Expectations in Finance and Macroeconomics

Yueran Ma

Chicago Booth

MFR Program Summer Session for Young Scholars
Historical Background

- Expectations are central to economic analyses

- 1940s—60s: Extensive effort to understand actual expectations
  - NBER volume led by Franco Modigliani: *The Quality and Economic Significance of Anticipations Data* (1960)

- Rational Expectations Revolution (1970s—)
  - Models dictate expectations agents should hold.
  - Useful theoretical construct. Not necessarily an empirical statement.

- Frictionless Benchmark: Full Information Rational Expectations (FIRE)
Recent Research

Growing empirical analyses of expectations data:

- Expectations are observable
- Expectations are important to economic decisions
- Expectations can be imperfectly rational
Recent Research

Growing empirical analyses of expectations data:

- Expectations are observable
- Expectations are important to economic decisions
- Expectations can be imperfectly rational

Domains of analyses:

- Financial markets: stock returns, bond yields, credit spreads
- Macroeconomic outcomes: inflation, GDP
- Corporate decisions: earnings & investment
- Households: income, house prices
Recent Research

Growing empirical analyses of expectations data:

- Expectations are observable
- Expectations are important to economic decisions
- Expectations can be imperfectly rational

Domains of analyses:

- Financial markets: stock returns, bond yields, credit spreads
- Macroeconomic outcomes: inflation, GDP
- Corporate decisions: earnings & investment
- Households: income, house prices

Two-way interactions between data and theory:

- Data informs theory. Theory organizes & unifies empirical evidence.
Research Program on Expectations

1. Measure and analyze expectations

2. Develop empirically founded, portable models of beliefs

3. Incorporate them in macro/finance analyses
Plan

Part 1. Empirical Evidence on Expectations

1. Informativeness of Expectations Data
2. Empirical Structure of Expectations

Part 2. Models of Expectations Formation

3. Deviations from FI in FIRE
4. Deviations from RE in FIRE

Open Questions, Data Sources, and Additional References
Outline

1. **Empirical Evidence on Expectations**
   - Informativeness of Expectations Data
   - Structure of Expectations

2. **Models of Expectations**
   - Deviations from FI in FIRE
   - Deviations from RE in FIRE

3. **Summary and Additional Resources**
Expectations and Decisions

- Expectations in data have significant explanatory power for decisions
  - Stock returns: Greenwood-Shleifer 14, Andonov-Rauh 18, Giglio-Maggiori-Stroebel-Utkus 20
  - Firm investment: Gennaioli-Ma-Shleifer 16, Richter-Zimmermann 21

- Both in the aggregate and at the firm/individual level

- Survey expectations are informative about decisions
  - Beyond traditional predictors
  - Can help differentiate models of decisions
Investor Expectations and Stock Market Investments

Greenwood-Shleifer 14: Aggregate equity mutual fund flows
Investor Expectations and Stock Market Investments

Figure IV: Expected 1-Year Stock Returns and Equity Share

Giglio-Maggiori-Stroebel-Utkus 20: Individual Vanguard account holders
CFO Expectations and Firm Investment

Geinnaioli-Ma-Shleifer 16: Aggregate CFO expectations and investment
CFO Expectations and Firm Investment

\[ \Delta \text{CAPX}_{qt} = \alpha + \beta E^*_q [\Delta \text{Earnings}] + \lambda X_{qt} + \epsilon_{qt} \]

<table>
<thead>
<tr>
<th>CFO Expectations of Next 12m Earnings Growth</th>
<th>Realized Next 12m Investment Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFO Expectations of Next 12m Earnings Growth</td>
<td>0.5903 0.5853 0.2799 0.2611</td>
</tr>
<tr>
<td>(8.14) (8.41) (3.52) (3.20)</td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>0.0278</td>
</tr>
<tr>
<td>(0.37)</td>
<td></td>
</tr>
<tr>
<td>Past 12m Agg. Stock Returns</td>
<td>0.1975</td>
</tr>
<tr>
<td></td>
<td>(4.20)</td>
</tr>
<tr>
<td>Past 12m Credit Spread Change</td>
<td>-0.1035</td>
</tr>
<tr>
<td></td>
<td>(-3.82)</td>
</tr>
<tr>
<td>Past 12m Asset Growth</td>
<td>0.7021 0.6645 0.4473 0.8382</td>
</tr>
<tr>
<td>(6.48) (3.53) (3.43) (11.72)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>57 57 57 57</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.610 0.611 0.748 0.719</td>
</tr>
</tbody>
</table>

Geinnaioli-Ma-Shleifer 16: Firm-level CFO expectations and investment
Relevance of Expectations Data

Explaining stock prices

- Expectations of future cash flows explain stock prices in aggregate and cross section
  - Bordalo-Gennaioli-La Porta-Shleifer 19, 22

Explaining lending and credit cycles

- Differences in expectations, not just balance sheet conditions, explain bank lending
  - Fahlenbrach-Prilmeier-Stulz 17, Richter-Zimmermann 21, Ma-Palogorova-Peydro 22
- Deviations from rational expectations help understand credit cycles
  - Greenwood-Hanson 13, Baron-Xiong 17, Krishnamurthy-Li 21, Maxted 22
Relevance of Expectations Data

Why consider beliefs not just preferences?

- Growing amount of evidence from forecasts; models are testable
- Some outcomes hard to explain by preferences alone
- Example: “instability from beliefs” and credit cycles
  - Predictable negative excess returns & crises (large negative returns)
  - If driven by low risk aversion & risks anticipated, loan loss provisions should not be too low during credit booms; no “neglected risks”
- Policy designs
  - Farhi-Werning 22
Outline

1. Empirical Evidence on Expectations
   - Informativeness of Expectations Data
   - Structure of Expectations

2. Models of Expectations
   - Deviations from FI in FIRE
   - Deviations from RE in FIRE

3. Summary and Additional Resources
Structure of Expectations

- Tendency to over-extrapolate recent shocks or trends
  - Project them too much into the future

- Holds in many settings
  - **Stock returns**: Greenwood-Shleifer 14
  - **Bond yields**: Piazzesi-Salomao-Schneider 15, Brooks-Lustig-Katz 19
  - **Credit spreads**: Bordalo-Gennaioli-Shleifer 18
  - **Firm earnings**: Gennaioli-Ma-Shleifer 16, Bordalo-Gennaioli-La Porta-Shleifer 19, Richter-Zimmerman 19
  - **Macroeconomic outcomes**: Bordalo-Gennaioli-Ma-Shleifer 20
  - **House prices**: Kuchler-Zafar 18, De Stefani 19
  - **Controlled experiment**: Afrouzi-Kwon-Landier-Ma-Thesmar 21
Greenwood-Shleifer 14: Extrapolative expectations of stock returns
Extrapolative Tendencies in Expectations

A. Investor Expectations of Stock Returns

Table 5
Relationship between model expected returns and survey expected returns

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Log(D/P)</td>
<td>-0.328</td>
<td>-0.443</td>
<td>-0.305</td>
<td>-0.193</td>
<td>-0.554</td>
<td>-0.567</td>
<td>-0.312</td>
</tr>
<tr>
<td>[p-val]</td>
<td>[0.000]</td>
<td>[0.003]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>[0.000]</td>
</tr>
<tr>
<td>-Surplus C</td>
<td>-0.481</td>
<td>-0.529</td>
<td>-0.283</td>
<td>-0.054</td>
<td>-0.670</td>
<td>-0.736</td>
<td>-0.298</td>
</tr>
<tr>
<td>[p-val]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>[0.191]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>[0.000]</td>
</tr>
<tr>
<td>cay</td>
<td>0.025</td>
<td>0.139</td>
<td>-0.016</td>
<td>-0.185</td>
<td>0.366</td>
<td>-0.003</td>
<td>-0.133</td>
</tr>
<tr>
<td>[p-val]</td>
<td>[0.776]</td>
<td>[0.380]</td>
<td>[0.788]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>[0.988]</td>
<td>[0.023]</td>
</tr>
<tr>
<td>Composite ER</td>
<td>-0.572</td>
<td>-0.443</td>
<td>-0.300</td>
<td>0.125</td>
<td>-0.349</td>
<td>-0.8074</td>
<td>-0.361</td>
</tr>
<tr>
<td>[p-val]</td>
<td>[0.000]</td>
<td>[0.003]</td>
<td>[0.000]</td>
<td>[0.003]</td>
<td>[0.000]</td>
<td>[0.000]</td>
<td>[0.000]</td>
</tr>
</tbody>
</table>

Greenwood-Shleifer 14: Extrapolative vs. model return expectations
Extrapolative Tendencies in Expectations

B. Analyst Forecasts of Credit Spreads

Bordalo-Gennaioli-Shleifer 18: Predictable errors in credit spread forecasts
Extrapolative Tendencies in Expectations

C. CFO Forecasts of Firm Earnings

Gennaioli-Ma-Shleifer 16: Predictable errors in CFO earnings forecasts
Extrapolative Tendencies in Expectations

D. Professional Forecasters on Macroeconomic Outcomes

\[
\begin{align*}
    x_{t+h} - F_t^i x_{t+h} &= \alpha + \beta \left( F_t^i x_{t+h} - F_{t-1}^i x_{t+h} \right) + e_{t+h} \\
    \text{(Forecast Error)} & \text{ (Forecast Revision)}
\end{align*}
\]
Extrapolative Tendencies in Expectations

D. Professional Forecasters on Macroeconomic Outcomes

\[ x_{t+h} - F_t^i x_{t+h} = \alpha + \beta \left( F_t^i x_{t+h} - F_t^{i-1} x_{t+h} \right) + e_{t+h} \]

Forecast Error

Forecast Revision

Bordali-Gennaioli-Ma-Shleifer 20: Predictable errors in macro forecasts
Extrapolative Tendencies in Expectations

E. Controlled Experiments

- Forecast AR1. \( x_t = \rho x_{t-1} + \epsilon_t \). Randomly assign to \( \rho \in \{0, 0.2, 0.4, 0.6, 0.8, 1\} \).
  - 40 obs at beginning. Forecast 40 rounds. MTurk & MIT students.
Extrapolative Tendencies in Expectations

E. Controlled Experiments

- Forecast AR1. \( x_t = \rho x_{t-1} + \epsilon_t \). Randomly assign to \( \rho \in \{0, 0.2, 0.4, 0.6, 0.8, 1\} \).
  
  - 40 obs at beginning. Forecast 40 rounds. MTurk & MIT students.

\[
x_{t+h} - F_t^i x_{t+h} = \alpha + \beta \left[ F_t^i x_{t+h} - F_{t-1}^i x_{t+h} \right] + e_t^i
\]

Afrouzi-Kwon-Landier-Ma-Thesmar 21: Predictable forecast errors in simple experiments
Extrapolative Tendencies in Expectations

E. Controlled Experiments

- Forecast AR1. $x_t = \rho x_{t-1} + \epsilon_t$. Randomly assign to $\rho \in \{0, 0.2, 0.4, 0.6, 0.8, 1\}$.
  - 40 obs at beginning. Forecast 40 rounds. MTurk & MIT students.

Implied Persistence: $F^i_t x_{t+h} = \alpha + \hat{\rho} x_t + e^i_{t+h}$

Afrouzi-Kwon-Landier-Ma-Thesmar 21: Predictable forecast errors in simple experiments
Are There Exceptions?
A. Some Short-Term Forecasts

1. Short-term corporate earnings (equity analysts)
   - $\beta \approx 0.16$ for near-term analyst earnings forecasts (Bouchaud-Krueger-Landier-Thesmar 19)
   - $\beta \approx -0.3$ for long-term analyst earnings forecasts (Bordalo-Gennaioli-La Porta-Shleifer 19)

2. Short-term corporate sales (Italian firm managers)
   \[
   x_{t+1}^i - F_t^i x_{t+1} = \lambda + \kappa \left[ x_t^i - F_{t-1}^i x_t \right] + e_{t+h}^i
   \]
   - $\kappa \approx 0.1$ (Ma-Ropele-Thesmar-Sraer 20)

3. Short-term interest rate forecasts (professional forecasters)
   - Error-revision coefficient $> 0$ for 3M interest rates, $< 0$ for 10Y interest rates
   - Bordalo-Gennaioli-Ma-Shleifer 20, D'Arienzo 20, Wang 21
Are There Exceptions?

B. Unattended Shocks

Figure 3. Response of Forecast Errors of Consumers, Firms, and FOMC Members to Shocks.

Coibion-Gorodnichenko 12: Response of forecast errors to deflationary shocks
Are There Exceptions?

C. Consensus Macro Forecasts

\[ x_{t+h} - \bar{F}_{t+h} = \alpha + \beta \left( \bar{F}_{t+h} - \bar{F}_{t+h} \right) + e_{t+h} \]

- Average Forecast Error
- Average Forecast Revision

\[ \beta > 0 \text{ (Coibion-Gorodonichenko 15)} \]
  - Possibly due to informational frictions

- Unlike individual-level results: \( \beta < 0 \) for most series (Bordalo-Gennaioli-Ma-Shleifer 20)
Are There Exceptions?

C. Consensus Macro Forecasts

\[
\begin{align*}
\bar{x}_{t+h} - \bar{F}_t x_{t+h} &= \alpha + \beta \left[ \bar{F}_t x_{t+h} - \bar{F}_{t-1} x_{t+h} \right] + e_{t+h} \\
\text{Average Forecast Error} &\quad \text{Average Forecast Revision}
\end{align*}
\]

- $\beta > 0 \ (\text{Coibion-Gorordonichenko 15})$
  - Possibly due to informational frictions

- Unlike individual-level results: $\beta < 0$ for most series (Bordalo-Gennaioli-Ma-Shleifer 20)

- Difference arises from heterogeneous information sets across forecasts
  - People don’t necessarily react to the same information
  - More on this later
Research analyzing survey data often use **error-revision regressions**

- **Individual level:** \[ x_{t+h} - F^i_{t} x_{t+h} = \alpha + \beta \left[ F^i_{t} x_{t+h} - F^i_{t-1} x_{t+h} \right] + e_{t+h} \]
- **Consensus level:** \[ x_{t+h} - \bar{F}_{t} x_{t+h} = \alpha + \beta \left[ \bar{F}_{t} x_{t+h} - \bar{F}_{t-1} x_{t+h} \right] + e_{t+h} \]

**Individual level: Test RE in FIRE**

- **Key advantage:** Do not need to know forecaster information set
  - Forecast revision as a “summary statistic” for information processed
- **Limitations:** Not necessarily well-behaved for transitory process
  - RE: FR = 0 for i.i.d. process ⇒ \( \beta \) not reliably estimated
- Magnitude of \( \beta \) may not be easy to interpret without a given model
  - Also some path dependence given FR includes \( F_{t-1} \)

**Consensus level: Affected by information frictions & FI in FIRE**
Taking Stock: Empirical Findings

Individual-level forecasts:
- Tend to over-adjust to recent observations: “over-extrapolation”, “over-reaction”
- Stronger when true process more transitory
- Stronger for longer-horizon forecasts

Consensus (average) forecasts:
- Also affected by informational frictions
  - Infrequent update/inattention
  - Heterogeneous information
Outline

1 Empirical Evidence on Expectations
   - Informativeness of Expectations Data
   - Structure of Expectations

2 Models of Expectations
   - Deviations from FI in FIRE
   - Deviations from RE in FIRE

3 Summary and Additional Resources
Deviations from FI: Sticky Information

Mankiw-Reis 02: Infrequent updating (stickiness)

Basic ideas:
- Each period: updating with prob \((1 - \lambda)\); no updating with prob \(\lambda\)
- Use RE conditional on updating

Predictions:
- Individual level: if revise forecasts, forecast errors not predictable
  - Cannot be predicted by forecast revisions
  - Could be predicted by other things (not in info set)
- Consensus level: forecast revisions are insufficient
  - \(\bar{F}_t x_{t+h} = (1 - \lambda) \sum_{j=0}^{\infty} \lambda^j E_{t-j} x_{t+h}\) (some people have stale expectations)
  - Positive correlation between average forecast errors & forecast revisions
Deviations from FI: Noisy Information

Woodford 03: Observe noisy signals

Basic ideas:

- Observe noisy representation of current state: $y_{it} = x_t + \omega_{it}$
  - Can interpret as noisy perception, or heterogeneous info.
- Forecasts formed by Kalman filtering: $F_t^i x_t = G y_{it} + (1 - G) F_{t-1}^i x_t$
  - $G \leq 1$ is Kalman gain

Predictions:

- Individual level: forecast errors not predictable
- Consensus level: forecast revisions are insufficient (given $G < 1$)
Outline

1 Empirical Evidence on Expectations
   - Informativeness of Expectations Data
   - Structure of Expectations

2 Models of Expectations
   - Deviations from FI in FIRE
   - Deviations from RE in FIRE

3 Summary and Additional Resources
Overview

Models of information frictions above:
- "Under-reaction" to information neglected or imperfectly perceived
- Unbiased with respect to information processed

Models of imperfect rationality below:
- "Over-reaction" to information being processed
- Because it’s more representative (diagnostic expectations)
  or more available in mind (memory-based models)
Some Earlier/Simpler Approaches

Direct extrapolation:

\[ F_t x_{t+1} = x_t + \phi (x_t - x_{t-1}) \]

- Does not have “kernel of truth”
  - Forecasting rule does not adapt to property of true process.
  - \( \phi \) needs to vary in different settings to fit data.

Over-estimation of persistence:

\[ F_t x_{t+1} = \tilde{\rho} x_t, \quad \tilde{\rho} > \rho \]

- Need a way to specify relationship between \( \hat{\rho} \) and \( \rho \).

Lack of adjustment to the setting, subject to Lucas critique
Diagnostic Expectations
Motivation: Representativeness

- Kahneman-Tversky 83: “An attribute is representative of a class if it is very diagnostic; that is, the relative frequency of this attribute is much higher in that class than in a relevant reference class.”

- Assess distribution of attribute $T$ in class $G$

$$h(T = t|G)$$

- Following KT, define representativeness of $T = t$ for $G$ as:

$$R = \frac{h(T = t|G)}{h(T = t|\neg G)}$$

- Subjective perception distorts $h(T = t|G)$ by function of $R$
Example of Representativeness: Stereotypes

- Hair color: $T \equiv \{\text{red, light, dark}\}$, $G = \text{Irish}$, $-G = \text{World}$

<table>
<thead>
<tr>
<th>hair colour</th>
<th>red</th>
<th>light</th>
<th>dark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irish</td>
<td>10%</td>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>World</td>
<td>1%</td>
<td>14%</td>
<td>85%</td>
</tr>
</tbody>
</table>

- Given data (Irish), stereotype inflates prevalence of red hair:

$$\frac{h(\text{red hair}| \text{Irish})}{h(\text{red hair}| \text{World})} = 10$$

- In a dynamic environment, given news:
  - Inflate future states whose objective probability goes up the most
  - The context is lagged information
Example of Representativeness: Stereotypes

- Hair color: $T \equiv \{\text{red, light, dark}\}$, $G = \text{Irish}$, $-G = \text{World}$

<table>
<thead>
<tr>
<th>hair colour</th>
<th>red</th>
<th>light</th>
<th>dark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irish</td>
<td>10%</td>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>World</td>
<td>1%</td>
<td>14%</td>
<td>85%</td>
</tr>
</tbody>
</table>

- Given data (Irish), stereotype inflates prevalence of red hair:

$$\frac{h(\text{red hair}|\text{Irish})}{h(\text{red hair}|\text{World})} = 10$$

- In a dynamic environment, given news:
  - Inflate future states whose objective probability goes up the most
  - The context is lagged information
Setup

- State of the economy $\Omega_t$ at $t$ follows AR1
  \[
  \omega_t = \rho \cdot \omega_{t-1} + \epsilon_t
  \]

- After seeing the state $\omega_t$, decision-maker needs to represent:
  \[
  h(\Omega_{t+1} = \omega_{t+1}|\Omega_t = \omega_t)
  \]

- A future state is more representative at $t$
  if it has become more likely in light of recent data:
  \[
  R_t(\omega_{t+1}) = \frac{h(\Omega_{t+1} = \omega_{t+1}|\Omega_t = \omega_t)}{h(\Omega_{t+1} = \omega_{t+1}|\Omega_t = \rho \cdot \omega_{t-1})}
  \]

- Reference is information at $t - 1$: $-G = \{\Omega_t = \rho \cdot \omega_{t-1}\}$
Diagnostic Expectations

- Distorted subjective distribution $h^\theta_t(\omega_{t+1})$ is:

$$
\begin{align*}
    h(\Omega_{t+1} = \omega_{t+1}|\Omega_t = \omega_t) & \cdot \frac{h(\Omega_{t+1} = \omega_{t+1}|\Omega_t = \omega_t)}{h(\Omega_{t+1} = \omega_{t+1}|\Omega_t = \rho \cdot \omega_{t-1})} \cdot \frac{1}{Z_t} \\
    \theta & \text{ measures the degree of representativeness bias} \\
    & \quad \text{Typically estimated to be between 0.5 and 1.}
\end{align*}
$$

- Diagnostic expectations given by:

$$
E^\theta_t (\omega_{t+1}) = \int_\mathbb{R} \omega \cdot h^\theta_t (\omega) \, d\omega
$$

- Rational expectations: special case for $\theta = 0$ or no news $\epsilon_t = 0$
Diagnostic Expectations

When $\omega_t$ is AR1 with normal $(0, \sigma^2)$ shocks, the distribution $h^\theta(\omega_{t+1})$ is also normal, with variance $\sigma^2$ and mean:

$$E^\theta_t (\omega_{t+1}) = E_t (\omega_{t+1}) + \theta [E_t (\omega_{t+1}) - E_{t-1}(\omega_{t+1})]$$

Can further express $E^\theta_t (\omega_{t+1})$ as:

$$E^\theta_t (\omega_{t+1}) = E_t (\omega_{t+1}) + \rho\theta [\omega_t - E_{t-1}(\omega_t)]$$

Rational Expectations

Over-reaction to Recent Shock $\epsilon_t$

Predictable forecast errors:

$$E_t [\omega_{t+1} - E^\theta_t (\omega_{t+1})] = -\rho\theta \epsilon_t$$
Subjective Probability Distribution

- Subjective distribution $h_t^\theta(\omega_{t+1})$ shifts too much to news
Properties

\[ E_t^\theta (\omega_{t+1}) = E_t (\omega_{t+1}) + \theta [E_t (\omega_{t+1}) - E_{t-1}(\omega_{t+1})] \]

- Rational expectations as special case, when:
  - \( \theta = 0 \), persistence \( \rho = 0 \), or no news

- "Kernel of truth"
  - Subjective belief incorporates features of rational beliefs & adapt to the setting of true process ("forward-looking")
  - But exaggerate impact of recent shocks
  - Not subject to Lucas critique (not mechanical dependence on past)

- Refreshes every period
  - Can add more lags beyond \([E_t (\omega_{t+1}) - E_{t-1}(\omega_{t+1})]: -G = \{\Omega_{t-h}\}\)
Biased Beliefs + Information Frictions
Diagnostic Kalman Filter: Bordao-Gennaioli-Ma-Shleifer 20

- Data generating process: $x_t = \rho x_{t-1} + u_t$
  - $\rho \in [0, 1]$ and $u_t \sim \mathcal{N}(0, \sigma_u^2)$

- Each forecaster $i \in [0, 1]$ receives noisy signal
  - $s_t^i = x_t + \epsilon_t^i$
    - $\epsilon_t^i \sim \mathcal{N}(0, \sigma_{\epsilon}^2)$
    - $\epsilon_t^i$ may capture inattention or heterogeneous information/interpretation (Woodford 2003)

- Distorted beliefs characterized by:
  - $x_{t+h|t}^{i,\theta} = x_{t+h|t-1}^i + (1 + \theta) \frac{\sum \sigma_h^2}{\sum + \sigma_{\epsilon}^2} \rho^h \cdot (s_t^i - x_{t+h|t-1}^i)$
Predicting Forecast Errors with Forecast Revisions

Forecast Error on Forecast Revision Regression Coefficient

- **Consensus** level:

  \[ \beta = \frac{\text{cov} \left( x_{t+h} - x_{t+h|t}^{\theta}, x_{t+h|t}^{\theta} - x_{t+h|t-1}^{\theta} \right)}{\text{var} \left( x_{t+h|t}^{\theta} - x_{t+h|t-1}^{\theta} \right)} = \left( \sigma_{\epsilon}^2 - \theta \Sigma \right) h^* \]

  - Sign \( \propto \sigma_{\epsilon}^2 - \theta \Sigma \). Forecasters do not react to others’ private information.

- **Individual** level:

  \[ \beta^p = \frac{\text{cov} \left( x_{t+h} - x_{t+h|t}^{i,\theta}, x_{t+h|t}^{i,\theta} - x_{t+h|t-1}^{i,\theta} \right)}{\text{var} \left( x_{t+h|t}^{i,\theta} - x_{t+h|t-1}^{i,\theta} \right)} = -\frac{\theta (1 + \theta)}{(1 + \theta)^2 + \theta^2 \rho^2} \]

  - Negative if \( \theta > 0 \).

- Aggregation can change the interpretation of aggregate relationships.
Noisy Memory
Background

Recent interests in the role of memory in belief formation
- Beliefs shaped by information available in the brain
- Many facts about memory from psychology & neuroscience
  - Kahana: *Foundations of Human Memory*
- More generally, some information can be more actively utilized than others
- Imperfect memory naturally leads to over-weighting recent observations

Recent approaches of modeling
- (1) Costly recall/information utilization. (2) Noisy memory.
- For AR1 process $x_t = \mu + \rho (x_{t-1} - \mu) + \epsilon_t$, biases of mean $\mu$ simple & effective.
Model in a nutshell

\[
\hat{\mu}_t = E[\mu|m_t] + \gamma_t(x_t - (1 - \rho)E[\mu|m_t] - \rho x_{t-1})
\]

- $\lambda_t$ affects memory cost. $x_t$ observed after memory state $m_t$ is formed.
- $\gamma_t$ is function of memory precision; depend on $\lambda_t$ (optimally chosen).
- High cost/low precision $\Rightarrow$ more weight on $x_t$. 
Model fit using experimental forecasts of AR1 processes
Taking Stocks: Models and Data

1. Incorrect persistence $\hat{\rho} > \rho$
   - $F_t x_{t+h} = \mu + \hat{\rho}^h (x_t - \mu)$
   - Unclear how $\hat{\rho}$ varies with $\rho$. Bias ↓ when $h \uparrow$.

2. Over-react to recent shocks
   - Diagnostic expectations: $F_t x_{t+h} = E_t x_{t+h} + \theta (E_t x_{t+h} - E_{t-1} x_{t+h}) = \mu + \rho^h (x_t - \mu) + \theta \rho^h \epsilon_t$
   - Bias ↓ when $\rho \downarrow$ (same as RE when $\rho = 0$). Bias ↓ when $h \uparrow$.

3. Biases in beliefs about long-run mean
   - $F_t x_{t+h} = (1 - \rho^h) \hat{\mu}_t + \rho^h x_t$
   - Bias likely ↑ when $\rho \downarrow$. Bias ↑ when $h \uparrow$.
   - Parsimonious for greater bias when process transitory, horizon long
Outline

1. Empirical Evidence on Expectations
   - Informativeness of Expectations Data
   - Structure of Expectations

2. Models of Expectations
   - Deviations from FI in FIRE
   - Deviations from RE in FIRE

3. Summary and Additional Resources
Summary

- Substantial information from data on expectations
  - Structure of beliefs. Impact on decisions.

- Progress in unification of empirical evidence & models
  - Empirical evidence increasingly clear
  - Modeling approaches taking shape

- Potential unification with biases in judgment in general

- New venues for understanding economic activities
  - Credit cycles. Financial crises. Over- and under-investment...
Open Questions

1. **Measurement of biases in survey data**
   - Face challenges when researchers do not know DGP, information set
   - Is forecast error predictability a reliable approach? Anything else?

2. **Expectations of fundamentals vs. output vs. prices/returns**

3. **Heterogeneity and disagreement**
   - Where does heterogeneity come from? How does heterogeneity affect aggregation?

4. **Beliefs about central tendencies vs. tails**
   - Most expectations data so far about central tendencies
   - But beliefs about tails can be important, e.g., credit cycles, tech boom

5. **Consequences of biased beliefs**
   - How much does the bias component drive asset prices, investment, etc.?
   - More dependent on model structure.
Open Questions

Very useful survey on “Expectations Data in Asset Pricing” by Adam and Nagel

*Mechanisms of subjective belief formation in asset pricing models should not only produce empirically realistic asset price behavior, but they should also be plausible in light of observable data on investor expectations. With increasing availability of survey data, the study of investor expectations has become a very active area of research.*

Key components:

- Belief formation (applied to cash flows or prices/returns)
- Sensitivity of portfolios to beliefs
- Heterogeneity and aggregation
Open Questions

“We are all like little mice nibbling on the infinite cheese of knowledge. We will never consume the cheese, but it is the love of doing it together and how it shapes us, that’s important.”

Yueran Ma (Chicago Booth)
Additional Practical Notes

- Testing deviations from rational expectations
  - Requires large $T$. Large $N$ and small $T$ is tricky.

- Kendall/Stambaugh bias (time series) & Nickell bias (panel with individual fixed effects)
  - Suppose with AR1 process $x_{t+1} = \rho x_t + u_{t+1}$
    Bias in estimating $\rho$: $E[\hat{\rho} - \rho] = -\left(\frac{1+3\rho}{T}\right) + o\left(\frac{1}{T^2}\right)$
  - Suppose use $z_t$ to predict $x_{t+1}$, where $z_{t+1} = \phi z_t + v_{t+1}$
    Want to estimate $x_{t+1} = \beta z_t + e_{t+1}$
    Bias in estimating $\beta$: $\gamma E[\hat{\rho} - \rho]$, where $\gamma = \sigma_{uv}/\sigma_{u}^2$
  - Forecast errors likely auto-correlated with overlapping horizons

- Be careful interpreting tests using average beliefs
Expectations Data

- Duke CFO Survey: www.cfosurvey.org
  - Forecasts of next 12 months
  - Earnings, sales, CAPX, R&D, employment, wage, productivity, price; S&P 500 returns.
  - Aggregate and sectoral data. Quarterly since 1998.

- IBES Analyst (on WRDS)
  - Quarterly, annual, and long-term growth forecasts
  - Mainly EPS and sales. Firm-level data, since 1980s.

- IBES Firm Guidance (on WRDS)
  - Quarterly and annual forecasts
  - Mainly EPS and sales. Firm-level data, since 1980s.
Expectations Data

- **American Association of Individual Investors**
  - Next 6 months stock market sentiment (qualitative)
  - Aggregate data. Weekly since late 1980s.

- **Gallup**
  - Next 12 months stock market sentiment
  - Aggregate data. Monthly since 1990s (with gaps).
  - See Robin Greenwood’s website

- **Shiller**
  - Individual stock market confidence index
  - Aggregate data. Monthly since early 2000s.

- **RAND American Life Panel**
  - Stock returns within range. Since 2008.
Expectations Data

- **Michigan Survey of Consumers**
  - Inflation, consumer sentiment, stock returns (occasional)
  - Aggregate and house-hold level data. Monthly (not panel)

- **New York Fed Survey of Consumer Expectations**
  - Inflation, spending, unemployment rate, house prices, etc.
  - Proprietary. Monthly since late 2012.

- **Survey of Professional Forecasters**
  - GDP, inflation, interest rates
  - Aggregate and forecaster-level. Quarterly since late 1960s.

- **BlueChip Survey**
  - GDP, inflation, Treasury rates, AAA/BAA yield
Some Earlier Work


References and Additional Readings
Expectations and Outcomes: Stock Market


References and Additional Readings

Expectations and Outcomes: Credit Market


References and Additional Readings
Expectations and Outcomes: Firms


References and Additional Readings
Structure of Expectations


References and Additional Readings

Structure of Expectations


