Week 6:
Market Efficiency and Asset Pricing

Dr Christian Engels
ce50@st-andrews.ac.uk

FI5614 Behavioural Finance

Department of Finance
University of St Andrews Business School

Outline

Market Efficiency

Theoretical Foundations and Challenges

Empirical Puzzles

Limits to Arbitrage and Agency Relationships

Market Efficiency

Market Efficiency: Readings and Topics

Required readings:

- Ackert & Deaves, Chapter 2 (main)

Optional reading:

- Shleifer (2000), *Inefficient Markets*, Chapter 1

Topics covered:

1. The Efficient Market Hypothesis: definitions and forms
2. Theoretical foundations and behavioural challenges
3. Empirical puzzles and anomalies
4. Limits to arbitrage and agency relationships

Security Prices Should Fully Reflect All Available Information

Efficient Financial Market (Fama, 1970)

"Security prices always fully reflect the available information."

If prices are right, then:

$$P = E[P^*] = \sum_{t=1}^{\infty} \frac{E[CF_t]}{(1 + E[R])^t}$$

where the market uses the "right" $E[R]$ and $E[CF_t]$.

→ There is no possibility of trading systems based only on currently available information that earn excess returns (Fama, 1970).

If Prices Incorporate All Information, Changes Must Be Unpredictable

The efficient market hypothesis evolved from the random walk theory of asset prices, pioneered by Bachelier (1900) and advanced by Samuelson (1965):

> *"In an informationally efficient market, price changes must be unforecastable if they are properly anticipated—i.e. if they fully incorporate the expectations and information of all market participants."*

→ Stock prices respond only to new information

→ Then prices must move in a random and unpredictable manner

Randomness in price changes ≠ irrationality in price levels. Randomly evolving prices are the necessary consequence of rational investors competing to discover relevant new information before the rest of the market.

Fama and Shiller Disagree on What Asset Pricing Has Taught Us

"What, fundamentally, would you say was the relevance of your work, to the world at large?"

Fama

"The idea is really 'how do you measure risk?' And if the market is pricing things correctly, what is the relation between the expected return, which is the compensation for risk, and the risk."

Shiller

"There's a basic human element in it that is irreducible. Predicting what asset prices will do is partly similar to trying to predict what one person will do…the field of finance will never completely understand asset pricing movements."

Source: Nobel Prize interviews, 2013.

Three Forms of Efficiency Define Progressively Larger Information Sets

Market efficiency is defined relative to an information set Ω_t (Roberts, 1967):

Weak form

Ω_t includes only market trading historical data—past prices, trading volume, short interest

Semi-strong form

Ω_t includes all publicly available information—historical data plus firm prospects, balance sheet data, earnings forecasts

Strong form

Ω_t includes all relevant information known to any market participant, including insider information

$\rightarrow$ "There is not another proposition in economics that has more solid empirical evidence supporting it than the EMH" (Jensen, 1978).

Testing Efficiency Requires Both a Pricing Model and an Information Set

Malkiel (1992) Definition

"A capital market is said to be efficient if it fully and correctly reflects all relevant information in determining security prices."

Two empirical predictions:

Quick, accurate reaction

When news about a security's value hits the market, its price should react and incorporate the news quickly and correctly

Non-reaction to non-information

Prices should not move without any news about the security's fundamental value

We Can Never Test Efficiency Alone—It Is Always a Joint Hypothesis

Joint-Test Hypothesis

"Making money" means earning superior returns after adjusting for risk—but measuring risk requires a model.

All tests of market efficiency jointly test:

1. Markets are efficient
2. Returns are correctly priced by a particular model (e.g. CAPM)

Rejection means:

- Markets are not efficient, *or*
- The pricing model is faulty, *or*
- Both

→ But which? This ambiguity is the joint-hypothesis problem.

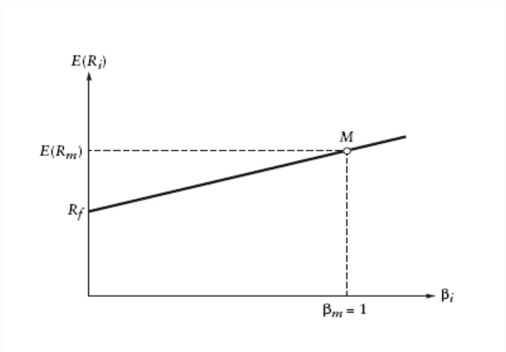
CAPM Establishes the Benchmark: Only Market Risk Is Priced

The Capital Asset Pricing Model is the equilibrium benchmark:

$$E(R_i) = R_f + \beta_i \times [E(R_m) - R_f]$$

where:

- R_f: risk-free rate
- $E(R_m) - R_f$: market risk premium
- $\beta_i = \frac{\text{Cov}(R_i, R_m)}{\text{Var}(R_m)}$: market beta



Anomalies Are Systematic Deviations That Cannot Be Explained Away

If the unexplained residuals of the pricing model have a systematic pattern, we have:

Anomalies (Tversky and Kahneman, 1986)

"Deviations from the presently accepted paradigm that are too *widespread* to be ignored, too *systematic* to be dismissed as random error, and too *fundamental* to be accommodated by relaxing the normative system."

→ Fama (1998) calls this the "literature of anomalies".

But: Grossman and Stiglitz (1980) show that prices can only fully reflect all available information if information and trading costs are zero. In equilibrium, prices reflect information to the point where the marginal benefits of acting on information do not exceed the marginal costs.

Theoretical Foundations and Challenges

Three Progressively Weaker Arguments Support Market Efficiency

Investor rationality

Rational investors value securities at the NPV of future dividends, discounted using risk characteristics, and quickly respond to new information. Prices incorporate all available information, and with rational risk-neutral investors, prices follow random walks.

Collective rationality

To the extent that some investors are irrational, their trades are random and uncorrelated—they cancel each other out. Excessive trading volume, but prices remain close to fundamentals.

Arbitrage

To the extent that irrational investors' demands are correlated, rational arbitrageurs simultaneously buy underpriced and sell overpriced close substitutes, bringing prices back to fundamentals. Irrational investors lose money and eventually leave the market.

→ Each pillar is weaker than the last—but each must fail for prices to persistently deviate from fundamentals.

Deviations from Rationality Are Pervasive and Systematic

Investors' deviations from economic rationality are not random—they are pervasive and systematic (Kahneman and Riepe, 1998):

Cognitive biases

- Prospect theory preferences (Kahneman and Tversky, 1979)
- Representativeness and the law of small numbers
- Overconfidence and anchoring

Social and contextual biases

- Framing effects and mental accounting
- Social norms and herding
- Attention biases and memory distortions

→ If biases are correlated across investors, they do not cancel out—and the second pillar fails.

Behavioural Models Ask: Why Does Mispricing Persist?

If biases are systematic and arbitrage is limited, two key questions arise:

1. Why does mispricing persist in the market?
2. How do noise traders survive the market?

Two modelling approaches:

Modified preferences and beliefs

Investors maximise expected utility, but the utility function is non-standard and expectations are not Bayesian

Heterogeneous agents

Rational traders (arbitrageurs) and irrational traders (noise traders) interact, and the rational traders cannot fully correct noise traders' influence on prices

→ "No free lunch" does not imply "right price."

Empirical Puzzles

Three Aggregate Puzzles Challenge the Efficient Market Hypothesis

Volatility puzzle

Stock prices are far more volatile than could be justified by the volatility of future dividends

Equity premium puzzle

Investors appear to demand a risk premium far larger than standard models predict

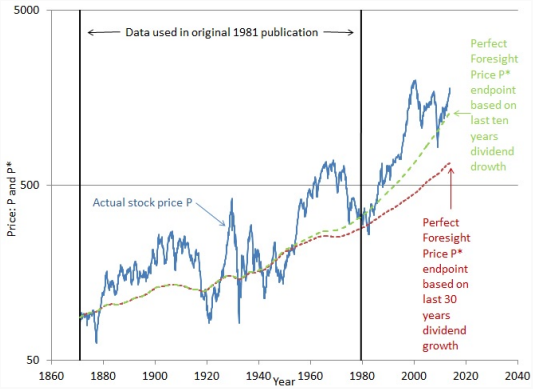
Predictability puzzle

Stock returns are forecastable to a degree that seems inconsistent with efficiency

In empirical literature, the average log return on the stock market is observed 3.9% higher than the risk-free rate (vs. 0.1%), the standard deviation of log stock returns is 18% (vs. 12%), and the dividend/price ratio explains 27% of the variation of cumulative stock returns over the subsequent four years.

Stock Prices Are Far More Volatile Than Dividends Can Justify

If prices are the expected present value of future dividends, price volatility should track dividend volatility. It doesn't (Shiller, 1981, 2013):



What drives excess volatility?

- Changing risk aversion and habit formation (Campbell and Cochrane, 1999)
- Representativeness: investors overestimate dividend variability
- Overconfidence about private information
- "Money illusion" (Ritter and Warr, 2002)

Investors Demand a Risk Premium Too Large for Standard Theory to Explain

Even though stocks appear attractive (high average returns, low covariance with consumption growth), investors appear unwilling to hold them (Mehra and Prescott, 1985):

U.S.	Real return on a market index (%) Mean	Real return on a relatively riskless security (%) Mean	Equity premium (%) Mean
1802–2004 (Siegel)	8.38	3.02	5.36
1871–2005 (Shiller)	8.32	2.68	5.64
1889–2005 (Mehra–Prescott)	7.67	1.31	6.36
1926–2004 (Ibbotson)	9.27	0.64	8.63

Investment period	Stocks Real	Stocks Nominal	T-bills Real	T-bills Nominal
1802–2004	$655,348.00	$10,350,077.00	$293.00	$4,614.00
1926–2004	$238.30	$2,533.43	$1.54	$17.87

Behavioural explanations:

- Myopic loss aversion (Benartzi and Thaler, 1995): loss-averse investors evaluating portfolios annually
- Ambiguity aversion (Maenhout, 1999): compensation for perceived ambiguity in the probability distribution

One Group of Stocks Persistently Earns Higher Returns Than Another

Empirical studies document systematic differences in average returns across groups of stocks:

Calendar patterns

January effect, weekend effect, turn-of-the-month effect

Firm characteristics

Size effect, book-to-market effect, scaled-price ratios

Price patterns

Momentum and mean reversion

Reaction to news and non-news

Under-reaction, overreaction, and price movements without fundamental news

→ Are these genuine inefficiencies, compensation for risk, or artefacts of data snooping?

Calendar Effects Mostly Vanish Once We Account for Data Snooping

Average returns seem to differ systematically within the calendar year:

- January effect: unusually high returns in the first five days of January, especially for small firms (Keane, 1983; Reinganum, 1983)
- Weekend effect: average index returns significantly negative over weekends (Smirlock and Starks, 1986)
- Turn-of-the-month effect: investors receive no reward for bearing market risk except at turns of the month

But Sullivan, Timmermann, and White (2001) examine 9,500 possible calendar rules over 100 years of S&P 500 data. After accounting for data snooping with a bootstrap procedure:

→ No significant calendar effect survives.

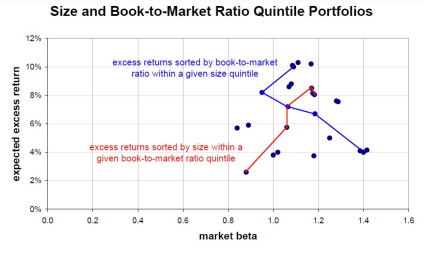
Small Firms and Value Firms Earn Higher Returns Than CAPM Predicts

Size effect

Fama and French (1992): the smallest stock decile earns 0.74%/month more than the largest—an anomaly relative to CAPM (Banz, 1981). The effect has strongly decreased over the last 20 years.

Value effect

Fama and French (1992): the highest B/M decile ("value") earns 1.53%/month more than the lowest ("growth"). → The Fama–French three-factor model (1993) adds size and value factors to CAPM.



Long-Term Winners Become Losers, but Short-Term Winners Keep Winning

Two patterns that seem contradictory—but coexist:

Overreaction (long horizon)

De Bondt and Thaler (1985): past extreme losers outperform past extreme winners by ∼8% per year over the subsequent three years.

→ Long-term trends tend to reverse.

Momentum (short horizon)

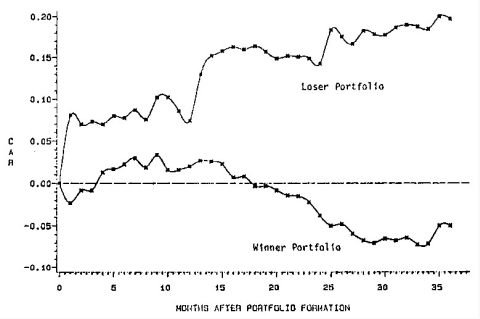
Jegadeesh and Titman (1993): the top prior-six-month decile outperforms the bottom decile by ∼10% per year over the next six months.

→ Short-term trends tend to persist.

→ The same market produces both effects—one at 6–12 month horizons, the other at 3–5 year horizons.

Past Extreme Losers Dramatically Outperform Past Extreme Winners

De Bondt and Thaler (1985): "Buy the dogs and sell the stars." Every three years from 1926 to 1982, rank all NYSE stocks by prior three-year return. Form "winner" (35 best) and "loser" (35 worst) portfolios. Track returns over the subsequent three years.



Source: De Bondt and Thaler (1985).

Black Monday and Flash Crashes: Prices Move Without News

Black Monday (29 October 1987)

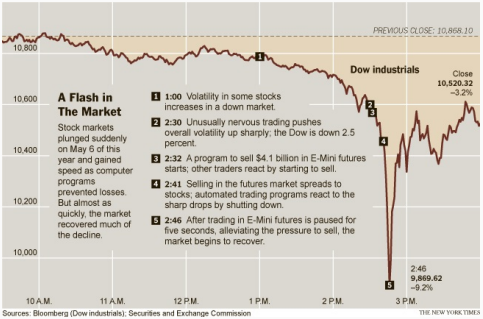
No apparent news for a single-day drop of 22.6% (Cutler et al., 1991)

Flash Crash (6 May 2010)

In 36 minutes, broad indices collapsed and rebounded—the biggest intraday DJIA point decline in history

Incidental affect

Sunshine correlates with stock returns across 26 countries (Hirshleifer and Shumway, 2003)



Limits to Arbitrage and Agency Relationships

Real-World Arbitrage Is Risky, Costly, and Limited

In theory, arbitrageurs correct mispricing through the simultaneous purchase and sale of close substitutes at different prices. In practice:

Fundamental risk

Close substitutes are rarely perfect—the hedge leaves residual exposure

Noise trader risk

Mispricing might become *worse* before it corrects

Model risk

The estimate of fundamental value itself may be incorrect—the "joint hypothesis" again

→ With finite risk-bearing capacity, arbitrageurs' aggregate ability to correct prices is limited.

Fundamental Risk: Perfect Substitutes Are Rare

Perfect Substitute

A security with similar cash flows in all states of the world—implying complete markets.

Example:

- You believe Ford shares are underpriced
- Buying Ford is risky—even if you are better informed, you can lose money
- You can hedge by shorting other auto stocks (GM, Toyota), but the hedge is not perfect

Sufficient conditions for limited arbitrage:

1. Arbitrageurs are risk-averse—mispricing cannot be wiped out by a single trader
2. Fundamental risk is systematic—it cannot be eliminated by many investors each holding small positions

Noise Trader Risk: Mispricing Can Get Worse Before It Gets Better

Noise Trader Risk

The risk that mispricing will widen rather than correct within the arbitrageur's investment horizon.

- Arbitrageurs are typically professional managers (usually hedge funds)
- They manage other people's money, which can be withdrawn—especially after bad performance
- There is a risk that within this horizon, the mispricing will not correct itself, or that prices will deviate *even further*

Sufficient conditions:

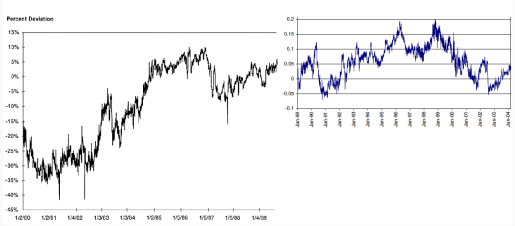
1. Arbitrageurs are risk-averse with short horizons
2. Noise trader risk is systematic

→ Arbitrageurs will not trade aggressively against mispricing, and prices can deviate from fundamental value.

Royal Dutch/Shell: Identical Cash Flows, Persistent Mispricing

In 1907, Royal Dutch and Shell Transport merged while remaining separate holding companies—an identical claim to a common cash flow stream in a 60:40 ratio. The law of one price implies: $P_{RD}/P_S \cong 1.5$

Minimal fundamental risk and model risk—yet prices deviated by up to 35% from theoretical parity for years:



Source: Froot and Dabora (1999). Data from CRSP.

Index Membership Drove the Mispricing—Not Fundamentals

Royal Dutch was a member of the S&P 500 index:

- Index funds tracking the S&P 500 were forced to buy the more expensive version of the stock
- Large-cap US mutual fund performance is benchmarked against the index

On 10 July 2002, S&P announced it was dropping all foreign stocks, including Royal Dutch, from the index:

- The premium fell from 6% the previous day to 1% on the announcement
- But it rose again until 2005, when they unified their capital structure

→ Uninformed demand from institutional constraints—not information—drove the mispricing.

The Index Effect: Adding a Stock to the S&P 500 Raises Its Price

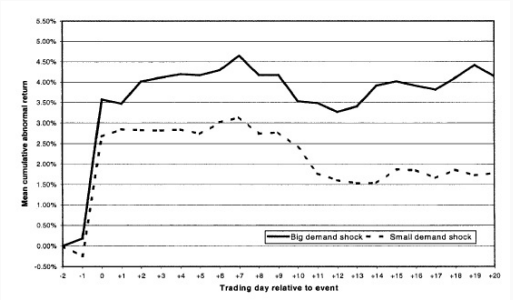
Index Effect

When stocks are included in or excluded from the S&P 500, there is a large price change independent of any change in fundamental value.

"No news moves prices":

- Uninformed demand from index-tracking funds
- Absence of close substitutes

Wurgler and Zhuravskaya (2002): the price jump is largest for stocks with the worst substitute securities.

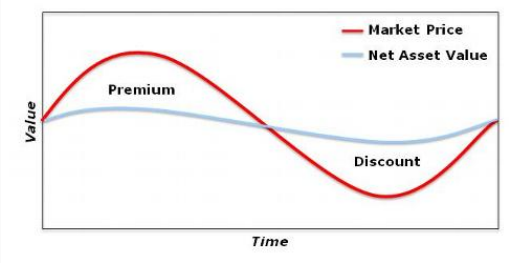


Closed-End Funds Trade at Persistent Discounts to Net Asset Value

Closed-end funds issue a fixed number of shares that trade on the secondary market.

If markets are efficient, the fund's share price should equal its net asset value (NAV).

In practice, closed-end funds typically trade at a discount to NAV—sometimes exceeding 20%.



Standard explanations:

- Tax liability on unrealised capital gains?
- Illiquidity of underlying assets?
- Management fees?

→ None fully accounts for the size and persistence of the discount.

Arbitrageurs Face an Agency Problem: They Trade with Other People's Money

The limits to arbitrage are not just about risk—they are about agency relationships:

The principal-agent problem

- Arbitrageurs (hedge fund managers) invest on behalf of outside investors
- Outside investors cannot observe the arbitrageur's skill or strategy quality directly
- They use recent performance as a signal

The consequences

- Poor short-term returns → capital withdrawals → forced liquidation
- Rational arbitrageurs avoid positions that may lose money in the short run, even if profitable in the long run
- Smart money becomes timid money

→ The separation of brains and capital is the central agency problem in arbitrage (Shleifer and Vishny, 1997).

Performance-Based Capital Flows Amplify Mispricing Instead of Correcting It

Shleifer and Vishny (1997) formalise the agency problem in arbitrage:

1. An arbitrageur identifies a mispricing and takes a position
2. In the short run, the mispricing widens—noise traders push prices further from fundamentals
3. Outside investors observe poor performance and withdraw capital
4. The arbitrageur is forced to liquidate at the worst possible time
5. The mispricing persists or deepens

The cruel irony: capital flows *toward* arbitrageurs when mispricings are small (and opportunities are limited) and *away* when mispricings are large (and opportunities are greatest).

→ Performance-based arbitrage is least effective precisely when it is most needed.

The Beauty Contest: Rational Investors Must Predict Irrational Behaviour

Keynesian Beauty Contest

The expected price depends on what rational investors believe irrational investors' views will be—not on fundamentals alone.

Even fully rational investors cannot ignore noise traders:

- If you know a stock is overpriced but expect noise traders to push it higher, the rational response may be to ride the bubble
- Your profit depends not on being right, but on being right at the right time

Additional frictions:

- Learning and implementation costs limit the number of traders able to spot and eliminate mispricing

→ Rational arbitrage requires not just correct beliefs, but coordination—and coordination is costly.

Have Increased Liquidity and Trading Reduced These Anomalies?

Chordia, Subrahmanyam, and Tong (2014) ask whether anomalies have attenuated as markets have become more liquid and trading activity has increased.

Other examples of limits to arbitrage in practice:

- American Depositary Receipts—foreign shares trading in US markets at prices that deviate from home-market equivalents
- Dual share classes—shares with identical cash flow rights but different voting rights trading at different prices
- Equity carve-outs—parent companies valued at less than the market value of their publicly traded subsidiaries

→ We have explanations for why arbitrage is limited. The deeper question is: why do investors trade mispriced securities in the first place?

→ This is where behavioural finance enters.

Conclusions

Market Efficiency Is a Useful Benchmark—Not a Description of Reality

1. The EMH rests on three pillars: investor rationality, collective rationality, and arbitrage. All three face serious challenges.

2. The joint-test problem means we can never definitively reject efficiency—but the anomalies are too systematic to be dismissed

3. Real-world arbitrage is limited by fundamental risk, noise trader risk, and agency relationships between arbitrageurs and their investors

4. Mispricing persists because the people who identify it cannot always act on it—the separation of brains and capital is the central friction

→ The question is not whether markets are efficient or inefficient—it is understanding the conditions under which prices deviate from fundamentals, and why those deviations persist.