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 → inconsistent with **FI**  
     (Coibion and Gorodnichenko, 2015, CG)
  2. *Individual* forecast errors are predictable → inconsistent with **RE**  
     (Bordalo et al, 2020, BGMS)
Public information in FIRE tests

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• Use of surveys of professional forecasters to test the FIRE hypothesis
  1. *Consensus* forecast errors are predictable $\rightarrow$ inconsistent with FI (Coibion and Gorodnichenko, 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
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

Model: analytical results

- empirics consistent with strategic diversification incentives in survey responses
  - Want to be both right and stand out from the crowd

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 $h$

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

▷ Coefficients $G_1$ and $G_2$ arbitrary, not necessarily "optimal"

• This implies

\[
\tilde{f}_{t+h,t} = \frac{1 - G}{G} \left( \tilde{E}_t[x_{t+h}] - \tilde{E}_{t-1}[x_{t+h}] \right) - \frac{G_1}{G} \rho^h e_t + \varepsilon_{t+h,t+1}
\]

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

• CG (2015) run the regression

\[
\tilde{f}_{t+h,t} = \alpha + \beta_{CG} \tilde{f}_{t+h,t} + err_t
\]

▷ 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

Notes:
Red lines: \( CG = \frac{1}{1 + \beta_{CG}} \). Standard errors are robust to heteroskedasticity and Newey-West with the automatic bandwidth selection procedure of Newey and West (1994). Blue lines: panel regression with individual and time fixed effects. Standard errors are corrected for heteroskedasticity and autocorrelation as in Vogelsang (2012). Confidence intervals reported at 10% significance level.
Over-reaction to new information

- BGMS (2020) consider the regression

\[ x_{t+h} - \tilde{E}_t^i(x_{t+h}) = \alpha + \beta_{BGMS}(\tilde{E}_t^i(x_{t+h}) - \tilde{E}_{t-1}(x_{t+h})) + \text{err}_t^i \]

- 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)

\[ fe_{t+h,t}^i = \alpha + \beta_1 fr_{t+h,t}^i + \beta_2(\tilde{E}_{t-1}[x_{t+h}] - \tilde{E}_{t-1}^i[x_{t+h}]) + \text{err}_t^i \]

- 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

Honest mean FE dispersion
Posted mean FE dispersion
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

$$fr_{t+h,t} - \tilde{fr}_{t+h,t} = G(\tilde{E}_{t-1}(x_{t+h}) - \tilde{E}_{t-1}(x_{t+h})) - G_2\rho^h\eta_t^i$$

Therefore we run the following panel regression with fixed effects

$$fr_{t+h,t} = \alpha_i + \beta(\bar{E}_t - 1(x_{t+h}) - \tilde{E}_{t-1}(x_{t+h})) + \gamma_t + \text{err}_i$$

We find a stable $\hat{G} \approx 0.5$ (at $h=3$) $\Rightarrow$ higher belief stickiness
Fact 2: novel strategy to estimate stickiness

- Novel strategy to recover $G$ exploiting the panel dimension

- The linear model of beliefs implies

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

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

- $\hat{\beta} = G$ 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)

Panel regression with individual fixed effects. Standard errors are corrected for heteroskedasticity and autocorrelation as in Vogelsang (2012). Confidence intervals reported at 10% significance level.
### Fact 2: Novel strategy to estimate stickiness

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\beta$ (1)</th>
<th>SE (2)</th>
<th>p-value (3)</th>
<th>Median (4)</th>
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<tr>
<td>Nominal GDP</td>
<td>0.53</td>
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<td>Ten-year Treasury rate</td>
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**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).
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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**: \( pi_{1,t}^i \equiv \tilde{E}_{t-1}[x_{t+h}] - \tilde{E}_{t-1}[x_{t+h}] \)
  2. Lagged realization of \( x_t \): \( pi_{2,t}^i \equiv x_{t-1} - \tilde{E}_{t-1}[x_{t+h}] \)

\[
fe_{t+h,t}^i = \alpha + \beta_1 fr_{t+h,t}^i + \beta_2 pi_{1,t}^i + \beta_3 pi_{2,t}^i + err_t^i
\]

- We find \( \beta_1 > \beta_2 \): larger underreaction to past consensus \( pi_{1,t}^i \)
  - Intuitively consistent with strategic diversification
  - Helps diff. with more elaborate behavioral models (e.g. Broer-Khohlas (2019))
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.
Static model
Agents submit forecast $\hat{x}^i$ about $x$ to the survey

Their problem is

$$\min \quad u^i = E^i \left[ (\hat{x}^i - x)^2 - \lambda (\hat{x}^i - \bar{x})^2 \right]$$

$$foc: \quad \hat{x}^i = \frac{1}{1 - \lambda} E^i[x] - \frac{\lambda}{1 - \lambda} E^i[\bar{x}]$$

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

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

- Their problem is

$$\min u^i = E^i \left[ (\hat{x}^i - x)^2 - \lambda (\hat{x}^i - \bar{x})^2 \right]$$

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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

$$g = x + e, \quad e \sim N(0, \nu^{-1})$$

$$s^i = x + \eta^i, \quad \eta^i \sim N(0, \tau^{-1})$$
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)
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

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

  - \( \delta_2 = \frac{\gamma_2}{(1-\lambda)+\lambda\gamma_2} > \gamma_2 \): \textbf{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 \( \gamma_1 = \frac{\nu}{\tau + \nu + \chi} \), \( \gamma_2 = \frac{\tau}{\tau + \nu + \chi} \).

• 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

\[ \delta_1 = \frac{(1-\lambda)\gamma_1}{(1-\lambda)+\lambda\gamma_2} < \gamma_1: \text{underweight new public information (Fact 4a)} \]
\[ \delta_2 = \frac{\gamma_2}{(1-\lambda)+\lambda\gamma_2} > \gamma_2: \text{overweight new private information (Fact 4b)} \]
\[ \delta_1 + \delta_2 > \gamma_1 + \gamma_2: \text{overweight new information (Fact 3)} \]

\[ \delta_1 + \delta_2 < 1: \text{consensus belief sticky (Fact 1)} \]
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)
Honest and posted beliefs

- 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)

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

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

\[ g_t = x_t + e_t, \quad e_t \sim N(0, \nu^{-1}) \]
\[ s^i_t = x_t + \eta^i_t, \quad \eta^i_t \sim N(0, \tau^{-1}) \]

- **Global game**

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

⇒ Individual posted forecast update similar to KF

\[ \hat{x}^i_{t,t} = \hat{x}^i_{t,t-1} + G_1(g_t - \hat{x}^i_{t,t-1}) + G_2(s^i_t - \hat{x}^i_{t,t-1}) \]

- With \( G_1 < K_1 \) and \( G_2 > K_2 \), where \( K_1, K_2 \) are the optimal weights
For each series we estimate

- Fundamental parameters ($\rho, \xi$) from actual data
- Signal noises ($\nu, \tau$) and strategic incentive ($\lambda$) with GMM
- Target moments:
  1. Mean FE dispersion
  2. Estimated posted gain $G$ (Fact 2)
  3. Estimated overreaction to private information $\beta_1$ (Fact 4a)
Structural estimation

• For each series we estimate
  ▶ Fundamental parameters ($\rho$, $\xi$) from actual data
  ▶ Signal noises ($\nu$, $\tau$) and strategic incentive ($\lambda$) with GMM
  ▶ Target moments:
    ① Mean FE dispersion
    ② Estimated posted gain $G$ (Fact 2)
    ③ Estimated overreaction to private information $\beta_1$ (Fact 4a)

• Very good match of untargeted moments (Facts 1, 3, 4b)
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
We compare underreaction to two public signals:

1. **Past consensus:** \( p_{i,t}^1 \equiv \tilde{E}_{t-1}[x_{t+h}] - \tilde{E}_{t-1}[x_{t+h}] \)

2. **Past actual:** \( p_{i,t}^2 \equiv x_{t-1} - \tilde{E}_{t-1}[x_{t+h}] \)

\[
fe_{t+h,t} = \alpha + \beta_1 p_{i,t}^1 + \beta_2 p_{i,t}^2 + err^i_t
\]

- We find \( \beta_1 > \beta_2 \): larger underreaction to past consensus \( p_{i,t}^1 \)
- Consistent with idea of strategic diversification
  - But also with modified overconfidence of *Broer & Khojas (2019)*
• Broer and Khohlas (2019) regress FE on public signal by itself

\[ f_{t+h,t}^i = \alpha + \beta_{BK} g_t + err_t^i \]

• They find \( \beta_{BK} \geq 0 \): mixed reaction to new public information
Our correction to BK

- We run the same regression but isolating the surprise component:
  \[ fe_{t+h, t} = \alpha + \beta \pi_{t+h, t} + \text{err}_{t}, \quad \pi_{t} \equiv g_{t} - \tilde{E}_{t-1}[x_{t+h}] \]

- We find $\beta > 0$: underreaction to new public information
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%. 
Extension: heterogeneous priors

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

\[ fe_{t+h,t}^i = \alpha + \beta pi_{t+h,t}^i + err_t^i, \quad \beta_{model} = 0 \]

• 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

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<th>Variable</th>
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<th>Data 2</th>
<th>Model 1</th>
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## Untargeted Moments

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