Lecture 2:
Market Efficiency and the CAPM

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Outline

- Efficient Markets
- CAPM
- Event Studies
- Fama – French 1992

Efficient Markets

Definition of Market Efficiency

- Market efficiency in its most basic form is the simple statement that:

  "The market correctly uses all information available to it to set prices."

- This is really two different statements:

  1. The market is aware of all available information.
  2. The market uses that information to set prices

Notions of Market Efficiency

- Classical notions of market efficiency were laid out by Fama (1970):
  - Weak Form: Can't predict returns using historical prices.
  - Semi-Strong: Can't predict returns using all publicly available information.
  - Strong: Can't predict returns using private information.

Tests of Market Efficiency

- Tests of market efficiency are concerned with whether or not the market does correctly use available information in setting security prices.
- Most common are tests of whether some subset of that information is fully reflected in prices
  - Do current security prices fully reflect any and all information in past prices and returns?
  - Studies of the adjustment of stock prices to information in:
    - Stock Splits
    - M&A Announcements
    - Dividend Announcements
    - Earnings Announcements
    - Spin-Offs
    - New Issues
    - Debt Issuances
    - Tone of Earnings Reports
    - Auditor Changes
  - Are there individual or groups (e.g. hedge fund managers) who earn reliably higher returns than other groups of investors?

Tests of Market Efficiency

- Tests of market efficiency don't say one can't "beat the market". Rather, they say one can't earn "*excess returns*" above and beyond any risks one is incurring.
- If you believe there is a positive relationship between risk and return then any manager who takes on out-sized risk should earn out-sized return.
- So market efficiency is really a statement that no one can earn "excess returns" (or "excess risk adjusted returns").
- Define what is "excess"? Define "risk adjusted"?
- Well to do that you need a model of how returns are determined. Actually, the model that the market is using.
    - We call this the "model of market equilibrium".

Two Important "Wrinkles"

- So to test whether the market is efficient, you need to specify some model of how returns are being determined to understand if the returns that are earned are *excess returns.*
  - Again, you need to specify the "model of market equilibrium" when you test if you test if markets are efficient (or if you have found some great trading strategy)

THIS IS THE CATCH IN TESTS OF MARKET EFFICIENCY:

Any test of market of efficiency is simultaneously a joint test of market efficiency and the model of market equilibrium.

Any time you reject the notion that markets are efficient, you face the problem of knowing whether this reflects a true violation of market efficiency or a poor (wrong) model market equilibrium!

Two Important Wrinkles

- If you believe there is a positive relationship between risk and return then any manager who takes on out-sized risk should earn out-sized return.
- So maybe a manager who is earning large returns is loading up on some "risk" that will come back to haunt them (e.g. "picking up pennies in front of a steam roller").
- Examples of bad models of market equilibrium:
  - Expected returns are constant across time $E(R_{i,t}) = E(R_i)$
    - Are returns really constant throughout the business cycle?
  - Expected returns are the same for all stocks $E(R_{i,t}) = E(R_t)$
    - Are you expectations for an Emerging Market small cap stocks really the same as for a large S&P 500 stock?
- Tests that find "market inefficiencies" (or "profitable trading strategies") may not be inefficiencies but not correctly specifying risk – the model of market equilibrium

Near-Efficient Markets

- Modern notion of market efficiency is due to Grossman and Stiglitz (1980)
  - Conundrum: Can a market be efficient in the strong form? Suppose it is costly to collect information and to trade based on it.
    - If all information is in the price, why ever invest in gathering the information?
    - But if no one invests in gathering the information, how would the information get to be reflected in the price?
  - "Near efficient" markets
- Active managers search for pockets of inefficiency. Whether they actually add value is a question we will revisit.

Efficient Markets and (Too Much?) Information

- The key to Market Efficiency is that markets assess all relevant information correctly in setting prices.
- Question:
  - Can there be too much information?
  - Have we reached information overload?
    - For models? (how would that manifest itself?)
    - For people?
  - Can no financial information be relevant to the pricing of stocks?
    - ESG?
    - Social Influencers?

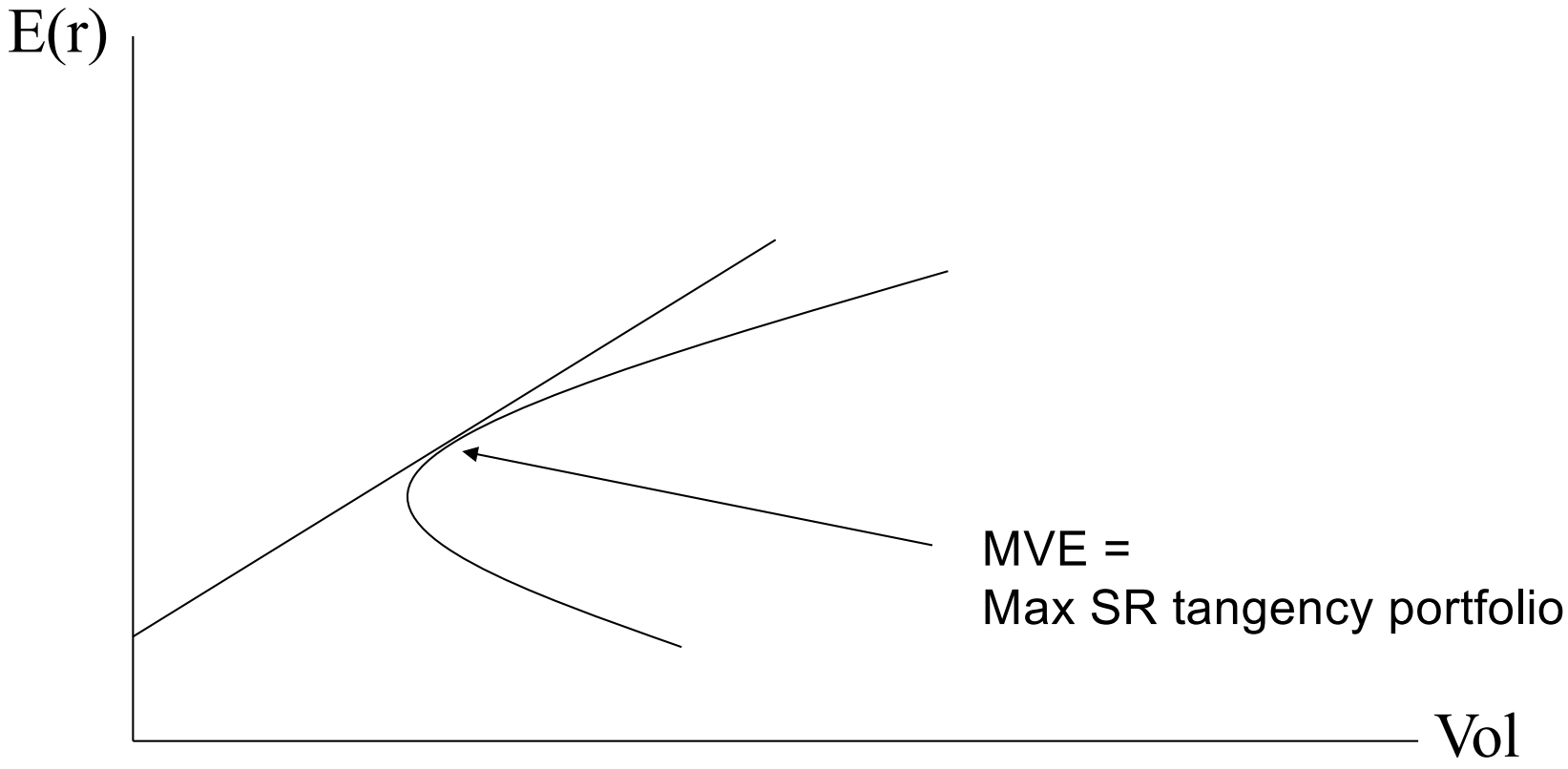
CAPM

CAPM

- The CAPM is an equilibrium model which specifies risk-return trade-offs of (1) an individual stock relative to the market portfolio and (2) the market portfolio return and risk. It is derived assuming
  - Single-period investment horizon
  - Individual investors are price takers
  - No taxes and transaction costs
  - Information is costless and available to all investors
  - Investors are rational mean-variance optimizers
  - Homogeneous expectations
- Which ones are most important?
- Would you expect anomalous returns relative to the CAPM for strategies focused on where these assumptions fail?

CAPM

- Under mean-variance utility, investors hold the risk-free asset and the mean-variance efficient (MVE) portfolio (Two-fund separation). The MVE, which consists only of risky assets, has the highest attainable Sharpe ratio. The precise holdings of the risk-free asset and the MVE are determined by an investor's risk aversion



CAPM

- The economic concept of diversification underlies the CAPM. Investors hold the market portfolio because it diversifies away idiosyncratic risk.
- The CAPM is an equilibrium model: prices are set where supply = demand
- Example: suppose everyone's optimal portfolio assigns $w_{IBM} = 0$
  - This cannot be an equilibrium, someone must hold IBM!
  - What happens? If no-one wants to hold it, IBM must be overpriced
  - IBM's expected return is too low
  - What happens? Price falls (expected returns increase), until investors want to hold exactly the number of IBM shares outstanding.
  - Find prices so that supply = demand (equilibrium)

CAPM

- The CAPM gives two risk-return results
- Capital Market Line: (the Capital Allocation Line when the MVE portfolio is the market)

$$E(r_m) - r_f = \bar{\gamma}\sigma_m^2$$

where $\bar{\gamma}$ is wealth-weighted risk aversion

- Security Market Line: (risk premiums of individual stocks relative to the market):

$$E(r_i) - r_f = \frac{\text{cov}(r_i, r_m)}{\text{var}(r_m)}\left(E(r_m) - r_f\right)$$

$$E(r_i) - r_f = \beta_i\left(E(r_m) - r_f\right)$$

- Beta, which is the CAPM's measure of risk, involves diversification benefits. The lower the stock's beta, the lower the covariance (or correlation) with the market portfolio, and hence the higher the diversification benefits. Thus, low beta stocks are less risky and do not need high expected returns to be held in equilibrium.

CAPM Lessons

1. Don’t hold an individual asset, hold the factor (market)

2. Each investor has her own optimal exposure of factor (market) risk

3. The average investor holds the market

4. The factor risk premium has an economic story

5. Risk is factor (market) exposure = beta

6. The CAPM is a single period model – it is about the cross-section of returns not the dynamics of a security’s price

Question:

What are the testable implications of the CAPM?

Event Studies

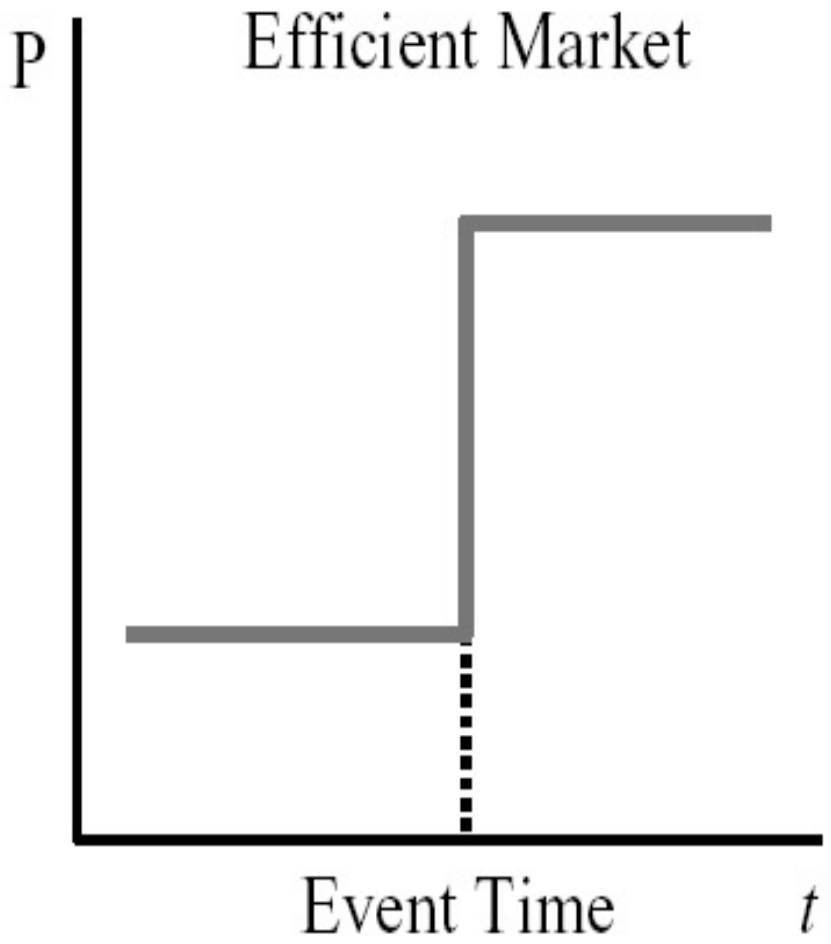
Event Study Analysis

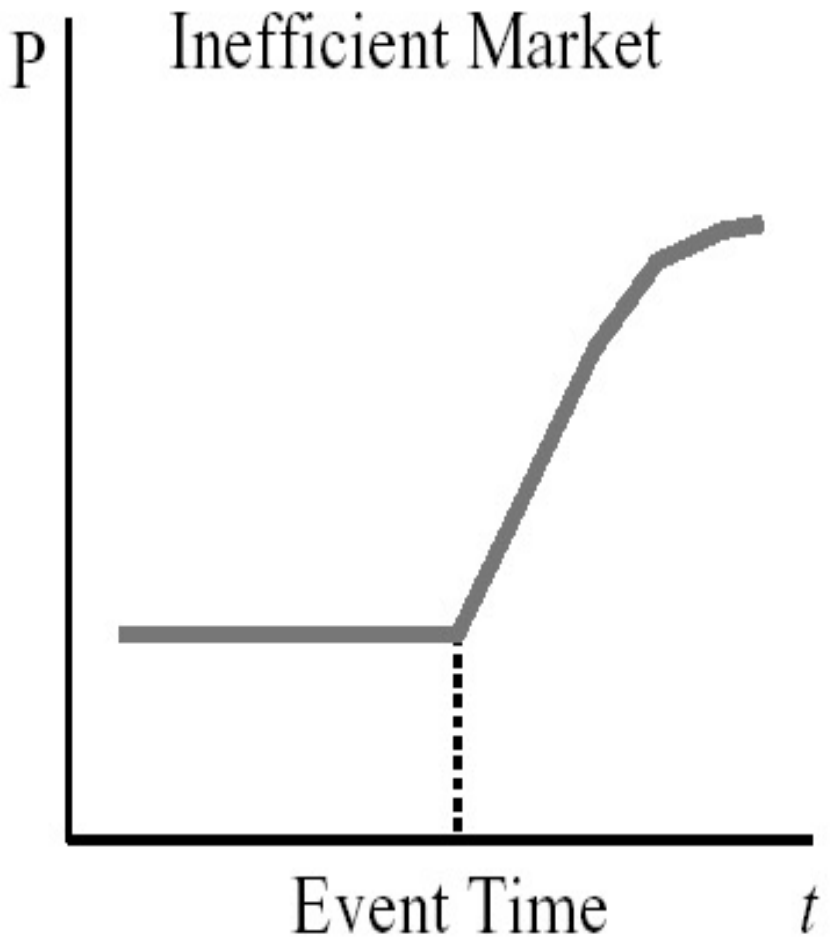
- Definition: An event study attempts to measure the valuation effects of a corporate event, such as a merger or earnings announcement, by examining the response of the stock price around the announcement of the event.

- One underlying assumption is that the market processes information about the event in an efficient and unbiased manner.

- Thus, we should be able to see the effect of the event on prices.

Event Study Analysis





Event Study Analysis

The event that affects a firm's valuation may be:

1. Within the firm's control, such as the event of the announcement of a stock split
2. Outside the firm's control, such as a macroeconomic announcement that will affect the firm's future operations in some way.

Various events have been examined, such as:

- Mergers and Acquisitions
- Earnings announcements
- Issuance of new debt and equity
- Announcements of macroeconomic variables
- Dividend announcements
- CEO changes and Deaths
- Auditor changes
- Geopolitical events (e.g. wars, terrorist attacks, etc)
- etc., etc.

Event Study Analysis

- Technique mainly used in corporate finance as well as asset pricing.
- Simple on the surface, but there are a lot of issues.

- Long history in finance:
  - First paper that applies event-studies, as we know them today: Fama, Fisher, Jensen, and Roll (1969) for stock splits.
  - Today, we find thousands of papers using event-study methods.

- This is also known as an event-time analysis to differentiate it from a calendar time analysis.

- References:

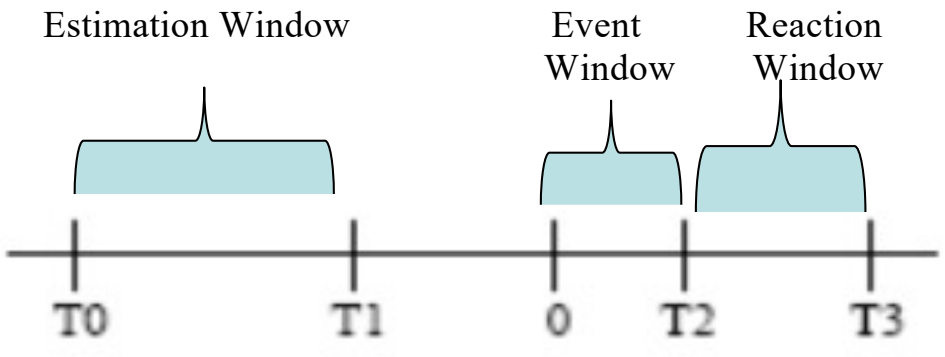
- Loughran and Ritter (1995): Long-term performance study.
- Barber and Lyon (1997) and Lyon, Barber and Tsai (1999): Long- term performance studies.
- Eckbo, Masulis and Norli (2000) and Mitchell and Stafford (2000): Potential problems with the existing long-term performance studies.
- M.J. Seiler (2004), **Performing Financial Studies: A Methodological Cookbook**. Chapter 13.
- Kothari and Warner (2006), Econometrics of event studies, Chapter 1 in **Handbook of Corporate Finance: Empirical Corporate Finance**

Event Study Design

- The steps for an event study are as follows:
  - Event Definition
  - Selection Criteria
  - Normal and Abnormal Return Measurement
  - Estimation Procedure
  - Testing Procedure
  - Empirical Results
  - Interpretation

Event Study Design

- The time-line for a typical event study is shown below in event time:



- The interval T0-T1is the estimation period for a stock's "market beta"
- The interval T1-T2 is the event window
- Time 0 is the event date in calendar time or the date of the announcement
- The interval T2-T3 is the post-event window when you are observing the market reaction
- There is often a gap between the estimation and event periods

Issues with Timeline

- Definition of an event: We have to define what is an "event"
  - It must be unexpected. Why?
  - Also, we must know the *exact* date of the event. And the time (why?)
  - Dating is always a problem (WSJ is not a good source – information leakage).

- Frequency of the event study "sampling":
  - We have to decide how fast the information is incorporated into prices.
  - We cannot look at yearly returns. We can't look at 10-seconds returns. People usually look at daily, weekly or monthly returns.

- Sample Selection: We have to decide what is the universe of companies in the sample.

- Horizon of the event study: If markets are efficient, we should consider short horizons –i.e., a few days. However, people have looked at long-horizons. Event studies can be categorized by horizon:
  - Short horizon (from 1-month before to 1-month after the event)
  - Long horizon (up to 5 years after the event).

Models for Measuring Performance

- We can always decompose a return as:

$$R_{i;t} = E[R_{i;t} | X_t] + \xi_{i,t},$$

where X_t is the conditioning information at time t:

- In event studies, $\xi_{i;t}$ is called the "abnormal" return.
- Question: Why abnormal?
- It is assumed that the unexplained part is due to some "abnormal" event that is not captured by the model.
- In a sense, we want to get close to a natural experiment.
  - There is an exogenous (unanticipated) shock that affects some stocks.
  - We want to compare the returns of those stocks around the announcement to others that are not affected.

Models for Measuring Performance

- Definition of "Normal" Returns: We need a benchmark (control group) against which to judge the impact of returns.
  - There is a huge literature on this topic.
  - This is precisely what we need to do in event studies: We need to specify expected returns (we just call them "normal" returns).
  - Note that if we are looking at short horizon studies, we can assume that expected returns do not change. No problem, here.
  - If we are looking at long horizons, we know that expected returns change. Big problem. We have to be careful.
  - In long horizon studies, the specification of expected returns makes a huge difference, because small errors are cumulated. There is no easy way out of this problem.

Models for Measuring Performance

- **Constant mean return model**

- For each asset i, the constant mean return model assumes that asset returns are given by:

$$R_{i,t} = E[R_{i;t} \mid X_t] + \xi_{i,t},$$

$$\text{where } E[R_{i;t} \mid X_t] = \mu,$$

$$E[\xi_{i,t}] = 0 \text{ and } Var[\xi_{i,t}] = \sigma_{\xi,i2}$$

- **Market Model**

- For each asset i, the MM assumes that asset returns are given by:

$$R_{i,t} = E[R_{i;t} \mid X_t] + \xi_{i,t},$$

$$\text{where } E[R_{i;t} \mid X_t] = \alpha_i + \beta_i R_{m,t},$$

$$E[\xi_{i,t}] = 0 \text{ and } Var[\xi_{i,t}] = \sigma_{\xi,i}^2$$

- In this model $R_{m,t}$ is the return on the market portfolio, and the model's linear specification follows from an assumed joint normality of returns.

- Usually a broad-based stock index is used as the market portfolio (S&P 500 or the CRSP EW or CRSP VW).

  - Note when $\beta_i = 0$, we have the constant mean return model.

- The MM improves over the constant mean return model: we remove from $\xi_{i,t}$ changes related to the return on the market portfolio.

Estimation of Abnormal Returns

- **Cumulated Abnormal Returns (CARs)**

$$AR_{i,t} = R_{i,t} - E[R_{i;t} | X_t]$$

$$CAR^{i}_{t,;t+K} = \Sigma_k \, AR_{i,,t+k}$$

If we fix K; we can compute the variance of the CAR. Then, under certain conditions:

$$CAR^{i}_{t,;t+K} \sim N(0,\sigma^2_{i,,t+k})$$

Sometimes we are looking at only several categories (j = 1,..,J) (IPO and non-IPO firms). Suppose there are $N_1,\ldots,N_J$ firms in each category.

- Then, the CAR for each category is:

$$\overline{CAR}^{j}_{t,t+K} = \frac{1}{N_j} \sum^{N_j} CAR^{n}_{t,t+k}$$

- The advantage of aggregating across assets is immediately clear

$$\overline{CAR}^{j}_{t,t+K} \sim N\left(0, \frac{1}{N_j^2} \sum \sigma^2_{i,t,t+K}\right)$$

Testing

- Null Hypothesis: Event has no impact on returns –i.e., no abnormal mean returns, unusual return volatility, etc.
- The focus is usually on mean returns.

- **Parametric Test**.
- Traditional t-statistics (or variations of them) are used:

$$t_{CAR} = \overline{CAR}_{i\tau} / \left(\sigma(CAR_{i\tau}) / \sqrt{n}\right)$$

or

$$t_{BHAR} = \overline{BHAR}_{i\tau} / \left(\sigma(BHAR_{i\tau}) / \sqrt{n}\right)$$

Appealing to the CLT, a standard normal is used for both tests

Testing

Non-Parametric Test.

- Advantage: Free of specific assumptions about return distribution.

Intuition: Let $p = P(CAR_i \geq 0)$, then under the usual event studies hypothesis, we have H_0: $p \leq 0.5$ against H1 : $p > 0.5$.

(Note if distribution of CAR_i is not symmetric, we need to adjust the formulation of p.)

- Popular Tests: Sign Test (assumes symmetry in returns) and Rank Test (allows for non-symmetry in returns). See Corrado (1989).

Example: Sign Test

Let N+ be the number of firms with CAR>0, and N the total number of firms in the sample. Then, H_0 can be tested using

$$= [(N+/N) - 0.5]/\ 2 \quad N \sim N(0,1)$$

- Usually, non-parametric tests are used as a check of the parametric tests.

Testing

Econometrics Problems

There can be MANY econometric problems in event studies

1. Misspeciation of expected returns (i.e. wrong inference due to bias in the estimates of abnormal returns)

2. Non-random sample: leading to non-normal distributions (i.e. wrong inference due to standard error calculations)

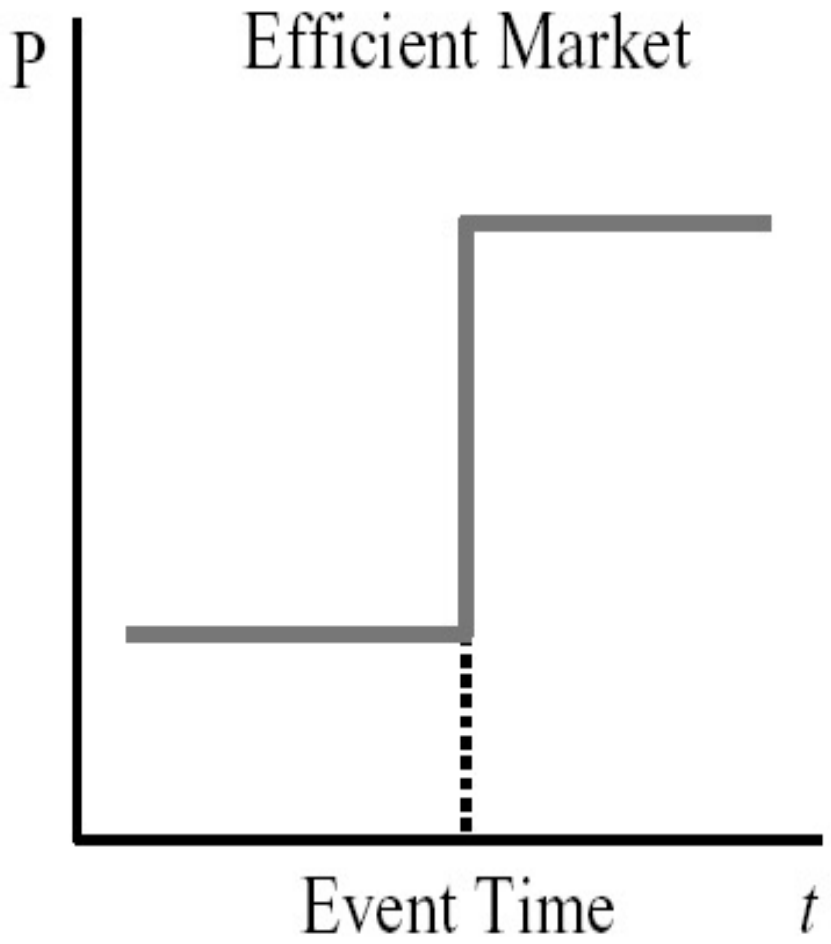
3. Confounding Effects: multiple events being announced at the same time (e.g. when companies announce earnings they also announce many other pieces of information like dividends, future earnings guidance, restructurings, etc.).

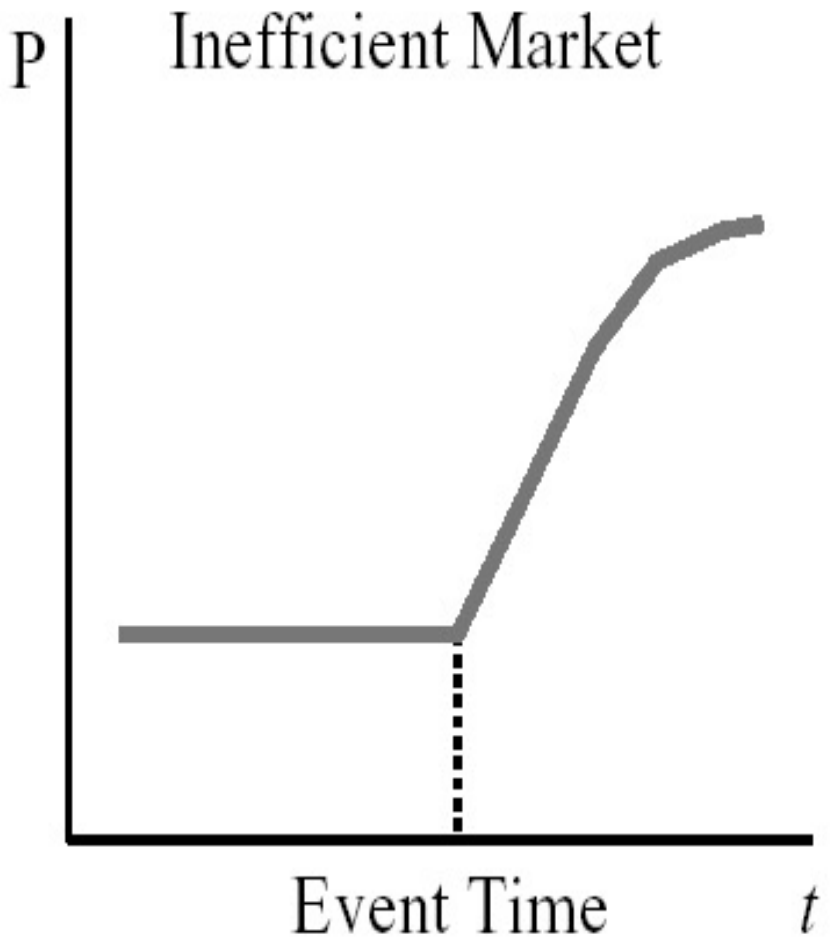
4. Information Anticipation: Markets are responding to outcomes that different than its expectation. You need to have the appropriate model of "expectations". Otherwise either the lack of a response or the size of the response will lead you to an erroneous conclusion.

Note many of these problems are due to voluntary events vs non-voluntary events. In particular, major corporate events cluster through time by industry.

=> positive cross-correlation of abnormal returns (standard errors need to be corrected. Traditional t-tests tend to overstate).

Event Study Analysis





Examples: Winner Versus Losers

Winner Stocks and Loser Stocks

DeBondt and Thaler (1985) show that stocks with the worst returns over the prior 36 months (Losers) signficantly outperform the stocks with the best returns over the prior 36 months (Winners)

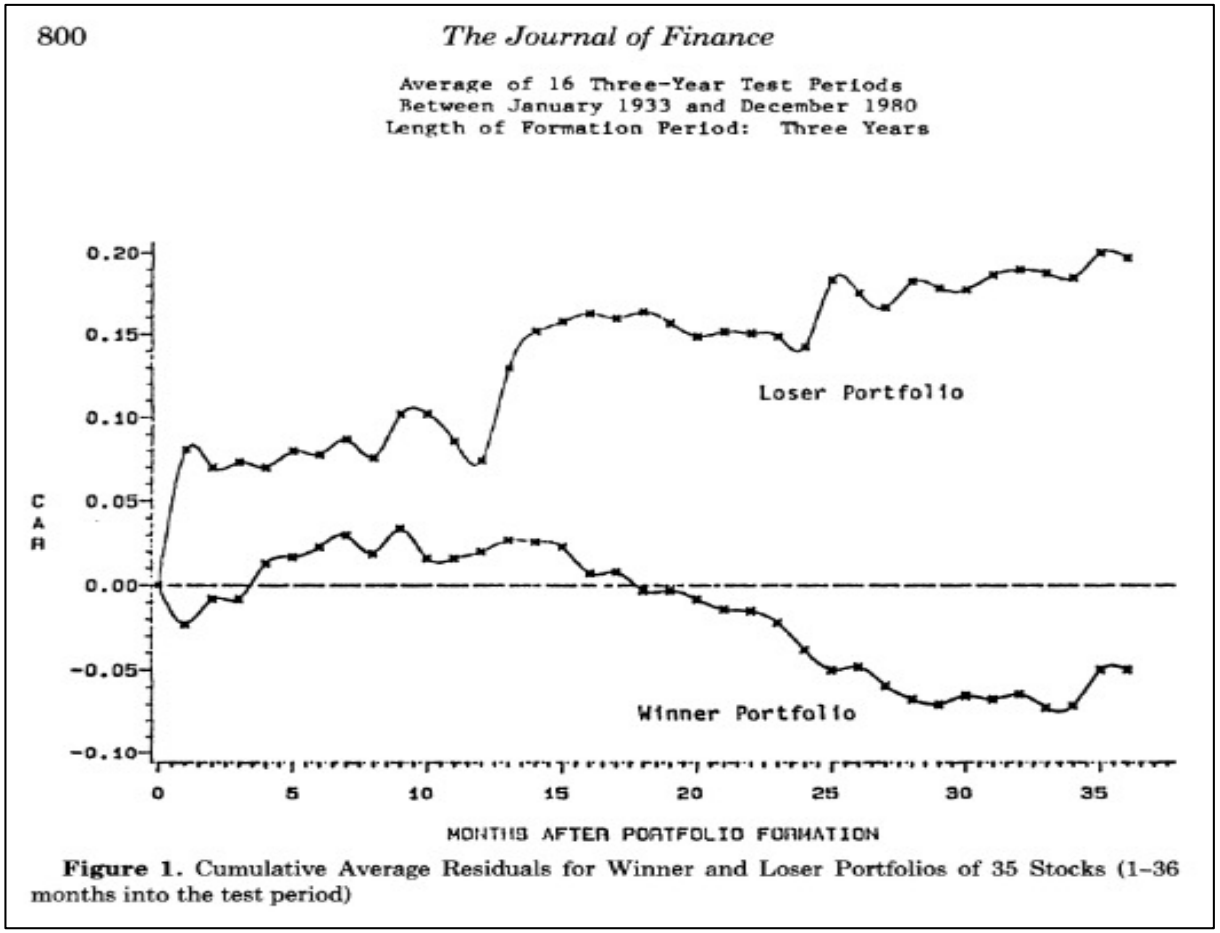


Figure 1. Cumulative Average Residuals for Winner and Loser Portfolios of 35 Stocks (1–36 months into the test period)

Examples: Winner Versus Losers

Winner Stocks and Loser Stocks

DeBondt and Thaler (1985) show that stocks with the worst returns over the prior 36 months (Losers) signficantly outperform the stocks with the best returns over the prior 36 months (Winners).

Note: Losers portfolio significantly outperform in January

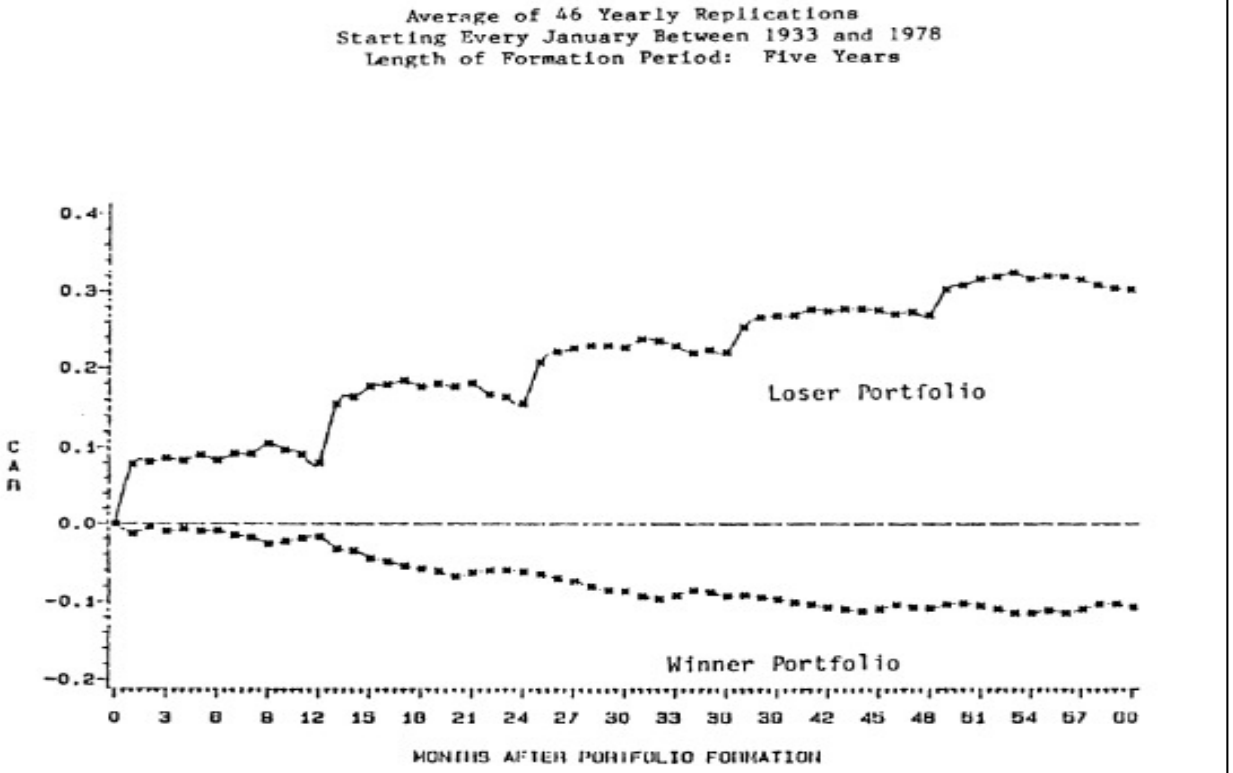


Figure 3. Cumulative Average Residuals for Winner and Loser Portfolios of 35 Stocks (1–60 months into the test period)

Potential Bad Candidates for Event Studies

The following would make for difficult event studies

- Widely Anticipated and Debated Events:
  - Regulation Changes by Governmental Bodies
  - Legislation Passing
- Event Timing is Hard to Pinpoint
  - Invasion of Iraq / Ukraine
  - End of Soviet Empire
  - Covid
- Instances With Multiple News Announcements
  - Dividend Announcements
  - Earnings
  - Restructurings
- Non-Economics News
  - Super Bowl Winner
  - Amount of Sunshine at the Stock Exchange

Fama-French (1992)

Fama French (1992)

Questions:

What is the contribution of this paper? Why is it the most important in Finance in the last 25 years?

What are the two empirical implications of the CAPM?

1. "Expected returns on securities are a positive linear function of their βs"
2. "Market βs suffice to describe the cross-section of expected returns"

What are several of the empirical contradictions to the CAPM?

- Size
- Earnings-to-Price
- Book-to-Price
- Leverage

Fama French (1992)

Questions:

What do they want to test in this paper?

"Our goal is to evaluate the joint roles of market β, size, E/P, leverage and book-to-market equity in the cross-section of average stock returns on NYSE, AMEX and NASDAQ stocks."

What do they conclude? What are their bottom-line results?

"β does not seem to help explain the cross-section of average returns"

"[T]he combination of size and book-to-market equity seems to absorb the roles of leverage and E/P in average stock returns, at least during our 1963-1990 sample period".

Fama French (1992)

Why do they start with the data in 1962?

Why do they leave a six-month gap between the date of BE and the ME variables?

How often are they “re-calculating” the variables?

Do you see any issues in the rules they are using, data they are requiring of firms?

Fama French (1992)

How do they estimate βs? What are these “pre-ranking” βs? How do they separate out β from size and why are they worried about it?

What are post-ranking βs?

Fama French (1992)

Table I: Panel A

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
Panel A: Average Monthly Returns (in Percent)											
All	1.25	1.34	1.29	1.36	1.31	1.33	1.28	1.24	1.21	1.25	1.14
Small-ME	1.52	1.71	1.57	1.79	1.61	1 50	1.50	1.37	1.63	1.50	1.42
ME-2	1.29	1.25	1.42	1.36	1.39	1.65	1.61	1.37	1 31	1.34	1.11
ME-3	1.24	1.12	1.31	1.17	1.70	1.29	1.10	1.31	1.36	1.26	0.76
ME-4	1.25	1.27	1.13	1.54	1.06	1.34	1.06	1.41	1.17	1.35	0.98
ME-5	1.29	1.34	1.42	1.39	1.48	1.42	1.18	1.13	1.27	1.18	1.08
ME-6	1.17	1.08	1.53	1.27	1.15	1.20	1.21	1.18	1.04	1.07	1.02
ME-7	1.07	0.95	1.21	1.26	1.09	1.18	1.11	1.24	0.62	1.32	0.76
ME-8	1.10	1.09	1.05	1.37	1.20	1.27	0.98	1.18	1.02	1.01	0.94
ME-9	0.95	0.98	0.88	1.02	1.14	1.07	1.23	0.94	0.82	0.88	0.59
Large-ME	0.89	1.01	0.93	1.10	0.94	0.93	0.89	1.03	0.71	0.74	0.56

Fama French (1992)

Table I: Panel B & C

Table I — *Continued*

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
Panel B: Post-Ranking βs											
All		0.87	0.99	1.09	1.16	1.26	1.29	1 35	1.45	1.52	1.72
Small-ME	1.44	1.05	1.18	1.28	1.32	1.40	1.40	1.49	1.61	1.64	1 79
ME-2	1.39	0.91	1.15	1.17	1.24	1.36	1.41	1.43	1.50	1.66	1.76
ME-3	1.35	0 97	1 13	1.13	1.21	1.26	1.28	1.39	1.50	1.51	1.75
ME-4	1.34	0 78	1.03	1.17	1.16	1.29	1.37	1.46	1.51	1 64	1.71
ME-5	1 25	0 66	0.85	1.12	1.15	1.16	1.26	1.30	1.43	1.59	1.68
ME-6	1.23	0.61	0.78	1.05	1.16	1.22	1.28	1.36	1.46	1.49	1.70
ME-7	1.17	0.57	0.92	1.01	1.11	1.14	1.26	1.24	1.39	1.34	1.60
ME-8	1.09	0.53	0.74	0.94	1.02	1.13	1.12	1.18	1.26	1.35	1.52
ME-9	1 03	0 58	0.74	0.80	0.95	1.06	1.15	1.14	1.21	1.22	1.42
Large-ME	0.92	0.57	0.71	0.78	0.89	0.95	0.92	1.02	1.01	1.11	1.32
Panel C: Average Size (ln(ME))											
All	4.11	3.86	4.26	4 33	4.41	4.27	4.32	4.26	4.19	4 03	3.77
Small-ME	2.24	2.12	2.27	2.30	2.30	2.28	2.29	2.30	2.32	2.25	2.15
ME-2	3.63	3.65	3.68	3.70	3.72	3.69	3 70	3.69	3.69	3.70	3.68
ME-3	4.10	4.14	4.18	4.12	4.15	4.16	4.16	4.18	4 14	4.15	4.15
ME-4	4.50	4.53	4.53	4.57	4.54	4.56	4.55	4.52	4.58	4.52	4.56
ME-5	4.89	4.91	4.91	4.93	4.95	4.93	4.92	4 93	4.92	4.92	4.95
ME-6	5.30	5.30	5 33	5 34	5.34	5.33	5.33	5.33	5.33	5.34	5.36
ME-7	5.73	5.73	5.75	5.77	5.76	5.73	5.77	5.77	5 76	5.72	5.76
ME-8	6.24	6.26	6.27	6.26	6.24	6.24	6.27	6.24	6.24	6.24	6 26
ME-9	6.82	6.82	6.84	6.82	6.82	6.81	6.81	6.81	6.81	6.80	6.83
Large-ME	7.93	7.94	8.04	8.10	8.04	8 02	8.02	7.94	7.80	7.75	7.62

Fama French (1992)

Table 2: Panels A & B

	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel A: Portfolios Formed on Size												
Return	1.64	1.16	1.29	1.24	1.25	1.29	1.17	1.07	1.10	0.95	0.88	0.90
β	1.44	1.44	1.39	1.34	1.33	1.24	1.22	1.16	1.08	1.02	0.95	0.90
ln(ME)	1.98	3.18	3.63	4.10	4.50	4.89	5.30	5.73	6.24	6.82	7.39	8.44
ln(BE/ME)	−0.01	−0.21	−0.23	−0.26	−0.32	−0.36	−0.36	−0.44	−0.40	−0.42	−0.51	−0.65
ln(A/ME)	0.73	0.50	0.46	0.43	0.37	0.32	0.32	0.24	0.29	0.27	0.17	−0.03
ln(A/BE)	0.75	0.71	0.69	0.69	0.68	0.67	0.68	0.67	0.69	0.70	0.68	0.62
E/P dummy	0.26	0.14	0.11	0.09	0.06	0.04	0.04	0.03	0.03	0.02	0.02	0.01
E(+)/P	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0 10	0.10	0.09	0.09
Firms	772	189	236	170	144	140	128	125	119	114	60	64

Table II—*Continued*

	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel B: Portfolios Formed on Pre-Ranking β												
Return	1.20	1 20	1.32	1.26	1.31	1.30	1.30	1.23	1.23	1.33	1.34	1.18
β	0.81	0.79	0.92	1.04	1.13	1.19	1.26	1.32	1.41	1.52	1 63	1.73
ln(ME)	4.21	4.86	4.75	4.68	4.59	4.48	4.36	4.25	3.97	3.78	3.52	3.15
ln(BE/ME)	−0.18	−0.13	−0.22	−0.21	−0.23	−0.22	−0.22	−0.25	−0.23	−0.27	−0.31	−0.50
ln(A/ME)	0.60	0.66	0.49	0.45	0.42	0.42	0.45	0.42	0.47	0 46	0.46	0.31
ln(A/BE)	0.78	0.79	0.71	0.66	0.64	0.65	0.67	0.67	0.70	0.73	0.77	0 81
E/P dummy	0.12	0.06	0.09	0.09	0.08	0.09	0.10	0.12	0.12	0.14	0.17	0.23
E(+)/P	0.11	0.12	0.10	0.10	0.10	0.10	0.10	0.09	0.10	0.09	0 09	0.08
Firms	116	80	185	181	179	182	185	205	227	267	165	291

Fama French (1992)

What are the Fama-McBeth regressions that they run in Table 3?

At time t, for all stocks j=1,……,*n*, we run the following regression

$$R_{j,t} - r_{f,t} = \gamma_0 + \gamma_1 X_{j,t-1}$$

How do we interpret the coefficient $\widehat{\gamma_1}$? What is the economic interpretation?

Well, let's think of it this way:

First, we run a series of time-series regressions, from, say t-60,……t-2, to get estimates of a stocks $\hat{\beta}$. In other words, we just estimate a stock's β in a traditional way.

Now let's re-look at the regression above:

$$R_{j,t} = \gamma_0 + \gamma_1 \hat{\beta}_{j,t-1}$$

Now, how would you interpret the coefficient $\widehat{\gamma_1}$?

Answer: It is the estimate of that month's market premium $(R_m - r_f)$

Fama French (1992)

What is being reported in Table 3 are average $\hat{\gamma}$ coming from a series of cross-sectional regressions.

In other words: at time t, for all stocks j=1,…..,*n*, we run the following regression

$$R_{j,t} - r_{f,t} = \gamma_0 + \gamma_1 X_{j,t-1}$$

This is done T times for t=1,…..*T* and then the coefficients reported are:

$$\bar{\hat{\gamma}} = \sum \hat{\gamma}_t \quad \text{and the t-statistics come from} \quad \frac{\bar{\hat{\gamma}}}{standard\ error\ (\hat{\gamma}_t)}$$

So the coefficients reported in Table 3 come from what we call Fama-McBeth regressions and should be interpreted as the “risk-premium” on a “factor”.

Fama French (1992)

Table 3

β	ln(ME)	ln(BE/ME)	ln(A/ME)	ln(A/BE)	E/P Dummy	E(+)/P
0.15 (0.46)						
	−0.15 (−2 58)					
−0.37 (−1.21)	−0.17 (−3.41)					
		0.50 (5.71)				
			0.50 (5 69)	−0.57 (−5.34)		
					0.57 (2.28)	4.72 (4.57)
	−0.11 (−1.99)	0.35 (4.44)				
	−0 11 (−2 06)		0.35 (4.32)	−0 50 (−4.56)		
	−0.16 (−3.06)				0.06 (0 38)	2.99 (3.04)
	−0.13 (−2.47)	0.33 (4.46)			−0.14 (−0.90)	0.87 (1.23)
	−0.13 (−2.47)		0.32 (4.28)	−0.46 (−4.45)	−0.08 (−0.56)	1.15 (1.57)

Fama French (1992)

Table 4: Panels A & B

Portfolio	0	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel A: Stocks Sorted on Book-to-Market Equity (BE/ME)													
Return		0.30	0.67	0.87	0.97	1.04	1.17	1.30	1.44	1.50	1.59	1.92	1.83
β		1.36	1.34	1.32	1.30	1.28	1.27	1.27	1.27	1.27	1.29	1.33	1.35
ln(ME)		4.53	4.67	4.69	4.56	4.47	4.38	4.23	4.06	3.85	3.51	3.06	2.65
ln(BE/ME)		−2.22	−1.51	−1.09	−0.75	−0.51	−0 32	−0.14	0.03	0.21	0.42	0.66	1.02
ln(A/ME)		−1.24	−0.79	−0.40	−0.05	0.20	0.40	0.56	0.71	0.91	1.12	1.35	1.75
ln(A/BE)		0.94	0.71	0.68	0.70	0.71	0.71	0.70	0.68	0.70	0.70	0.70	0.73
E/P dummy		0.29	0.15	0.10	0.08	0.08	0.08	0.09	0.09	0.11	0.15	0.22	0.36
E(+)/P		0.03	0.04	0.06	0.08	0.09	0.10	0.11	0.11	0.12	0.12	0.11	0.10
Firms		89	98	209	222	226	230	235	237	239	239	120	117

Table IV—*Continued*

Portfolio	0	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel B: Stocks Sorted on Earnings-Price Ratio (E/P)													
Return	1.46	1.04	0.93	0.94	1.03	1.18	1.22	1.33	1.42	1.46	1.57	1.74	1.72
β	1.47	1.40	1.35	1.31	1.28	1.26	1.25	1.26	1.24	1.23	1.24	1.28	1.31
ln(ME)	2.48	3.64	4.33	4.61	4.64	4.63	4.58	4.49	4.37	4.28	4.07	3.82	3.52
ln(BE/ME)	−0.10	−0.76	−0.91	−0.79	−0.61	−0.47	−0.33	−0.21	-0.08	0.02	0.15	0.26	0.40
ln(A/ME)	0.90	−0.05	−0.27	−0.16	0.03	0.18	0.31	0.44	0.58	0.70	0.85	1.01	1.25
ln(A/BE)	0.99	0.70	0.63	0.63	0.64	0.65	0.64	0.65	0.66	0.68	0 71	0.75	0.86
E/P dummy	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E(+)/P	0.00	0.01	0.03	0.05	0.06	0.08	0.09	0.11	0.12	0.14	0.16	0.20	0.28
Firms	355	88	90	182	190	193	196	194	197	195	195	95	91

Fama French (1992)

Table 5

Table V

Average Monthly Returns on Portfolios Formed on Size and Book-to-Market Equity; Stocks Sorted by ME (Down) and then BE/ME (Across): July 1963 to December 1990

In June of each year t, the NYSE, AMEX, and NASDAQ stocks that meet the CRSP-COMPUSTAT data requirements are allocated to 10 size portfolios using the NYSE size (ME) breakpoints. The NYSE, AMEX, and NASDAQ stocks in each size decile are then sorted into 10 BE/ME portfolios using the book-to-market ratios for year $t-1$. BE/ME is the book value of common equity plus balance-sheet deferred taxes for fiscal year $t-1$, over market equity for December of year $t-1$. The equal-weighted monthly portfolio returns are then calculated for July of year t to June of year $t+1$.

Average monthly return is the time-series average of the monthly equal-weighted portfolio returns (in percent).

The All column shows average returns for equal-weighted size decile portfolios. The All row shows average returns for equal-weighted portfolios of the stocks in each BE/ME group.

	Book-to-Market Portfolios										
	All	Low	2	3	4	5	6	7	8	9	High
All	1.23	0.64	0.98	1.06	1.17	1.24	1.26	1.39	1.40	1.50	1.63
Small-ME	1.47	0.70	1.14	1.20	1.43	1.56	1.51	1.70	1.71	1.82	1.92
ME-2	1.22	0.43	1.05	0.96	1.19	1.33	1.19	1.58	1.28	1.43	1.79
ME-3	1.22	0.56	0.88	1.23	0.95	1.36	1.30	1.30	1.40	1.54	1.60
ME-4	1.19	0.39	0.72	1.06	1.36	1.13	1.21	1.34	1.59	1.51	1.47
ME-5	1.24	0.88	0.65	1.08	1.47	1.13	1.43	1.44	1.26	1.52	1.49
ME-6	1.15	0.70	0.98	1.14	1.23	0.94	1.27	1.19	1.19	1.24	1.50
ME-7	1.07	0.95	1.00	0.99	0.83	0.99	1.13	0.99	1.16	1.10	1.47
ME-8	1.08	0.66	1.13	0.91	0.95	0.99	1.01	1.15	1.05	1.29	1 55
ME-9	0.95	0.44	0.89	0.92	1.00	1.05	0.93	0.82	1.11	1.04	1.22
Large-ME	0.89	0.93	0.88	0.84	0.71	0.79	0.83	0.81	0.96	0.97	1.18

Fama French (1992)

Questions:

Does this mean that stocks are priced irrationally?

No! Low stock prices and high book-to-price may be capturing some “multi-dimensional” risk and thus require higher expected stock returns. BE/ME may be proxying for some sort of “distress” factor.

Is there another possibility?

“BE/ME just captures the unraveling (regression toward the mean) of irrational markets whims about the prospect of the firms”

What evidence do Fama-French (1992) present on either side of this question?

Summary

Summary

- Questions:
  - How does the joint hypothesis limit tests of market efficiency? Is there any way around this?
  - What are the testable implications of the CAPM?
  - What does the rejection of the CAPM by Fama-French (1992) mean for notions of market efficiency?
  - Bill Miller of Legg Mason consistently beat the return of the S&P 500 for 16 years in a row. Does that mean that he is a skilled manager? Is this a rejection of market efficiency? How should you think about and measure the risk he took?
  - How might you test whether β or some other characteristic can predict stock returns?
  - What are the main conclusions of Fama-French (1992)?
  - How I interpret Table 1: Panel A of Fama-French (1992)? Or any of the other key tables discussed in class?
  - How does one test for bubbles?

Summary

- Questions:
  - Does the Internet dot-com crash of the late 1990s and the housing market crash of 2006-2008 prove to you that market is inefficient?
  - Does the fact that small stocks seem to outperform larger stocks prove the market is inefficient? Why or why not?
  - Why is it important to use a survivorship bias free dataset like CRSP?
  - Describe the process of running a Fama-McBeth regression. How would interpret the output of that regression?
  - Explain the difference and similarities between a “double sort” process and a multi-variate regression with two independent variables.
  - If I find that returns vary over the course of the business cycle does this mean the market is inefficient?
  - Why would a researcher do any event study?
  - What types of events would make for good event studies and what might make for bad event studies?

Summary

- Questions:
  - How does the role of endogeneity play a role in interpreting event studies?
  - What are “confounding effects”? Why do they make inference in finance difficult?
  - Can you give examples where it is important but extremely difficult to get the time correct for an event study? What type of events might make it difficult?
  - How might you control for information leakage in an event study? Where might you expect to see it?
  - Some people claim that Osama Bin Landen placed large market bets prior to the 9/11 attack. If one was doing an event study on this single event what might the “return graph” look like? What other type of events might have this same problem, broadly speaking?

Formal Appendix on Market Efficiency Definition

Definition of Market Efficiency

More formally we can write this:

Φ_{t-1} = the set of information available at time t-1 which is available for determining securities prices at time t-1

$\Phi_{t-1}{}^{M}$ = the set of information that the market uses to determine securities price at times t-1. Thus $\Phi_{t-1}{}^{M}$ is a subset of Φ_{t-1}; $\Phi_{t-1}{}^{M}$ contains at most the information in Φ_{t-1} but it could contain less.

$p_{j,t-1}$ = price of security *j* at time t-1, *j* = 1, 2, …,*n*, where *n* is the number of securities in the market.

$f_m(p_{1,t+\tau}, p_{2,t+\tau}, \dots, p_{n,t+\tau}|\Phi_{t-1}{}^{M})$ = the joint probability density function for security prices at time $t+\tau$ $(\tau \geq 0)$ assessed by the market at time t-1 based on information $\Phi_{t-1}{}^{M}$

$f(p_{1,t+\tau}, p_{2,t+\tau}, \dots, p_{n,t+\tau}|\Phi_{t-1})$ = the "true" joint probability density function for security prices at time $t+\tau$ $(\tau \geq 0)$ that is implied by the information Φ_{t-1}

Definition of Market Efficiency

What does Φ_{t-1} include?

- It might simply be called “the state of the world”.
  - It includes current and past values of relevant variables like earnings of firms, GNP, the “political climate”, tastes of consumers and investors, analyst estimates, etc.
  - Since Φ_{t-1} includes past history of all relevant variables, it includes Φ_{t-2}.
  - It is also assumed to include the relationship and dynamics across all relevant variables. This includes relationship among current and past variables and also whatever can be predicted about future states of the world from the current state.
  - In short, Φ_{t-1} includes not only the state of the world at time t-1 but also whatever is knowable about the evolution of the state world through time.
  - We assume that one of the things that is knowable is the implication of the current state of the world for the joint probability distribution of security prices in the future.

Definition of Market Efficiency

So what is the process of price formation?

- At time t-1, on the basis of ${\Phi_{t-1}}^{M}$, "the market" assesses a joint probability distribution of security prices for time t, $f_m\left(p_{1,t+\tau}, p_{2,t+\tau}, \ldots, p_{n,t+\tau} | {\Phi_{t-1}}^{M}\right)$
- From this assessment of the distribution of prices at time t, the market then determines the appropriate prices, $p_{1,t-1}, p_{2,t-1}, \ldots, p_{n,t-1}$
- The current appropriate prices are determined by some ***model of market equilibrium*** – that is, by a model that determines what equilibrium current prices should be on the basis of the joint distribution of prices at time t.
- "Market equilibrium" has its usual meaning: a set of market-clearing prices at which the demand for each security is equal to the outstanding supply of the security.

Definition of Market Efficiency

So more formally we can define an efficient market as:

$$\Phi_{t-1}{}^{M} = \Phi_{t-1}$$

Which implies:

$$f_m\left(p_{1,t+\tau}, p_{2,t+\tau}, \cdots, p_{n,t+\tau} | \Phi_{t-1}{}^{M}\right) = f\left(p_{1,t+\tau}, p_{2,t+\tau}, \cdots, p_{n,t+\tau} | \Phi_{t-1}\right)$$

In other words, market efficiency is stating that:

1. The market is aware of all available information.
2. The market uses the information correctly to set prices.