

Advanced Asset Pricing: Lecture 1

INTRODUCTION: REVIEW OF EMPIRICAL FACTS AND MODELING FRAMEWORKS

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Outline

Review & Overview of AP 101

Zooming Out: Recent History of AP

Overview

Empirical facts

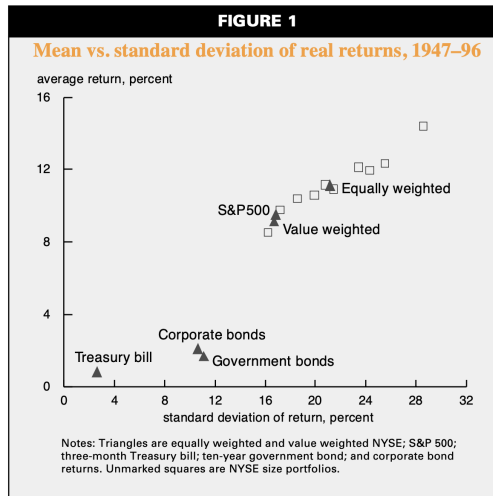
[prices, returns, covariances, ...]



Theory

[preferences, beliefs, institutions, heterogeneity, portfolio construction, ...]

Empirical Review: Average Returns



- ▶ Orderly (and remarkably consistent, incl. post-'96) relationship between σ and $E[R]$
- ▶ *Relative* returns make sense across assets, but do *absolute* returns?
- ▶ How steep should slope be?
- ▶ Can we make sense of $E[R_{\text{equity}} - R_f] \approx 7\%$?

Source: Cochrane (*Econ. Perspectives*, 1997)

Empirical Review: Equity Premium

Table 6.2. *The Equity Premium Puzzle*

Country	Sample period	$\overline{aer_e}$	$\sigma(er_e)$	$\sigma(m)$	$\sigma(\Delta c)$	$\rho(er_e, \Delta c)$	RRA(1)	RRA(2)
USA	1947Q2–2011Q2	7.39	15.86	46.57	1.64	0.18	154.98	28.42
Australia	1970Q1–2011Q2	3.95	20.58	19.21	1.77	−0.11	<0	10.89
Canada	1970Q1–2011Q2	5.01	17.93	27.94	1.93	0.09	166.97	14.51
France	1973Q2–2011Q2	7.68	23.22	33.06	1.80	0.00	<0	18.34
Germany	1978Q4–2011Q2	8.03	23.94	33.54	4.19	−0.01	<0	8.01
Italy	1971Q2–2011Q2	2.96	25.71	11.51	2.23	0.08	66.96	5.15
Japan	1970Q2–2011Q2	3.95	21.33	18.49	2.92	0.05	118.09	6.32
Netherlands	1977Q2–2011Q2	8.22	19.70	41.72	2.21	0.13	141.29	18.90
Sweden	1970Q1–2011Q2	10.44	25.28	41.32	1.81	0.07	314.53	22.87
Switzerland	1982Q2–2011Q2	9.27	20.01	46.33	1.30	0.07	483.74	35.60
UK	1970Q1–2011Q2	6.99	19.96	35.00	2.68	−0.04	<0	13.07

Source: Campbell (2018)

- ▶ ~7% equity premium holds going back to 1870
- ▶ Smaller (~2.5%) pre-Industrial Revolution in Netherlands & UK (Golez and Koudijs, 2018)

Theory Review: Basics

Pricing Equation

For payoff X , gross return $R = X/P$, stochastic discount factor M :

$$P = E[MX], \quad \text{or} \quad E[MR] = 1 \quad (\star)$$

► **Rep. agent case:**

$$\begin{aligned} \text{Euler equation (FOC):} \quad P_t &= E_t \left[\beta \frac{U'(C_{t+1})}{U'(C_t)} X_{t+1} \right] \\ \Rightarrow M_{t+1} &= \beta \frac{U'(C_{t+1})}{U'(C_t)} \end{aligned} \quad (\dagger)$$

- But (\star) **does not require** rep. agent (or complete markets, or distributional assumptions, ...)
- Holds under law of one price ($P_{A+B} = P_A + P_B$); no arbitrage implies $M > 0$
 - Complete markets \Rightarrow unique M
 - (\dagger) also works as SDF for any unconstrained individual agent

Theory Review: Basics

Pricing Equation

For payoff X , gross return $R = X/P$, stochastic discount factor M :

$$P = E[MX], \quad \text{or} \quad E[MR] = 1 \quad (\star)$$

Implications:

1. $R_f = 1/E[M]$
2. For any asset i , $E[R_i - R_f] = -R_f \text{Cov}(M, R_i)$ (low payoffs in bad states \Rightarrow high ER)
 $= -R_f \sigma_M \sigma_i \rho_{M,i}$
3. Simple Hansen-Jagannathan bound: $\left| \frac{E[R_i - R_f]}{\sigma_i} \right| \leq \frac{\sigma_M}{E[M]}$

Back to the Equity Premium Puzzle

$$0.5 \approx \frac{E[R_{eq} - R_f]}{\sigma_{eq}} = -R_f \sigma_M \rho_{M,eq}$$

Rep. agent, CRRA: $\approx \gamma \sigma_c \rho_{c,eq} = \gamma \times 0.0164 \times 0.18$ (1)

$$\leq \gamma \sigma_c = \gamma \times 0.0164$$
 (2)

Country	Sample period	$\overline{aer_e}$	$\sigma(er_e)$	$\sigma(m)$	$\sigma(\Delta c)$	$\rho(er_e, \Delta c)$	RRA(1)	RRA(2)
USA	1947Q2–2011Q2	7.39	15.86	46.57	1.64	0.18	154.98	28.42

Source: Campbell (2018)

Back to the Equity Premium Puzzle

More general version:

$$0.5 \approx \frac{E[R_{eq} - R_f]}{\sigma_{eq}} \leq \frac{\sigma_M}{E[M]}$$

- ▶ $R_f = 1/E[M]$ implies $E[M] \approx 1$
- ▶ Since $M > 0$, H-J bound is restrictive: M is within 2 standard deviations of its lower bound
 - ▶ Any model that explains the equity premium has to have a volatile SDF
 - ▶ Could come from high effective risk aversion (habit formation), big tail risks that generate high marginal utility (rare disasters, long-run risks), big uninsured risks to cross-sectional distribution, trading frictions, ...

Theory Review: Discount-Rate Variation

Cochrane (2011)

“Previously [40 years ago], we thought returns were unpredictable, with variation in price-dividend ratios due to variation in expected cash flows. Now it seems all price-dividend variation corresponds to discount-rate variation.”

- ▶ Why? Consider unpredictable returns world: $\bar{R} \equiv E_t[R_{t+1}] = R_f + \text{constant risk premium}$
- ▶ Gives dividend discount model: $P_t = \frac{E_t[D_{t+1} + P_{t+1}]}{\bar{R}} = \dots = \sum_{j=1}^{\infty} \frac{E_t[D_{t+j}]}{\bar{R}^j}$ (no bubbles)
 - ▶ Aside: What happened to $P_t = E_t[M_{t+1}X_{t+1}] = E_t[M_{t+1}(D_{t+1} + P_{t+1})]$?
 - ▶ Nothing! Can always write $E_t[R_{t+1}] = R_{f,t+1}(1 - \text{Cov}_t(M_{t+1}, R_{t+1}))$ as before, then substitute
 - ▶ $E_t[R_{t+1}]$ will be asset-specific (thus representation at top is useful for thinking about asset-specific ERs), whereas M_{t+1} works for all traded assets

Theory Review: Discount-Rate Variation

Cochrane (2011)

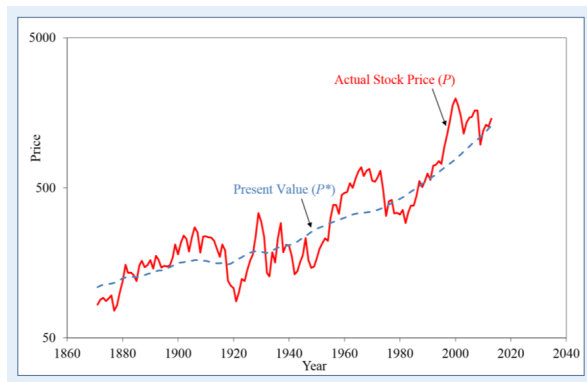
“Previously [40 years ago], we thought returns were unpredictable, with variation in price-dividend ratios due to variation in expected cash flows. Now it seems all price-dividend variation corresponds to discount-rate variation.”

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- ▶ Gives dividend discount model: $P_t = \frac{E_t[D_{t+1} + P_{t+1}]}{\bar{R}} = \dots = \sum_{j=1}^{\infty} \frac{E_t[D_{t+j}]}{\bar{R}^j}$ (no bubbles)
- ▶ Ex-post fundamental value is $P_t^* = \sum_{j=1}^{\infty} \frac{D_{t+j}}{\bar{R}^j}$ (using realized dividends)
- ▶ Since $P_t + \text{error} = P_t^*$, we should see P_t be less volatile than P_t^*

Empirical Review: Excess Volatility and Discount-Rate Variation

$$P_t = \sum_{j=1}^{\infty} \frac{E_t[D_{t+j}]}{\bar{R}^j}, \quad P_t^* = \sum_{j=1}^{\infty} \frac{D_{t+j}}{\bar{R}^j}, \quad P_t + \text{error} = P_t^*$$

$\Rightarrow P_t$ should be less volatile than P_t^* . **It's not!**



Source: Shiller (1981) using real S&P 500 prices, updated in Shiller (2015)

Empirical Review: Excess Volatility and Discount-Rate Variation

$$P_t = \sum_{j=1}^{\infty} \frac{E_t[D_{t+j}]}{\bar{R}^j}, \quad P_t^* = \sum_{j=1}^{\infty} \frac{D_{t+j}}{\bar{R}^j}, \quad P_t + \text{error} = P_t^*$$

$\Rightarrow P_t$ should be less volatile than P_t^* . **It's not!**

- Discount rates (expected returns) in P_t equation must be time-varying to make sense of variation in P_t , given the smoothness in dividend growth (and P_t^*)

Empirical Review: Predictable Discount-Rate Variation

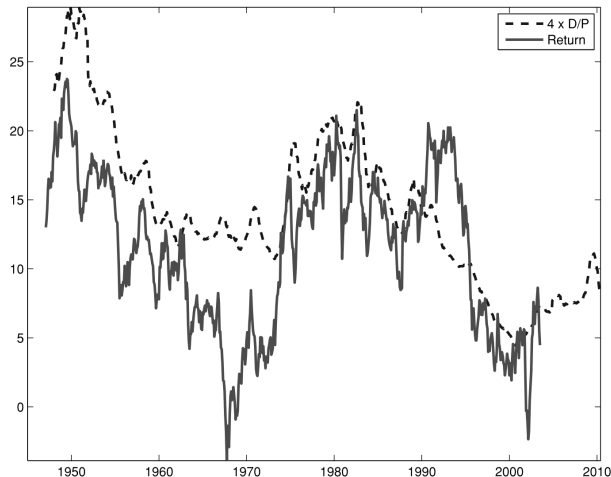


Figure 1. Dividend yield and following 7-year return. The dividend yield is multiplied by four. Both series use the CRSP value-weighted market index.

Source: Cochrane (2011)

- ▶ $P_t = \sum_{j=1}^{\infty} \frac{E_t[D_{t+j}]}{E_t[R_{t \rightarrow t+j}]}$ implies
$$\frac{P_t}{D_t} = \sum_{j=1}^{\infty} \frac{E_t[\prod_{\tau=t+1}^j G_{\tau}]}{E_t[R_{t \rightarrow t+j}]}, G_{t+1} \equiv \frac{D_{t+1}}{D_t}$$
- ▶ With ~unpredictable div. growth, high P/D (low D/P) should predict low returns. Chart shows it does!

Theory Review: Linear PV Approximation with Variable Discount Rates

Campbell-Shiller Decomposition

Assuming stationarity, the following first-order approximation holds for the log price-dividend ratio (lower case \Leftrightarrow log):

$$p_t - d_t = \text{constant} + \sum_{j=1}^{\infty} \rho^j (\Delta d_{t+j} - r_{t+j}),$$

$$\rho = \frac{1}{1 + \exp(\overline{d-p})} \approx \frac{\overline{P/D}}{1 + \overline{P/D}} \approx 0.96$$

Notes:

1. Lack of expectation isn't a typo: approx. ex-post accounting identity (and in expectation too)
2. Under stationarity, higher valuation (lower dividend yield) should forecast some combination of higher dividend growth & lower returns
 - ▶ Equities: $p_t - d_t$ weakly predicts cash-flow growth, but predicts returns moderately well at some horizons (prev. slide)
3. Previous point applies across asset classes (next slide, via Cochrane (2011))

Review: Linear PV Approximation with Variable Discount Rates

Campbell-Shiller Decomposition

First-order approximation for any stationary log valuation ratio ($f \Leftrightarrow$ fundamental):

$$p_t - f_t = \text{constant} + \sum_{j=1}^{\infty} \rho^j (\Delta f_{t+j} - r_{t+j})$$

► A pervasive phenomenon:

1. Stocks. DP \rightarrow Return, not dividend growth
2. Treasuries. Yield \rightarrow Return, not rising rates
3. Bonds/CDS. Yield \rightarrow Return, not default
4. Foreign Exchange. Interest spread \rightarrow Return, not devaluation
5. Sovereign Debt, Foreign Assets. \rightarrow Return, not repayment, exports
6. Houses. Price/Rent \rightarrow Return, not rent growth.

[Slide pulled from Cochrane (2011) talk; figure from corresponding paper.]

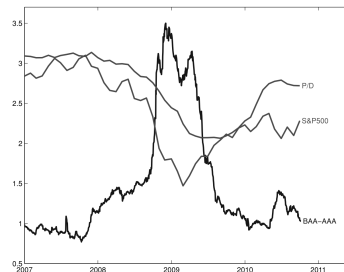


Figure 12. Common Risk Premiums. P/D is the S&P500 price-dividend ratio from CRSP. S&P500 is the level of the S&P500 index from CRSP. BAA-AAA is that bond spread, from the Board of Governors. P/D is divided by 15 and the S&P500 is divided by 500 to fit on the same scale.

Review: Implications of Time-Series Predictability

- ▶ Already know from equity premium that SDF must be volatile...
- ▶ What do we learn from price volatility and return predictability patterns?

$$E_t[R_{i,t+1} - R_{f,t+1}] = -R_{f,t+1} \underbrace{\text{Cov}_t(M_{t+1}, R_{i,t+1})}_{\text{must be appropriately time-varying}}$$

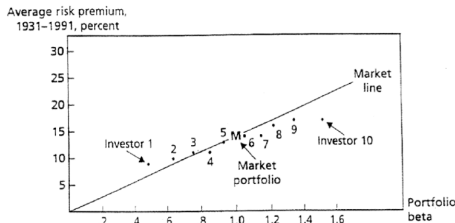
Since $\text{Cov}_t(M_{t+1}, R_{i,t+1}) = \sigma_{M,t} \sigma_{i,t} \rho_{M,i,t}$, we could have:

1. Heteroskedastic SDF: $\sigma_{M,t}$ higher in bad times (e.g., habit formation gives higher γ_t in bad times; think about how this works for variable rare disasters, long-run risks, or het. agents models)
2. Heteroskedastic returns
3. Time-varying $\rho_{M,i,t}$ (e.g., extrapolative belief models: more severe probability distortions for crash states before recessions, and M_{t+1} = state-specific probability distortion \times IMRS)

Why? Take agent w/ incorrect state probs.: $P_t = E_t^{\text{agent}}[(\beta U'_{t+1}(s) / U'_t(s)) X_{t+1}(s)] = E_t^{\text{true}}[\underbrace{(\pi^{\text{agent}}(s) / \pi(s)) (\beta U'_{t+1}(s) / U'_t(s))}_{M_{t+1}} X_{t+1}(s)]$

Empirical Review: Returns in the Cross-Section

- ▶ Have reviewed time-series patterns across asset classes
- ▶ What about cross-sectional patterns?
- ▶ Starting point: CAPM $\Rightarrow E[R_i - R_f] = \beta_i E[R_m - R_f]$ (intercept α should be 0)



Source: Black (1993), using beta-sorted portfolios

- ▶ SML is too flat, but looks ok if you squint (or assume different risk-free rate)
- ▶ But complete chaos as soon as you sort on other characteristics

Empirical Review: Returns in the Cross-Section

- ▶ Starting point: CAPM $\Rightarrow E[R_i - R_f] = \beta_i E[R_m - R_f]$
 - ▶ Complete chaos as soon as you sort on other characteristics. **Value** (sorting on firm book-to-market ratio: 1 is low BTM, i.e. growth; 5 is high BTM, i.e. value) first, then adding size:

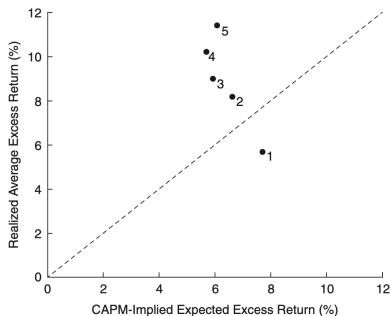
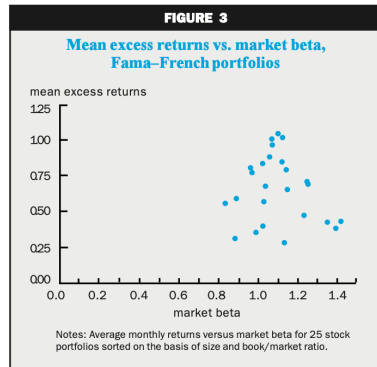


Figure 3.6. The CAPM and the Value Effect

Source: Campbell (2018)



Source: Cochrane (1999)

Empirical Review: Returns in the Cross-Section

- ▶ Starting point: CAPM $\Rightarrow E[R_i - R_f] = \beta_i E[R_m - R_f]$
 - ▶ Complete chaos as soon as you sort on other characteristics. **Order restored with FF3 (1993) factor model...**

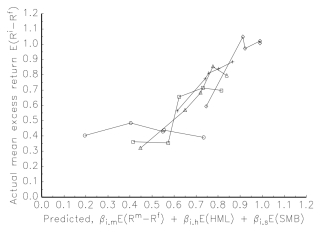


Figure 48. Average excess return vs. prediction of the Fama-French 3 factor model. Lines connect portfolios of different size categories within book to market category.

Source: Cochrane (2005)

- ▶ ... But only temporarily, as new anomalies and factor models have proliferated since then

Theory Review: Returns in the Cross-Section

- ▶ Why are factor models (CAPM, FF3, ...) a reasonable place to start?
- ▶ Recall:

$$\begin{aligned} E[R_i - R_f] &= -R_f \text{Cov}(M, R_i) \\ &= \underbrace{\beta_{i,M}}_{\frac{\text{Cov}(M, R_i)}{\text{Var}(M)}} \times \underbrace{\lambda_M}_{-R_f \text{Var}(M)} \end{aligned}$$

- ▶ Single-factor structure for returns; all that matters is exposure to SDF
- ▶ This would be directly implementable if we knew M , but we don't; have to look for candidates
- ▶ Factor model for SDF: $M_{t+1} = a_t + \sum_{k=1}^K b_{kt} f_{k,t+1}$, with f_k observable, mean-zero, mutually orthogonal. Then above becomes

$$E_t[R_i - R_f] = \sum_{k=1}^K \underbrace{\beta_{ikt}}_{\sigma_{ikt}/\sigma_{kt}^2} \times \underbrace{\lambda_{kt}}_{b_{kt}\sigma_{kt}^2/a_t}$$

- ▶ Approx. factor model for *realized returns*: Also get $E[R_i - R_f] \approx \beta' \lambda$ (Arbitrage Pricing Theory)

Preliminary Takeaways

- ▶ $E[MR] = 1$ is so general (& requires so little structure) that it's not itself a theory; instead, provides starting framework for understanding the relationship between model and data
 - ▶ Not the only possible framework to start from! You'll see others in this course
- ▶ Content comes from assumptions of any particular model (which can be translated into assumptions on M & R)
 - (a) And whether the model illuminates something about the data we see (or vice versa, if observed data implies restrictions on underlying economic structure) ["positive" AP]
 - (b) Or is helpful in understanding policy or optimal portfolio choice ["normative" AP]
- ▶ We'll cover theory and tools for estimation

Outline

Review & Overview of AP 101

Zooming Out: Recent History of AP

Zooming out: time series overview of the field: 2000-2010

- ▶ 2000 - **Hans Stoll** (1083): Friction
- ▶ 2001 - **Franklin Allen** (431): Do financial institutions matter?
- ▶ 2002 - **George Constantinides** (211): Rational asset prices
- ▶ 2003 - **Maureen O'Hara** (961): Liquidity and Price Discovery
- ▶ 2004 - Doug Diamond (319): Committing to commit: short-term debt when enforcement is costly
- ▶ 2005 - Rene Stulz (1399): The limits of financial globalization
- ▶ 2006 - **John Campbell** (3439) - Household finance
- ▶ 2007 - **Richard Green** (67): Issuers, underwriter syndicates, and aftermarket transparency
- ▶ 2008 - **Ken French** (1088): The cost of active investing
- ▶ 2009 - **Jeremy Stein** (433): Sophisticated investors and market efficiency
- ▶ 2010 - **Darrell Duffie** (875): Asset price dynamics with slow-moving capital

Zooming out: time series overview of the field: 2011-2022

- ▶ 2011 - **John Cochrane** 2011 (2048): Discount rates
- ▶ 2012 - Raghuram Rajan (161): The Corporation in Finance
- ▶ 2013 - **Sheridan Titman** (32): Financial markets and investment externalities
- ▶ 2014 - **Robert Stambaugh** (186): Investment noise and trends
- ▶ 2015 - Luigi Zingales (503): Does finance benefit society?
- ▶ 2016 - Patrick Bolton 2016 (31): Debt and money: financial constraints and sovereign finance
- ▶ 2017 - Campbell Harvey (351): Scientific outlook in financial economics
- ▶ 2018 - **David Scharfstein** 2018 (43): Pension policy and the financial system
- ▶ 2019 - Pete Demarzo 2019 (54): Collateral and commitment
- ▶ 2020 - David Hirshleifer (115): Social transmission bias in economics and finance
- ▶ 2021 - **Kenneth Singleton** (9): How much "Rationality" is there in bond-market risk premiums?
- ▶ 2022 - John Graham (11): Corporate finance and reality

Allen 2001: Do financial institutions matter?

- ▶ Institutions invest on behalf of households, yet the institution is a “veil”
But corporate finance has agency problems in their core
- ▶ 1950: 90% of U.S. equities held by individuals
⇒ now, closer to 30% (Kojien Yogo 2019)
- ▶ This helps to explain bubbles (eg., Palace Grounds in Tokyo reached value of entirety of Canada in 1989!)!
- ▶ Also, financial institutions provide liquidity ⇒ can cause financial fragility and contagion



O'Hara 2003: Liquidity and price discovery

- ▶ **Q:** What's the implication of market microstructure for asset pricing?
- ▶ Markets impact asset prices through two functions (1) Liquidity; and (2) Price discovery
- ▶ “The CAPM, the APT, and consumption-based CAPM all assume symmetric information”.
- ▶ Here, information is not symmetric, and equilibrium outcomes may not be revealing (that is, prices do not reveal all information)
- ▶ So, if there are informed traders, why would uninformed traders trade against them? The solution is usually noise traders. BUT, “why are they so stupid?”
- ▶ Uninformed traders choose assets that have lower risk of losing to informed participants \Rightarrow lower “information risk”
- ▶ Traders demand compensation to hold assets with high uncertainty (risk) around information:
 \Rightarrow so, in equilibrium, assets with private information require higher returns

Green 2007: Issuers, underwriter syndicates, and aftermarket transparency

- ▶ **Q.** How does imperfect competition in financial markets affect firms?
- ▶ Highlights the agency and competitive issues in primary markets
- ▶ Secondary markets are not perfectly competitive:
 1. Institutional investors are infinitely elastic
 2. Retail investors face costs to learn \Rightarrow price dispersion
- ▶ How does this affect firms?
 1. Firms hire underwriters to help issue securities
 2. Underwriters have limited capacity to sell to retail investors
 3. So, they underprice securities
 4. And issuers don't do anything about it!

Stein 2009: Sophisticated investors and market efficiency

- ▶ **Q.** As the market becomes more sophisticated, will efficiency increase?
- ▶ Simple economic reasoning would say yes
- ▶ But, no! Why?
 - ⇒ arbitraguers inflict negative externalities on each other
 1. Crowded-trade effect: each arbitraguer does not know who else is trading the same way at the same time ⇒ coordination problem
 2. Leverage decision: suppose many arbitraguers are levered up on the same security for the same trade; an orthogonal negative shock on one trader would lead to a round of liquidations
- ▶ Importantly, his model of the world has infinitely capitalized arbitraguers with rational expectations and optimized ex-ante leverage decisions.
- ▶ Makes a case for policy
- ▶ Inspired by a real event: “Quant meltdown” of August 2007

Duffie 2010: Asset price dynamics with slow-moving capital

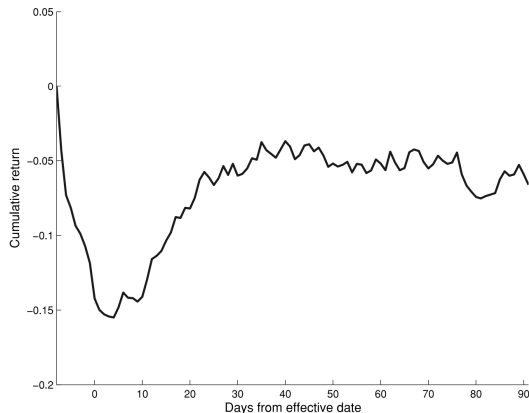


Figure 1. Average cumulative returns for deleted S&P 500 stocks, 1990-2001. The average number of days between the announcement and effective deletion dates is 7.56. The passage of time from announcement to deletion for each equity is re-scaled to 8 days before averaging the cumulative returns during this period across the equities. The original data provided by Jeremy Graveline were augmented by Haoxiang Zhu.

- ▶ **Q.** How does the slow movement of investment capital affect asset price dynamics?
- ▶ Capital can move slowly \Rightarrow a demand or supply shock hits a relatively small subset of capital first, and is absorbed slowly over time
- ▶ This immediate price impact can reflect:
 1. Attention costs to trade
 2. Institutional restrictions to moving capital around

Titman 2013: Financial markets and investment externalities

- ▶ Q. What's the link between asset returns and the economy?
- ▶ Some macro finance facts:
 1. Changes in aggregate stock prices predict future stock returns, *not* future dividend growth (Cochrane 2011)
 2. Firms invest more after positive stock returns
 3. Stock returns \iff GDP growth
 4. Wider credit spreads \implies economic activity decline (Gilchrist Zakrejsek 2012)
- ▶ What causes what?
 - ▶ Traditionally, cash flows \implies prices
 - ▶ Recently, financial market activity \implies economic activity.

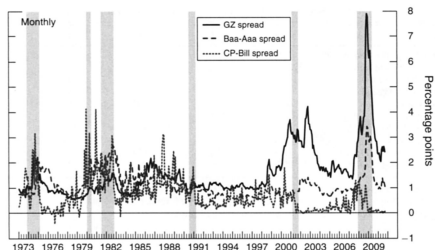


FIGURE 1. SELECTED CORPORATE CREDIT SPREADS

Notes: Sample period: 1973:1–2010:9. The figure depicts the following credit spreads: GZ spread = the average credit spread on senior unsecured bonds issued by nonfinancial firms in our sample (the solid line); Baa–Aaa = the spread between yields on Baa- and Aaa-rated long-term industrial corporate bonds (the dashed line); and CP–Bill = the spread between the yield on one-month A1/P1 nonfinancial commercial paper and the one-month Treasury yield (the dotted line). The shaded vertical bars represent the NBER-dated recessions.

Source: Gilchrist and Zakrejsek (2012)

Looking ahead

- ▶ We'll touch on many of these topics in the coming months
- ▶ It may not seem like it, but the course is a history lesson
- ▶ The goal is to get a solid grasp of the history so you can build on it