\mathbf{e}_t(\mathbf{B})$:
  - *Event constraints:* identified unc shock >75th (1987Q4, 2008Q4) [LMN] or 50th (Bloom's dates + 2016Q1) percentile of the empirical density in selected dates (Dates)
  - *External variable constraints*: shocks must have negat. (posit.) correlation with stock market returns (gold price)

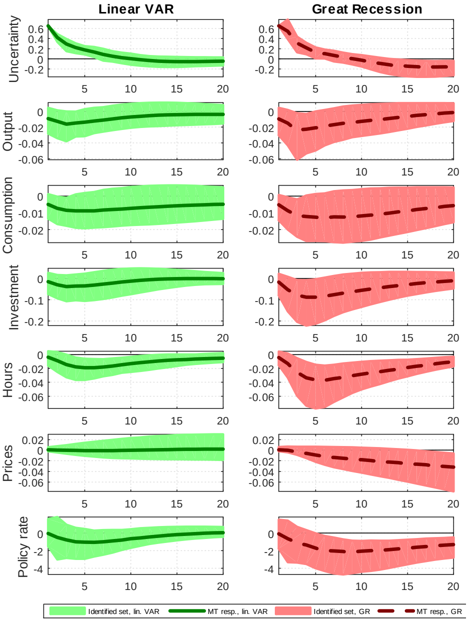
Interacted-VAR (cont'd)

- GIRFs as in Koop et al. (1996), Kilian and Vigfusson (2011):

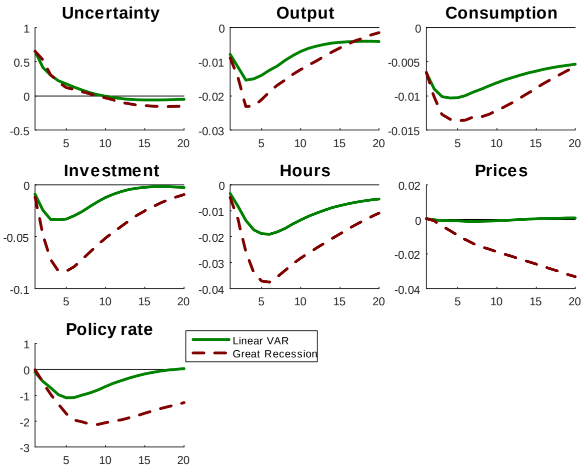
$$GIRF_{\mathbf{y}}(h, \delta, \boldsymbol{\omega}_{t-1}) = E[\mathbf{y}_{t+h} | \delta, \boldsymbol{\omega}_{t-1}] - E[\mathbf{y}_{t+h} | \boldsymbol{\omega}_{t-1}]$$

- Focus on two responses:
  - great recession: $GIRF_{\mathbf{y}}(h, \delta, \boldsymbol{\omega}_{2008Q3})$
  - nested linear VAR: $IRF_{\mathbf{y}}(h, \delta)$
- $\delta = \delta_{2008Q4} = 4.4$ standard deviation uncertainty shock (Distribution)
- Details: Sample: 1962Q3-2017Q4, VAR(4), OLS estimation
- Linearity rejected (pval < 0.01) via LR tests

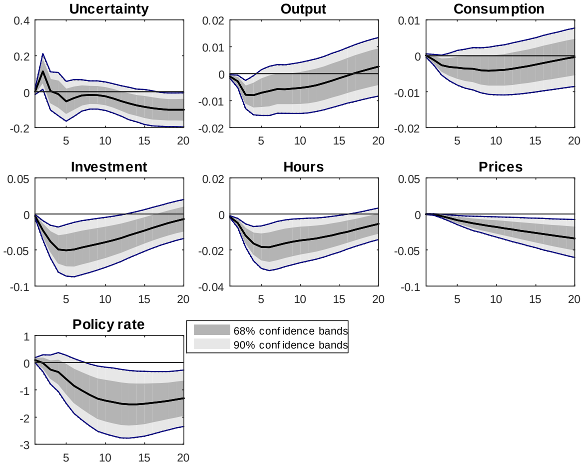
IVAR results: State-conditional GIRFs



IVAR results: Median Target GIRFs



IVAR results: Difference of state-conditional GIRFs



▶ ▸ Model uncertainty

IVAR results: main results

- Real effects of financial uncertainty shocks stronger during the Great Recession
- Results robust to: credit spread, higher-order terms, money, fiscal stance, LMN financial uncertainty, time-varying VCV (▸ checks)
- **DSGE model-related interpretation?**

DSGE framework

DSGE model at a glance

- Medium-scale New Keynesian DSGE model à la Basu and Bundick (2017,2018)
  - sticky prices (Rotemberg), invest. adj. costs, var. cap. util.
- External habits in consumption added to generate hump-shaped responses
- EZ preferences:

$$
\begin{aligned}
V_t &= \left[(1-\beta)\left(a_t \tilde{C}_t^{\eta}(1-N_{t,})^{(1-\eta)}\right)^{\frac{1-\sigma}{\theta_V}} + \beta(E_t V_{t+1}^{1-\sigma})^{\frac{1}{\theta_V}}\right]^{\frac{\theta_V}{1-\sigma}} \\
\tilde{C}_t &= C_t - H_t \ , \quad \text{with } H_t = bC_{t-1} \\
\theta_V &\equiv (1-\sigma)/(1-\psi^{-1})^{-1}
\end{aligned}
$$

- Demand-side uncertainty shock:

$$
\begin{aligned}
a_t &= (1-\rho_a)a + \rho_a a_{t-1} + \sigma_{t-1}^a \varepsilon_t^a \\
\sigma_t^a &= (1-\rho_{\sigma^a})\sigma^a + \rho_{\sigma^a}\sigma_{t-1}^a + \sigma^{\sigma^a}\varepsilon_t^{\sigma^a}
\end{aligned}
$$

DSGE model at a glance (cont'd)

- Comovements due to an uncertainty shock, economic intuition: $unc \uparrow$, $C \downarrow$, $L^s \uparrow$, $L^d =$, $w \downarrow$, $mc \downarrow$, $p \approx$, $markup \uparrow$, $Y \downarrow$, $L^d \downarrow$, $H \downarrow$, $I \downarrow$
- Model-implied VXO, match with our IVAR analysis:

$$VXO_t^M = 100 \cdot \sqrt{4 \cdot VAR_t \left(R_{t+1}^E \right)}$$

- DSGE IRFs can be captured directly by a VAR, direct inference sensible ▸ Monte Carlo

DSGE model: State-dependent estimation

- Christiano et al.'s (2011) Bayesian Minimum Distance approach applied to a III-order approximated model, state-dependent estimation
- IVAR GIRFs as "data". Under some assumptions, able to write the (limited information) likelihood and characterize the (quasi-) posterior density
- Our application allows for state-dependent parameters, employs an observable variable to identify the states, and is not computationally cumbersome
- Basu and Bundick (2017) nonlinear model estimated on the basis of state-dependent GIRFs

Christiano et al.'s (2011) Bayesian MD estimation

- IVAR GIRFs $\widehat{\boldsymbol{\psi}^i}$ as "data", distribution as a function of the true DSGE model parameters $\boldsymbol{\zeta}_0$:

$$\widehat{\boldsymbol{\psi}^i} \overset{a}{\sim} N(\boldsymbol{\psi}\left(\boldsymbol{\zeta}_0^i\right), \mathbf{V}^i(\boldsymbol{\zeta}_0^i, n^i)), \text{ for } i = R, E$$

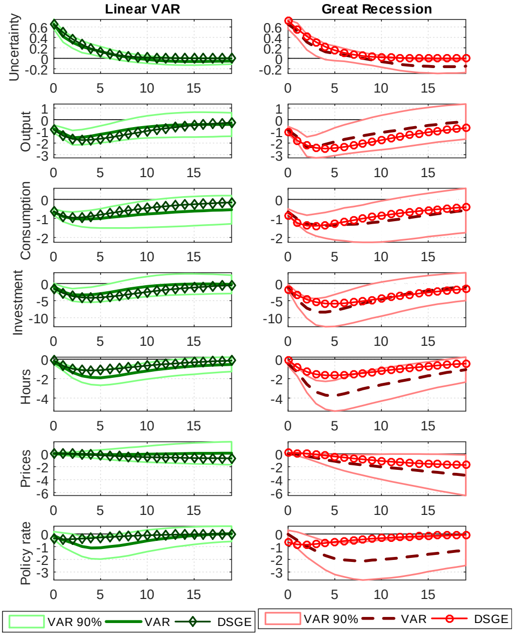
- Approx. likelihood (Kim 2002):

$$\begin{aligned} f(\widehat{\boldsymbol{\psi}^i}|\boldsymbol{\zeta}^i) &= \left(\frac{1}{2\pi}\right)^{\frac{N^i}{2}} \left|\mathbf{V}^i(\boldsymbol{\zeta}_0^i, n^i)\right|^{-\frac{1}{2}} \\ &\times \exp\left[-\frac{1}{2}\left(\widehat{\boldsymbol{\psi}^i} - \boldsymbol{\psi}\left(\boldsymbol{\zeta}^i\right)\right)' \mathbf{V}^i(\boldsymbol{\zeta}_0^i, n^i)^{-1}\left(\widehat{\boldsymbol{\psi}^i} - \boldsymbol{\psi}\left(\boldsymbol{\zeta}^i\right)\right)\right] \end{aligned}$$

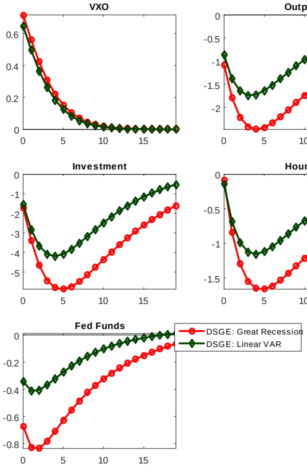
- $\boldsymbol{\psi}\left(\boldsymbol{\zeta}^i\right)$: DSGE-based GIRFs (III order perturbation)
- $p(\boldsymbol{\zeta}^i)$ common between regimes, posterior density (MCMC):

$$f(\boldsymbol{\zeta}^i|\widehat{\boldsymbol{\psi}^i}) = \frac{f(\widehat{\boldsymbol{\psi}^i}|\boldsymbol{\zeta}^i)p(\boldsymbol{\zeta}^i)}{f(\widehat{\boldsymbol{\psi}^i})}$$

DSGE fit: linear vs Great Recession



DSGE's GIRFs



VXO
Output
Consumption
Investment
Hours
Price level
Fed Funds
DSGE: Great Recession
DSGE: Linear VAR

DSGE model's estimated parameters

		Priors	Posteriors	
			Linear VAR	Great Recession
			All param.	All param.
Parameter	Interpretation	D(mean,std)	Mode,std	Mode,std
ρ_{σ^a}	Unc.shock,pers.	B(0.77,0.10)	**0.64,** 0.03	**0.65,** 0.03
σ	Risk aversion	G(100,60)	**385.90,** 50.45	**533.04,** 59.16
b	Habits	B(0.75,0.15)	**0.64,** 0.06	**0.66,** 0.04
ϕ_K	Inv. adj. costs	G(3.92,2)	**2.29,** 0.50	**3.21,** 0.60
ϕ_P	Price adj. costs	G(240,40)	**236.78,** 32.26	**282.10,** 33.54
ρ_π	TR par., inflat.	IG(1.5,0.25)	**1.05,** 0.01	**1.05,** 0.01
ρ_y	TR par., out. gr.	G(0.2,0.15)	**0.20,** 0.04	**0.28,** 0.05

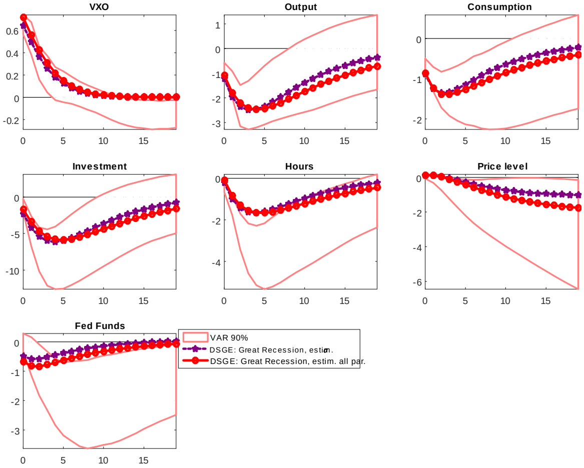
- calibrated parameters

DSGE results: Drivers

Role of state-dependent parameters

- Lots of instability in structural parameters, e.g. risk aversion, investment adj costs, price adj costs, CB response to output
- Relative role? Explorations conducted by swapping parameters one at at time point to risk aversion as crucial (▸ Counterfactual)
- Re-estimate our models by allowing for risk aversion only to be state-dependent; rest of the model calibrated with estimates conditional on linear VAR (▸ Distance criterion)

A risk aversion-only story?



DSGE model: Assessment

- Good performance of the model in replicating state-dependent IVARs
- Hours: Difficult to match, common across macro models.
  - Possibly, missmatch between theoretical concept and empirical counterpart due to heterogeneities on the labor market (Solon et al 1994); call for compositionally-adjusted measure of hours worked (Basu and Bundick 2017)
- Uncertainty persistence: unchanged

DSGE model: Assessment (cont'd)

- **Crucial parameter: Higher risk aversion in Great Recession,** which implies (Swanson 2018 ▸ formula):

$$RRA_{GR} = 145 > RRA_{lin} = 105$$

- Higher RRA in Great Recession in line with:
  - macro-finance (Cochrane 2017, Kim 2014)
  - experimental evidence (Cohn et al. 2015, Guiso et al. 2017)
  - surveys (Schildberg-Hörisch 2018)
- Nonlinearity implicit in the model not sufficient to match empirical facts (▸ no endog. asymmetries)
- [Too high RRA?
  - Rudebusch and Swanson (2012): estimated RRA of 110
  - Barillas, Hansen and Sargent (2009): high RRA / true model vs. low RRA / doubts on model]

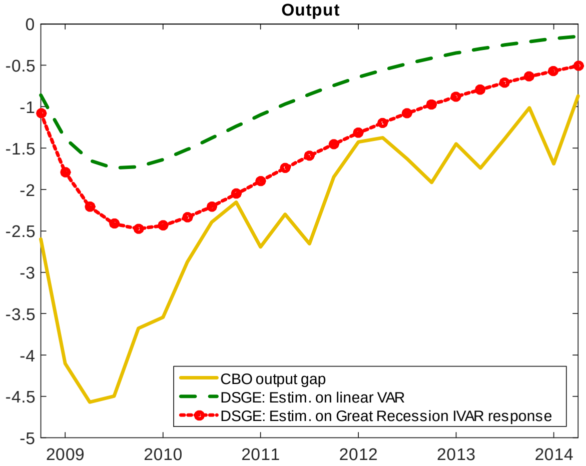
Output loss

Role of nonlinearities for exercises with DSGE model

- **How much of the total output loss during the Great Recession is due to an uncertainty shock?**
- Uncertainty shock in 2008Q4: 4.4 standard deviation uncertainty shock (similar for linear/nonlinear VAR model)
- DSGE model's predictions conditional on estimates obtained with linear vs. nonlinear VAR?
- Actual data-reference: CBO output gap (2008Q3=0), sample: 2008Q4-2014Q2

Great recession: Role of nonlinearities

Output response to the uncertainty shock in 2008Q4



- Total loss: -53%; DSGE/nonlinear (linear) VAR: -31% (-20%)

Our findings offer empirical support to:

- *"[...] Although some nonlinearities are accounted for in our modeling exercises, we cannot be certain that our simulations provide reasonable approximations of the economy's behavior in times of large idiosyncratic shocks."*
  - Alan Greenspan, opening remarks at the "Monetary Policy and Uncertainty" symposium, Jackson Hole, August 29, 2003

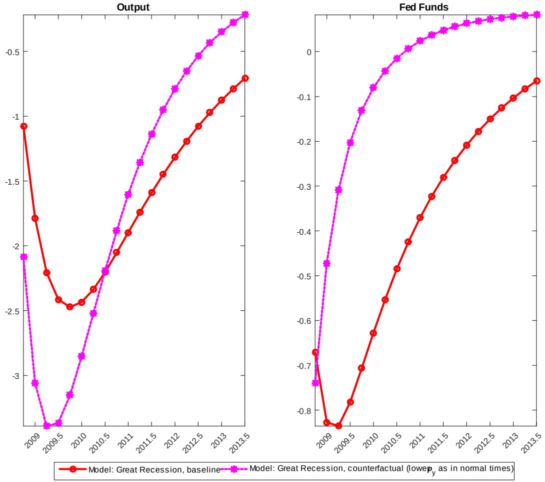
- *"For negative economic shocks such as the financial crisis in 2008–2009, the evidence rather consistently documents an increase in risk aversion, using a variety of methods."*
  - Schildberg-Hörisch (2018, *Journal of Economic Perspectives*, "Are Risk Preferences Stable?")

Output loss: Policy counterfactual

Role of monetary policy according to the DSGE

- **What was the role of monetary policy in the propagation of the 2008Q4 uncertainty shock?**
- Estimation:
  - $\rho_\pi^{GR} = \rho_\pi^{linear}$
  - $\rho_y^{GR} = 0.28 > \rho_y^{linear} = 0.20$
- Q: Did the Fed helped mitigate the depth of the Great Recession?
- Parallel with Great Depression: monetary policy was not accomodative enough (Friedman and Schwartz, 1963; Christiano, Motto, and Rostagno, 2003)
- Counterfactual ex.: replace ρ_y^{GR} with ρ_y^{linear}
  - what would have happened?
- Actual data-reference: in 2008Q3 FFR = 1.94

Great recession: Role of monetary policy



- ▶ The Fed immediate and aggresive response played a significant role in mitigating the depth of the Great Recession.

Conclusions

- IVAR analysis, real effects of financial uncertainty shocks stronger during the Great Recession
- Predictions matched with a nonlinear DSGE model estimated in a state-dependent fashion. Crucial parameter: risk aversion (counter-cyclical). Informative to build theoretical models with endogenous mechanisms
- DSGE model estimated conditional on nonlinear VAR explains about 60% of the output loss during the Great Recession, just 40% if data modeled with a linear VAR
- Implications for model calibration and policy - should a central bank directly react to financial volatility?
- More aggressive monetary policy prevented a great*er* recession
- Future research on financial & labor market frictions.

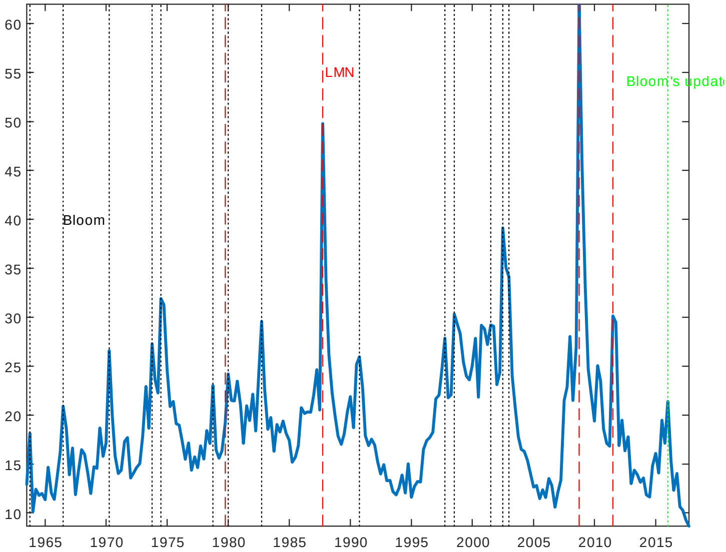
Thanks a lot!

Uncertainty in the time of the Great Recession

"If you think that another Depression might be around the corner, **better to be careful and save more. Better to wait and see how things turn out***. Buying a new house, a new car or a new laptop can surely be delayed a few months. The same goes for firms:* **given the uncertainty, why build a new plant or introduce a new product now? Better to pause until the smoke clears***. This is perfectly understandable behavior on the part of consumers and firms—but* **behaviour which has led to a collapse of demand, a collapse of output and the deep recession** *we are now in."*

Olivier Blanchard, IMF's Chief Economist, The Economist, Jan. 29, 2009 back

Event constraints

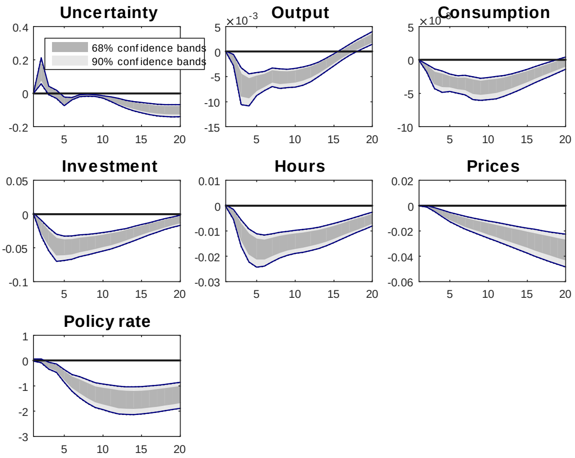


Event constraints: cont'd (back)

	Event contraints		
t	Event	Constraint on $e_{FU.t}$	Source
1962Q4	Cuban missile crisis	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1963Q4	Assassination of JFK	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1966Q3	Vietnam buildup	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1970Q2	Cambodia and Kent state	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1973Q4	OPEC I, Arab-Israeli War	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1974Q3	Franklin National	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1978Q4	OPEC II	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1979Q4	Volcker experiment	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	LMN
1980Q1	Afghanistan, Iran hostages	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1982Q4	Monetary policy turning point	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1987Q4	Black Monday	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 75th)$	Bloom & LMN
1990Q4	Gulf War I	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1991Q4	Dissolution of the Soviet Union	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1997Q4	Asian crisis	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
1998Q3	Russian, LTCM default	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
2001Q3	9/11	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
2002Q3	Worlcom, Enron	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
2003Q1	Iraq invasion	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom
2008Q4	Great recession	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 75th)$	Bloom & LMN
2011Q3	Debt ceiling crisis	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	LMN
2016Q1	FFR liftoff, China, Japanese negative rate	$e_{FU.t} > perc(\mathbf{e}_{FUt}(\mathbf{B}), 50th)$	Bloom (update)

External variable constraints		
External variable S_t	Constraint on $\rho(e_{FUt}, S_t)$	
Stock market return	$< perc(\rho(\mathbf{e}_{FUt}(\mathbf{B}), S_t), 50th)$	LMN
Real price of gold (log difference)	$> perc(\rho(\mathbf{e}_{FUt}(\mathbf{B}), S_t), 50th)$	LMN

Difference of state-conditional GIRFs: Model uncertainty



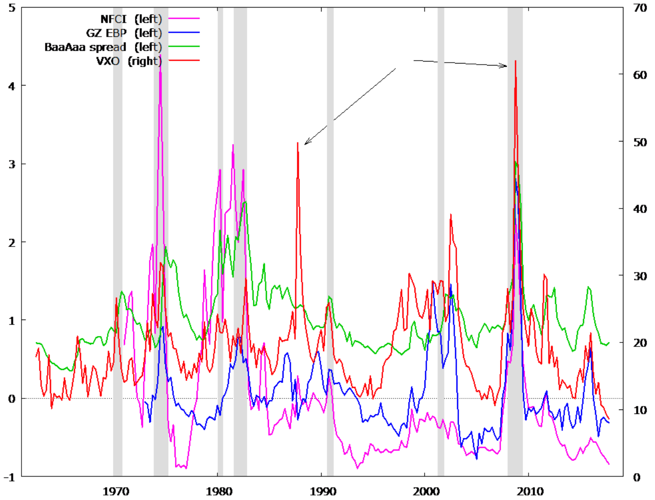
▶ back

VAR checks: credit spread

- *"the shocks that produced the [great] recession were primarily associated with financial disruptions and heightened uncertainty"* (Stock and Watson, 2012)
- Narrative restrictions to disentangle the shocks:
  - uncertainty shocks: baseline NSR
  - financial (first moment) shocks: $shock_{2008Q4} > median(shocks(\mathbf{B})_{2008Q4})$ & $shock_{1987Q4} < median(shocks(\mathbf{B})_{1987Q4})$
- NSR allow us to not take a stance on the contemporaneous relationship between uncertainty and financial shocks
- We are interested in correctly identifying uncertainty shocks

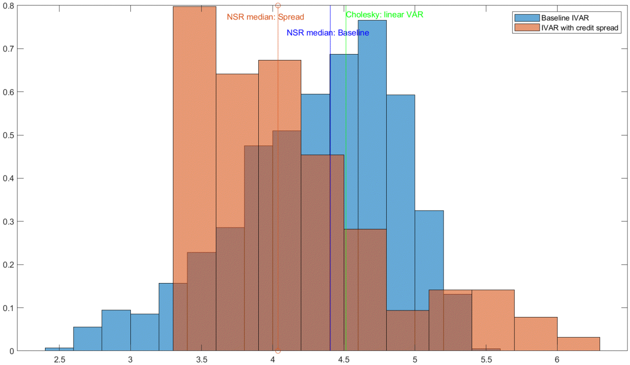
VAR checks: credit spread (cont'd)

- Uncertainty vs financial stress:



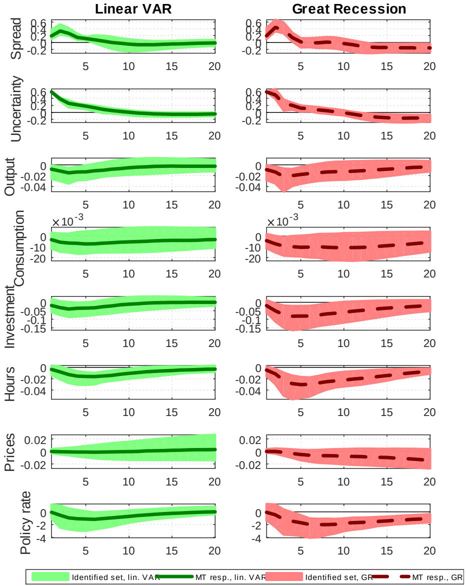
VAR checks: credit spread (cont'd)

- Size of the uncertainty shock in 2008Q4:

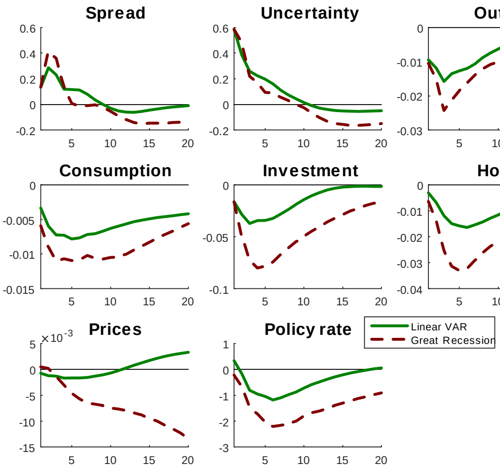


- Part of the uncertainty spike is acknowledged to be a consequence of other shocks (back*)

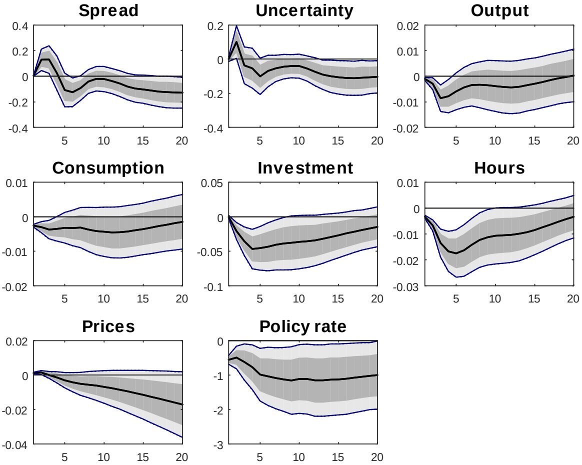
VAR checks: credit spread (cont'd)



VAR checks: credit spread (cont'd)



VAR checks: credit spread (cont'd)



Peak responses: Baseline vs. credit spread case

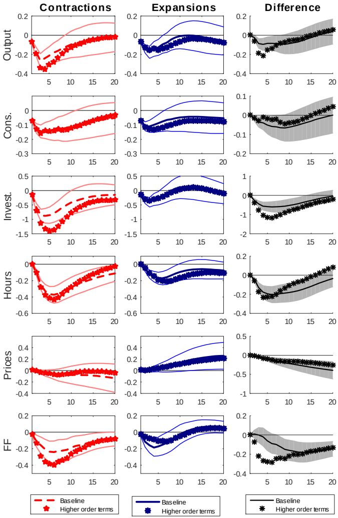
	Output	Consumption	Investment	Hours
Baseline IVAR and VAR				
Peak response: Linear	-1.54%	-1.03%	-3.34%	-1.90%
Peak response: Great Recession	-2.32%	-1.36%	-8.32%	-3.75%
Ratio GR/Linear	1.50	1.32	2.49	1.97
IVAR and VAR with financial spread				
Peak response: Linear	-1.58%	-0.78%	-3.70%	-1.63%
Peak response: Great Recession	-2.44%	-1.10%	-8.11%	-3.33%
Ratio GR/Linear	1.54	1.41	2.19	2.04

- back

IVAR with higher order terms

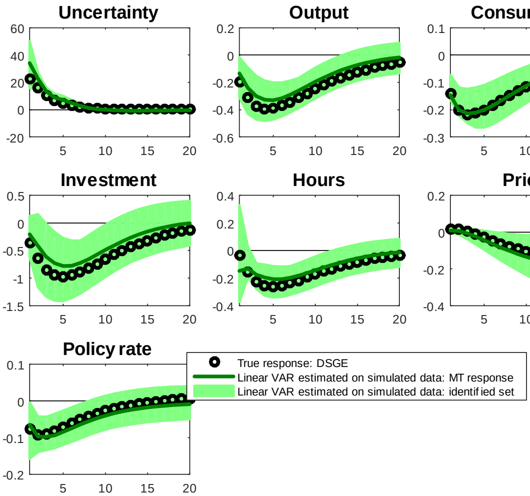
back

$$Y_t = \alpha + \sum_{j=1}^{L} A_j Y_{t-j} + \left[\begin{array}{c} \sum_{j=1}^{L} c_j \ln VXO_{t-j} \times \Delta \ln GDP_{t-j} \\ + \sum_{j=1}^{L} c_j \left(\ln VXO_{t-j} \right)^2 \times \Delta \ln GDP_{t-j} \\ + \sum_{j=1}^{L} c_j \ln VXO_{t-j} \times \left(\Delta \ln GDP_{t-j} \right)^2 \end{array} \right] + u_t$$



Monte Carlo exercise: Validation identification in population

- Sample of 2500 simulated observations from non-pruned, III order-approx. DSGE (▸ back):

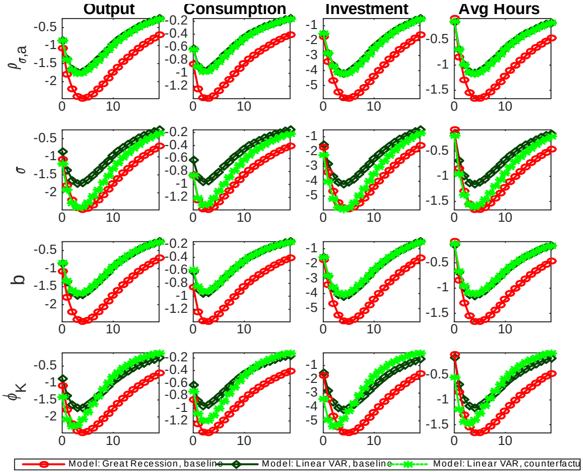


DSGE calibrated parameters

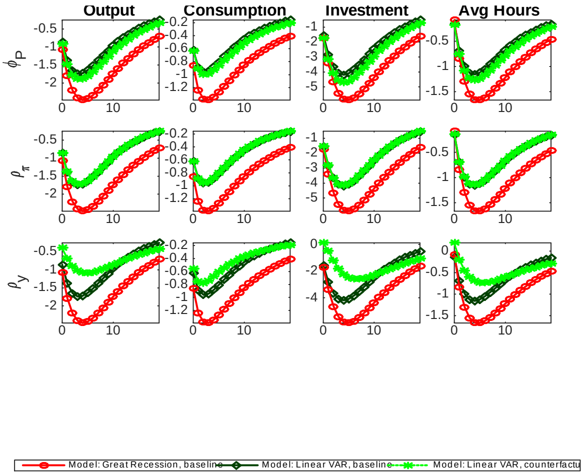
Par.	Description	Value	Source
σ_{σ^a}	volatility of the uncertainty shock	0.004	BB (2018)
ρ^a	persistence of the preference shock	0.98	BB (2018)
σ^a	volatility of the preference shock	0.005	BB (2018)
ρ^Z	persistence of the technology shock	0.35	BB (2018)
σ^Z	volatility of the technology shock	0.019	BB (2018)
α	capital's share in production	0.333	BB (2017,2018)
β	household discount factor	0.994	BB (2017,2018)
δ	steady state depreciation rate	0.025	BB (2017,2018)
δ_1	first-order utilization parameter	$1/\beta - 1 + \delta$	BB (2017,2018)
Π	steady state inflation rate	1.005	BB (2017,2018)
ν	firm leverage parameter	0.9	BB (2017,2018)
δ_2	second-order utilization parameter	0.0003	BB (2017,2018)
θ_μ	elasticity of subst. between intermediate goods	6.0	BB (2017,2028)
ψ	intertemporal elasticity of substitution	0.5	BB (2018)

back

Counterfactual exercise: drivers response in great recession



Counterfactual exercise: drivers response in great recession (2)



▶ back

Avg. distance criterion: drivers of state-dependent resp.

$$Avg.Crit = \sum_{i=contr,\mathrm{exp}} \frac{1}{2}\left(\widehat{\psi^i} - \psi\left(\zeta^i\right)\right)' \mathbf{V}_i^{-1}\left(\widehat{\psi^i} - \psi\left(\zeta^i\right)\right)$$

Average distance criterion: 1 parameter-only estimations	
ρ_{σ^a}	115.34
σ	**108.06**
b	113.67
ϕ_K	110.13
ϕ_P	118.40
ρ_π	121.82
ρ_y	114.95

▶ back

RRA for the Basu and Bundick´s model with ext. habits

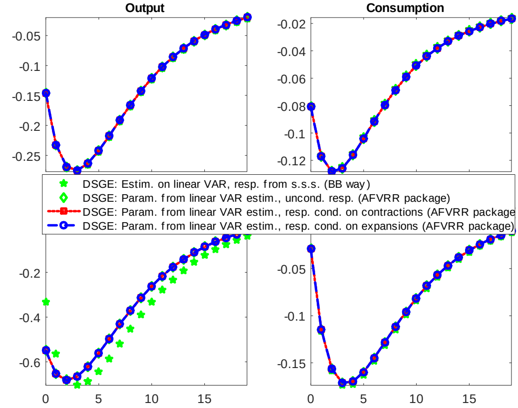
$$RRA \underset{\bar{N}\ arbitrary}{\equiv} R^c$$

$$\begin{aligned} RRA &= \left(\frac{\eta}{\eta+(1-\eta)(1-b)}\right)\cdot \\ &\left(\frac{1}{\psi}\cdot\frac{\left(1+\frac{(1-\eta)}{\eta}(1-b)\right)}{(1-b)\left(1+\frac{(1-\eta)}{\eta}\right)}+\left(\sigma-\frac{1}{\psi}\right)\left(\frac{\eta}{(1-b)}+1-\eta\right)\right)\end{aligned}$$

- if $b=0 \rightarrow RRA=\eta\cdot\sigma$
- back

Any endog. asymmetry?: DSGE state-conditional GIRFs

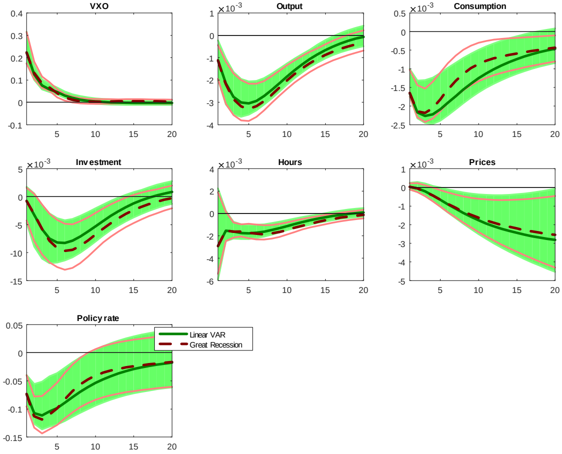
- Role of initial conditions in the *pruned* DSGE model for the propagation of the uncertainty shock (Andreasen, Fernández-Villaverde, and Rubio-Ramírez (2017)):



- Theoretically proved in Cacciatore and Ravenna (2018)

Any endog. asymmetry?: (I)VAR estim. on simulated data

- Sample of 2500 simulated observations from *non-pruned*, III order-approx. DSGE:



- If non-pruned, IV order-approx. DSGE: approximation errors too big! (back)