Econ 219B
Psychology and Economics: Applications (Lecture 13)

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April 23, 2008
Outline

1. Market Reaction to Biases: Introduction

2. Market Reaction to Biases: Pricing

3. Intro to Problem Set

4. Market Reaction to Biases: Behavioral Finance
1 Market Reaction to Biases: Introduction

- So far, we focused on consumer deviations from standard model

- Who exhibits these deviations?

  1. **Self-control and naivete'**. Consumers (health clubs, food, credit cards, smoking), Employees (retirement saving, benefit take-up), Students (homework)

  2. **Reference dependence**. Workers (labor supply, increasing wages), (inexperienced) traders (sport cards), Investors, Consumers (insurance), House owners

  3. **Social preferences**. Consumers (giving to charities), Employees (effort, strikes)
4. **Biased Beliefs.** Individual investors, CEOs, Consumers (purchases, betting)

5. **Inattention.** Individual investors, Consumers (eBay bidding, taxation)

6. **Menu Effects.** Individual investors, Consumers (loans, 410(k) plans)

7. **Social Pressure and Persuasion.** Voters, Employees (productivity), Individual investors (and analysts)

8. **Emotions.** Individual investors, Consumers

- What is missing from picture?
- Experienced agents
- Firms
- Broadly speaking, market interactions with ‘rational’ agents

- Market interactions
  - Everyone ‘born’ with biases
  - But: Effect of biases lower if:
    * learning with plenty of feedback
    * advice, access to consulting
    * specialization
* Competition ‘drives out of market’ (BUT: See last lecture)

- For which agents are these conditions more likely to be satisfied?
  - Firms

- In particular, firms more likely to be aware of biases
• Implications? Study biases in the market

• Six major instances:
  – Interaction between firms and consumers (contract design, price choice — today)
  – Interaction between experienced and inexperienced investors (noise traders and behavioral finance — today or next week)
  – Interaction between managers and investors (corporate finance — next week)
  – Interaction between employers and employees (labor economics — briefly next week)
  – Interaction between politicians and voters (political economy — next week)
  – Institutional design (next week)
2 Market Reaction to Biases: Pricing

- Consider now the case in which consumers purchasing products have biases

- Firm maximize profits

- Do consumer biases affect profit-maximizing contract design?

- How is consumer welfare affected by firm response?

- Analyze first the case of consumers with $(\beta, \hat{\beta}, \delta)$ preferences
2.1 Self-Control

MARKET (I). INVESTMENT GOODS

• Monopoly
• Two-part tariff: $L$ (lump-sum fee), $p$ (per-unit price)
• Cost: set-up cost $K$, per-unit cost $a$

Consumption of investment good

Payoffs relative to best alternative activity:

• Cost $c$ at $t = 1$, stochastic
  – non-monetary cost
  – experience good, distribution $F(c)$

• Benefit $b > 0$ at $t = 2$, deterministic
CONSUMER BEHAVIOR.

- Long-run plans at $t = 0$:

  Consume $\iff \beta \delta (-p - c + \delta b) > 0$

  $\iff c < \delta b - p$

- Actual consumption decision at $t = 1$:

  Consume $\iff c < \beta \delta b - p$ (Time Inconsistency)

- Forecast at $t = 0$ of consumption at $t = 1$:

  Consume $\iff c < \hat{\beta} \delta b - p$ (Naiveté)
FIRM BEHAVIOR. Profit-maximization

\[
\max_{L,p} \delta \left\{ L - K + F(\beta \delta b - p)(p - a) \right\}
\]

s.t. \( \beta \delta \left\{ -L + \int_{-\infty}^{\hat{\beta} \delta b - p} (\delta b - p - c) dF(c) \right\} \geq \beta \bar{\delta} u \)

- Notice the difference between \( \beta \) and \( \hat{\beta} \)
Solution for the per-unit price $p^*$:

\[
p^* = a \quad \text{[exponentials]}
\]

\[
- (1 - \hat{\beta}) \delta b \frac{f (\hat{\beta}\delta b - p^*)}{f (\beta\delta b - p^*)} \quad \text{[sophisticates]}
\]

\[
- \frac{F (\hat{\beta}\delta b - p^*) - F (\beta\delta b - p^*)}{f (\beta\delta b - p^*)} \quad \text{[naives]}
\]

Features of the equilibrium

1. *Exponential agents* ($\beta = \hat{\beta} = 1$).
   
   Align incentives of consumers with cost of firm 
   
   $\implies$ marginal cost pricing: $p^* = a$. 
\[ p^* = a \]  
\[ - \left( 1 - \beta \right) \delta b \frac{f(\hat{\beta} \delta b - p^*) - F(\beta \delta b - p^*)}{f(\beta \delta b - p^*)} \]  
\[ F(\hat{\beta} \delta b - p^*) - F(\beta \delta b - p^*) \]  

2. *Hyperbolic agents.* Time inconsistency  
\[ \Rightarrow \text{below-marginal cost pricing: } p^* < a. \]

(a) *Sophisticates* \((\beta = \hat{\beta} < 1)\): commitment.

(b) *Naives* \((\beta < \hat{\beta} = 1)\): overestimation of consumption.
MARKET (II). LEISURE GOODS

Payoffs of consumption at $t = 1$:

- Benefit at $t = 1$, stochastic
- Cost at $t = 2$, deterministic

⇒ Use the previous setting: $-c$ is “current benefit”, $b < 0$ is “future cost.”

Results:

1. *Exponential agents.*
   
   Marginal cost pricing: $p^* = a$, $L^* = K$ (PC).

2. *Hyperbolic agents* tend to overconsume. ⇒
   
EMPIRICAL PREDICTIONS

Two predictions for time-inconsistent consumers:

1. Investment goods (Proposition 1):
   (a) Below-marginal cost pricing
   (b) Initial fee (Perfect Competition)

2. Leisure goods (Corollary 1)
   (a) Above-marginal cost pricing
   (b) Initial bonus or low initial fee (Perfect Competition)
FIELD EVIDENCE ON CONTRACTS

- US Health club industry ($11.6bn revenue in 2000)
  - monthly and annual contracts
  - Estimated marginal cost: $3-$6 + congestion cost
  - Below-marginal cost pricing despite small transaction costs and price discrimination

- Vacation time-sharing industry ($7.5bn sales in 2000)
  - high initial fee: $11,000 (RCI)
  - minimal fee per week of holiday: $140 (RCI)
• Credit card industry ($500bn outstanding debt in 1998)
  – Resale value of credit card debt: 20% premium (Ausubel, 1991)
  – No initial fee, bonus (car / luggage insurance)
  – Above-marginal-cost pricing of borrowing

• Gambling industry: Las Vegas hotels and restaurants:
  – Price rooms and meals below cost, at bonus
  – High price on gambling
WELFARE EFFECTS

Result 1. Self-control problems + Sophistication $\Rightarrow$ First best

- Consumption if $c \leq \beta \delta b - p^*$

- Exponential agent:
  - $p^* = a$
  - Consume if $c \leq \delta b - p^* = \delta b - a$

- Sophisticated time-inconsistent agent:
  - $p^* = a - (1 - \beta)\delta b$
  - Consume if $c \leq \beta \delta b - p^* = \delta b - a$

- Perfect commitment device

- Market interaction maximizes joint surplus of consumer and firm
Result 2. Self-control + Partial naivété ⇒ Real effect of time inconsistency

• \( p^* = a - \left[ F(\delta b - p^*) - F(\beta \delta b - p^*) \right] / f(\beta \delta b - p^*) \)

• Firm sets \( p^* \) so as to accentuate overconfidence

• Two welfare effects:
  – Inefficiency: \( \text{Surplus}_{\text{naive}} \leq \text{Surplus}_{\text{soph}} \).
  – Transfer (under monopoly) from consumer to firm

• Profits are increasing in naivete’ \( \hat{\beta} \)(monopoly)

• \( \text{Welfare}_{\text{naive}} \leq \text{Welfare}_{\text{soph}} \).

• Large welfare effects of non-rational expectations
2.2 Self-Control 2


- Extend DellaVigna and Malmendier (2004):
  - incorporate heterogeneity in naiveté
  - allow more flexible functional form in time inconsistency
  - different formulation of naiveté
• Setup:
  1. Actions:
     - Action $a \in [0, 1]$ taken at time 2
     - At time 1 utility function is $u(a)$
     - At time 2 utility function is $v(a)$
  2. Beliefs: At time 1 believe:
     - Utility is $u(a)$ with probability $\theta$
     - Utility is $v(a)$ with probability $1 - \theta$
     - Heterogeneity: Distribution of types $\theta$
  3. Transfers:
     - Consumer pays firm $t(a)$
     - Restrictive assumption: no cost to firm of providing $a$
Therefore:

- Time inconsistency \((\beta < 1) \rightarrow \text{Difference between } u \text{ and } v\)

- Naiveté \((\hat{\beta} > \beta) \rightarrow \theta > 0\)

- Partial naiveté here modelled as stochastic rather than deterministic

- Flexibility in capturing time inconsistency (self-control, reference dependence, emotions)
• Main result:

• **Proposition 1.** There are two types of contracts:
  1. Perfect commitment device for sufficiently sophisticated agents \( (\theta < \theta_0) \)
  2. Exploitative contracts for sufficiently naive agents \( (\theta > \theta_0) \)

• Commitment device contract:
  - Implement \( a_\theta = \max_a u(a) \)
  - Transfer:
    * \( t(a_\theta) = \max_a u(a) \)
    * \( t(a) = \infty \) for other actions
  - Result here is like in DM: Implement first best
• Exploitative contract:
  – Agent has negative utility:
    \[ u(a_\theta^v) - t(a_\theta^v) < 0 \]
  – Maximize overestimation of agents:
    \[ a_\theta^u = \arg \max (u(a) - v(a)) \]
2.3 Bounded Rationality

- Gabaix and Laibson (2003), *Competition and Consumer Confusion*

- Non-standard feature of consumers:
  - Limited ability to deal with complex products
  - Imperfect knowledge of utility from consuming complex goods

- Firms are aware of bounded rationality of consumers
  → design products & prices to take advantage of bounded rationality of consumers
Three steps:

1. Given product complexity, given number of firms: What is the mark-up? Comparative statics.

2. Given product complexity: endogenous market entry. What is the mark-up? What is the number of firms?

3. Endogenous product complexity, endogenous market entry: What are mark-up, number of firms, and degree of product complexity?

We will go through 1, skip 2, and talk about the intuition of 3.
Example: Checking account. Value depends on

- interest rates
- fees for dozens of financial services (overdrafts, more than $x$ checks per months, low average balance, etc.)
- bank locations
- bank hours
- ATM locations
- web-based banking services
- linked products (e.g. investment services)

Given such complexity, consumers do not know the exact value of products they buy.
Model

- Consumers receive noisy, *unbiased* signals about product value.
  - Agent $a$ chooses from $n$ goods.
  - True utility from good $i$:
    $$ Q_i - p_i $$
  - Utility signal
    $$ U_{ia} = Q_i - p_i + \sigma_i \varepsilon_{ia} $$

$\sigma_i$ is complexity of product $i$.
$\varepsilon_{ia}$ is zero mean, iid across consumers and goods, with density $f$ and cumulative distribution $F$.
(Suppress consumer-specific subscript $a$; $U_i \equiv U_{ia}$ and $\varepsilon_i \equiv \varepsilon_{ia}$.)
• Consumer decision rule: Picks the one good with highest signal $U_i$ from $(U_i)_{i=1}^n$.

(Assumption! What justifies this assumption?) Demand for good $i$

$$D_i = P \left( U_i > \max_{j \neq i} U_j \right)$$

$$= E \left[ P \left[ \text{for all } j \neq i, U_i > U_j | \epsilon_i \right] \right]$$

$$= E \left[ \prod_{j \neq i} P \left[ U_i > U_j | \epsilon_i \right] \right]$$

$$= E \left[ \prod_{j \neq i} P \left[ \frac{Q_i - p_i - (Q_j - p_j) + \sigma_i \epsilon_i}{\sigma_j} > \epsilon_j | \epsilon_i \right] \right]$$

$$D_i = \int f(\epsilon_i) \prod_{j \neq i} F \left( \frac{Q_i - p_i - (Q_j - p_j) + \sigma_i \epsilon_i}{\sigma_j} \right) d\epsilon_i$$
Market equilibrium with exogenous complexity

Bertrand competition with

- $Q_i$: quality of a good,
  - $\sigma_i$: complexity of a good,
  - $c_i$: production cost
  - $p_i$: price

- Simplification: $Q_i, \sigma_i, c_i$ identical across firms. (*Problem:* How should consumers choose if all goods are known to be identical?)

- Firms maximize profit $\pi_i = (p_i - c_i) D_i$

- Symmetry reduces demand to

$$D_i = \int f(\varepsilon_i) F \left( \frac{p_j - p_i + \sigma \varepsilon_i}{\sigma} \right)^{n-1} d\varepsilon_i$$
Example of demand curves

Gaussian noise $\varepsilon \sim N(0,1)$, 2 firms

Demand curve faced by firm 1:

$$D_1 = P(Q - p_1 + \sigma\varepsilon_1 > Q - p_2 + \sigma\varepsilon_2)$$
$$= P(p_2 - p_1 > \sigma\sqrt{2}\eta) \text{ with } \eta = (\varepsilon_2 - \varepsilon_1) / \sqrt{2} \text{ N}(0,1)$$
$$= \Phi \left( \frac{p_2 - p_1}{\sigma\sqrt{2}} \right)$$

Usual Bertrand case ($\sigma = 0$): infinitely elastic demand at $p_1 = p_2$

$$D_1 \in \begin{cases} 
1 & \text{if } p_1 < p_2 \\
[0, 1] & \text{if } p_1 = p_2 \\
0 & \text{if } p_1 > p_2 
\end{cases}$$
Complexity case ($\sigma > 0$): Smooth demand curve, no infinite drop at $p_1 = p_2$. At $p_1 = p_2 = p$ demand is $1/2$.

\[
\max_{p_1} \Phi \left( \frac{p_2 - p_1}{\sigma \sqrt{2}} \right) [p_1 - c_1]
\]

\[
f.o.c. : -\frac{1}{\sigma \sqrt{2}} \phi \left( \frac{p_2 - p_1}{\sigma \sqrt{2}} \right) [p_1 - c_1] + \Phi \left( \frac{p_2 - p_1}{\sigma \sqrt{2}} \right) = 0
\]

**Intuition for non-zero mark-ups:** Lower elasticity increases firm mark-ups and profits. Mark-up proportional to complexity $\sigma$. 
Endogenous complexity

- Consider Normal case $\rightarrow$ For $\sigma \rightarrow \infty$

$$\max_{p_1} \Phi \left( \frac{p_2 - p_1}{\sigma \sqrt{2}} \right) \left[ p_1 - c_1 \right] \rightarrow \max_{p_1} \frac{1}{2} \left[ p_1 - c_1 \right]$$

Set $\sigma \rightarrow \infty$ and obtain infinite profits by letting $p_1 \rightarrow \infty$

(Choices are random, Charge as much as possible)

- Gabaix and Laibson: Concave returns of complexity $Q_i(\sigma_i)$

  Firms increase complexity, unless “clearly superior” products in model with heterogenous products.

**In a nutshell:** market does not help to overcome bounded rationality. Competition may not help either
• More work on Behavioral IO:

• **Heidhus-Koszegi (2006, 2007)**
  – Incorporate reference dependence into firm pricing
  – Assume reference point rational exp. equilibrium (**Koszegi-Rabin**)
  – Results on
    * Price compression (consumers hate to pay price higher than reference point)
    * But also: Stochastic sales

• **Gabaix-Laibson (1996)**
  – Consumers pay attention to certain attributes, but not others (Shrouded attributes)
- Form of limited attention
- Firms charge higher prices on shrouded attributes (add-ons)
- Similar to result in DellaVigna-Malmendier (2004): Charge more on items consumers do not expect to purchase

- **Ellison (2006):** Early, very concise literature overview

- **Future work:** *Empirical Behavioral IO*
  - Document non-standard behavior
  - Estimate structurally
  - Document firm response to non-standard feature
3 Intro to Problem Set

- Problem set focused on financial markets
- Biases of investors and accountants
- Accounting — Information on company performance
  - accounting books
  - quarterly earnings announcement
- Two main focuses:
  - Optimal accounting rules
  - Stock price response to profitability information in accounting books
• What is right valuation of company?
  – Crucial to guarantee right allocation of capital
  – Denote $e_{t,k}$ earnings (profits) of company $k$ in year $t$
  – Stock price = Discounted sum of future cash flows:
    $$ p_{t,k} = e_{t,k} + \frac{e_{t+1,k}}{1 + r} + \frac{e_{t+2,k}}{(1 + r)^2} + ... $$
  – Need forecasts of future profitability $e_{t,k}$

• Two main components:
  – Short-run earnings performance
  – Long-run performance
  – Analysts provide forecasts on both
• **Analysts.** Process information on companies and make it available (for a fee)
  
  – Sell-side. Work for brokerage firm (investment bank)
  
  – Buy-side. Work for mutual funds

  – Sell-side analysts:
    * more likely to have conflict of interest (Inv. Bank selling shares of target company)
    * data widely available (IBES, FirstCall)
• Analysts generate two main outputs:

1. Earning forecasts $\hat{e}_{t,k}$
   - Dollar earning per share of company
   - Quarterly or annual
   - Forecast $h$ years into the future: $h \simeq 3, 4$ years

2. Long-term "growth rate" of earnings $g_e$

• Common forecasting model:

$$\hat{p}_{t,k} = e_{t,k} + \frac{\hat{e}_{t+1,k}}{1 + r} + \frac{\hat{e}_{t+2,k}}{(1 + r)^2} + \ldots$$

$$+ \sum_{t=0}^{\infty} \frac{1}{(1 + r)^{h+t}} \hat{e}_{t+h,k} \ast g_e$$
Company releases of information

- Each quarter: Announcement of accounting performance
  - Scheduled announcement, conference call
  - Release of accounting indicators
  - Special focus on earnings per share $e_{t,k}$

- Comparison of forecasted and realized earnings

- Measure of new information: earning surprise $e_{t,k} - \hat{e}_{t,k}$.

- Renormalize by price of share: $s_{t,k} = \left( e_{t,k} - \hat{e}_{t,k} \right) / p_{t,k}$

- Investors react to new information by updating stock price $p_{t,k}$
Problem set

Focus on response of stock prices to earning surprise

Economic significance:

- Processing of new information
  - Clean measure of information
  - Clean measure of response
- Timing of release of information by company
Identify in the data three anomalies:

- **Anomaly 1. Post-Earnings Announcement Drift.** (Chan, Jegadeesh, and Lakonishok, 1996; Bernard and Thomas, 1989).
  
  - Announcements of good news in earnings $e_{t,k}$ are followed by higher returns over next 2-3 quarters.
  
  - Arbitrage should eliminate this.
  
  - Interpretation: Investors inattentive initially, news incorporated slowly over time.

Measure new information using earnings surprise $s_{t,k}$.

Follow standard ‘quantile’ procedure: Divide into quantiles based on $s_{t,k}$. 


• Plot returns for each quantile

• Focus on light blue line for now (Figure from DellaVigna and Pollet, 2006)
• Anomaly 2. Less Immediate Response and more Drift when More distractions (DellaVigna-Pollet, forthc.; Hirshleifer-Lim-Teoh, 2007)
  – Announcements on Friday (DVP) or with more competing news (HLT):
    * Drift stronger and Immediate response lower
    * Inattention: More distracted investors
• **Anomaly 3.** (Degeorge, Patel, and Zeckhauser, 1999)
  
  – CEOs shift the earnings so as to meet analyst expectations
• Similar result if earnings compared to earnings 4 quarters ago or compared to zero profits

• Interpretation:
  – Investors have ‘bias’: They penalize significantly companies that fail to meet thresholds
  – Managers cater to this bias by manipulating earnings
4 Methodology: Clustering Standard Errors

- Common econometric issue: Errors correlated across groups of observations

- Example 1. State-Year panel: Effect of abortion on crime
  1. Persistent shock to State over time (Autocorrelation)
  2. Correlation in shocks across State within year (Cross-Sectional correlation)

- Example 2. Earnings announcement panel
  1. Persistent shock to Company over time (Autocorrelation)
  2. Correlation in shocks across companies within date (Cross-Sectional correlation)
- OLS standard errors assume i.i.d. cross-sectionally and over time

- Clustered standard errors can take care of Issue 1 or 2 — not both:
  1. Cluster by State (Company):
     - Assume independence across States (companies)
     - Allow for any correlation over time within State (company)
  2. Cluster by year (date)
     - Assume independence across years (dates)
     - Allow for any correlation within a year (date) across States (companies)

- How does this work?
• Assume simple univariate regression:

\[ y_{it} = \alpha + \beta x_{it} + \varepsilon_{it} \]

• OLS estimator:

\[ \hat{\beta} = \beta + (x' x)^{-1} x' \varepsilon = \beta + \frac{Cov(x, \varepsilon)}{Var(x)} \]

• \( Var(\hat{\beta}) \) under i.i.d. assumptions:

\[ Var(\hat{\beta})_{OLS} = (x' x)^{-1} \sum_{i,t} (x_{it} \hat{\varepsilon}_{it})(\hat{\varepsilon}_{it} x_{it})(x' x)^{-1} \frac{1}{NT} = \frac{\hat{\sigma}^2}{\sum x_{it}^2 NT} \]

• White-heteroskedastic:

\[ Var(\hat{\beta})_{Het} = \frac{1}{\sum_{it} x_{it}^2} \sum_{it} \frac{x_{it}^2 \hat{\varepsilon}_{it}^2}{\sum x_{it}^2} \]
• White-heteroskedastic:

\[
Var (\hat{\beta})_{Het} = \frac{1}{\sum_{it} x_{it}^2} \sum_{it} \frac{(x_{it}\hat{e}_{it})^2}{\sum x_{it}^2}
\]

– Notice: Second sum is weighted average of \(\hat{e}_{it}^2\), with more weight given to observations with higher \(x_{it}^2\)

– If high \(x_{it}^2\) is associated with high \(\hat{e}_{it}^2\), \(Var (\hat{\beta})_{Het} > Var (\hat{\beta})_{OLS}\)

• Standard Errors Clustered by \(I\) (allow for autocorrelation):

\[
Var (\hat{\beta})_{Clust} = \frac{1}{\sum_{it} x_{it}^2} \sum_{i} \frac{\left(\sum_t x_{it}\hat{e}_{it}\right)^2}{\sum x_{it}^2}
\]

– First sum all the covariances \(x_{it}\hat{e}_{it}\) within a cluster

– Then square up and add across the clusters

– Notice: This is as if one cluster (one \(i\)) was one observation
• That is, this form of clustering allows

\[ E(u_{it}u_{it'}|X_{it}X_{it'}) \neq 0 \]

– Correlation within cluster \( i \)

• Requires

\[ E(u_{it}u_{i't'}|X_{it}X_{i't'}) = 0 \]

for \( i \neq i' \)

– No correlation across clusters
• When is $\text{Var} \left( \hat{\beta} \right)_{\text{Clust}} > \text{Var} \left( \hat{\beta} \right)_{\text{Het}}$?

• Example: Assume $I = 2$, $T = 2$

$$\text{Var} \left( \hat{\beta} \right)_{\text{Het}} = \frac{1}{\sum_{it} x_{it}^2} \left( x_{11} \hat{\epsilon}_{11} \right)^2 + \left( x_{12} \hat{\epsilon}_{12} \right)^2 + \left( x_{21} \hat{\epsilon}_{21} \right)^2 + \left( x_{22} \hat{\epsilon}_{22} \right)^2$$

• Compare to

$$\text{Var} \left( \hat{\beta} \right)_{\text{Clust}} = \frac{1}{\sum_{it} x_{it}^2} \left( x_{11} \hat{\epsilon}_{11} + x_{12} \hat{\epsilon}_{12} \right)^2 + \left( x_{21} \hat{\epsilon}_{21} + x_{22} \hat{\epsilon}_{22} \right)^2$$

$$= \text{Var} \left( \hat{\beta} \right)_{\text{Het}} + \frac{1}{\sum_{it} x_{it}^2} \frac{2x_{11} \hat{\epsilon}_{11} \hat{\epsilon}_{12} x_{12} + x_{21} \hat{\epsilon}_{21} \hat{\epsilon}_{22} x_{22}}{\sum x_{it}^2}$$

- Hence, $\text{Var} \left( \hat{\beta} \right)_{\text{Clust}} > \text{Var} \left( \hat{\beta} \right)_{\text{Het}}$ if $Ex_{i1}x_{i2} > 0$ and $E\hat{\epsilon}_{i1}\hat{\epsilon}_{i2} > 0$ → Positive correlation within cluster among $x$ variables and $\epsilon$

- Positive correlation → Standard errors understated if no clustering
• Calculation of Adjustment of Standard Errors due to Clustering
  
  – $T$ observations within cluster
  
  – Within-cluster correlation of $x$: $\rho_x$
  
  – Within-cluster correlation of $\varepsilon$: $\rho_\varepsilon$

• Compare $\text{Var} \left( \hat{\beta} \right)_{\text{Clust}}$ and $\text{Var} \left( \hat{\beta} \right)_{\text{OLS}}$:

$$\text{Var} \left( \hat{\beta} \right)_{\text{Clust}} = \text{Var} \left( \hat{\beta} \right)_{\text{OLS}} \ast (1 + (T - 1) \rho_x \rho_\varepsilon)$$

  – Standard errors downward biased with OLS if $\rho_x \rho_\varepsilon > 0$, or positive correlations (as above)
  
  – No bias if no correlation in either $x$ or $\varepsilon$
  
  – Bias larger the larger is $T$
  
  – Illustrative case: Suppose all observations within cluster identical ($\rho_x = \rho_\varepsilon = 1$) $\rightarrow$ Bias $= T$
• Issues with clustering:

• Issue 1. **Number of clusters**
  – Convergence with speed $I \rightarrow$ Need a large number of clusters $I$ to apply LLN
  – Beware of papers that apply clustering with $<20$ clusters
  – **Cameron-Gelbach-Miller (2008):** Test with good finite sample properties even for $I \approx 10$

• Issue 2. **Cluster in only one dimension**
  – Clustering by $I$ controls for autocorrelation
  – Clustering by $T$ controls for cross-sectional correlation
  – How can control for both? Cannot really $\rightarrow$ However: **Cameron-Gelbach-Miller (2006):** Two-way clustering, can do so
• Readings on clustered standard errors:

  – **Stata Manual** $\rightarrow$ basic, intuitive

  – **Bertrand-Duflo-Mullainathan (QJE, 2004)** $\rightarrow$ Excellent discussion of practical issues with autocorrelation in diff-in-diff papers, good intuition

  – **Peterson (2007)** $\rightarrow$ Fairly intuitive, applied to finance

  – **Cameron-Trivedi (2006) and Wooldridge (2003)** $\rightarrow$ More serious treatment

  – **Colin Cameron (Davis)’s website** $\rightarrow$ Updates
5 Market Reaction to Biases: Behavioral Finance

- Who do ‘smart’ investors respond to investors with biases?

- First, brief overview of anomalies in Asset Pricing (from Barberis and Thaler, 2004)

  1. **Underdiversification.**
     
     (a) Too few companies.
     - Investors hold an average of 4-6 stocks in portfolio.
     - Improvement with mutual funds
     
     (b) Too few countries.
     - Investors heavily invested in own country.
     - Own country equity: 94% (US), 98% (Japan), 82% (UK)
     - Own area: own local Bells (Huberman, 2001)
(c) Own company
   – In companies offering own stock in 401(k) plan, substantial investment in employer stock

2. **Naive diversification.**
   – Investors tend to distribute wealth ‘equally’ among alternatives in 401(k) plan (Benartzi and Thaler, 2001; Huberman and Jiang, 2005)

3. **Excessive Trading.**
   – Trade too much given transaction costs (Odean, 2001)
4. **Disposition Effect in selling**
   - Investors more likely to sell winners than losers

5. **Attention Effects in buying**
   - Stocks with extreme price or volume movements attract attention (Odean, 2003)

- Should market forces and arbitrage eliminate these phenomena?
• **Arbitrage:**
  – Individuals attempt to maximize individual wealth
  – They take advantage of opportunities for free lunches

• Implications of arbitrage: ‘Strange’ preferences do not affect pricing

• Implication: For prices of assets, no need to worry about behavioral stories

• Is it true?
• Fictitious example:
  – Asset A returns $1 tomorrow with $p = 0.5$
  – Asset B returns $1$ tomorrow with $p = 0.5$

  – Arbitrage $\rightarrow$ Price of A has to equal price of B
  – If $p_A > p_B$,
    * sell A and buy B
    * keep selling and buying until $p_A = p_B$
  – Viceversa if $p_A < p_B$
• Problem: Arbitrage is limited (de Long et al., 1991; Shleifer, 2001)

• In Example: can buy/sell A or B and tomorrow get fundamental value

• In Real world: prices can diverge from fundamental value

• Real world example. Royal Dutch and Shell
  – Companies merged financially in 1907
  – Royal Dutch shares: claim to 60% of total cash flow
  – Shell shares: claim to 40% of total cash flow
  – Shares are nothing but claims to cash flow
  – Price of Royal Dutch should be 60/40=3/2 price of Shell
• $p_{RD}/p_{S}$ differs substantially from 1.5 (Fig. 1)

![Graph showing log deviations from Royal Dutch/Shell parity. Source: Froot and Dabora (1999).]

• Plenty of other example (Palm/3Com)
• What is the problem?
  – Noise trader risk, investors with correlated valuations that diverge from fundamental value
  – (Example: Naive Investors keep persistently bidding down price of Shell)
  – In the long run, convergence to cash-flow value
  – In the short-run, divergence can even increase
  – (Example: Price of Shell may be bid down even more)
• **Noise Traders**

• DeLong, Shleifer, Summers, Waldman (*JPE* 1990)

• Shleifer, *Inefficient Markets*, 2000

• Fundamental question: What happens to prices if:
  – (Limited) arbitrage
  – Some irrational investors with correlated (wrong) beliefs

• First paper on Market Reaction to Biases

• *The* key paper in Behavioral Finance
The model assumptions

A1: Arbitrageurs risk averse and short horizon

→ Justification?

* Short-selling constraints

  (per-period fee if borrowing cash/securities)

* Evaluation of Fund managers.

* Principal-Agent problem for fund managers.
A2: noise traders (Kyle 1985; Black 1986)

misperceive future expected price at \( t \) by

\[
\rho_t \overset{i.i.d.}{\sim} \mathcal{N}(\rho^*, \sigma^2_{\rho})
\]

misperception correlated across noise traders (\( \rho^* \neq 0 \))

\[\rightarrow\] Justification?

* fads and bubbles (Internet stocks, biotechs)
* pseudo-signals (advice broker, financial guru)
* behavioral biases / misperception riskiness
What else?

- $\mu$ noise traders, $(1 - \mu)$ arbitrageurs

- OLG model
  - Period 1: initial endowment, trade
  - Period 2: consumption

- Two assets with identical dividend $r$
  - safe asset: perfectly elastic supply
    $\Rightarrow$ price$=1$ (numeraire)
  - unsafe asset: inelastic supply (1 unit)
    $\Rightarrow$ price?

- Demand for unsafe asset: $\lambda^a$ and $\lambda^n$, with $\lambda^a + \lambda^n = 1$. 
• CARA:

\[ U(w) = -e^{-2(\gamma w)} \text{ (} w \text{ wealth when old)} \]

\[ E[U(w)] = \int_{\infty}^{\infty} -e^{-2\gamma w} \cdot \frac{1}{\sqrt{2\pi\sigma^2}} \cdot e^{-\frac{1}{2\sigma^2}(w-\overline{w})} \]

\[ = -e^{-2\gamma(\overline{w}-\gamma\sigma^2_w)} \]

\[ \max E[U(w)] \quad \overset{\text{pos. mon. transf.}}{\Rightarrow} \quad \max \overline{w} - \gamma\sigma^2_w \]
Arbitrageurs:

$$\max(w_t - \lambda^a_t p_t)(1 + r)$$

$$+ \lambda^a_t (E_t[p_{t+1}] + r)$$

$$- \gamma (\lambda^a_t)^2 Var_t(p_{t+1})$$

Noise traders:

$$\max(w_t - \lambda^n_t p_t)(1 + r)$$

$$+ \lambda^n_t (E_t[p_{t+1}] + \rho_t + r)$$

$$- \gamma (\lambda^n_t)^2 Var_t(p_{t+1})$$

(Note: Noise traders know how to factor the effect of future price volatility into their calculations of values.)
f.o.c.

Arbitrageurs: \( \frac{\partial E[U]}{\partial \lambda^a_t} = 0 \)

\[
\lambda^a_t = \frac{r + E_t[p_{t+1}] - (1 + r)p_t}{2\gamma \cdot Var_t(p_{t+1})}
\]

Noise traders: \( \frac{\partial E[U]}{\partial \lambda^n_t} = 0 \)

\[
\lambda^n_t = \frac{r + E_t[p_{t+1}] - (1 + r)p_t}{2\gamma \cdot Var_t(p_{t+1})} + \frac{\rho_t}{2\gamma \cdot Var_t(p_{t+1})}
\]
Interpretation

- Demand for unsafe asset function of:
  - (+) expected return \((r + E_t[p_{t+1}] - (1 + r)p_t)\)
  - (-) risk aversion \((\gamma)\)
  - (-) variance of return \((Var_t(p_{t+1}))\)
  - (+) overestimation of return \(\rho_t\) (noise traders)

- Notice: noise traders hold more risky asset than arb. if \(\rho > 0\) (and viceversa)

- Notice: Variance of prices come from noise trader risk. “Price when old” depends on uncertain belief of next periods’ noise traders.
Impose general equilibrium: $\lambda^a + \lambda^n = 1$

Price

$$p_t = 1 + \frac{\mu(\rho_t - \rho^*)}{1 + r} + \frac{\mu \rho^*}{r} - \frac{2\gamma \mu^2 \sigma^2}{r(1 + r)^2}$$

- Noise traders affect prices!

Interpretation

- Term 1: Variation in noise trader (mis-)perception
- Term 2: Average misperception of noise traders
- Term 3: Compensation for noise trader risk
- Special case: $\mu = 0$ (no noise traders)
Relative returns of noise traders

- Compare returns to noise traders $R^n$ to returns for arbitrageurs $R_a$:

$$\Delta R = R^n - R^a = (\lambda^n_t - \lambda^a_t) [r + p_{t+1} - p_t (1 + r)]$$

$$E (\Delta R) = \rho^* - \frac{(1 + r)^2 (\rho^*)^2 + (1 + r)^2 \sigma^2}{2\gamma \mu \sigma^2}$$

- Noise traders hold more risky asset if $\rho^* > 0$
- Return of noise traders can be higher if $\rho^* > 0$ (and not too positive)
- Noise traders therefore may outperform arbitrageurs if optimistic!
- (Reason is that they are taking more risk)
Welfare

• Sophisticated investors have higher utility

• Noise traders have lower utility than they expect

• Noise traders may have higher returns (if $\rho^* > 0$)

• Noise traders do not necessarily disappear over time
• Three fundamental assumptions

1. OLG: no last period; short horizon

2. Fixed supply unsafe asset (\(a\) cannot convert safe into unsafe)

3. Noise trader risk systematic

• Noise trader models imply that biases affect asset prices:
  – Reference Dependence
  – Attention
  – Persuasion
• Here:
  – Biased investors
  – Non-biased investors
• Behavioral corporate finance:
  – Investors (biased)
  – CEOs (smart)
• Behavioral Industrial Organization:
  – Consumers (biased)
  – Firms (smart)
6 Next Lecture

- More Market Response to Biases
  - Managers: Corporate Decisions
  - Employers: Contracting
  - Politicians: Political Economy
  - Welfare Response to Biases
- Methodology of Field Psychology and Economics
- Concluding Remarks