Imperfect Macroeconomic Expectations: Evidence and Theory

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State of The Art

Lots of lessons outside representative agent, rational expectations benchmark

But also a "wilderness" of alternatives

- Rational inattention, sticky info, etc. (Sims, Mankiw & Reis, Mackowiak & Wiederholt)
- Higher-order uncertainty (Morris & Shin, Woodford, Nimark, Angeletos & Lian)
- Level-K thinking (Garcia-Schmidt & Woodford, Farhi & Werning)
- Cognitive discounting (Gabaix)
- Over-extrapolation (Gennaioli, Ma & Shleifer, Fuster, Laibson & Mendel, Guo & Wachter)
- Over-confidence (Kohlhas & Broer, Scheinkman & Xiong)
- Representativeness (Bordalo, Gennaioli & Shleifer)
- Undue effect of historical experiences (Malmendier & Nagel)
- ...

This Paper

Contributions:

- Use a parsimonious framework to organize existing theories and evidence
- Provide new evidence
- Clarify *which* evidence is most relevant for the theory
- Identify the "right" model of expectations for business cycle context

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Main lessons:

- Little support for FIRE, cognitive discounting, level-k
- Mixed support for over-confidence or representativeness
- Best model: dispersed info + over-extrapolation
- Best way to connect theory and data: IRFs of average forecasts (and their term structure)

Outline

The Facts

Facts Meet Theory (without/with GE)

Conclusion

Fact 1: Aggregate Forecast Errors are Predictable

Coibion and Gorodnichenko (2015)

$$\left(x_{t+k} - \overline{\mathbb{E}}_t x_{t+k}\right) = a + K_{CG} \cdot \left(\overline{\mathbb{E}}_t x_{t+k} - \overline{\mathbb{E}}_{t-1} x_{t+k}\right) + u_t$$

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	(1)	(2)	(3)	(4)
variable	Unemployment		Inflation	
sample	1968-2017	1984-2017	1968-2017	1984-2017
Revision$_t$ (K_{CG})	0.741	0.809	1.528	0.292
	(0.232)	(0.305)	(0.418)	(0.191)
R^2	0.111	0.159	0.278	0.016
Observations	191	136	190	135

Notes: The dataset is the Survey of Professional Forecasters and the observation is a quarter between Q4-1968 and Q4-2017. The forecast horizon is 3 quarters. Standard errors are HAC-robust, with a Bartlett ("hat") kernel and lag length equal to 4 quarters. The data used for outcomes are first-release.

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Bad news for: RE + *common* information

Good news for: (i) RE + *dispersed* noisy information

(ii) under-confidence, under-extrapolation, cognitive discounting, level-K

Fact 2: Individual Forecast Errors are Predictable

Bordalo, Gennaioli, Ma, and Shleifer (2018); Kohlhas and Broer (2018); Fuhrer (2018)

$$(x_{t+k} - \mathbb{E}_{i,t} x_{t+k}) = a + K_{\text{BGMS}} \cdot (\mathbb{E}_{i,t} x_{t+k} - \mathbb{E}_{i,t-1} x_{t+k}) + u_t$$

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	(1)	(2)	(3)	(4)
variable	Unemployment		Inflation	
sample	1968-2017	1984-2017	1968-2017	1984-2017
$\text{Revision}_{i,t}$ (K_{BGMS})	0.321	0.398	0.143	-0.263
	(0.107)	(0.149)	(0.123)	(0.054)
R^2	0.028	0.052	0.005	0.025
Observations	5383	3769	5147	3643

Notes: The observation is a forecaster by quarter between Q4-1968 and Q4-2017. The forecast horizon is 3 quarters. Standard errors are clustered two-way by forecaster ID and time period. Both errors and revisions are winsorized over the sample to restrict to 4 times the inter-quartile range away from the median. The data used for outcomes are first-release.

BGMS argue that $K_{\text{BGMS}} < 0$ is more prevalent in other forecasts. If so, then:

Bad news for: under-extrapolation, cognitive discounting, and level-K thinking

Good news for: over-extrapolation and over-confidence (or "representativeness")

But: perhaps $K_{\text{BGMS}} \approx 0$ "on average"

Facts 1 + 2 $\Rightarrow$ Dispersed Info

variable sample	Unemployment 1968-2017	 1984-2017	Inflation 1968-2017	 1984-2017
K_{CG}	0.741	0.809	1.528	0.292
K_{BGMS}	0.321	0.398	0.143	-0.263
$K_{CG} > K_{BGMS}$	✓	✓	✓	✓

Q: What does $K_{CG} > K_{BGMS}$ mean?

A: *My* forecast revision today predicts *your* forecast error tomorrow

Evidence of dispersed private information

combined regression

The Missing Piece: Conditional Moments

So far: unconditional correlations of forecasts, outcomes, and errors

What we really want to know: conditional responses to the ups and downs of the business cycle

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What we really want to know: conditional responses to the ups and downs of the business cycle

Solution: estimate IRFs of forecasts to shocks

Shocks: usual suspects; or DSGE shocks; or "main BC shocks" (Angeletos, Collard & Dellas, 2020)

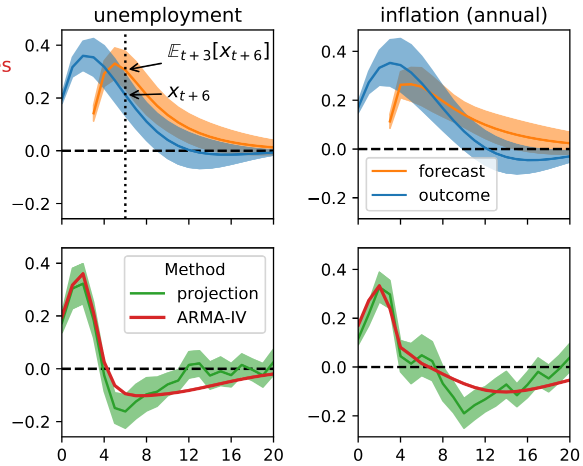
Estimation method: plain-vanilla linear projection; or big VARs; or ARMA-IV (novel approach) details

Moments of interest:

$$\left(\frac{\partial \text{ForecastError}_{t+k}}{\partial \text{BusinessCycleShock}_t} \right)_{k=0}^{K} = \text{Pattern of mistakes}$$

Fact 3: Dynamic Over-Shooting in Response to Business Cycle Shocks

Each "slice" compares 3-Q-ahead forecasts with outcome



forecast and outcome

forecast error

Shaded area = ± 1 SE

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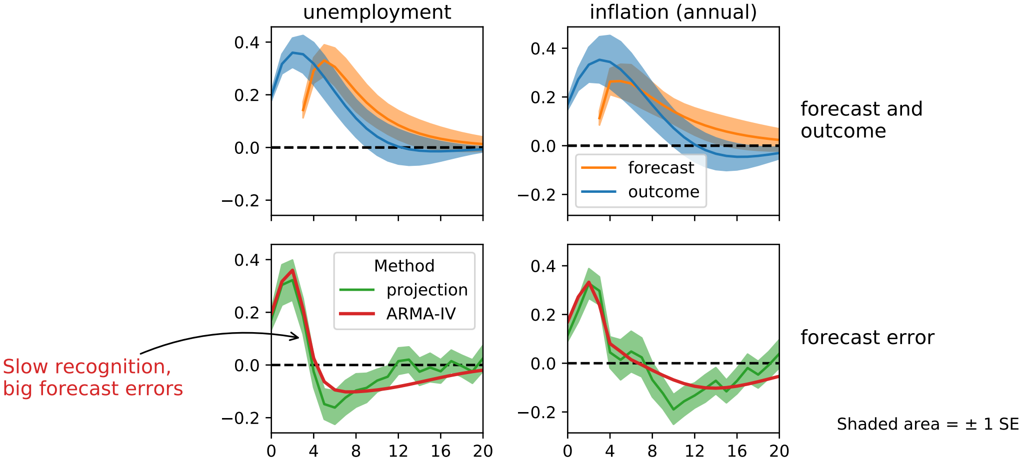

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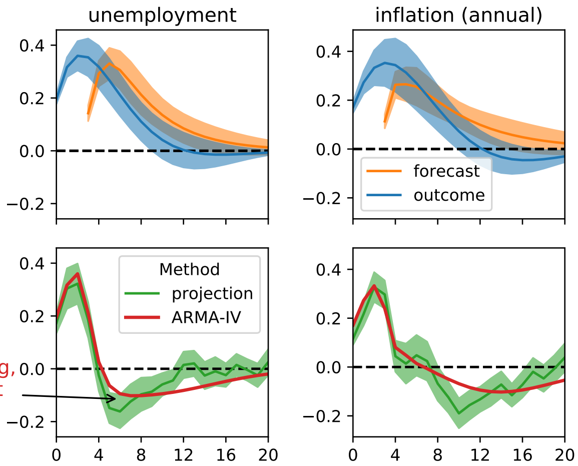

forecast and outcome

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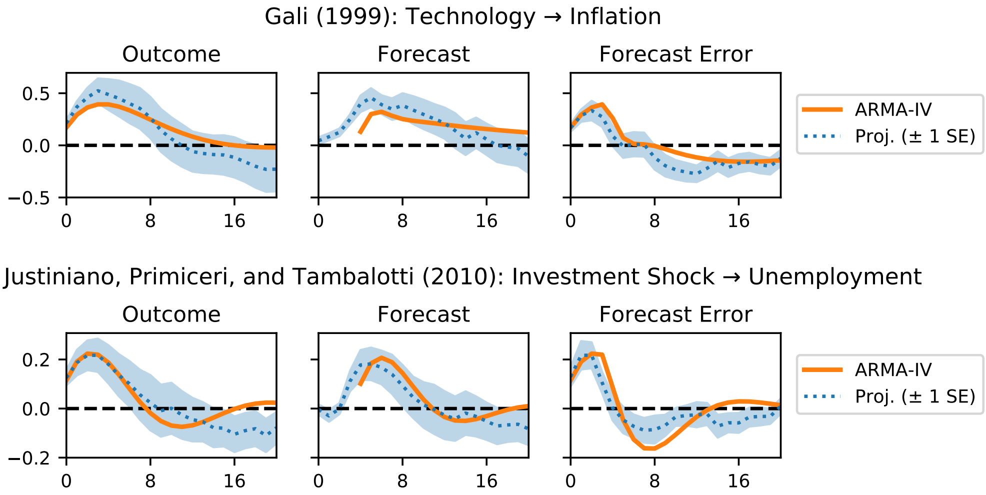
Delayed over-shooting, smaller but persistent forecast errors

Shaded area = ± 1 SE

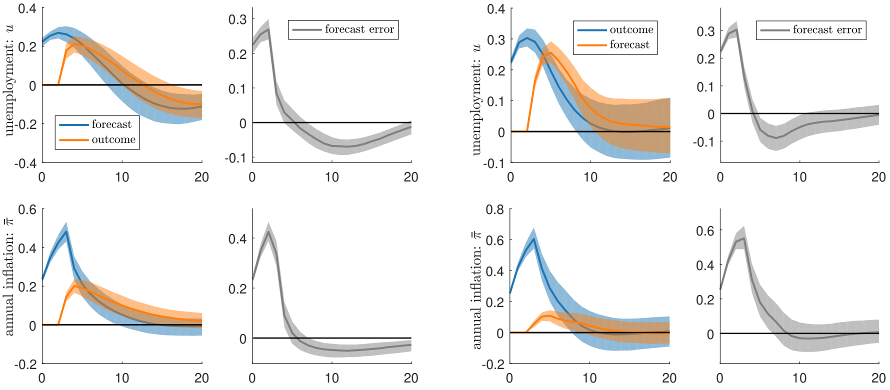
Fact 3 [Over-shooting]: Same Pattern with Other Identified Shocks



Fact 3 [Over-shooting]: Same Pattern in a Structural VAR

13-Variable Model: macro "usual suspects" + unemployment and inflation forecasts (SPF) list

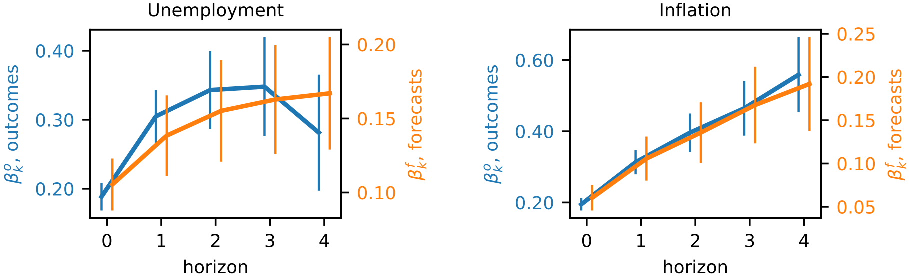
ACD, 2020 (max-share for BC) Cholesky (one-step-ahead Error)



Fact 3 [Over-shooting]: Over-persistence in the "Term Structure"

$$\bar{\mathbb{E}}_t[x_{t+k}] = \alpha_k + \beta_k^f \cdot \epsilon_t + \gamma' W_t + u_{t+k}$$ Expectation from $t = 0$

$$x_{t+k} = \alpha_k + \beta_k^o \cdot \epsilon_t + \gamma' W_t + u_{t+k}$$ Reality from $t = 0$



Outline

Need to Combine Frictions to Explain Facts

	Theory	Fact 1	Fact 2	Fact 3
Information	Noisy common information	No	No*	No
	Noisy dispersed information	Yes	No*	No

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Need to Combine Frictions to Explain Facts: A Winning Combination

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Tractable NK Model with Imperfect Expectations

Familiar Ingredients

Euler equation/DIS

$$c_t = \mathbb{E}_t^*[c_{t+1}] - \varsigma r_t + \epsilon_t$$

Market clearing

$$c_t = y_t$$

Demand shock

$$\xi_t \equiv -\varsigma r_t + \epsilon_t = (1 - \rho \mathbb{L})\eta_t$$

Prices fully rigid (relax later on)

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over- or under-extrapolation?

$\hat{\rho} < \rho$ in GE ≈ cognitive discounting, level-K

Theoretical Results: Transparent Mapping from Moments to Model

Proposition: Mapping to Forecast Data

Closed-form expressions:

F1. $K_{\text{CG}} = \mathcal{K}_{\text{CG}}(\hat{\tau}, \rho, \hat{\rho}; \text{mpc})$

F2. $K_{\text{BGMS}} = \mathcal{K}_{\text{BGMS}}(\tau, \hat{\tau}, \rho, \hat{\rho}; \text{mpc})$

F3. $\left\{ \frac{\partial \overline{\text{Error}}_{t+k}}{\partial \eta_t} \right\}_{k \geq 1} = F(\hat{\tau}, \rho, \hat{\rho}; \text{mpc})$

Proposition: Equilibrium Outcomes

As-if representative, rational agent with

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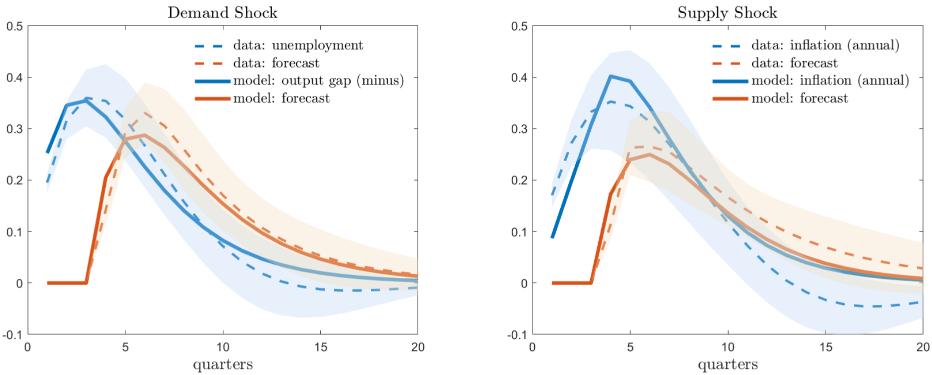
- General equilibrium matters through mpc = slope of Keynesian cross
- Actual dispersion τ only affects K_{BGMS}; irrelevant for aggregate outcomes and main facts
- **Key behavior** pinned down by $(\hat{\tau}, \rho, \hat{\rho})$
  - *Three parameters* $\rightarrow$ lots of phenomena!
  - Facts 1 and 3 are key; Fact 2 less so

New Keynesian Model Calibrated to Facts 1 and 3

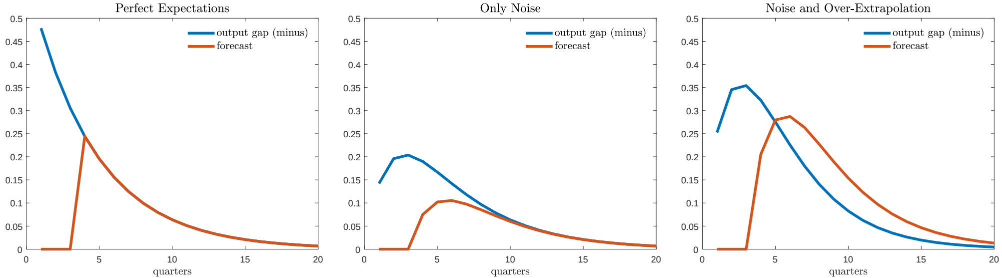


Good fit for demand shock, mediocre for supply shock

Right qualitative ingredients but no abundance of free parameters

parameter values

Counterfactuals: Interaction of Forces Matters



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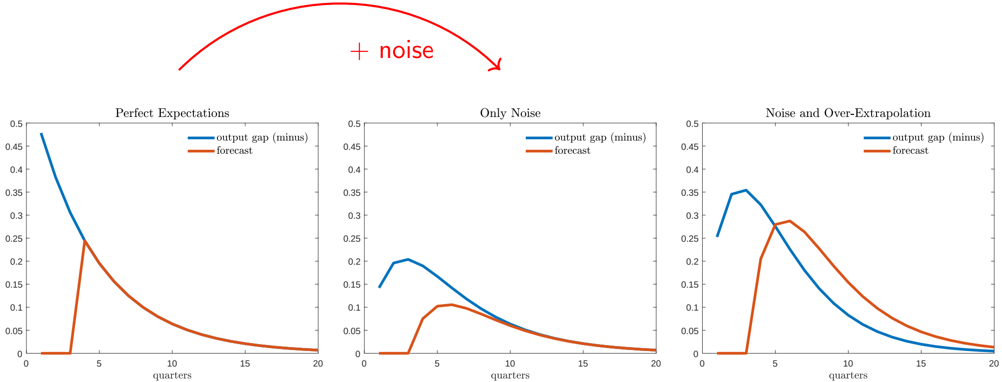
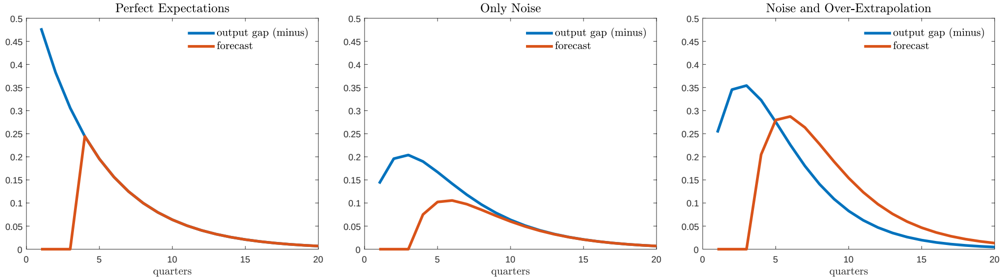


Noise smooths and dampens IRF
("stickiness/inertia and myopia")

Counterfactuals: Interaction of Forces Matters

+ over-extrapolation



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Over-extrapolation increases present value and amplifies initial response
("amplification and momentum")

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Limitations/Future Work:

- *Context*: “regular business cycles” vs. crises or specific policy experiments
- *Forecast data*: ideally we would like expectations of firms and consumers, and for the objects that matter the most for their choices

Facts 1 + 2: Showing Under-reaction and Dispersion

back

$$\text{Error}_{i,t,k} = a - K_{\text{noise}} \cdot (\text{Revision}_{i,t,k} - \text{Revision}_{t,k}) + K_{\text{agg}} \cdot \text{Revision}_{t,k} + u_{i,t,k}$$

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Estimation Strategy

Back Example

Overall goal: allow flexibility for dynamics to be "shock-specific"

ARMA-IV: two-stage-least-squares estimate of

$$x_t = \alpha + \sum_{p=1}^{P} \gamma_p \cdot x_{t-p}^{\text{IV}} + \sum_{k=1}^{K} \beta_k \cdot \epsilon_{t-k} + u_t$$

$$X_{t-1} = \eta + \mathcal{E}_{t-1}' \Theta + e_t$$

where $X_{t-1} \equiv (x_{t-p})_{p=1}^{P}$, $\mathcal{E}_{t-1} \equiv (\epsilon_{t-K-j})_{j=1}^{J}$ and $J \geq P$. Main specification: $P = 3$, $J = 6$.

Projection: OLS estimation at each horizon h of

$$x_{t+h} = \alpha_h + \beta_h \cdot \epsilon_t + \gamma' W_t + u_{t+h}$$

where the controls W_t are x_{t-1} and $\bar{\mathbb{E}}_{t-k-1}[x_{t-1}]$.

Estimation Strategy

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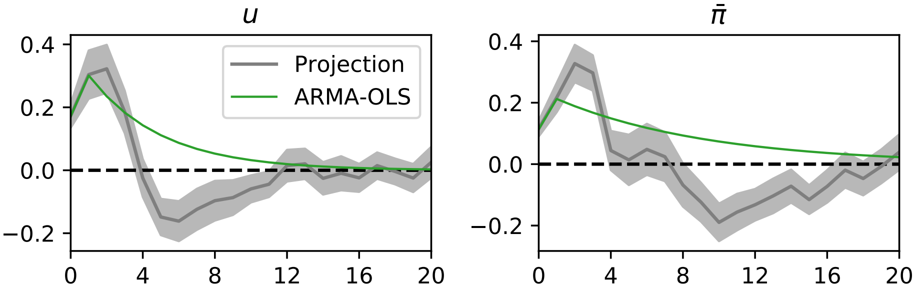

Figure 1: *

Forecast error estimation with projection method (grey) and ARMA-OLS(1,1) (green).

Variable List for SVAR

Back

10 usual suspects: real GDP, real investment, real consumption, labor hours, the labor share, the Federal Funds Rate, labor productivity, and utilization-adjusted TFP

3 forecast variables: three-period-ahead unemployment forecast, three-period annual inflation forecast, one-period-ahead quarter-to-quarter inflation forecast back

Table 1: Exogenously Set Parameters

Parameter	Description	Value
θ	Calvo prob	0.6
κ	Slope of NKPC	0.02
χ	Discount factor	0.99
mpc	MPC	0.3
ς	IES	1.0
ϕ	Monetary policy	1.5

Table 2: Calibrated Parameters

	$\hat{\rho}$	ρ	τ
Demand shock	0.94	0.80	0.38
Supply shock	0.82	0.57	0.15