Princeton Initiative
Institutional Investors and Asset Pricing

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Traditional asset pricing

- Assume rational expectations and no constraints.
- Portfolio-choice problem for investor i:

$$\max_{\mathbf{w}_i} \mathbb{E}\left[\frac{A_{i,T}^{1-\gamma_i}}{1-\gamma_i}\right]$$

subject to $A_{i,T} = A_i(w_i(0)R(0) + \mathbf{w}_i'\mathbf{R})$.

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1. Optimal portfolio choice:

$$\mathbf{w}_i \approx \frac{1}{\gamma_i}\Sigma^{-1}\mu$$

   - Portfolio separation theorem implies homogeneous demand up to leverage (Tobin 1958).
   - Trivially rejected by data on individual or institutional portfolios.

2. Market clearing implies CAPM:

$$\mu = \mu_M \beta$$

Two literatures

1. Empirical asset pricing (CAPM and multi-factor models): Ignore micro-foundations and test equilibrium implications on price data alone.
2. Asset pricing theory: Break the portfolio separation theorem and introduce heterogeneity in asset demand.
   - Heterogeneous expectations: Work in behavioral finance on over-reaction, under-reaction, and extrapolative expectations.
   - Hedging motives: Uninsurable income or liability risk.
   - Career concerns and herding: Fund managers are evaluated relative to a benchmark.
   - Constraints: Investment mandates (pension funds), regulatory capital (banks and insurance companies), or leverage (hedge funds).
   - Large institutions account for price impact when they trade.

Data on institutional holdings

1. SEC Form 13F: Quarterly U.S. stock holdings of institutions managing over $100m since 1980.
2. Capital IQ or FactSet Ownership: International stock holdings.
3. Thomson Reuters eMAXX: Quarterly bond holdings of institutions (mutual funds and insurance companies) since 2002.
   - Fed: System Open Market Accounts since 2003.
4. Securities Holding Statistics: Comprehensive holdings for the euro area since 2014.
5. Household-level data from Statistics Sweden for 1983–2007.

- Illustration on SEC Form 13F today.
- For details, see "An Equilibrium Model of Institutional Demand and Asset Prices" by Koijen & Yogo.

Questions

1. Have financial markets become more liquid over the last 30 years with the growing importance of institutional investors?
2. How much of the volatility and predictability of asset prices is explained by institutional demand?
3. Do large investment managers amplify volatility? Should they be regulated as SIFI (OFR 2013)?
4. How do large-scale asset purchases affect asset prices through institutional holdings?

New approach to asset pricing

1. A new demand system for financial assets.
    - Model asset demand as a function of characteristics.
    - Matches institutional holdings.
    - Derived from traditional portfolio choice with
        - Heterogenous beliefs.
        - Factor structure in returns.
2. IV estimator to address the endogeneity of institutional demand and asset prices.
3. Asset pricing applications:
    - Estimate the price impact of demand shocks.
    - Explain the role of institutions in volatility and predictability.

Portfolio choice

- Portfolio-choice problem for investor i:

$$\max_{\mathbf{w}_i} \mathbb{E}_i[\log(A_{i,T})]$$

subject to $A_{i,T} = A_i(w_i(0)R(0) + \mathbf{w}_i'\mathbf{R})$.

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1. Euler equation:

$$\mathbb{E}_i\left[\left(\frac{A_{i,T}}{A_i}\right)^{-1}(\mathbf{R} - R(0)\mathbf{1})\right] = \mathbf{0}$$

2. Optimal portfolio choice:

$$\mathbf{w}_i \approx \Sigma_i^{-1}\mu_i$$

- Assumption: Covariance matrix has factor structure, where $\Sigma_i = \Gamma_i \Gamma_i' + \gamma_i \mathbf{I}$ and

$$\mu_i(n) = \mathbf{y}(n)'\Phi_i + \phi_i$$
$$\Gamma_i(n) = \mathbf{y}(n)'\Psi_i + \psi_i$$

- Proposition: Mean-variance portfolio is linear in characteristics:

$$\frac{w_i(n)}{w_i(0)} = 1 + \mathbf{y}(n)'\Pi_i$$

where

$$\Pi_i = \frac{1}{\gamma_i w_i(0)}(\Phi_i - \Psi_i \times \text{const.})$$

Special case of mean-variance portfolio

- Specify vector of characteristics:

$$\mathbf{y}(n) = \begin{bmatrix} \mathbf{x}(n) \\ \log(\epsilon_i(n)) \end{bmatrix}, \Pi_i = \begin{bmatrix} \beta_i \\ 1 \end{bmatrix}$$

- Mean-variance portfolio:

$$\begin{aligned} \frac{w_i(n)}{w_i(0)} &= 1 + \mathbf{y}(n)'\Pi_i \approx \exp\{\mathbf{y}(n)'\Pi_i\} \\ &= \exp\{\mathbf{x}(n)'\beta_i\}\epsilon_i(n) \end{aligned}$$

- Approximation can be made arbitrary precise through polynomial in characteristics.

Three implementations of the mean-variance portfolio

- Estimate mean-variance portfolio among stocks in the S&P 500 index, subject to short-sale constraints.
  1. Benchmark: Unrestricted mean and covariance matrix.
  2. Factor structure: Impose FF 5-factor model on mean and covariance.
  3. Characteristics: Exponential-linear function of characteristics.

Statistic	Benchmark	Factor structure	Characteristics
Mean (%)	1.1	1.6	1.6
Standard deviation (%)	4.5	6.3	6.3
Certainty equivalent (%)	1.0	1.4	1.4
Correlation:			
Factor structure	0.55		
Characteristics	0.52	0.95	

Asset pricing model

- Investor i allocates wealth A_i across assets in the investment universe $\mathcal{N}_i \subseteq \{1, \ldots, N\}$ and an outside asset.
- Investor i's demand for asset $n \in \mathcal{N}_i$:

$$w_i(n) = \frac{\delta_i(n)}{1 + \sum_{m \in \mathcal{N}_i} \delta_i(m)}$$

$$\delta_i(n) = \exp\left\{\beta_{0,i} \mathrm{me}(n) + \sum_{k=1}^{K} \beta_{k,i} x_k(n)\right\} \epsilon_i(n)$$

- Budget constraint implies demand for the outside asset:

$$w_i(0) = \frac{1}{1 + \sum_{m \in \mathcal{N}_i} \delta_i(m)}$$

Asset pricing model

- Characteristics:
  - $x_1(n), \ldots, x_{K-1}(n)$: Log book equity, profitability, investment, dividends...
  - $x_K(n) = 1$: Constant.
  - $\epsilon_i(n)$: Unobserved characteristics.
- For example, an index fund:

$$w_i(n) = \frac{\mathrm{ME}(n)}{\exp\{-\beta_{K,i}\} + \sum_{m \in \mathcal{N}_i} \mathrm{ME}(m)}$$

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- Market clearing:

$$\mathrm{ME}(n) = \sum_{i=1}^{I} A_i w_i(n)$$

- Proposition: Unique equilibrium if demand is downward sloping for all investors (i.e., $\beta_{0,i} < 1$).

Summary of 13F institutions

- SEC Form 13F: Quarterly stock holdings of institutions managing over $100m.
  - Types: Banks, insurance companies, investment advisors, mutual funds, pension funds, other.
  - Household sector.
- Merged with stock prices and characteristics in CRSP-Compustat.
- Big data: 44 million observations.

		% of	Assets under management ($ million)		Number of stocks held		Number of stocks in investment universe	
Period	Number of institutions	market held	Median	90th percentile	Median	90th percentile	Median	90th percentile
1980–1984	544	35	336	2,667	117	382	173	497
1985–1989	781	41	399	3,599	114	448	184	624
1990–1994	980	46	403	4,549	105	507	168	734
1995–1999	1,322	51	464	6,564	101	551	154	839
2000–2004	1,803	57	371	6,082	87	516	143	870
2005–2009	2,446	65	333	5,415	73	458	125	806
2010–2014	2,832	63	325	5,483	67	444	105	683

Empirical specification

- Cross section of investor i's holdings:

$$\frac{w_i(n)}{w_i(0)} = \exp\left\{\beta_{0,i}\mathrm{me}(n) + \sum_{k=1}^{K-1}\beta_{k,i}x_k(n) + \beta_{K,i}\right\}\epsilon_i(n)$$

- Characteristics:
  1. Log book equity.
  2. Profitability.
  3. Investment.
  4. Dividends to book equity.
  5. Market beta.
- Estimate coefficients for each 13F institution and the household sector.

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- Characteristics:
  1. Log book equity.
  2. Profitability.
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  5. Market beta.
- Estimate coefficients for each 13F institution and the household sector.
- Traditional assumption in endowment economies:

$$\mathbb{E}[\epsilon_i(n)|\mathrm{me}(n), \mathbf{x}(n)] = 1$$

  1. Investor is atomistic.
  2. Latent demand is uncorrelated across investors.

IV Estimator

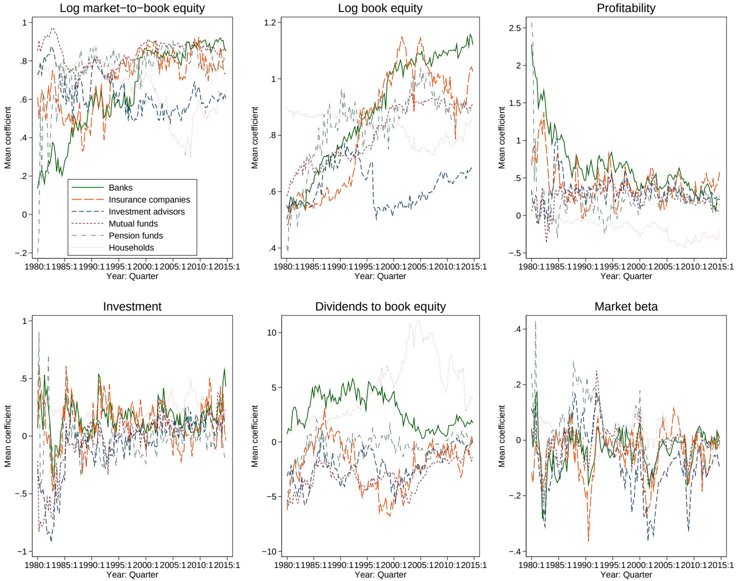
$$\frac{w_i(n)}{w_i(0)} = \begin{cases} \mathbb{1}_i(n) \exp\left\{\beta_{0,i}\mathrm{me}(n) + \sum_{k=1}^{K} \beta_{k,i} x_k(n)\right\} \epsilon_i(n) & \text{if } n \in \mathcal{N}_i \\ \mathbb{1}_i(n) = 0 & \text{if } n \notin \mathcal{N}_i \end{cases}$$

- Investors may not hold an asset for two reasons.
  1. $\epsilon_i(n) = 0$: Chooses not to hold an asset.
  2. $\mathbb{1}_i(n) = 0$: Cannot hold an asset outside the investment universe. (e.g., S&P 500 index fund has $\mathbb{1}_i(n) = 0$ for stocks outside the index).
- Assumption: Investment universe is exogenous.
- Valid instrument:

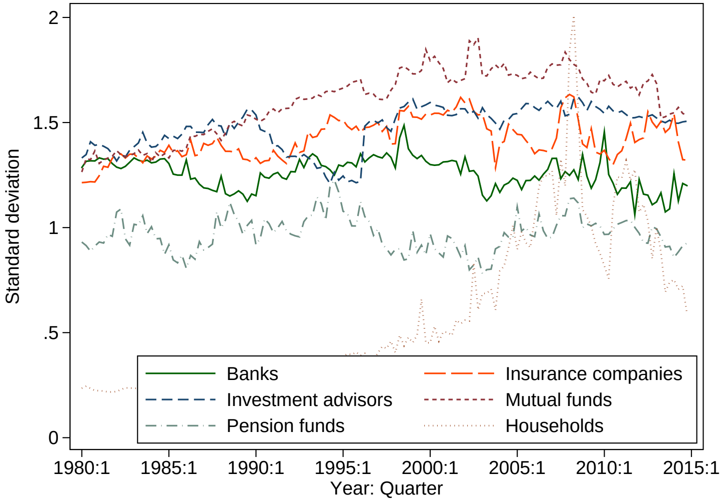
$$\widehat{\mathrm{me}}_i(n) = \log\left(\sum_{j \neq i} A_j \frac{\mathbb{1}_j(n)}{1 + \sum_{m=1}^{N} \mathbb{1}_j(m)}\right)$$

- Moment condition: $\mathbb{E}[\epsilon_i(n) | \widehat{\mathrm{me}}_i(n), \mathbf{x}(n)] = 1$

Coefficients on characteristics

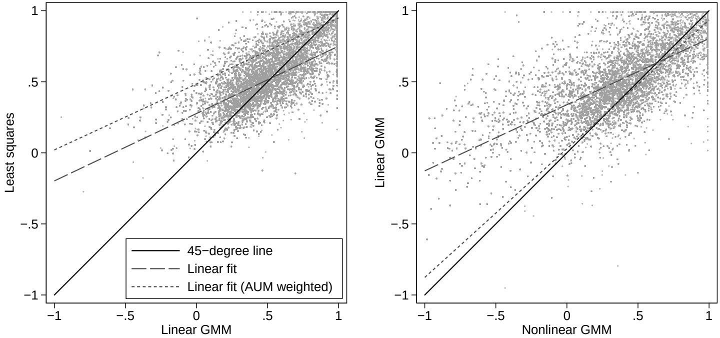


Standard deviation of latent demand



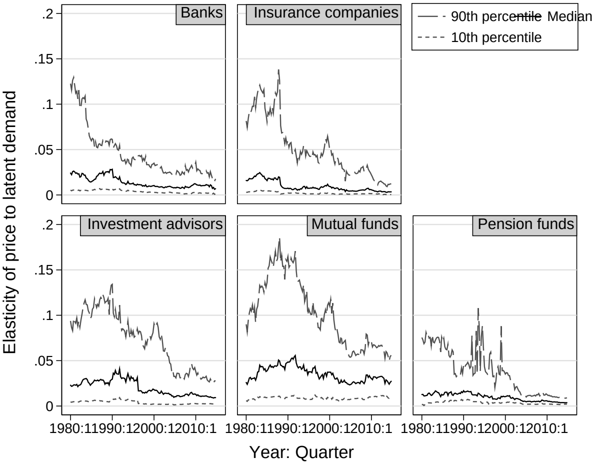
Comparison of the coefficients on log market equity

- Left: Least squares is upward biased.
- Right: Linear GMM (i.e., estimating in logs) is upward biased for smaller institutions.



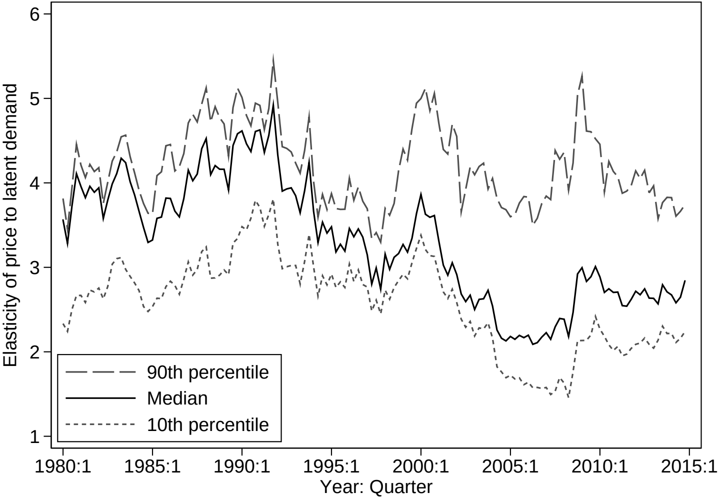
Price impact across stocks and institutions

- Price impact as a liquidity measure (Kyle 1985).
- Price impact for each investor i: $\partial p(n) / \partial \log(\epsilon_i(n))$.



Aggregate price impact across stocks

- Aggregate price impact: $\sum_{i=1}^{I} \partial p(n) / \partial \log(\epsilon_i(n))$.



Variance decomposition of stock returns

- Start with definition of log return:

$$r_{t+1}(n) = p_{t+1}(n) - p_t(n) + \log\left(1 + \frac{D_{t+1}(n)}{P_{t+1}(n)}\right)$$

- Model implies that

$$\mathbf{p}_t = g(\mathbf{s}_t, \mathbf{x}_t, \mathbf{A}_t, \beta_t, \epsilon_t)$$

1. $\mathbf{s}_t$: Shares outstanding.
2. $\mathbf{x}_t$: Asset characteristics.
3. $\mathbf{A}_t$: Assets under management.
4. β_t: Coefficients on characteristics.
5. ϵ_t: Latent demand.

Variance decomposition of stock returns

	% of variance
Supply:	
Shares outstanding	1.4
	(0.2)
Stock characteristics	6.1
	(0.3)
Dividend yield	0.4
	(0.0)
Demand:	
Assets under management	28.6
	(0.3)
Coefficients on characteristics	4.7
	(0.2)
Latent demand	58.8
	(0.4)
Observations	125,320

Variance decomposition of stock returns in 2008

- Are large investment managers systemic (OFR 2013)?

AUM ranking	Institution	AUM ($ billion)	Change in AUM (%)	% of variance	
	Supply: Shares outstanding, stock characteristics & dividend yield			5.0	(0.9)
1	Barclays Bank	699	-41	0.5	(0.1)
2	Fidelity Management & Research Co.	577	-63	1.4	(0.2)
3	State Street Corp.	547	-37	0.4	(0.1)
4	Vanguard Group	486	-41	0.5	(0.0)
5	AXA Financial	309	-70	0.4	(0.1)
6	Capital World Investors	309	-44	0.5	(0.2)
7	Wellington Management Co.	272	-51	0.4	(0.1)
8	Capital Research Global Investors	270	-53	0.1	(0.1)
9	T. Rowe Price Associates	233	-44	-0.2	(0.1)
10	Goldman Sachs & Co.	182	-59	0.1	(0.1)
	Subtotal: Largest 25 institutions	5,684	-47	5.5	
	Smaller institutions	6,493	-53	41.9	(2.6)
	Households	6,321	-47	47.6	(3.0)
	Total	18,499	-49	100.0	

Predictability of stock returns

- Recall that

$$\mathbf{p}_T = g(\mathbf{s}_T, \mathbf{x}_T, \mathbf{A}_T, \beta_T, \epsilon_T)$$

- Model ϵ_T as mean reverting and everything else as random walk.
- First-order approximation of expected long-run capital gain:

$$\begin{aligned}\mathbb{E}_t[\mathbf{p}_T - \mathbf{p}_t] \approx & g(\mathbb{E}_t[\mathbf{s}_T], \mathbb{E}_t[\mathbf{x}_T], \mathbb{E}_t[\mathbf{A}_T], \mathbb{E}_t[\beta_T], \mathbb{E}_t[\epsilon_T]) - \mathbf{p}_t \\ = & g(\mathbf{s}_t, \mathbf{x}_t, \mathbf{A}_t, \beta_t, \mathbf{1}) - \mathbf{p}_t\end{aligned}$$

- Intuition: Assets with high latent demand are expensive and have low expected returns.

Relation between stock returns and characteristics

Characteristic	All stocks	Excluding microcaps
Expected return	0.24	0.14
	(0.04)	(0.04)
Log market equity	-0.25	-0.17
	(0.08)	(0.08)
Book-to-market equity	0.01	0.07
	(0.04)	(0.06)
Profitability	0.31	0.27
	(0.05)	(0.06)
Investment	-0.36	-0.20
	(0.03)	(0.03)
Market beta	0.11	0.02
	(0.09)	(0.10)
Momentum	0.26	0.36
	(0.09)	(0.10)

Extensions and open issues

1. Endogenize supply (i.e., shares outstanding and characteristics) through the firm's problem.
2. Endogenize flows into institutions through the household's problem.
3. Data issues:
    - Data on aggregate short interest for NYSE, AMEX, and Nasdaq stocks.
    - Household sector is residual, but more detailed data for Sweden.
    - Linking stock and bond holdings data.
    - Fund-level data for mutual funds.

Conclusion

- Asset pricing model that matches institutional holdings.
  1. Rich heterogeneity in asset demand.
  2. Endogeneity of institutional demand and asset prices.
- Could answer questions that are difficult with reduced-form regressions or event studies.
- Additional questions:
  1. Which institutions drive anomalies?
  2. How does QE affect financial markets?
  3. How would regulatory reform (banks and insurance companies) affect asset prices and real investment?