Public Information and Survey of Expectations

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Public information in FIRE tests

- Expectations are crucial to both macroeconomics and finance
- Use of surveys of professional forecasters to test the **FIRE hypothesis**
  1. *Consensus* forecast errors are predictable $\rightarrow$ inconsistent with **FI** (Coibion and Gorodnishenko, 2015, CG)
  2. *Individual* forecast errors are predictable $\rightarrow$ inconsistent with **RE** (Bordalo et al, 2020, BGMS)

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  1. *Consensus* forecast errors are predictable $\rightarrow$ inconsistent with **FI** (Coibion and Gorodnishenko, 2015, CG)
  2. *Individual* forecast errors are predictable $\rightarrow$ inconsistent with **RE** (Bordalo et al, 2020, BGMS)
- Literature focuses on *heterogeneity* in individual forecasts, ignores common errors
- We take into account **common** components in information sets, and find
  1. Higher information rigidity/frictions than previously estimated
  2. Evidence of strategic incentives in survey reporting
     - Explains away apparent behavior expectational mistakes

Outline

1. Empirical Results: Taking public information into account
   - Common component of errors bias information rigidity estimates downward
   - Estimates correcting for the bias
   - Revisit evidence of apparent behavioral over-reaction in surveys
     - over-reaction to idiosyncratic/private info, but **under-reaction** to public info
     - inconsistent with standard behavioral theories
2. Model: analytical results
   - empirics consistent with **strategic diversification** incentives in survey responses
     - Want to be both right and *stand out from the crowd*
3. Quantitative results: recover true forecasts
   - Less precise – even more information rigidity
   - Less heterogeneous/dispersion

Empirical Results

- Null hypothesis: general structure of forecast $\tilde{E}_t^i[x_{t+h}]$ at time t about horizon h

$$\tilde{E}_t^i[x_t] = \tilde{E}_{t-1}^i[x_t] + G_1(g_t - \tilde{E}_{t-1}^i[x_t]) + G_2(s_t^i - \tilde{E}_{t-1}^i[x_t])$$

  - Coefficients G_1 and G_2 arbitrary, not necessarily "optimal"

- This implies

$$\underbrace{x_{t+h} - \bar{\tilde{E}}_t[x_{t+h}]}_{\bar{fe}_{t+h,t}} = \frac{1-G}{G}\underbrace{(\bar{\tilde{E}}_t[x_{t+h}] - \bar{\tilde{E}}_{t-1}[x_{t+h}])}_{\bar{fr}_{t+h,t}} - \frac{G_1}{G}\rho^h e_t + \varepsilon_{t+h,t+1}$$

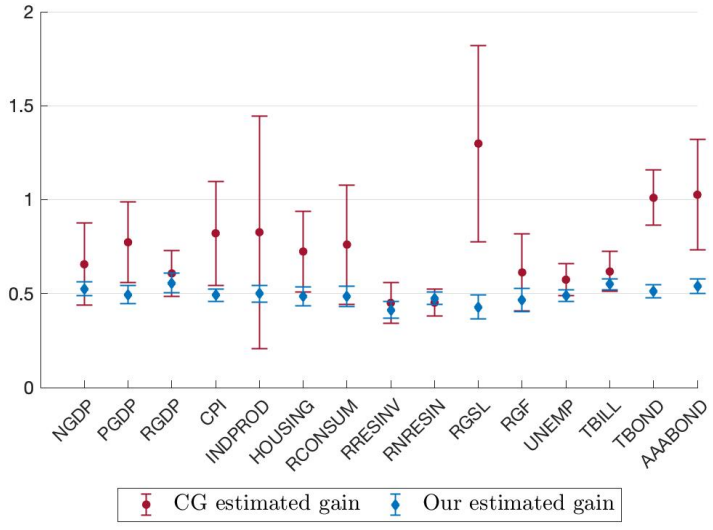
  with $G = G_1 + G_2$ total weight on new info $\Rightarrow$ Stickiness $1 - G$

- CG (2015) run the regression

$$\bar{fe}_{t+h,t} = \alpha + \beta_{CG}\bar{fr}_{t+h,t} + err_t$$

  - If no public information $\Rightarrow \hat{\beta}_{CG} = \frac{1-G}{G}$, a measure of information precision
  - With public information ($G_2 > 0$), this regression over-estimates G

Comparison between CG and our estimation strategy



Over-reaction to new information

- BGMS (2020) consider the regression

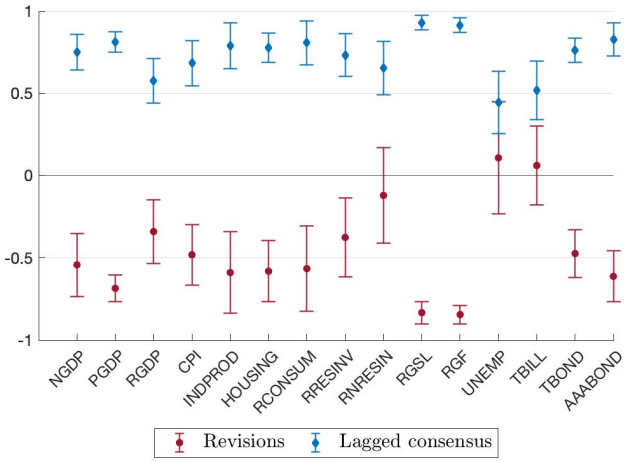
$$x_{t+h} - \tilde{E}^i_t(x_{t+h}) = \alpha + \beta_{BGMS}(\tilde{E}^i_t(x_{t+h}) - \tilde{E}_{t-1}(x_{t+h})) + err^i_t$$

- Under RE, $\beta_{BGMS} = 0$. They find $\beta_{BGMS} < 0$: **overreaction** to *new* information
- **This paper:** differentiate between reaction to public and private info
  - public signal: the lagged consensus forecast (adjusted for indiv. prior)

$$fe^i_{t+h,t} = \alpha + \beta_1 fr^i_{t+h,t} + \beta_2(\bar{\tilde{E}}_{t-1}[x_{t+h}] - \tilde{E}^i_{t-1}[x_{t+h}]) + err^i_t$$

- We find $\beta_2 > 0$: **underreaction** to *public* information
  - Similar, but **smaller**, under-reaction to alternative public signal: lagged x_t

Fact 4: underreaction to public information

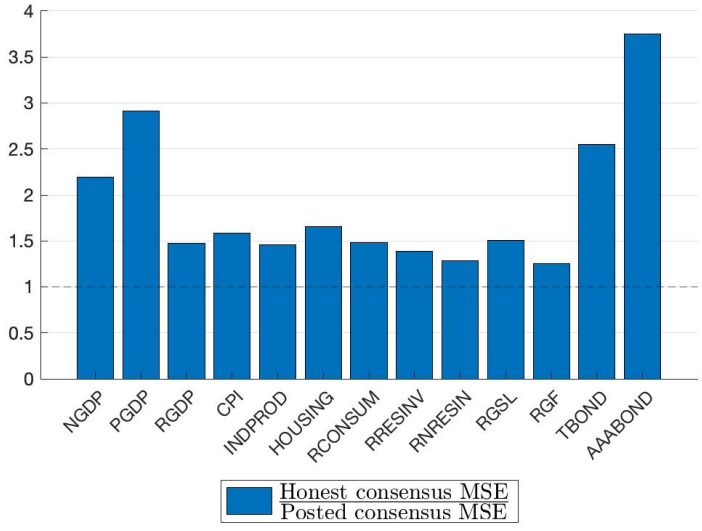


Notes: Panel regression with individual fe. Standard errors are corrected for heteroskedasticity and autocorrelation as in Vogelsang (2012). Confidence intervals reported at 10% significance level.

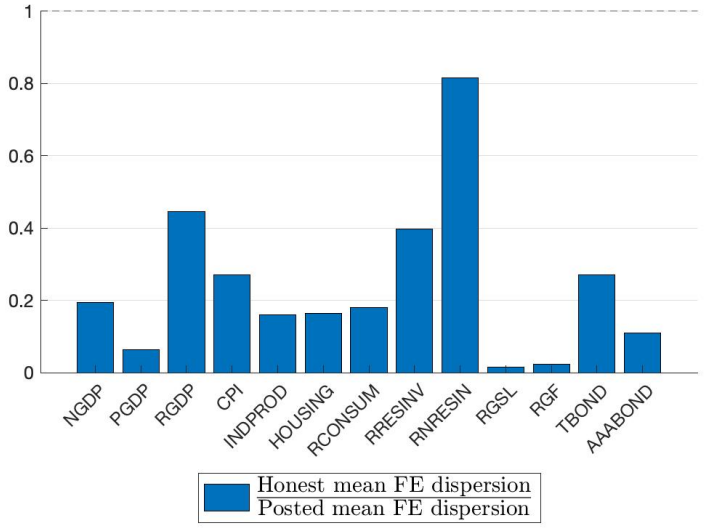
Biased survey estimates

- Results not consistent with std behavioral models: over-reaction to *all* info
- Analytical results (details in paper)
  - results consistent with RE with strategic reporting bias
  - strategic diversification: want to be right, but also stand-out from the crowd
- Strategic incentives: over-weight private/idiosyncratic information
  - consensus forecast *more precise* than true underlying information precision
- To recover true information rigidity, we estimate a quantitative version of model

True forecasts: MSE 30-100% higher



True forecasts: dispersion 80% lower



Takeaways

- Information precision is **lower** than commonly estimated
- Survey expectations **are not** direct measurement of agent expectations
- True forecasts are both **less accurate** and **dispersed** than raw survey data

Appendix

Fact 2: novel strategy to estimate stickiness

- Novel strategy to recover G exploiting the panel dimension
- The linear model of beliefs implies

$$fr^i_{t+h,t} - \bar{fr}_{t+h,t} = G(\bar{E}_{t-1}(x_{t+h}) - \tilde{E}^i_{t-1}(x_{t+h})) - G_2\rho^h\eta^i_t$$

Fact 2: novel strategy to estimate stickiness

- Novel strategy to recover G exploiting the panel dimension
- The linear model of beliefs implies

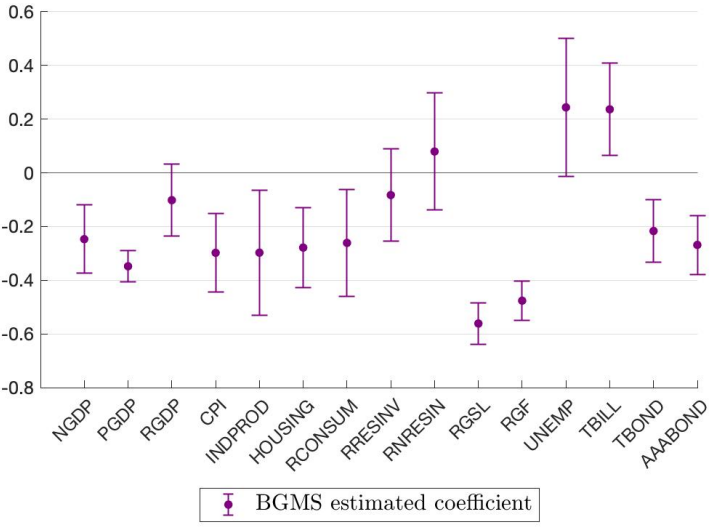
$$fr^i_{t+h,t} - \bar{fr}_{t+h,t} = G(\bar{E}_{t-1}(x_{t+h}) - \tilde{E}^i_{t-1}(x_{t+h})) - G_2\rho^h\eta^i_t$$

- Therefore we run the following panel regression with fixed effects

$$fr^i_{t+h,t} = \alpha_i + \beta(\bar{E}_{t-1}(x_{t+h}) - \tilde{E}^i_{t-1}(x_{t+h})) + \gamma_t + err^i_t$$

- $\hat{\beta} = G$ even with public information / common errors
- We find a *stable* $\hat{G} \approx 0.5$ (at h=3) $\Rightarrow$ higher belief **stickiness**

Fact 3: individual overreaction (BGMS 2020)



Fact 2: novel strategy to estimate stickiness

	3 quarters horizon			
	β	SE	p-value	Median
Variable	(1)	(2)	(3)	(4)
Nominal GDP	0.53	0.02	0.00	0.49
GDP price index inflation	0.49	0.03	0.00	0.52
Real GDP	0.56	0.03	0.00	0.52
Consumer Price Index	0.49	0.02	0.00	0.53
Industrial production	0.50	0.03	0.00	0.52
Housing Start	0.49	0.03	0.00	0.55
Real Consumption	0.49	0.03	0.00	0.48
Real residential investment	0.41	0.03	0.00	0.44
Real nonresidential investment	0.48	0.02	0.00	0.49
Real state and local government consumption	0.43	0.04	0.00	0.40
Real federal government consumption	0.47	0.04	0.00	0.48
Unemployment rate	0.49	0.02	0.00	0.54
Three-month Treasury rate	0.55	0.02	0.00	0.59
Ten-year Treasury rate	0.51	0.02	0.00	0.54
AAA Corporate Rate Bond	0.54	0.02	0.00	0.56

Notes: Columns 1-3: panel with individual and time fixed effects; column 4: median of individual demeaned regressions. Standard errors are corrected for heteroskedasticity and autocorrelation as in Vogelsang (2012).

Fact 2: novel strategy to estimate stickiness

	2 quarters horizon			
	β	SE	p-value	Median
Variable	(1)	(2)	(3)	(4)
Nominal GDP	0.61	0.01	0.00	0.62
GDP price index inflation	0.63	0.02	0.00	0.68
Real GDP	0.63	0.02	0.00	0.62
Consumer Price Index	0.70	0.02	0.00	0.71
Industrial production	0.59	0.02	0.00	0.63
Housing Start	0.53	0.02	0.00	0.56
Real Consumption	0.63	0.03	0.00	0.62
Real residential investment	0.56	0.02	0.00	0.64
Real nonresidential investment	0.61	0.03	0.00	0.61
Real state and local government consumption	0.60	0.05	0.00	0.56
Real federal government consumption	0.62	0.03	0.00	0.62
Unemployment rate	0.56	0.02	0.00	0.62
Three-month Treasury rate	0.63	0.03	0.00	0.67
Ten-year Treasury rate	0.60	0.02	0.00	0.63
AAA Corporate Rate Bond	0.61	0.02	0.00	0.62

Notes: Columns 1-3: panel with individual and time fixed effects; column 4: median of individual demeaned regressions. Standard errors are corrected for heteroskedasticity and autocorrelation as in Vogelsang (2012).

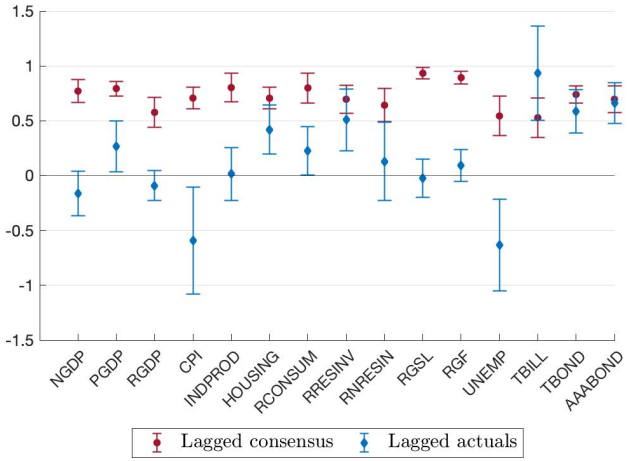
Public signals: past consensus and actual

- Different treatment of private/public info inconsistent with std behavioral models
- **Strategic diversification** is a rational explanation (e.g. Ottaviani-Sorensen (2006))
  - To stand out from the crowd of forecasters, underweight common information sources, over-weight private/idiosyncratic information
- To test further, compare underreaction to two different public signals:
  1. **Past consensus:** $pi^i_{1,t} \equiv \bar{\bar{E}}_{t-1}[x_{t+h}] - \tilde{E}^i_{t-1}[x_{t+h}]$
  2. **Lagged realization of x_t:** $pi^i_{2,t} \equiv x_{t-1} - \tilde{E}^i_{t-1}[x_{t+h}]$

$$fe^i_{t+h,t} = \alpha + \beta_1 fr^i_{t+h,t} + \beta_2 pi^i_{1,t} + \beta_3 pi^i_{2,t} + err^i_t$$

- We find $\beta_1 > \beta_2$: larger underreaction to past consensus $pi^i_{1,t}$
  - Intuitively consistent with strategic diversification
  - Helps diff. with more elaborate behavioral models (e.g. Broer-Khohlas (2019)) BK

Public signals: past consensus and actual



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Static model

Static strategic diversification game

- Agents submit forecast $\hat{x}^i$ about x to the survey
- Their problem is

$$\begin{aligned} min \quad & u^i = E^i\left[(\hat{x}^i - x)^2 - \lambda(\hat{x}^i - \bar{\hat{x}})^2\right] \\ foc: \quad & \hat{x}^i = \frac{1}{1-\lambda}E^i[x] - \frac{\lambda}{1-\lambda}E^i[\bar{\hat{x}}] \end{aligned}$$

  - $\lambda = 0$: agents submit their honest beliefs
  - $0 > \lambda > 1$: agents wants to stand out from the crowd

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  - $\lambda = 0$: agents submit their honest beliefs
  - $0 > \lambda > 1$: agents wants to stand out from the crowd

- They have prior $x \sim N(0, \chi^{-1})$ and observe signals

$$\begin{aligned} g &= x + e, \qquad e \sim N(0, \nu^{-1}) \\ s^i &= x + \eta^i, \qquad \eta^i \sim N(0, \tau^{-1}) \end{aligned}$$

Honest and posted beliefs

- Their honest/true posterior is

$$E^i[x] = \mu + \gamma_1(g - \mu) + \gamma_2(s^i - \mu)$$

  with $\gamma_1 = \frac{\nu}{\tau+\nu+\chi}$, $\gamma_2 = \frac{\tau}{\tau+\nu+\chi}$.

- Guess and verify a linear solution for $\hat{x}^i$ and get

$$\hat{x}^i = \mu + \delta_1(g - \mu) + \delta_2(s^i - \mu)$$

- Where
  - $\delta_1 = \frac{(1-\lambda)\gamma_1}{(1-\lambda)+\lambda\gamma_2} < \gamma_1$: **underweight** new *public* information (Fact 4a)

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- Where
  - $\delta_1 = \frac{(1-\lambda)\gamma_1}{(1-\lambda)+\lambda\gamma_2} < \gamma_1$: underweight new public information (Fact 4a)
  - $\delta_2 = \frac{\gamma_2}{(1-\lambda)+\lambda\gamma_2} > \gamma_2$: **overweight** new *private* information (Fact 4b)

Honest and posted beliefs

- Their honest posterior is

$$E^i[x] = \mu + \gamma_1(g - \mu) + \gamma_2(s^i - \mu)$$

  with $\gamma_1 = \frac{\nu}{\tau+\nu+\chi}$, $\gamma_2 = \frac{\tau}{\tau+\nu+\chi}$.

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- Where
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  - $\delta_2 = \frac{\gamma_2}{(1-\lambda)+\lambda\gamma_2} > \gamma_2$: overweight new private information (Fact 4b)
  - $\delta_1 + \delta_2 > \gamma_1 + \gamma_2$: **overweight** *new* information (Fact 3)

Honest and posted beliefs

- Their honest posterior is

$$E^i[x] = \mu + \gamma_1(g - \mu) + \gamma_2(s^i - \mu)$$

  with $\gamma_1 = \frac{\nu}{\tau+\nu+\chi}$, $\gamma_2 = \frac{\tau}{\tau+\nu+\chi}$.

- Guess and verify a linear solution for $\hat{x}^i$ and get

$$\hat{x}^i = \mu + \delta_1(g - \mu) + \delta_2(s^i - \mu)$$

- Where we find that
  - $\delta_1 = \frac{(1-\lambda)\gamma_1}{(1-\lambda)+\lambda\gamma_2} < \gamma_1$: underweight new public information (Fact 4a)
  - $\delta_2 = \frac{\gamma_2}{(1-\lambda)+\lambda\gamma_2} > \gamma_2$: overweight new private information (Fact 4b)
  - $\delta_1 + \delta_2 > \gamma_1 + \gamma_2$: overweight new information (Fact 3)
  - $\delta_1 + \delta_2 < 1$: consensus belief **stickiness** (Fact 1 & 2)

- **Proposition 5 (Fact 3)**

$$\beta_{BGMS} = \frac{-\lambda\tau\chi}{([(1-\lambda)\nu+\tau]^2+(1-\lambda)^2\nu\chi)} < 0$$

- **Proposition 6 (Facts 1 and 2)**

$$\beta_{CG} = \frac{(1-\lambda)\tau\chi}{([(1-\lambda)\nu+\tau]^2+[(1-\lambda)^2\nu+\tau]\chi)} > 0$$

- **Proposition 7 (Fact 4)**

$$\beta_1 = -\frac{\lambda(\nu+\chi)}{\tau+\nu+\chi} < 0$$

$$\beta_2 = \frac{\lambda\nu}{\tau+\nu+\chi} > 0$$

Quantitative model

Dynamic model: honest beliefs

- **Fundamental:** unobservable, AR(1)

$$x_t = \rho x_{t-1} + u_t, \qquad u_t \sim N(0, \xi^{-1})$$

- **Information:** private signal and public signal

$$g_t = x_t + e_t, \qquad e_t \sim N(0, \nu^{-1})$$
$$s_t^i = x_t + \eta_t^i, \qquad \eta_t^i \sim N(0, \tau^{-1})$$

- **Global game**

$$\hat{x}_{t,t}^i = \frac{1}{1-\lambda} E_t^i[x_t] - \frac{\lambda}{1-\lambda} E_t^i[\bar{\hat{x}}_{t,t}]$$

$\Rightarrow$ Individual posted forecast update similar to KF

$$\hat{x}_{t,t}^i = \hat{x}_{t,t-1}^i + G_1(g_t - \hat{x}_{t,t-1}^i) + G_2(s_t^i - \hat{x}_{t,t-1}^i)$$

- With $G_1 < K_1$ and $G_2 > K_2$, where K_1, K_2 are the optimal weights

Structural estimation

- For each series we estimate
  - Fundamental parameters (ρ, ξ) from actual data
  - Signal noises (ν, τ) and strategic incentive (λ) with GMM
  - Target moments:
    1. Mean FE dispersion
    2. Estimated posted gain G (Fact 2)
    3. Estimated overraction to private information β_1 (Fact 4a)

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  - Target moments:
    1. Mean FE dispersion
    2. Estimated posted gain G (Fact 2)
    3. Estimated overraction to private information β_1 (Fact 4a)
- Very good match of untargeted moments (Facts 1, 3, 4b)

Estimated parameters

Key results

1. Information rigidity is **higher** than the raw estimate

$$G_{true} \approx 0.4 < G_{posted} \approx 0.5 < G_{CG} \approx 0.75$$

   - due to both significant strategic incentive and common error component

2. Estimated degree of strategic behavior implies
   - The reported consensus forecast is **more accurate** than true avg expectations
     - True consensus forecast MSE 30-100% **larger** than *posted* one
   - True beliefs dispersion **lower** than raw estimate
     - True mean FE dispersion 80% **lower** than *posted* one

Public signals: past consensus and actual

- We compare underreaction to two public signals:
  1. **Past consensus:** $pi^i_{1,t} \equiv \bar{\tilde{E}}_{t-1}[x_{t+h}] - \tilde{E}^i_{t-1}[x_{t+h}]$
  2. **Past actual:** $pi^i_{2,t} \equiv x_{t-1} - \tilde{E}^i_{t-1}[x_{t+h}]$

$$fe^i_{t+h,t} = \alpha + \beta_1 pi^i_{1,t} + \beta_2 pi^i_{2,t} + err^i_t$$

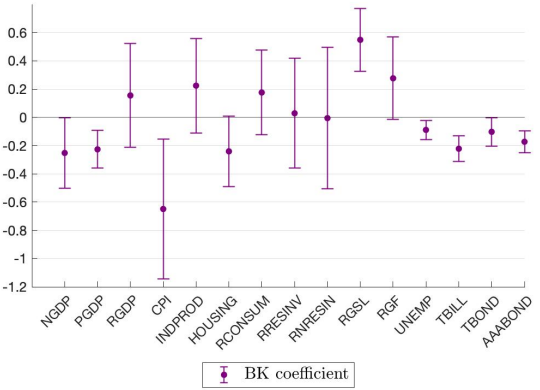
- We find $\beta_1 > \beta_2$: larger underreaction to past consensus $pi^i_{1,t}$
- Consistent with idea of **strategic diversification**
  - But also with modified overconfidence of Broer & Khohlas (2019)

BK overreaction to public signal

- Broer and Khohlas (2019) regress FE on public signal by itself

$$fe^i_{t+h,t} = \alpha + \beta_{BK} g_t + err^i_t$$

- They find $\beta_{BK} \gtrless 0$: **mixed** reaction to new public information



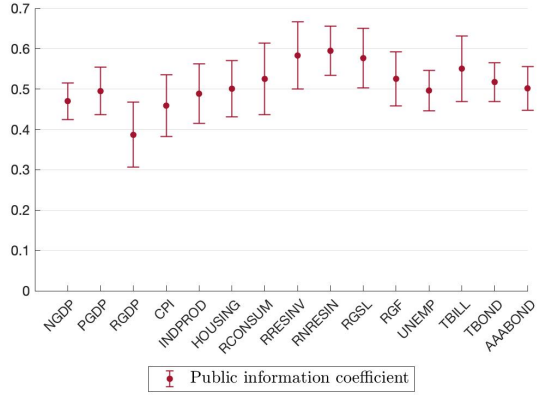
Our correction to BK

- We run the same regression but isolating the surprise component:

$$fe^i_{t+h,t} = \alpha + \beta pi^i_{t+h,t} + err^i_t, \qquad pi^i_t \equiv g_t - \tilde{E}^i_{t-1}[x_{t+h}]$$

- We find $\beta > 0$: **underreaction** to new public information

back



Survey anonymity

- We use the SPF, which is collected by the Fed anonymously
- However *"According to industry experts, forecasters often seem to submit to the anonymous surveys the same forecasts they have already prepared for public"* (Marinovic et al, 2013). Two reasons:
  1. Cost in compiling new forecasts
  2. Their strategic behavior could be uncovered by the editor of the anonymous survey
- Two observations supporting this claim:
  1. Anonymous SPF forecasts are very similar to non-anonymous Blue Chip ones (BGMS, 2020)
  2. The ECB asked it directly to their SPF panelists: "When responding to the SPF, what forecast do you provide?"
     - In 2013: 18% "new forecasts", 82% "latest available"
     - In 2008 below 10%.

Back

Extension: heterogeneous priors

- The benchmark strategic diversification model **does not match** the "univariate" underreaction to public information

$$fe^i_{t+h,t} = \alpha + \beta pi^i_{t+h,t} + err^i_t, \qquad \beta_{model} = 0$$

- Underweight public signal relative to private signal, not to prior
  - $\lambda > 0$ leads to underweight public info relative to private info
  - But both prior and new public signals are public
- In order to match this fact, allow for **heterogeneous priors** (Morris, 1995; Patton and Timmermann, 2010)
  - Now priors partially private: underweight new public info wrt priors
  - For some calibration still get overreaction to new info $\beta_{BGMS} < 0$
- We abstract from this in dynamic model

Target moments

	Mean Dispersion		C		β_1	
	Data	Model	Data	Model	Data	Model
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Nominal GDP	1.49	1.49	0.53	0.53	-0.54	-0.54
GDP price index inflation	0.33	0.33	0.49	0.49	-0.68	-0.68
Real GDP	0.92	0.92	0.56	0.56	-0.34	-0.34
Consumer Price Index	0.31	0.31	0.49	0.49	-0.48	-0.48
Industrial production	3.71	3.71	0.50	0.50	-0.59	-0.59
Housing Start	110.04	110.04	0.49	0.49	-0.58	-0.58
Real Consumption	0.51	0.51	0.49	0.49	-0.56	-0.56
Real residential investment	27.03	27.03	0.41	0.41	-0.37	-0.37
Real nonresidential investment	7.38	7.38	0.48	0.48	-0.12	-0.12
Real state and local government consumption	1.41	1.41	0.47	0.47	-0.84	-0.84
Real federal government consumption	6.40	6.40	0.43	0.43	-0.83	-0.83
Ten-year Treasury rate	0.17	0.17	0.51	0.51	-0.47	-0.47
AAA Corporate Rate Bond	0.34	0.34	0.54	0.54	-0.61	-0.61

Untargeted moments

	c_{CG}		β_{BGMS}		β_2	
	Data	Model	Data	Model	Data	Model
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Nominal GDP	0.66	0.71	-0.25	-0.31	0.75	0.21
GDP price index inflation	0.77	0.67	-0.35	-0.44	0.81	0.31
Real GDP	0.61	0.75	-0.10	-0.15	0.57	0.13
Consumer Price Index	0.82	0.73	-0.30	-0.24	0.67	0.16
Industrial production	0.83	0.82	-0.30	-0.22	0.79	0.26
Housing Start	0.72	0.76	-0.28	-0.28	0.78	0.23
Real Consumption	0.76	0.80	-0.26	-0.23	0.80	0.23
Real residential investment	0.45	0.72	-0.08	-0.17	0.73	0.11
Real nonresidential investment	0.45	0.52	0.08	-0.10	0.65	0.01
Real state and local government consumption	0.61	0.85	-0.48	-0.41	0.91	0.45
Real federal government consumption	1.30	0.89	-0.56	-0.35	0.93	0.37
Ten-year Treasury rate	1.01	0.59	-0.22	-0.38	0.76	0.09
AAA Corporate Rate Bond	1.03	0.62	-0.27	-0.48	0.83	0.18

Posted and honest gain

	Gain			Consensus MSE		
	Posted	Honest	Ratio	Posted	Honest	Ratio
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Nominal GDP	0.53	0.40	0.76	0.49	1.07	2.19
GDP price index inflation	0.49	0.32	0.66	0.05	0.14	2.92
Real GDP	0.56	0.49	0.88	0.78	1.14	1.47
Consumer Price Index	0.49	0.40	0.82	0.23	0.36	1.58
Industrial production	0.50	0.44	0.87	3.51	5.11	1.46
Housing Start	0.49	0.40	0.82	69.95	115.75	1.65
Real Consumption	0.49	0.42	0.86	0.46	0.68	1.49
Real residential investment	0.41	0.36	0.87	29.60	40.95	1.38
Real nonresidential investment	0.48	0.43	0.90	4.12	5.30	1.29
Real state and local government consumption	0.47	0.40	0.86	0.54	0.81	1.51
Real federal government consumption	0.43	0.39	0.90	5.96	7.49	1.26
Ten-year Treasury rate	0.51	0.33	0.64	0.04	0.11	2.55
AAA Corporate Rate Bond	0.54	0.29	0.54	0.04	0.14	3.75

Estimated parameters

Variable	ρ (1)	$\sqrt{\frac{\xi}{\nu}}$ (2)	$\sqrt{\frac{\xi}{\tau}}$ (3)	λ (4)
Nominal GDP	0.93	1.48	1.70	0.74
GDP price index inflation	0.93	1.60	2.13	0.88
Real GDP	0.80	1.30	1.36	0.47
Consumer Price Index	0.78	1.38	1.60	0.61
Industrial production	0.85	1.28	1.86	0.68
Housing Start	0.85	1.38	1.81	0.70
Real Consumption	0.87	1.33	1.84	0.67
Real residential investment	0.89	1.56	1.74	0.49
Real nonresidential investment	0.89	2.37	1.28	0.25
Real state and local government consumption	0.89	1.32	2.79	0.90
Real federal government consumption	0.80	1.29	2.90	0.87
Ten-year Treasury rate	0.83	1.81	1.56	0.72
AAA Corporate Rate Bond	0.85	1.76	1.82	0.87