Macroeconomic Effects of Financial Shocks: Comment

Johannes Pfeifer (University of Cologne)

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The macroeconomic effects of financial shocks

- Jermann and Quadrini (2012): proposed DSGE model incorporating the pecking order theory of debt and equity financing
- Used two distinct approaches:
  1. RBC model with Chari et al. (2007)-style business cycle accounting to construct a series of financial shocks
     $\rightarrow$ Great Recession strongly influenced by financial shocks
  2. Bayesian estimation of medium-scale New Keynesian DSGE model
     $\rightarrow$ financial shocks account for 46% of output growth volatility since beginning of Great Moderation
     $\rightarrow$ makes Justiniano et al. (2011) marginal efficiency of investment (MEI) shock irrelevant
- paper has become very influential: $\approx$ 800 Google Scholar citations

The issue(s)

- Following the descriptions in the paper, there is no evidence for the importance of the particular type of microfounded financial shock proposed by Jermann and Quadrini (2012)
- Business-cycle accounting exercise:
  - construction of TFP: inputs and output use different sectoral concept
  - approach does not achieve identification ("financial residuals")
- Estimated NK model:
  - Metropolis-Hastings algorithm obviously did not converge
  - mode is implausible: slope of New Keynesian Phillips Curve is four orders of magnitude too big
  - missing estimation codes do prevent checking source of problems

Business cycle accounting: Identification

- Equilibrium relationships are used to construct a series for financial conditions, $\hat{\xi}_t$, for TFP via the Solow residual, $\hat{z}_t$
- The driving processes are estimated as a bivariate VAR:

$$\begin{pmatrix} \hat{z}_{t+1} \\ \hat{\xi}_{t+1} \end{pmatrix} = \mathbf{A} \begin{pmatrix} \hat{z}_t \\ \hat{\xi}_t \end{pmatrix} + \begin{pmatrix} \varepsilon_{z,t+1} \\ \varepsilon_{\xi,t+1} \end{pmatrix}, \tag{1}$$

  where **A** is a two by two coefficient matrix.

- Crucial assumption: TFP residuals $\varepsilon_{z,t+1}$ and financial residuals $\varepsilon_{\xi,t+1}$ are i.i.d. with standard deviations σ_z and σ_ξ
- But: this restriction cannot be imposed during estimation, but can be tested

Business cycle accounting

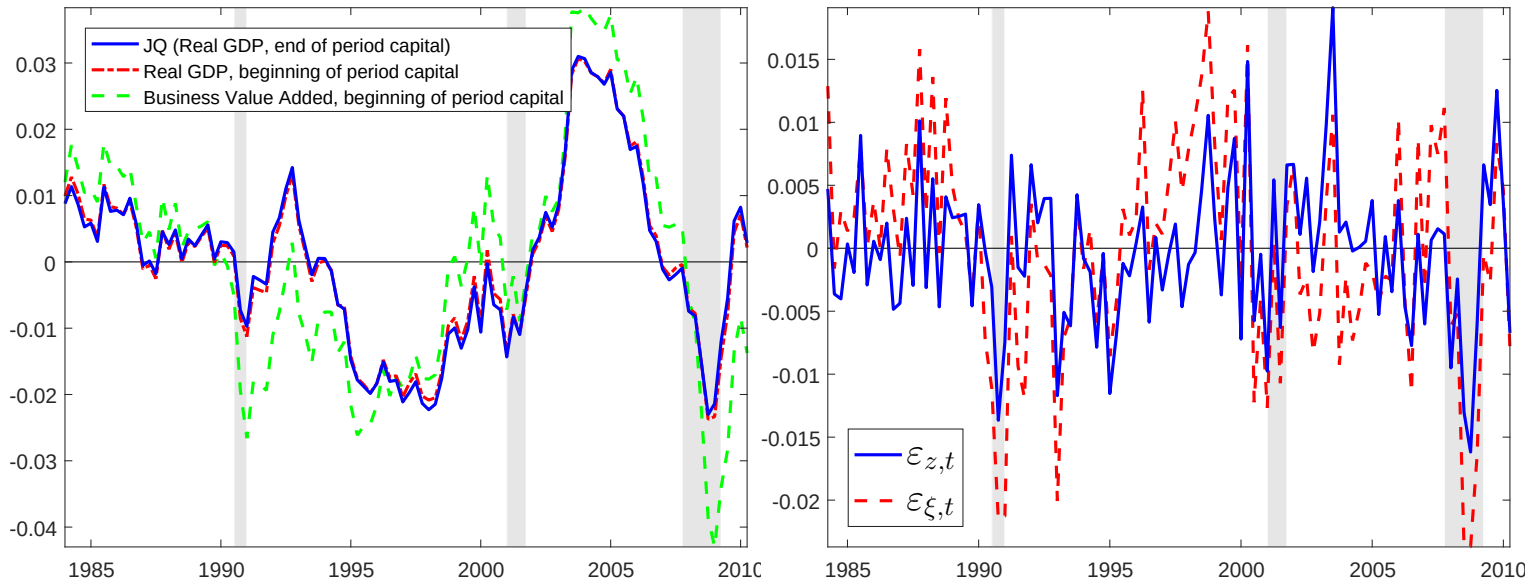
- TFP series $\hat{z}_t$ is constructed as Solow residual

$$\hat{z}_t = \hat{y}_t - \theta \hat{k}_t - (1-\theta)\hat{n}_t \,, \tag{2}$$

  where hats denote percentage deviations from long-run trend

- Inputs k_t and n_t relate to the private business sector
- Output y_t uses "Real gross domestic product", i.e. the full economy
- According to JQ's technical appendix, they intended to use "Gross value added: GDP: Business" as their output measure
- (Additional problem: JQ use end of period instead of beginning of period capital stock for TFP)

TFP Construction



TFP series VAR Residuals

- Private sector TFP dropped almost twice as much during the Great Recession
- Estimated shocks show a correlation of $\rho = 0.7425$
  $\rightarrow$ requires recalibration to match calibration targets

Figure: Counterfactual model simulations

Business cycle accounting: taking stock

- TFP residuals ("measure of our ignorance" (Abramovitz 1956)) account for 4.7 percentage points of the 8.2 percent GDP drop during the Great Recession (JQ: 2.6)
- Financial shock: accounts for drop of 2.8 percent of GDP (JQ: 4.4)
- Interpreting residuals as structural shocks as JQ does not provide strong evidence for importance of financial shocks
- But: structural shocks are not identified
  $\rightarrow$ turn to estimated structural model, which solves identification problem by construction

JQ's estimated New Keynesian model

- JQ add their financial friction and shock to a New Keynesian DSGE model with
  - wage and price stickiness
  - investment adjustment and capacity utilization costs
  - TFP, monetary policy, government spending, markup, and marginal efficiency of investment shocks
- Model is estimated with Bayesian techniques:
  1. use mode-finder to get mode of the posterior density
  2. employ Metropolis-Hastings algorithm to create Monte Carlo Markov Chain of parameter draws from the posterior around the mode
- Use debt repurchases as additional observable

The problem

- The paper provides almost no details on the estimation approach
- It is not clear how calibration targets like the government spending share are treated when other parameters affecting the steady state are estimated
- How can a beta distribution be used as a prior for parameters bigger than 1?
- Despite the AER's data policy, there are no replication codes for the estimation available

"An article about computational results is advertising, not scholarship. The actual scholarship is the full software environment, code and data, that produced the result." (John Claerbout)

JQ: implausible posterior estimates

TABLE 3—PARAMETERIZATION

Calibrated parameters	Value
Discount factor, β	0.982
Tax advantage, τ	0.350
Utility parameter, α	16.736
Production technology, θ	0.360
Depreciation rate, δ	0.025
Enforcement parameter, $\overline{\xi}$	0.199
Average gov. purchases, $\overline{G}$	0.179

Estimated parameters	Prior[mean,std]	Mode	Below 5%	Below 95%
Utility parameter, σ	Normal[1.5, 0.37]	1.090	1.082	1.091
Elasticity of labor, ε	Normal[2.0, 0.75]	1.761	1.759	1.765
Habit in consumption, λ	Beta[0.5, 0.30]	0.608	0.609	0.616
Wage adjustment, ω	Beta[0.5, 0.30]	0.278	0.276	0.285
Price adjustment cost, ϕ	IGamma[0.1, 0.30]	0.031	0.032	0.043
Investment adjustment cost, ϱ	IGamma[0.1, 0.30]	0.021	0.016	0.020

- HPDIs are smaller by a factor of 10 than in e.g. Christiano et al. (2014)
- Posterior is asymptotically normal
  $\rightarrow$ almost impossible for mode to be outside of 90% bounds
  $\rightarrow$ clear sign of MCMC non-convergence and parameter drift

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- Rotemberg (1982) price adjustment cost parameter implies Phillips Curve slope of 235 (Calvo duration: 1.004 quarters)
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Replication/Reestimation

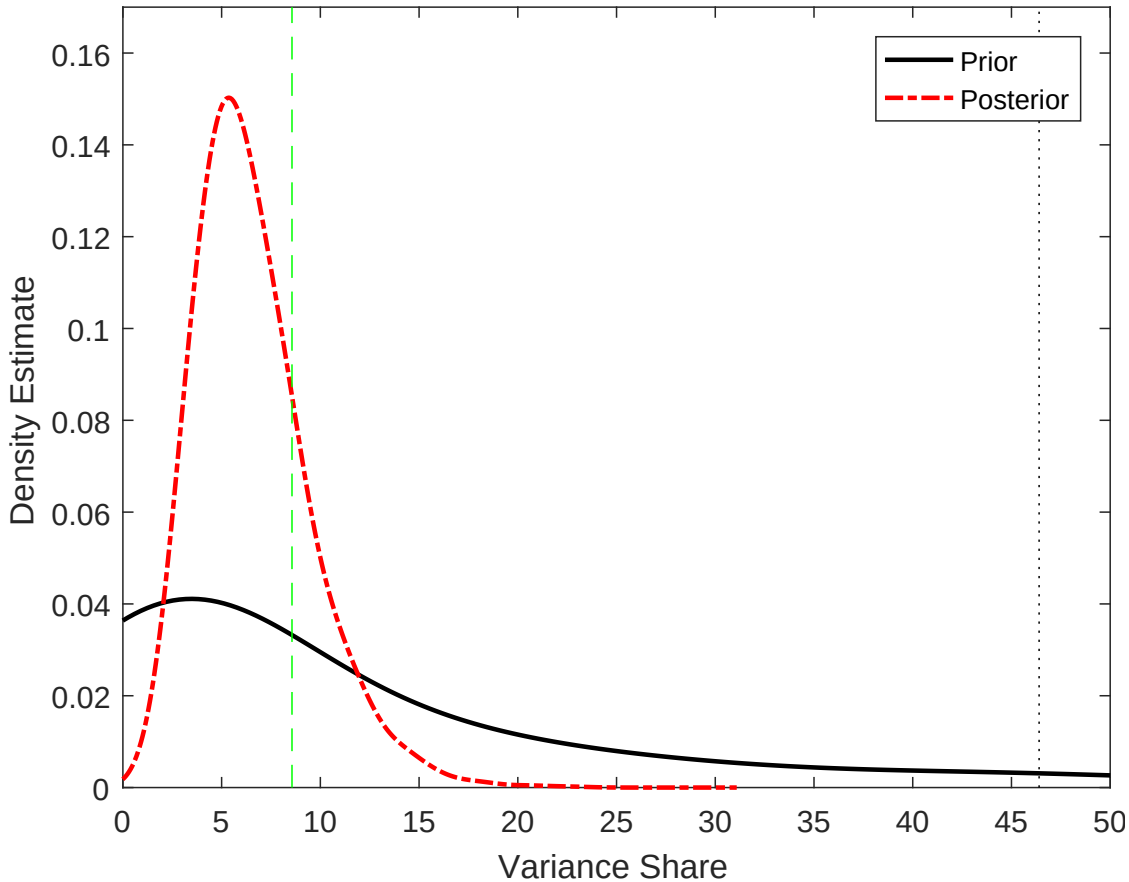
- Implement model in Dynare 4.5, while fixing typos in three first order conditions
- Assume net markup follows beta distribution specified in JQ
- Make sure model satisfies calibration targets for each parameter draw
- Use Covariance Matrix Adaptation Evolution Strategy (CMAES) algorithm (Hansen et al. 2003) for global mode-finding
- Run MCMC with 10 million draws, using 25% burn-in
- Check convergence via trace plots and the Geweke (1999) convergence diagnostics

Reestimation

	Prior Distribution			Posterior Distribution			
				JQ	Reestimation		
Parameter Name	Dist	Mean	S.D.	Mode	Mode	5%	95%
Risk aversion	norm	1.500	0.370	1.090	1.540	0.855	1.731
Frisch	norm	2.000	0.750	1.761	0.873	0.940	2.998
Habit parameter	beta	0.500	0.300	0.608	0.367	0.263	0.500
Calvo Wage	beta	0.500	0.300	0.278	0.075	0.037	0.220
Rotemberg price	invg	0.100	0.300	0.031	6.997	7.300	29.584
Investment adj. cost	invg	0.100	0.300	0.021	0.149	0.102	1.371
Capital utilization cost	beta	0.500	0.150	0.815	0.775	0.548	0.882
Equity cost	invg	0.200	0.100	0.426	0.287	0.254	0.935
Average price markup	beta	1.200	0.100	1.137	1.806	1.712	1.871

- HPDIs have usual size found in the literature
- Rotemberg price adjustment cost is almost 226 times bigger than in JQ (Calvo duration: 2.96 quarters)
- price markup of 80 percent much higher than typically found (e.g. Altig et al. 2011; Justiniano et al. 2013)

Prior and posterior forecast error variance share of the financial shock



- JQ microfounded financial shock explains 6% instead of 46% of output volatility

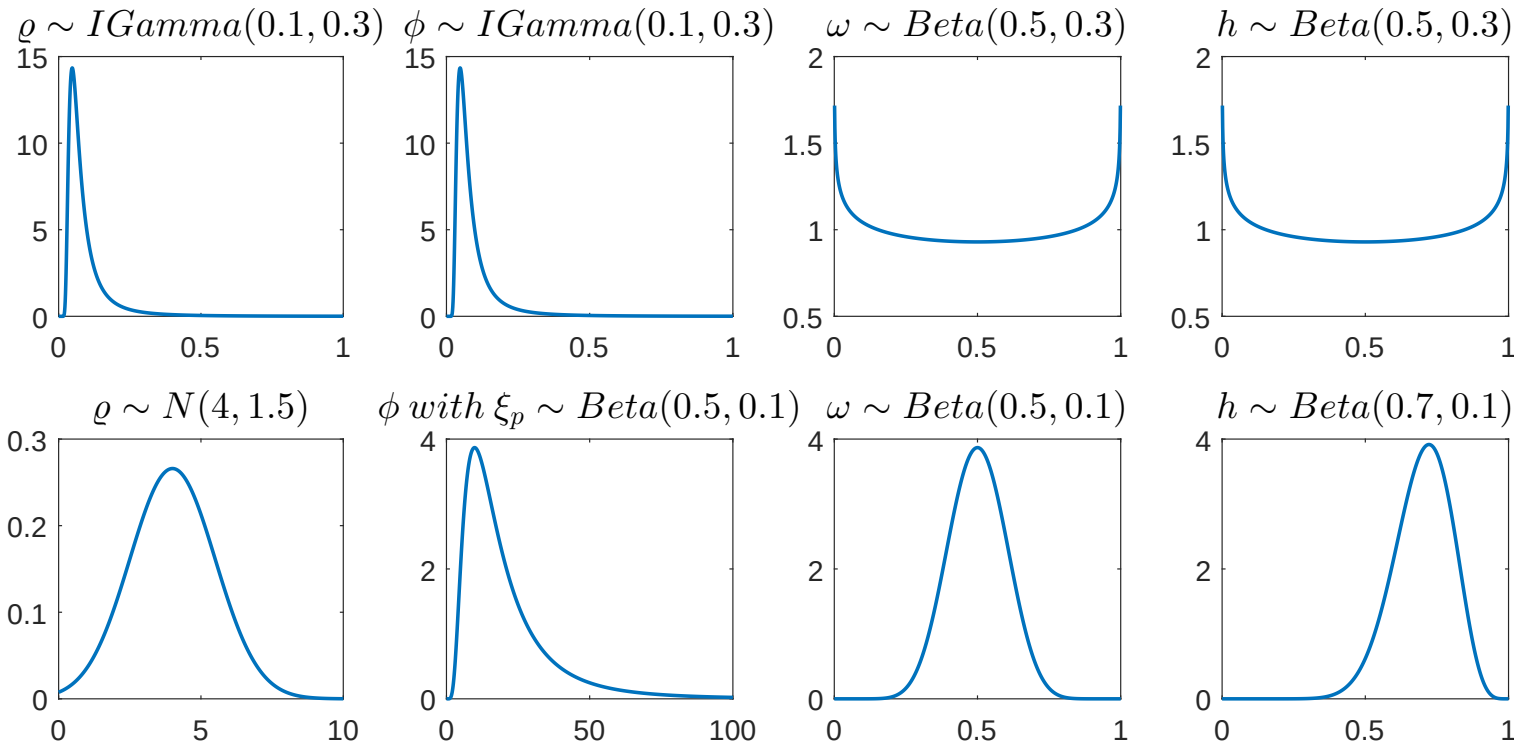
Posterior forecast error variance decomposition

	TFP	MEI	Intert.	Price MK	Wage MK	Govern.	Money	Fin.	Fin.
	ε_z	ε_ζ	ε_γ	ε_η	ε_υ	ε_g	ε_ς	ε_ξ	ε_ξ
	Reestimation								JQ
GDP	5.99	26.11	8.06	25.36	11.63	5.96	10.36	6.53	46.4
Consumption	4.33	23.27	20.81	8.85	24.66	5.95	7.56	4.57	0.6
Investment	1.98	74.45	5.97	11.08	2.68	0.10	2.39	1.35	24.7
Inflation	3.98	18.09	18.60	17.88	8.37	0.70	12.69	19.69	9.5
FF rate	1.24	53.30	31.64	4.16	5.68	1.53	1.09	1.36	4.7
Hours	22.42	26.15	3.69	14.52	17.36	6.74	5.95	3.17	33.5
Wages	2.13	4.98	15.45	21.51	36.78	1.52	8.15	9.48	1.0
Debt repayments	4.05	38.51	5.30	16.80	7.77	0.83	2.44	24.32	13.5

- Marginal efficiency of investment shock most important driver

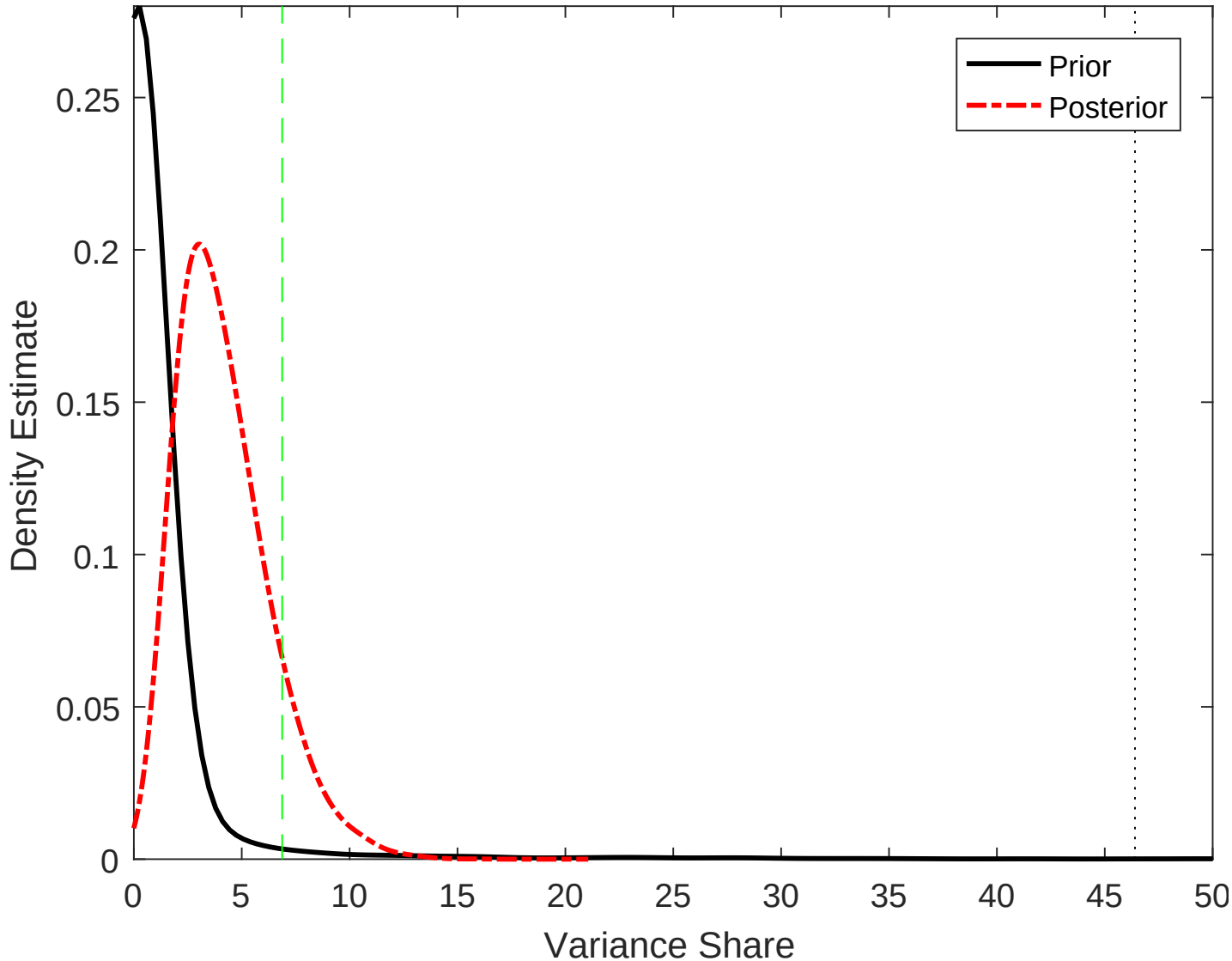
JQ vs. Smets and Wouters (2007) prior

- "The choice of the prior distributions are the same as those used in Smets and Wouters (2007) with the exception, of course, of the parameters that were not present in that model"



- Prior forces price stickiness to 0, forcing markup to account for flat Phillips Curve

Prior and posterior forecast error variance share of the financial shock: Smets/Wouters-type prior



Posterior forecast error variance decomposition: Smets/Wouters-type prior

	TFP	MEI	Intert.	Price MK	Wage MK	Govern.	Money	Fin.	Fin.
	ε_z	ε_ζ	ε_γ	ε_η	ε_υ	ε_g	ε_ς	ε_ξ	ε_ξ
	Reestimation								JQ
GDP	1.61	40.00	13.55	16.52	2.91	9.25	12.03	4.13	46.4
Consum	1.95	21.00	38.80	8.89	3.93	7.58	13.92	3.94	0.6
Invest	0.33	90.72	2.13	4.26	0.74	0.14	1.40	0.27	24.7
Inflat	3.94	2.44	18.93	35.89	7.09	1.75	6.99	22.97	9.5
FF rate	1.77	31.02	47.89	8.92	3.29	1.96	3.68	1.46	4.7
Hours	27.36	31.23	8.64	8.88	5.15	8.38	8.56	1.80	33.5
Wages	0.55	2.03	3.28	10.37	75.11	0.92	1.43	6.31	1.0
DebtPay	2.26	41.58	3.53	21.56	3.50	2.08	3.65	21.83	13.5

- Importance of marginal efficiency of investment shock very similar to Justiniano et al. (2011)

Conclusion

- Evidence provided by JQ actually not in favor of their particular type of micro-founded financial shock:
  - business cycle-accounting exercise suffers from non-identification
  - JQ's estimated model affected by non-convergence of the MCMC
- Reestimation yields results consistent with previous literature: marginal efficiency of investment shocks most important driver
- According to Justiniano et al. (2011), MEI shocks proxy for financial frictions
- Christiano et al. (2014): risk shocks "crowd out" MEI shocks in estimated model

Bibliography I

- Abramovitz, Moses (1956). "Resource and output trends in the United States since 1870". *American Economic Review 46* (2), 5–23.
- Altig, David, Lawrence J. Christiano, Martin Eichenbaum, and Jesper Lindé (2011). "Firm-specific capital, nominal rigidities and the business cycle". *Review of Economic Dynamics 14* (2), 225–247.
- Chari, V. V., Patrick J. Kehoe, and Ellen R. McGrattan (2007). "Business cycle accounting". *Econometrica 75* (3), 781–836.
- Christiano, Lawrence J., Roberto Motto, and Massimo Rostagno (2014). "Risk shocks". *American Economic Review 104* (1), 37–65.

Bibliography II


Galí, Jordi and Mark Gertler (1999). "Inflation dynamics: a structural econometric analysis". *Journal of Monetary Economics 44* (2), 195–222.


Geweke, John (1999). "Using simulation methods for Bayesian econometric models: inference, development, and communication". *Econometric Reviews 18* (1), 1–73.


Hansen, Nikolaus, Sybille D. Müller, and Petros Koumoutsakos (2003). "Reducing the time complexity of the derandomized evolution strategy with covariance matrix adaptation (CMA-ES)". *Evolutionary Computation 11* (1), 1–18.


Jermann, Urban and Vincenzo Quadrini (2012). "Macroeconomic effects of financial shocks". *American Economic Review 102* (1), 238–71.

Bibliography III

- Justiniano, Alejandro, Giorgio E. Primiceri, and Andrea Tambalotti (2011). "Investment shocks and the relative price of investment". *Review of Economic Dynamics 14* (1), 101–121.
- ——— (2013). "Is there a trade-off between inflation and output stabilization?". *American Economic Journal: Macroeconomics 5* (2), 1–31.
- Lindé, Jesper (2005). "Estimating new-Keynesian Phillips curves: a full information maximum likelihood approach". *Journal of Monetary Economics 52* (6), 1135–1149.
- Rotemberg, Julio J. (1982). "Sticky Prices in the United States". *Journal of Political Economy 90* (6), 1187–1211.
- Smets, Frank and Rafael Wouters (2007). "Shocks and frictions in US business cycles: a Bayesian DSGE approach". *American Economic Review 97* (3), 586–606.