What Are Empirical Monetary Policy Shocks? Estimating the Term Structure of Policy News

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Introduction

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- **Unresolved questions:** ... but what are these EMPS? Are they short-term interest rate surprises? News about future policy?
- **Essential!** Without an answer, evaluating theory with the empirical evidence is *impossible*

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3. Using many EMPS, can construct *synthetic* MPS with any term structure. We estimate effects of true policy surprises and news.
   - *Finding:* Surprises are contractionary; news is deflationary

Motivating Example

- A simple New Keynesian model:

New Keynesian Phillips curve:	$\pi_t = \beta \mathbb{E}[\pi_{t+1}] + \kappa y_t$
Euler equation:	$i_t = \mathbb{E}_t[\gamma(y_{t+1} - y_t) + \pi_{t+1}]$
Taylor rule:	$i_t = \phi_y y_t + \phi_\pi \pi_t + \nu_t$
Policy news:	$\nu_t = \nu_{0,t} + \nu_{1,t-1} + \nu_{2,t-2} + \ldots$

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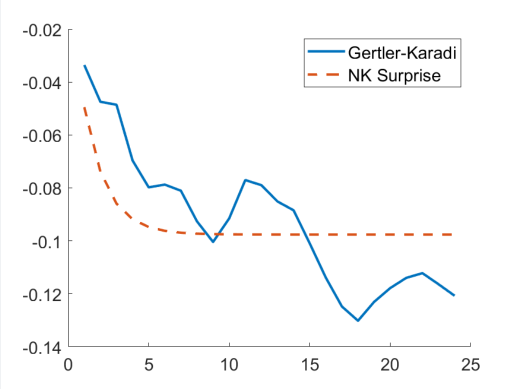
\end{aligned}$$

- Policy residual ν_t is partially anticipated; $\nu_{h,t-h}$ is h-period ahead news at time $t-h$.
- An EMPS is some combination of surprise/news shocks
- Each news shock has a unique IRF: *any* EMPS IRF can be rationalized by this model!

Do EMPS Look Like the NK Model?



(a) EMPS vs. NK Surprise Shock

(b)

Figure 1: CPI Responses to Monetary Shocks

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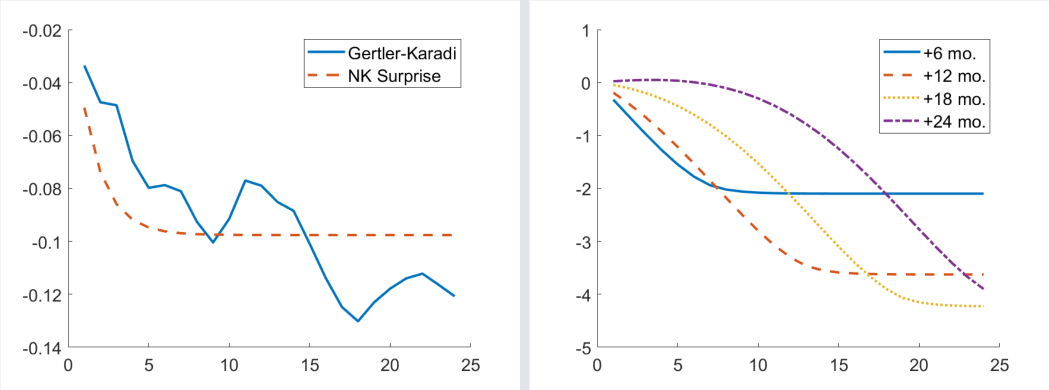

(a) EMPS vs. NK Surprise Shock

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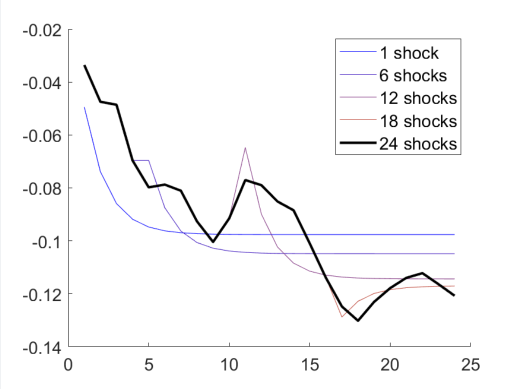
Figure 1: CPI Responses to Monetary Shocks

... Yes, for Some Term Structure of News



(a) MPS Approximations

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Figure 2: Rationalizing Gertler-Karadi with a Combination of News Shocks

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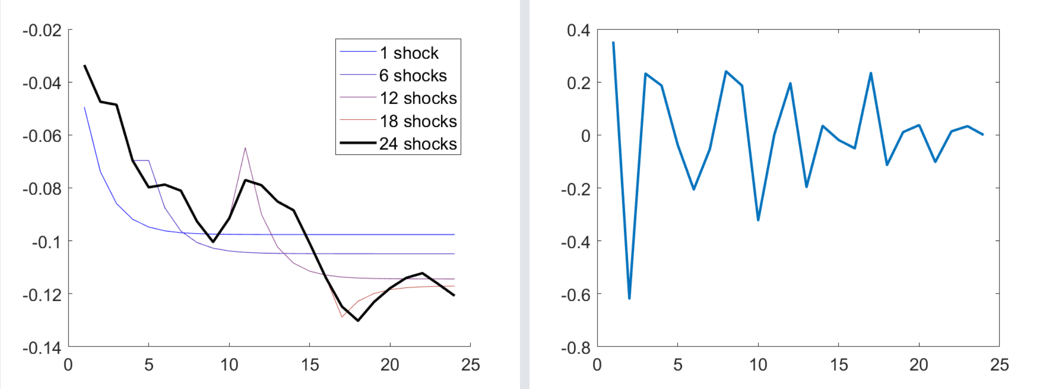

(a) MPS Approximations

(b) Rationalizing Term Structure

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Theoretical Framework

General Framework: Monetary Policy

- Monetary policy is given by a Taylor-type rule (y_t is the policy instrument):

$$y_t = x_t\phi + r_t \tag{1}$$

- The residual r_t may be autocorrelated:

$$r_t = \sum_{\ell=1}^{L} \left(\rho_{y,\ell} y_{t-\ell} + x_{t-\ell}\phi_\ell\right) + \nu_t \tag{2}$$

- The monetary policy *innovation* ν_t is a linear combination of independent news shocks:

$$\nu_t = \nu_{0,t} + \nu_{1,t-1} + \nu_{2,t-2} + \ldots + \nu_{H_\nu,t-H_\nu} \tag{3}$$

General Framework: Monetary Policy Shocks

- EMPS contain some information about policy news at many horizons. EMPS w_t^j of type j is:

$$w_t^j = \sum_{h=0}^{H_w} \beta_h^j \nu_{h,t} + \xi_t^j \tag{4}$$

- ξ_t^j is iid orth. to $\nu_{h,t}$ (measurement error, CBI, etc.)

General Framework: Term Structure of Monetary Policy News

- The term structure of EMPS j is the effect of the EMPS w_t^j on expectations of the policy innovation ν_t over many horizons:

$$\gamma_h^j \equiv \frac{d\mathbb{E}[\nu_{t+h}|w_t^j]}{dw_t^j}$$

- Given DGP (4), the term structure of EMPS can be written:

$$\nu_t = \sum_{h=0}^{H_w} \gamma_h^j w_{t-h}^j + u_t \tag{5}$$

with residual u_t

Empirical Strategy

Estimation Strategy

- Would like to regress $\nu_t = \sum_{h=0}^{H_w} \gamma_h^j w_{t-h}^j + u_t$, but ν_t is unobserved

▸ Why can't we just use OLS?

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  - 4. Regress innovations on lags of EMPS to estimate the γ_h^j term structure coefficients

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Estimation Strategy: One Step

- The 4-stage procedure can be estimated in one step:

$$\hat{\gamma} = (W'W)^{-1}W'M_{\mathbf{X}}(I - X(X'P_Z X)^{-1}X'P_Z)y$$

where P_Z and $M_{\mathbf{X}}$ are projection matrices that depend on instruments Z and macro variables X.

Monte Carlo Validation

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- $\hat{\gamma}$ consistently estimates the term structure if Z are valid instruments (exclusion: orthogonal to ν_t)
- This representation is useful because it has analytical standard errors:

$$Var\left(\hat{\gamma}|W, X, Z\right) = (W'W)^{-1}W'M_{\mathbf{X}}\ldots$$
$$\times \left(I - X(X'P_Z X)^{-1}X'P_Z\right)\Omega\left(I - X(X'P_Z X)^{-1}X'P_Z\right)' M_{\mathbf{X}}W(W'W)^{-1}$$

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- Estimator becomes

$$\hat{\gamma}^j = (W'W + \lambda\mathbf{P}_B)^{-1} W' M_{\mathbf{X}}(I - X(X'P_Z X)^{-1}X'P_Z)y$$

Data

- Monetary policy shocks from the literature
- Non-monetary macro shocks to use as instruments
- Standard macro time series for estimating the policy rule (inflation and output gap) and evaluating effects

Monetary Policy Shocks

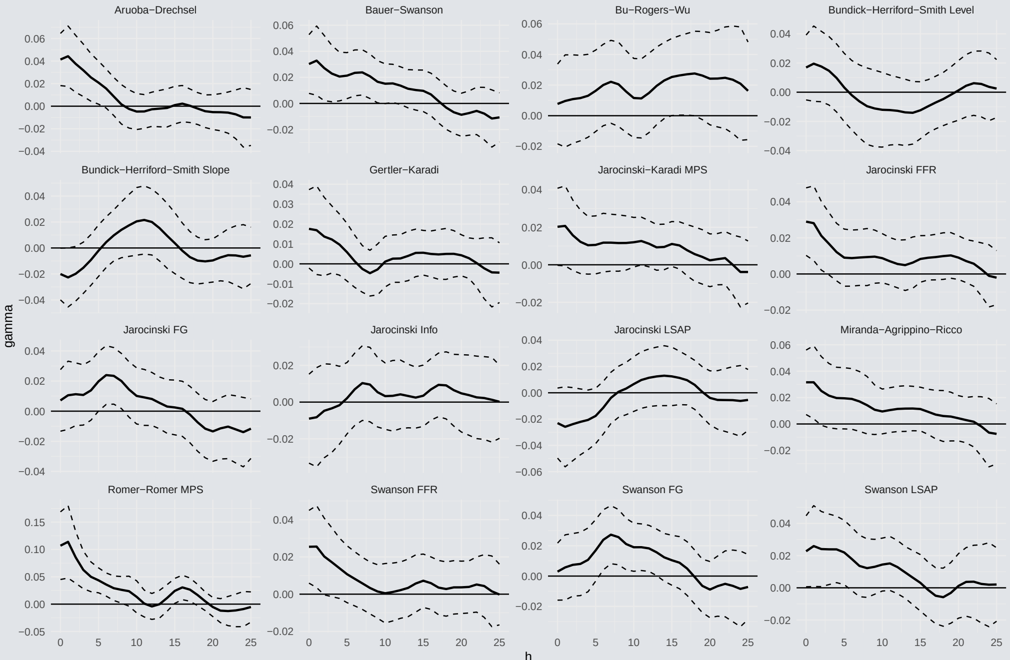
Shock Source	Method	Notes	Range
Gertler and Karadi (2015)	HFI	30 min. window around FOMC decisions	1990:M1-2007:M12
Jarociński and Karadi (2020)	HFI	2 shocks: pure monetary and Fed information	1990:M1-2016:M12
Bundick and Smith (2020)	HFI	2 shocks to term structure uncertainty	1994:M2-2019:M06
Miranda-Agrippino and Ricco (2021)	HFI	Orthogonalized w.r.t. Greenbook forecasts	1991:M1-2009:M12
Bu et al. (2021)	HFI	Alternative without intraday data	1994:M2-2024:M12
Bauer and Swanson (2023)	HFI	Includes Fed minutes and speeches	1988:M2-2023:M12
Swanson (2024)	HFI	Decomposed into 3 types of EMPS	1988:M2-2023:M12
Jarociński (2024)	HFI	Decomposed into 4 types of EMPS	1990:M2-2024:M9
Romer and Romer (2004)	Narrative	Orthogonalized w.r.t. Greenbook forecasts	1983:M1-2007:M12
Aruoba and Drechsel (2024)	Narrative	Natural language processing of Fed docs	1982:M10-2008:M10

Non-monetary Structural Shock Instruments

Shock Source	Method	Notes	Range
Government Spending Shocks			
Romer and Romer (2016)	Narrative	Social Security expansions	1951:M1-1991:M12
Fieldhouse et al. (2018)	Narrative	Government housing purchases	1952:M11-2014:M12
Oil Shocks			
Känzig (2021)	HFI	Oil supply news	1975:M1-2023:M6
Baumeister and Hamilton (2019)	SVAR	Oil supply, consumption/inventory demand	1975:M2-2024:M3
Other Shocks			
Kim et al. (2025)	External	ACI severe weather shocks	1964:M4-2019:M5
Adams and Barrett (2024)	SVAR	Shocks to inflation expectations	1979:M1-2024:M5

Estimation Results: Taylor Rule

- Baseline:
  - 12-month PCE inflation coeff.: 1.52
  - Monthly (detrended) employment coeff.: 0.37
  - r_t residual autocorr.: 0.95
- Robustness:
  - Inflation coefficient very robust across specifications, including inflation measure, lag selection, time periods, different IVs (but not inclusion of infl. expectations)
  - Real activity coefficient very sensitive to measure used (as expected)
  - OLS not robust at all!
- Coefficients *should* change depending on which variables appear in rule
- Key question: are the implied term structures robust? (Mostly yes)


Aruoba−Drechsel
Bauer−Swanson
Bu−Rogers−Wu
Bundick−Herriford−Smith Level
Bundick−Herriford−Smith Slope
Gertler−Karadi
Jarocinski−Karadi MPS
Jarocinski FFR
Jarocinski FG
Jarocinski Info
Jarocinski LSAP
Miranda−Agrippino−Ricco
Romer−Romer MPS
Swanson FFR
Swanson FG
Swanson LSAP
gamma
h

Estimation Results: Summarizing the Term Structures

- How should we quantify the term structures?

- R_k^2 statistic captures the proportion of ν_t variation that is explained by a shock at horizon k is

$$R_k^2 \equiv \frac{Var(\nu_t | w_{t-k}^j)}{Var(\nu_t | \{w_{t-h}^j\}_{h=0}^{H_w})} = \frac{(\gamma_k^j)^2}{\sum_{h=0}^{H_w} (\gamma_h^j)^2}$$

Shock	$R^2_{0:1}$	$R^2_{2:6}$	$R^2_{7:12}$	$R^2_{13:24}$
Swanson FG	0.01	0.22	0.59	0.18
Bu-Rogers-Wu	0.02	0.11	0.16	0.71
Jarocinski FG	0.04	0.35	0.36	0.25
Jarocinski Info	0.18	0.11	0.32	0.40
Bundick-Herriford-Smith Slope	0.21	0.17	0.43	0.19
Swanson LSAP	0.23	0.50	0.22	0.05
Bundick-Herriford-Smith Level	0.24	0.22	0.25	0.29
Bauer-Swanson	0.27	0.36	0.26	0.11
Jarocinski LSAP	0.28	0.45	0.07	0.20
Jarocinski-Karadi MPS	0.28	0.25	0.28	0.19
Miranda-Agrippino-Ricco	0.34	0.38	0.16	0.12
Jarocinski FFR	0.43	0.27	0.11	0.18
Gertler-Karadi	0.44	0.35	0.04	0.17
Aruoba-Drechsel	0.47	0.48	0.02	0.04
Swanson FFR	0.49	0.40	0.02	0.09
Romer-Romer MPS	0.52	0.36	0.05	0.07

Table 1: Decomposition of Term Structure by Horizon

Synthetic Monetary Policy Shocks

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- **Proposition:** For a linear combination of MPS $w_t^c = \lambda_a w_t^a + \lambda_b w_t^b$, the resulting term structure of monetary policy news $\vec{\gamma}^c$ is proportional to the linear combination of term structures:

$$\vec{\gamma}^c \propto \lambda_a \vec{\gamma}^a + \lambda_b \vec{\gamma}^b$$

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- Valuable! Allows us to isolate the effects of specific components of monetary policy news, e.g. surprises or forward guidance.

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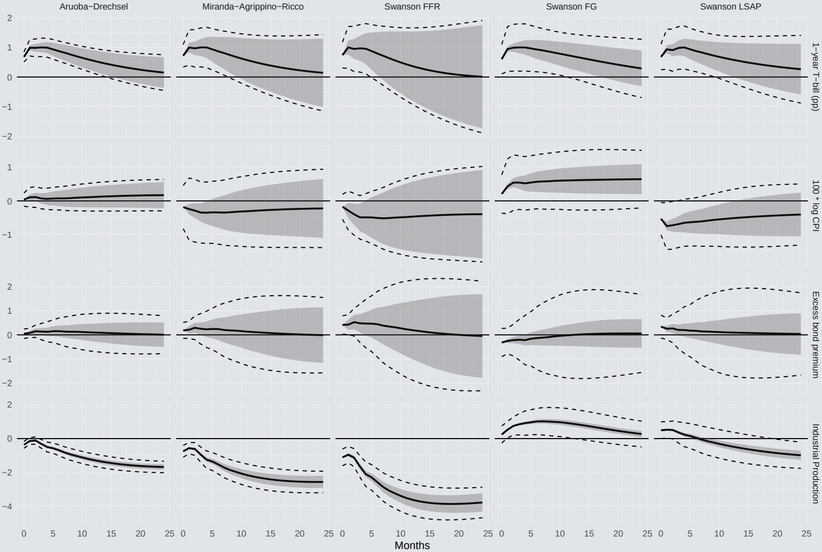
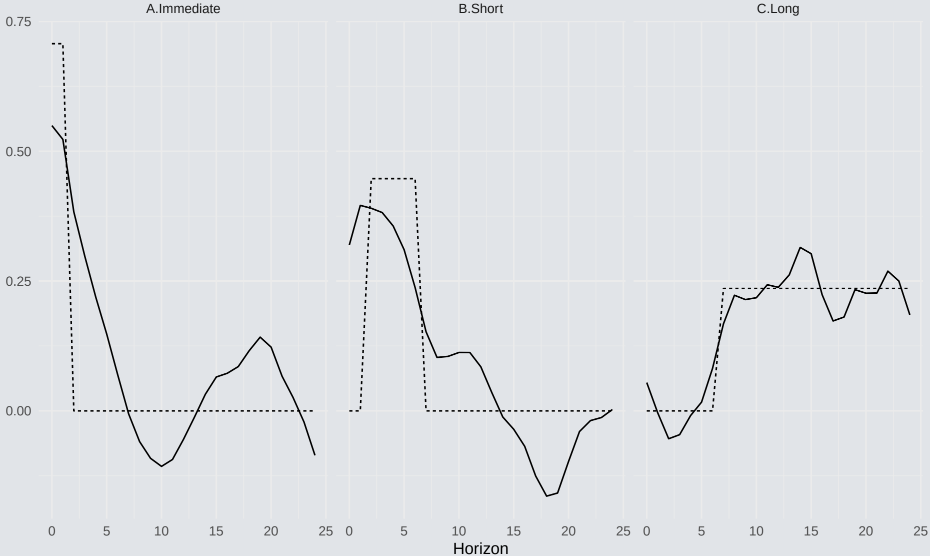
    - Immediate: horizons $0 - 1$
    - Short-run: horizons $2 - 7$
    - Long-run: horizons $8 - 25$
- Using 5 recent EMPS, we can accurately approximate these term structures.
- Then, estimate the macroeconomic effects using the standard Gertler-Karadi VAR

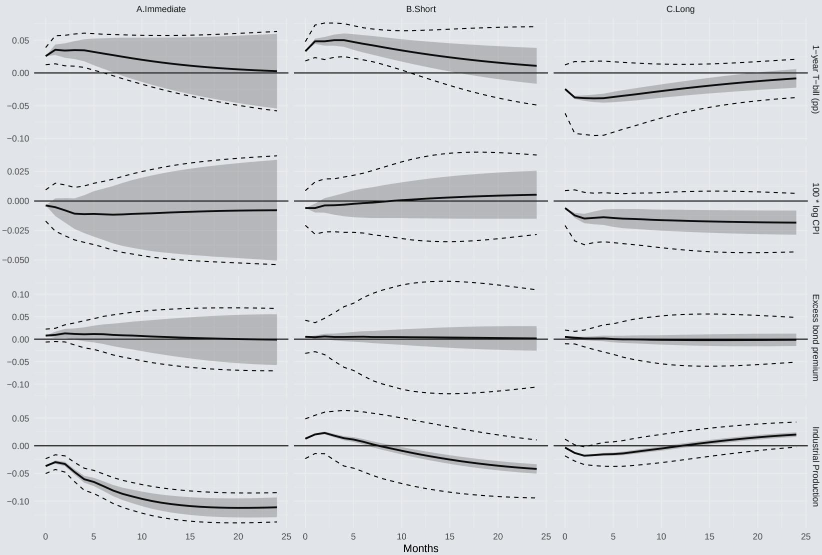
Macroeconomic Effects of Component EMPS



Synthetic Term Structures



Macroeconomic Effects of Synthetic MPS



Conclusions

- Analyzing an EMPS in a model requires knowing its term structure of monetary policy news; we derived a method to estimate it.
- Can use good EMPS to construct synthetic MPS with desired term structures
- Textbook-looking EMPS are not so ordinary when broken down into immediate shocks, forward guidance
- Main conclusions robust to most alternative specifications (except ZLB inclusion)

Robustness

Can't we just use OLS to estimate policy rules?

Traditional approach: Lagged outcomes as instruments (Clarida et al., 2000)

- Addresses endogeneity, but *only if* policy residuals are unforecastable
- Throws away contemporaneous variation

More recently: OLS bias isn't a big deal in most settings (Carvalho et al., 2021)

Our approach: Instrument contemporaneous endogenous policy variables with plausibly exogenous macro shocks from the literature.

- Best of both worlds: robustly addresses endogeneity and uses contemporaneous variation.
- OLS bias not necessarily small when news shocks matter.
- ... and in practice, OLS is not robust ▸ Back

Monte Carlo Validation: Long sample

		Model	Four-stage IV				OLS			
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Taylor Rule	ϕ_π	1.500	1.501	1.566	1.524	1.519	1.417	1.405	1.404	1.404
			(0.003)	(0.062)	(0.026)	(0.021)	(0.003)	(0.003)	(0.003)	(0.003)
	ϕ_y	0.125	0.128	0.120	0.146	0.137	0.093	0.084	0.084	0.084
			(0.002)	(0.008)	(0.013)	(0.009)	(0.001)	(0.001)	(0.001)	(0.001)
Term Structure	γ_0	0.435	0.435	0.434	0.450	0.443	0.402	0.394	0.393	0.392
			(0.004)	(0.005)	(0.013)	(0.009)	(0.004)	(0.004)	(0.004)	(0.004)
	γ_1	0.109	0.109	0.117	0.109	0.110	0.106	0.106	0.104	0.104
			(0.003)	(0.008)	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
	γ_2	0.017	0.020	0.016	0.021	0.020	0.017	0.016	0.016	0.016
			(0.004)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
	γ_3	0.004	0.009	0.011	0.008	0.009	0.009	0.009	0.007	0.007
			(0.004)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Residual lag length, L			1	1	1	1	1	1	6	24
Demand instrument			2	2	1	1				
Supply instruments			2	0	1	1				
Instrument lags			0	0	0	6				
F-test, first stage, π_t			374.2	7.7	26.2	7.3				
F-test, first stage, y_t			102.2	37.5	9.1	3.2				
Lagged y_t							No	Yes	Yes	Yes

Table 2: Monte Carlo Simulation: Long sample

Monte Carlo Validation: Short sample

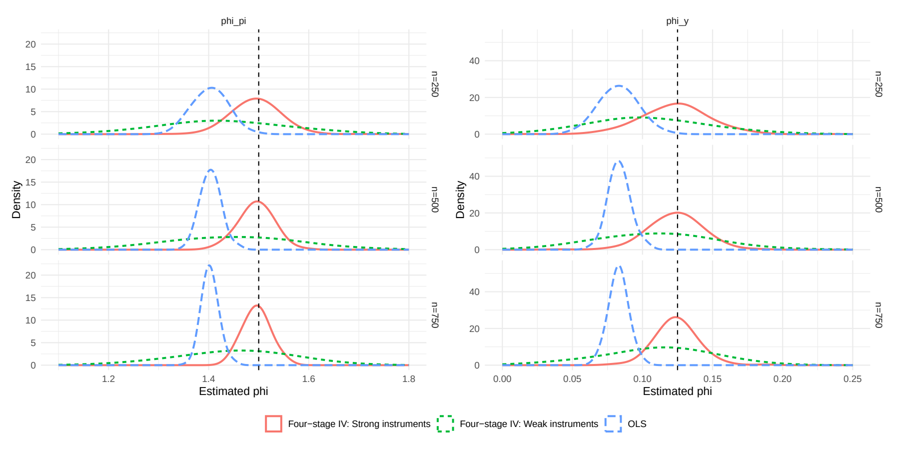


Figure 6: Distribution of estimated Taylor Rule coefficients

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Monte Carlo Validation: Short sample

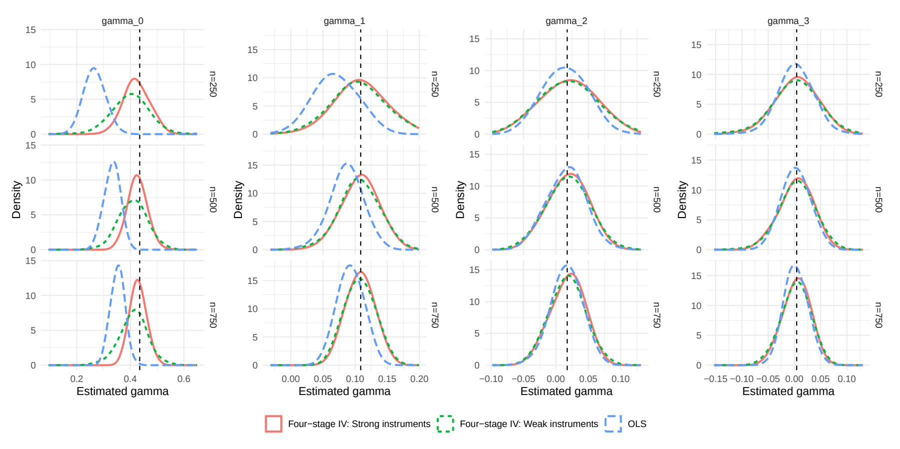

Figure 7: Distribution of estimated term structure of monetary policy.

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Monte Carlo Validation: Short sample

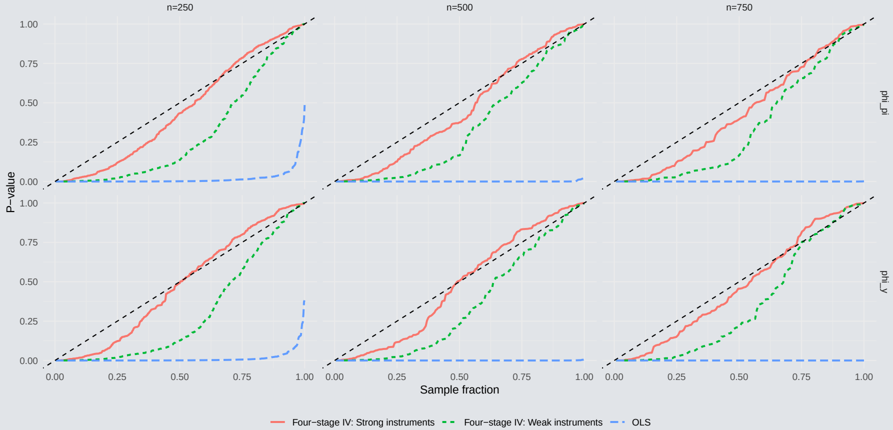

Figure 8: Distribution p-values of estimated Taylor Rule coefficients

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Monte Carlo Validation: Short sample

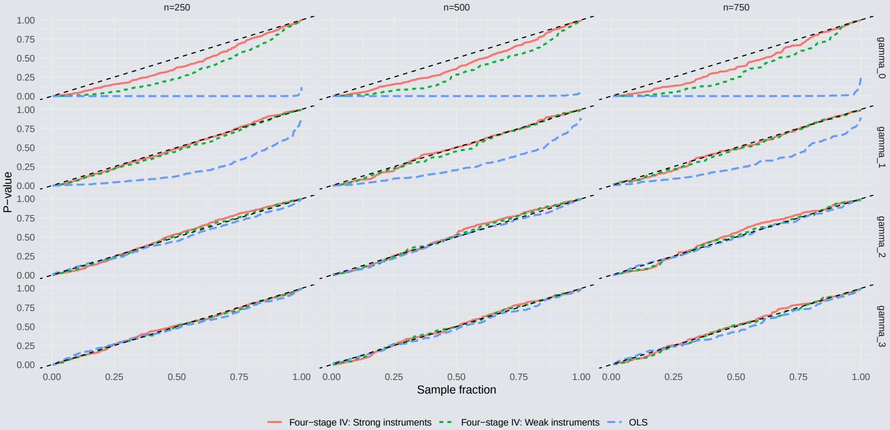

Figure 9: Distribution p-values of estimated term structure of monetary policy.

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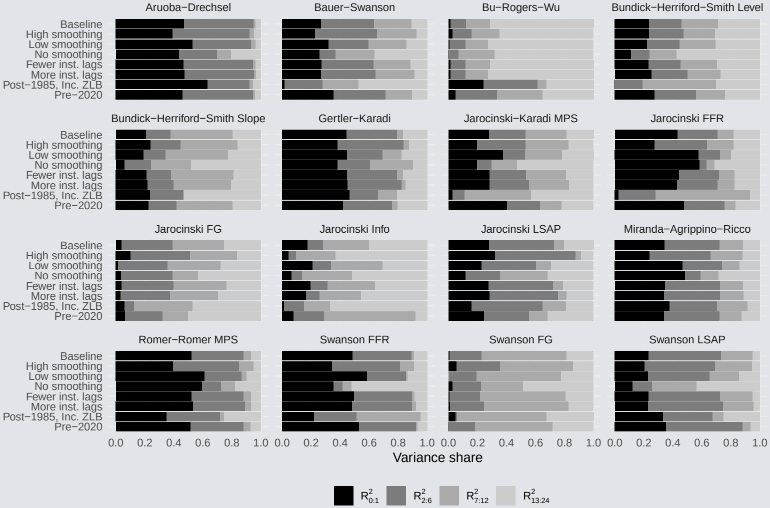
Variance decomposition robustness: Specifications



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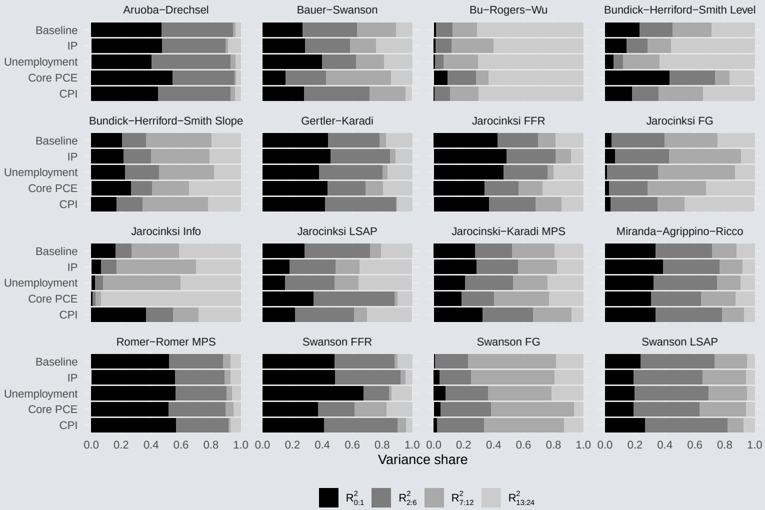
Variance decomposition robustness: Endogenous Variables



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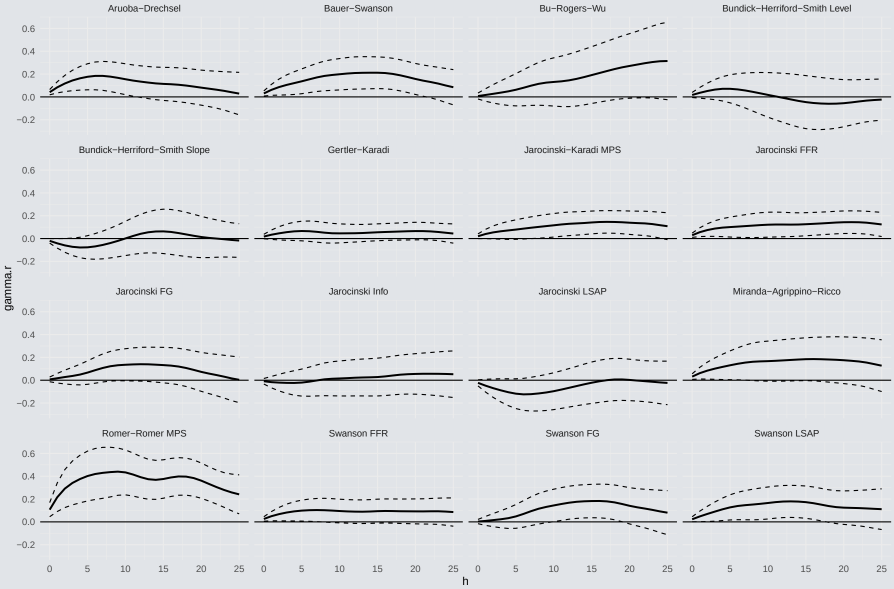
Aruoba−Drechsel
Bauer−Swanson
Bu−Rogers−Wu
Bundick−Herriford−Smith Level
Bundick−Herriford−Smith Slope
Gertler−Karadi
Jarocinski−Karadi MPS
Jarocinski FFR
Jarocinski FG
Jarocinski Info
Jarocinski LSAP
Miranda−Agrippino−Ricco
Romer−Romer MPS
Swanson FFR
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Aruoba−Drechsel
Bauer−Swanson
Bu−Rogers−Wu
Bundick−Herriford−Smith Level
Bundick−Herriford−Smith Slope
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Jarocinski LSAP
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