3 .

Market Efficiency

3. Market Efficiency

- Forms of Efficiency
- Testing Efficiency
- Anomalies

3.1 Forms of Efficiency

- Learning objectives
- Weak efficiency
- Semi-strong efficiency
- Strong efficiency
- Questions

Learning objectives

- define the three forms of market efficiency,
- give examples of statements that violate each of the three forms of efficiency,
- relate active versus passive fund performance with market efficiency

Defining efficiency

The concept of stock market efficiency arose from the observations in the 1960s that *"actively managed funds did not appear to outperform passively managed funds"*.

- An actively managed fund involves a fund manager choosing investments that he believes will do well.
- A passively managed fund means buying a portfolio that well represents the general market and not doing much more.
- Active funds generally charge more than passively managed ones for the extra work and the perceived star quality of the fund manager. But if they do not do better than passively managed funds, why bother?

OBS: Most stocks are held by funds. The fact that the average fund manager does not outperform the market is therefore inevitable!

Classifying efficiency

Statements of market efficiency are generally classified into three types.

- Strong – all information, public or private, is already reflected in prices
- Semi-strong – all public information is already reflected in prices.
- Weak – all information in historical prices is already reflected in prices.

The word *reflected* is important here. $\Longrightarrow$ It means that:

- one cannot use the information to make excess returns.
- one may be able to make extra money by taking on risk, but in no other way.

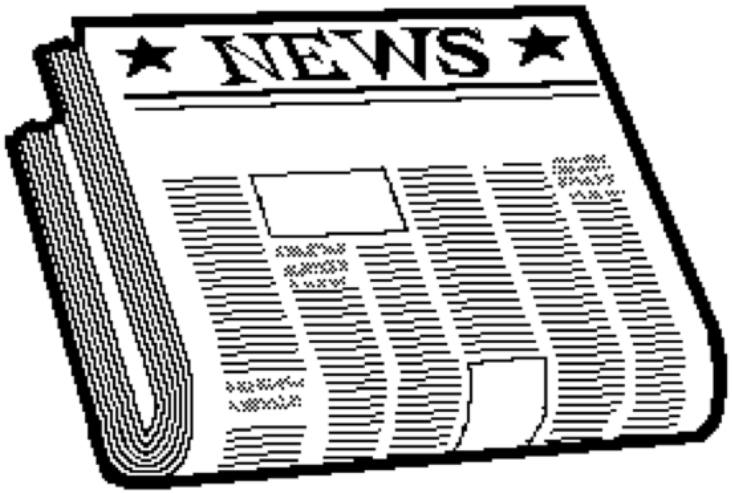
Consequences of strong efficiency

- Suppose markets are strongly efficient $\Longrightarrow$ This says that no information will ever help us make extra money on the stock market.
- Example: your friend who works for Mega-Bank tells you that they will take over Mini-Bank tomorrow and this will drive the price of MiniBank up. Strong efficiency says this information will not help you make money.

- Lawmakers certainly do not believe in strong efficiency of stock markets: insider trading is a crime in most countries.
- If markets are strongly efficient it shouldn't be since there's no benefit to it.

Consequences of semi-strong efficiency

- If markets are semi-strong, we recognize that insider trading is profitable, but deny that publicly available information is useful.



- So stock picking is a waste of time.
- There is no advantage in being intelligent beyond diversification to reduce risk.
- Returns should be truly random.

Consequences of weak efficiency

- Weak efficiency says that you cannot make money by doing mathematical/statistical analysis of historical price movements.
- If hedge funds employ mathematicians to forecast future price movements, based upon historical ones, they are just waisting money.
- For example, yesterday's price movement should not affect today's: zero auto-correlation. i.e. given a time series of changes

$$\Delta S_i = S_{i+1} - S_i.$$

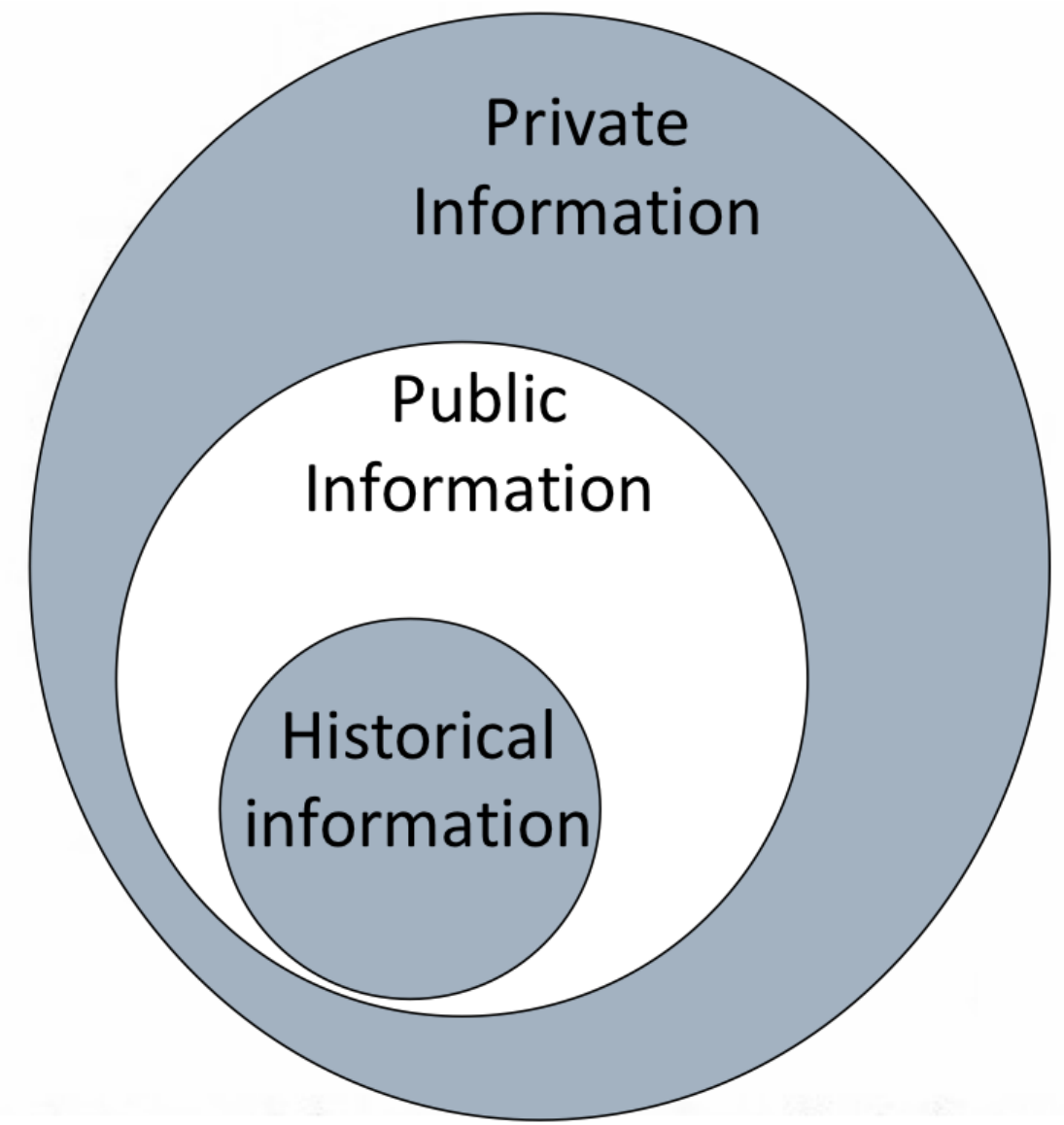
The two series

$$\Delta S_{i+1} \text{ and } \Delta S_i$$

should be uncorrelated.

- All sorts of technical analysis have no fundamental ground, even in weakly efficient markets.

Efficiency forms and information



- If markets are efficient, even in their weakest form, there is no room for technical analysis.
- Existence of laws against inside trading suggests markets may not be efficient in its strongest form.

Theory questions

- Define abnormal returns and relate it with equilibrium models.
- What are the three forms of stock market efficiency?
- A study shows that insider trading is an effective way to beat the market. What forms of market efficiency does this contradict?
- What is the relation between stock picking and market efficiency?
- Technical analysis goes against which market efficiency form(s)?

3.2 Testing Efficiency

- Learning objectives
- Testing weak efficiency
- Testing semi-strong efficiency
- Testing strong efficiency
- Questions

Learning Objectives

- discuss the difficulties in testing of market efficiency,
- identify the main techniques underlying week efficiency tests,
- explain the problems when testing semi-strong efficiency,
- explain the purpose of strong efficiency tests.
- sintetize the main observations from the empirical literature.

Does efficiency hold?

- Trading strategies that result in superior returns do not persist.
- This does not necessarily tell us much:
  - once a strategy is known to make money, it is exploited and the advantage disappears.
- But ... if enough strategies have been exploited then efficiency ought to approximately hold, since all these strategies use most of the information.
- Problem with efficiency testing:
  - To start with we need to assume an equilibrium model that allows us to characterise the process of price formation.
  - Only after it is possible to empirically test weather or not abnormal returns are possible, based upon the various types of available information.

Testing weak efficiency

"No one can prove that historical returns cannot be used to forecast future returns, since there are infinite number of ways one can combine historical data series". Fama (1976)

- Testing the Probability Distribution
  - The majority of distribution tests rely on the assumptions abnormal returns should be normally distributed.
  - This hypothesis requires analysing the moments of the distribution of returns – mean, variance, as well as measures of asymmetry and skewness.

Testing weak efficiency

- Testing Indepence
  - Autocorrelation analysis: one of the easiest tests consists of estimating correlation coefficients between returns of assets in different periods of time. However, existence of extreme observations negatively biases the correlation coefficients.
  - Sequence testing – Run Tests: it requires observing the signal (+ or -) of the price variation, independently of the extend of that variation. A sequence with the same signal is called run and the observed runs are then compared to those that would occur in a random sample.
  - Filter Tests: Even in the absence of simple relationships between price variations, it is possible that more complex relationships exist and they would possibly allow for abnormal returns.
    - The simplest way to test the existence of patterns that would reflect the existence of such patterns, involves formulating a rule of trading and check whether or not there is evident that that rule would allow for abnormal returns in the past.

Autocorrelation tests

Example :

	Lag				
Stock	1	2	3	4	5
Allied Chemical	0.017	−0.042	0.007	−0.001	0.027
Alcoa	0.118[a]	0.038	−0.014	0.022	−0.022
American Can	−0.087[a]	−0.024	0.034	−0.065[a]	−0.017
A.T.&T.	−0.039	−0.097[a]	0.000	0.026	0.005
American Tobacco	0.111[a]	−0.109[a]	−0.060[a]	−0.065[a]	0.007
Anaconda	0.067[a]	−0.061[a]	−0.047	−0.002	0.000
Bethlehem Steel	0.013	−0.065[a]	0.009	0.021	−0.053
Chrysler	0.012	−0.066[a]	−0.016	−0.007	−0.015
Du Pont	0.013	−0.033	0.060[a]	0.027	−0.002
Eastman Kodak	0.025	0.014	−0.031	0.005	−0.022
General Electric	0.011	−0.038	−0.021	0.031	−0.001
General Foods	0.061[a]	−0.003	0.045	0.002	−0.015
General Motors	−0.004	−0.056[a]	−0.037	−0.008	−0.038
Goodyear	−0.123[a]	0.017	−0.044	0.043	−0.002
International Harvester	−0.017	−0.029	−0.031	0.037	−0.052
International Nickel	0.096[a]	−0.033	−0.019	0.020	0.027

(...)

Autocorrelation tests

	Lag				
Stock	1	2	3	4	5
International Paper	0.046	−0.011	−0.058[a]	0.053[a]	0.049
Johns Manville	0.006	−0.038	−0.027	−0.023	−0.029
Owens Illinois	−0.021	−0.084[a]	−0.047	0.068[a]	0.086[a]
Procter & Gamble	0.099[a]	−0.009	−0.008	0.009	−0.015
Sears	0.097[a]	0.026	0.028	0.025	0.005
Standard Oil (Calif.)	0.025	−0.030	−0.051[a]	−0.025	−0.047
Standard Oil (N.J.)	0.008	−0.116[a]	0.016	0.014	−0.047
Swift & Co.	−0.004	−0.015	−0.010	0.012	0.057[a]
Texaco	0.094[a]	−0.049	−0.024	−0.018	−0.017
Union Carbide	0.107[a]	−0.012	0.040	0.046	−0.036
United Aircraft	0.014	−0.033	−0.022	−0.047	−0.067[a]
U.S. Steel	0.040	−0.074[a]	0.014	0.011	−0.012
Westinghouse	−0.027	−0.022	−0.036	−0.003	0.000
Woolworth	0.028	−0.016	0.015	0.014	0.007

[a]Coefficient is twice its computed standard error.

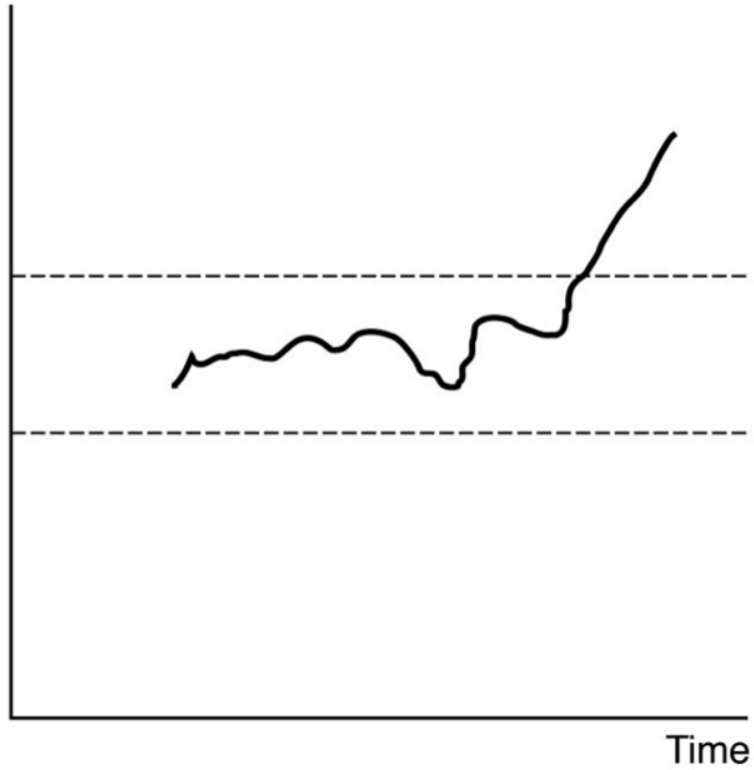
Autocorrelation tests

Author	Data	Variables	Time Interval	Average Correlation Coefficient
1. Kendall & Alexander [51]	19 indexes U.K.	Price	1 week	0.131
			2 weeks	0.134
			4 weeks	0.006
			8 weeks	−0.054
			16 weeks	0.156
2. Moore [51]	30 companies United States	Log prices	1 week	−0.056
3. Cootner [49]	45 companies United States	Log prices	1 week	−0.047
			14 weeks	0.131
4. Fama [79]	30 companies United States	Log prices	1 day	0.026
			4 days	−0.039
			9 days	−0.053
			16 days	−0.057
5. King [51]	63 companies United States	Log prices	1 month	0.018
6. Niarchos [171]	15 companies Greece	Log prices	1 month	0.036
7. Praetz [186]	16 indexes	Log prices	1 week	0.000
	20 companies Australia		1 week	−0.118
8. Griffiths [107]	5 companies U.K.	Prices	9 days	−0.026
			1 month	0.011
9. Jennergren [129]	15 companies Norway	Log prices	1 day	0.068
			2 days	−0.070
			5 days	−0.004
10. Jennergren and Korsvold [130]	30 companies Sweden	Log prices	1 day	0.102
			3 days	−0.021
			5 days	−0.016

Filter tests

Example:

- Rule: "buy when a given asset when up x% after a previous decrease and hold it until it decreases x% after a subsequent increase".
- The goal of these tests is to compare the returns obtained with such strategies with the returns one would obtain with a simple buy-and-hold strategy.



OBS: If the returns are purely random, filter rules cannot have a comparative advantage.

Filter tests

Example :

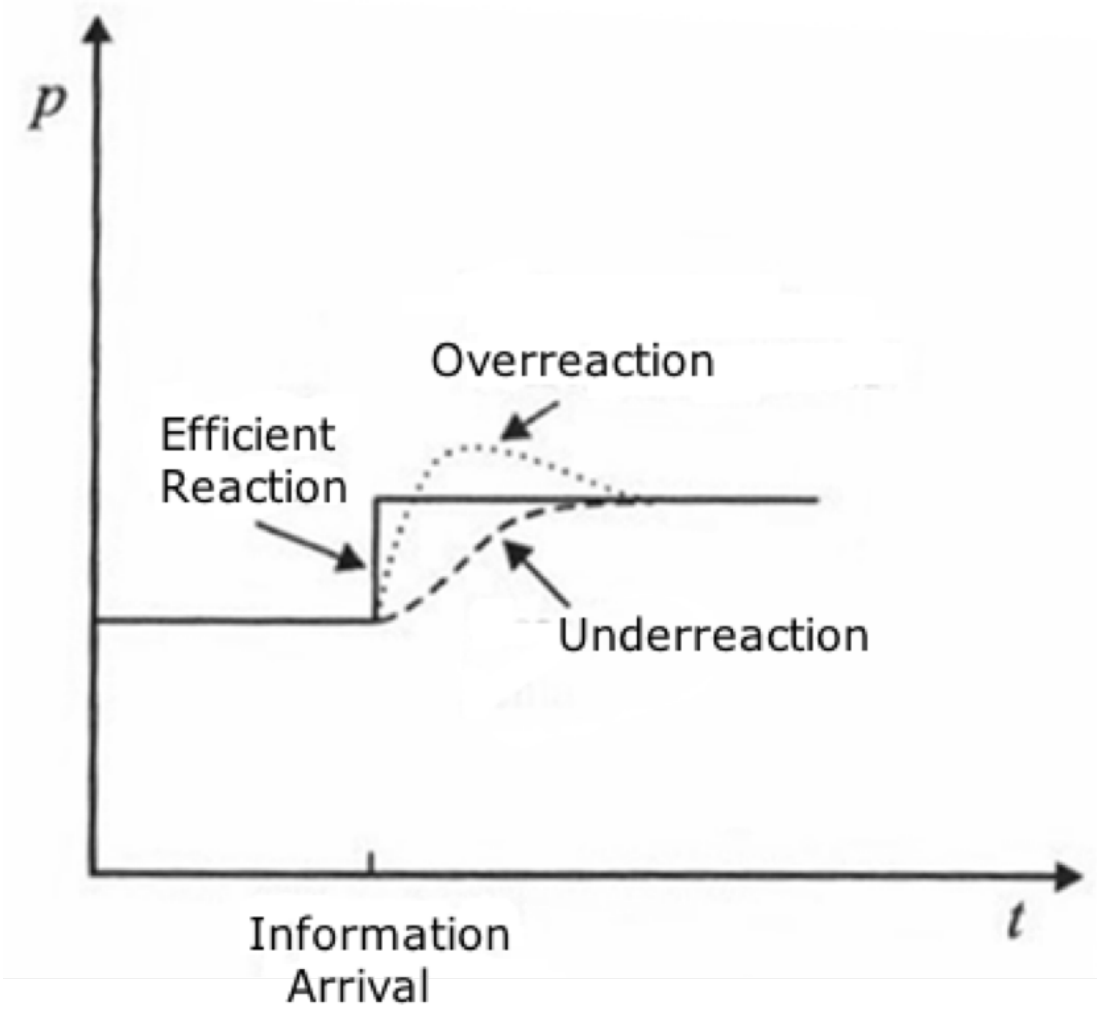
	Filter size															
	0.005		0.010		0.015		0.020		0.025		0.030		0.035		0.040	
Security	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	B
Allied Chemical	0.155	0.068	0.037	0.069	0.042	0.063	−0.030	0.066	−0.105	0.069	0.008	0.066	−0.002	0.064	−0.010	0.051
Alcoa	0.401	0.025	0.308	0.023	0.318	0.016	0.330	0.021	0.241	0.022	0.303	0.025	0.270	0.008	0.182	0.006
American Can	0.121	0.085	−0.065	0.075	−0.123	0.075	−0.088	0.078	−0.057	0.074	−0.129	0.072	−0.201	0.071	−0.226	0.070
A.T.&T.	0.150	0.189	0.146	0.189	0.158	0.189	0.133	0.185	0.135	0.182	0.131	0.180	0.143	0.176	0.076	0.182
Amer. Tobacco	0.165	0.170	0.019	0.168	0.018	0.172	0.012	0.168	−0.057	0.170	−0.080	0.168	0.002	0.163	0.048	0.162
Anaconda	0.288	0.047	0.101	0.049	−0.012	0.046	−0.048	0.042	−0.038	0.059	−0.005	0.057	−0.030	0.055	−0.019	0.055
Beth. Steel	0.082	0.032	0.051	0.033	0.030	0.036	−0.004	0.038	−0.038	0.054	−0.128	0.052	−0.250	0.049	−0.169	0.044
Chrysler	0.031	0.004	−0.090	−0.002	−0.090	0.002	−0.183	0.016	−0.234	0.015	−0.152	0.015	−0.082	0.012	0.029	0.012
Du Pont	0.152	0.107	0.125	0.106	0.087	0.108	0.100	0.105	0.032	0.097	0.054	0.097	0.084	0.098	0.058	0.103
Eastman Kodak	0.078	0.194	0.025	0.195	0.005	0.189	0.057	0.185	0.085	0.183	0.009	0.183	0.032	0.178	0.133	0.175
G.E.	0.080	0.078	0.046	0.075	−0.015	0.075	−0.016	0.069	0.013	0.069	−0.052	0.069	0.011	0.072	−0.010	0.070
General Foods	0.122	0.257	0.122	0.256	0.146	0.257	0.028	0.251	0.084	0.250	0.062	0.246	0.112	0.250	0.080	0.250
General Motors	0.107	0.088	0.108	0.091	0.065	0.091	0.048	0.094	−0.063	0.093	−0.101	0.098	−0.151	0.099	−0.171	0.095
Goodyear	−0.229	0.086	−0.195	0.083	−0.151	0.085	−0.109	0.076	−0.092	0.070	0.048	0.077	−0.013	0.077	0.076	0.112
Int. Harvester	−0.088	0.180	−0.082	0.177	−0.206	0.176	−0.112	0.174	−0.142	0.170	−0.113	0.178	−0.036	0.175	−0.018	0.178
Int. Nickel	0.218	0.148	0.170	0.136	0.118	0.136	0.077	0.137	0.005	0.155	0.088	0.148	0.105	0.147	0.041	0.160
Int. Paper	0.205	0.010	0.156	0.007	0.095	0.005	0.063	0.003	0.034	0.010	0.026	0.011	0.014	0.011	−0.013	0.015
Johns Manville	0.021	0.094	−0.016	0.093	−0.162	0.087	−0.159	0.085	−0.070	0.077	−0.194	0.072	−0.204	0.074	−0.157	0.074
Owens Illinois	0.008	0.113	−0.036	0.116	−0.043	0.115	−0.130	0.119	−0.120	0.120	−0.112	0.120	−0.091	0.124	−0.037	0.106
Procter & Gamble	0.315	0.210	0.290	0.212	0.221	0.206	0.176	0.208	0.130	0.212	0.066	0.212	0.015	0.219	0.100	0.222
Sears	0.337	0.258	0.249	0.256	0.225	0.252	0.167	0.252	0.196	0.251	0.181	0.255	0.238	0.247	0.203	0.241
Std. Oil (Calif.)	0.076	0.093	0.052	0.090	−0.079	0.094	−0.106	0.099	−0.124	0.099	−0.123	0.094	−0.117	0.097	−0.158	0.098
Std. Oil (N.J.)	0.036	0.077	−0.072	0.067	−0.094	0.067	−0.093	0.070	−0.084	0.068	−0.083	0.064	−0.084	0.057	−0.086	0.056
Swift & Co.	0.010	0.047	0.002	0.042	−0.026	0.037	0.016	0.035	−0.044	0.037	−0.115	0.037	−0.052	0.034	−0.060	0.031
Texaco	0.172	0.188	0.165	0.192	0.105	0.189	0.095	0.188	0.109	0.186	0.166	0.184	0.144	0.183	0.115	0.178
Union Carbide	0.290	0.052	0.124	0.052	0.145	0.049	0.097	0.050	0.067	0.049	0.028	0.047	0.038	0.038	0.089	0.037
United Aircraft	−0.025	0.054	−0.020	0.052	−0.023	0.054	−0.110	0.059	−0.134	0.053	−0.189	0.048	−0.025	0.049	−0.026	0.046
U.S. Steel	0.101	0.014	−0.039	0.010	0.036	0.014	0.049	0.027	0.077	0.028	0.072	0.035	0.027	0.030	0.032	0.025
Westinghouse	0.008	0.038	−0.103	0.040	−0.047	0.038	−0.215	0.054	−0.216	0.048	−0.097	0.049	−0.083	0.051	−0.015	0.047
Woolworth	0.068	0.128	0.012	0.132	0.088	0.131	0.029	0.129	−0.058	0.131	−0.076	0.132	−0.052	0.141	−0.061	0.140
Average	0.115	0.104	0.055	0.103	0.028	0.102	0.002	0.103	−0.016	0.103	−0.017	0.103	−0.008	0.102	0.001	0.101

Source: From Fama and Blume [78].

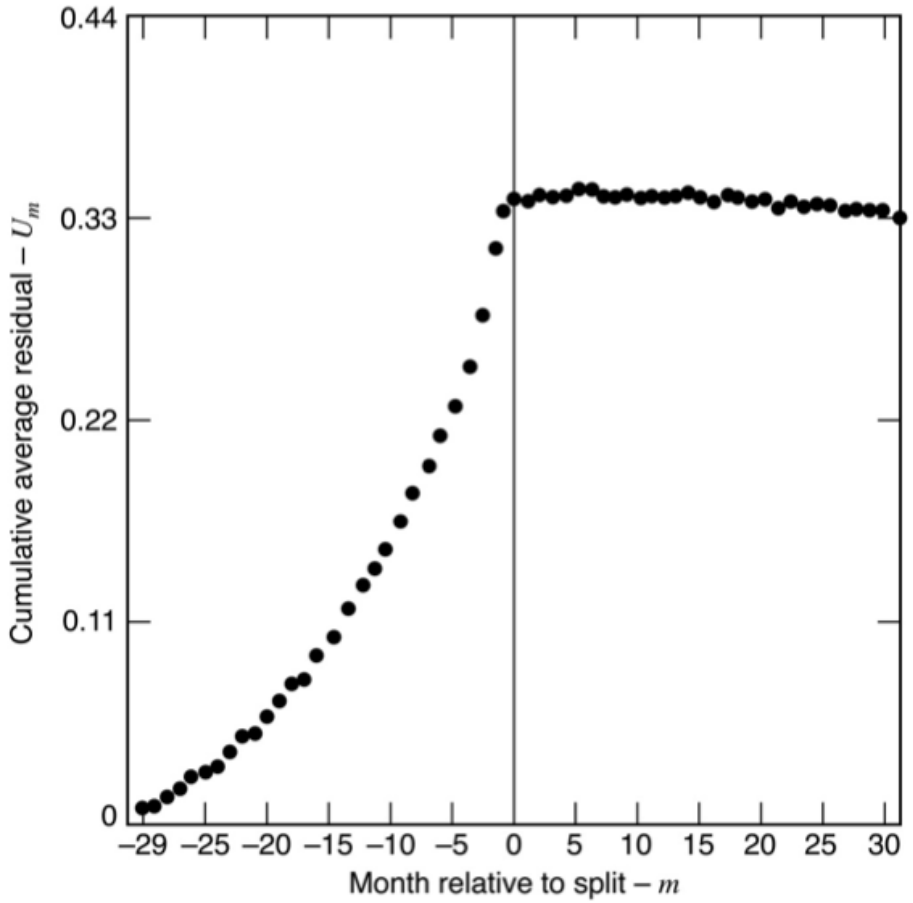
Testing semi-strong efficiency

- This kind of tests tries to find if a given price fully reflects all information publicly available about the company, as well the price adjustment speed to new information disclosure to the market.
- If a market is not efficient in the weak form, it will never be in the semi-strong form $\Longrightarrow$ So, semi-strong efficiency tests assume weak efficiency and do not look into time series.
- Even then, the amount of public information about any stock is very large, it is quite difficult to perform semi-strong tests addressing many different kinds of information.
- Test tend to focus on particular event or a set of similar events.
- Most empirical studies addresses events such as:
  - incorporation of reserves
  - results announcement
  - dividends announcements
  - raise of equity capital

Information speed adjustment



Examples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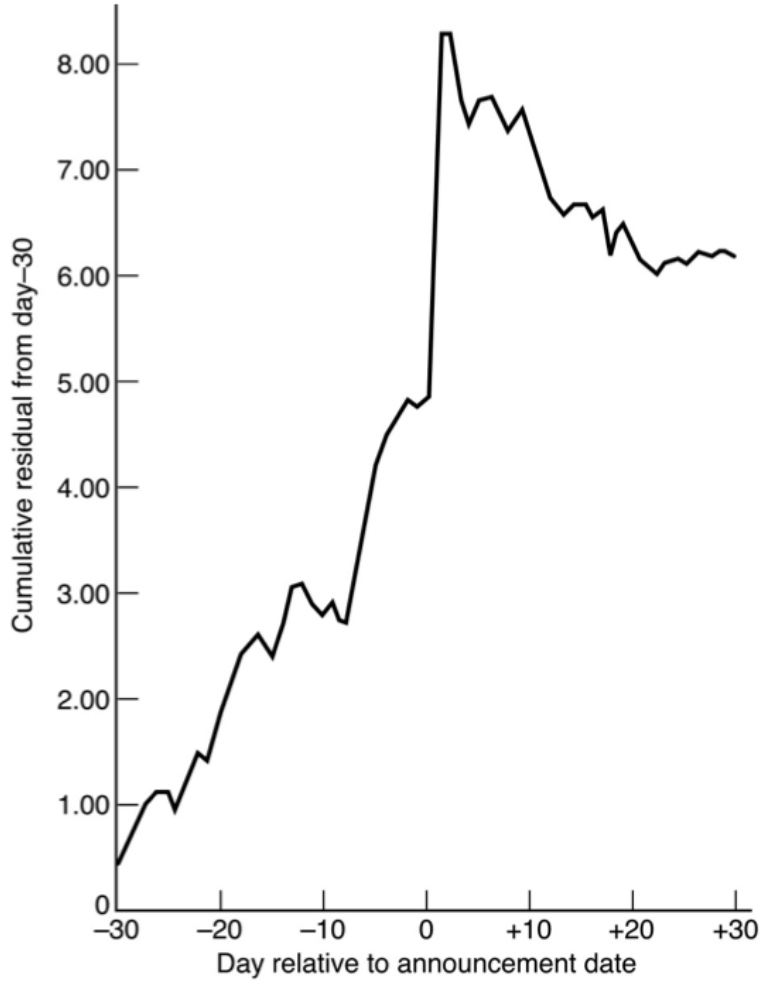
0.33
0.22
0.11
0
Cumulative average residual – U_m
–29 –25 –20 –15 –10 –5 0 5 10 15 20 25 30
Month relative to split – m


8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
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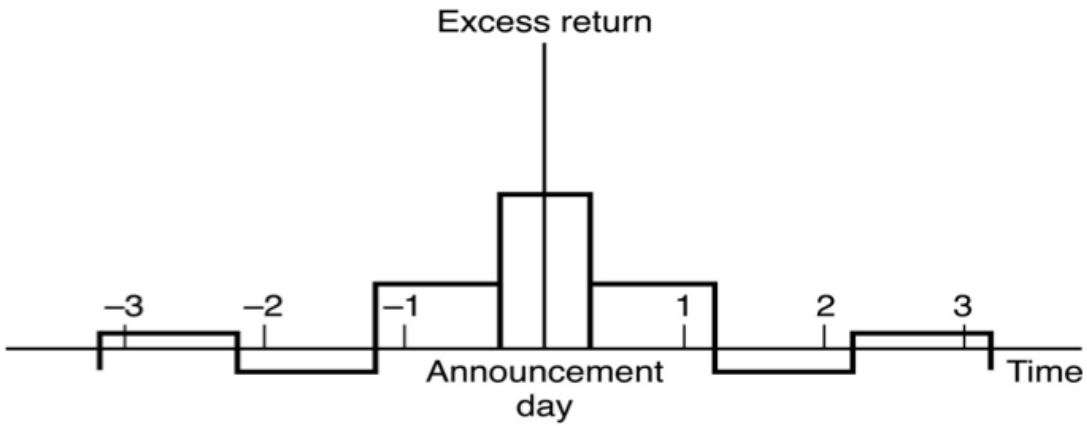
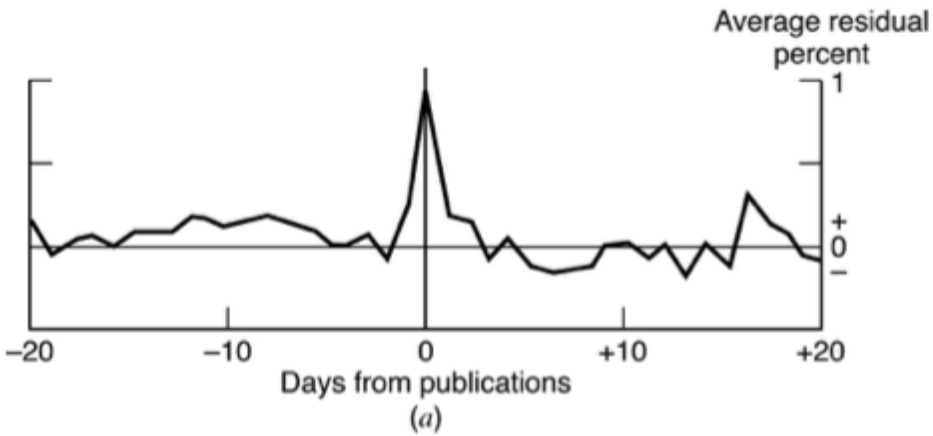
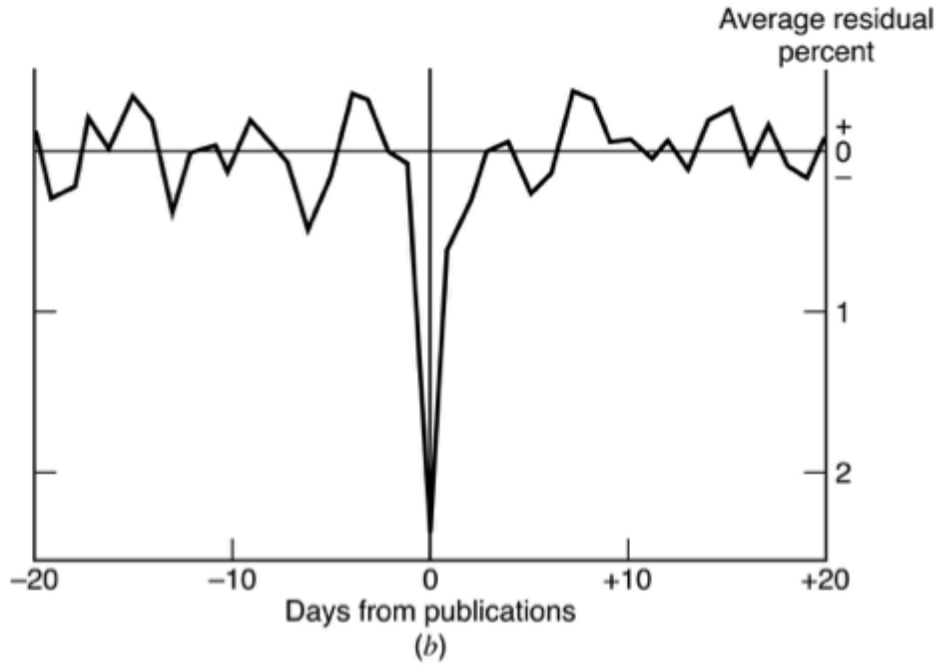
Cumulative residual from day–30
–30 –20 –10 0 +10 +20 +30
Day relative to announcement date

Examples


Excess return
–3
–2
–1
1
2
3
Announcement day
Time


Average residual percent
1
+
0
–
–20
–10
0
+10
+20
Days from publications
(a)


Average residual percent
+
0
–
1
2
–20
–10
0
+10
+20
Days from publications
(b)

Testing strong efficiency

- Strong form test assess market efficiency observing how the stock prices behaviour considering all public and private information.
- Two types of tests have being performed:
  - tests which objective is to relate excess returns with undisclosed information.
    - Since this information is not public and it is difficult to identify it
    - The general idea is to compare the investments made by individual investors and institutional investors, who may possess inside information
  - tests that try to analyse the performance of the most important market players. For example, analysts guidelines can be taken into account and studied.

Testing strong efficiency

"A blindfolded monkey throwing darts at a newspaper's financial pages could select a portfolio that would do just as well as one carefully selected by experts".

Burton Malkie

Theory questions

- Name the two main types of weak efficiency tests.
- What is the idea underlying autocorrelation tests?
- What form of market efficiency can we test using filter tests?
- Why are semi-strong efficiency tests mostly based upon event studies?
- What was the purpose of the "blindfolded monkey" experiment?
- Explain the difficulties in testing strong efficiency.

3.3 Anomalies

- Learning objectives
- January effect
- Twin shares
- Size effect
- Rebound effect
- Excess volatility
- Crashes
- Bubbles
- Questions

Learning objectives

- Discuss the relationship between the concepts of "anomalies", market efficiency and market rationality.
- Give examples of anomalies in financial markets.
- Discuss bubbles.
- Give other examples of evidence against rationality.
- Define the market risk premium puzzle.

Anomalies

- In the non-investing world, an anomaly is a strange or unusual occurrence.
- In financial markets, anomalies refer to situations when a security or group of securities performs contrary to what theory tells us to expect.
- Anomalies can only be interpreted as a proof of market inefficiency, when (and if) it is possible to find a true arbitrage opportunity that allows to exploit it.
- Otherwise, they say nothing in term of market efficiency.
- Anomalies as a pre-cursor to behavioural finance $\Longrightarrow$ sometimes there seems to be some irrationality the way financial markets behave.

The January effect

- Stocks make excess returns in January.

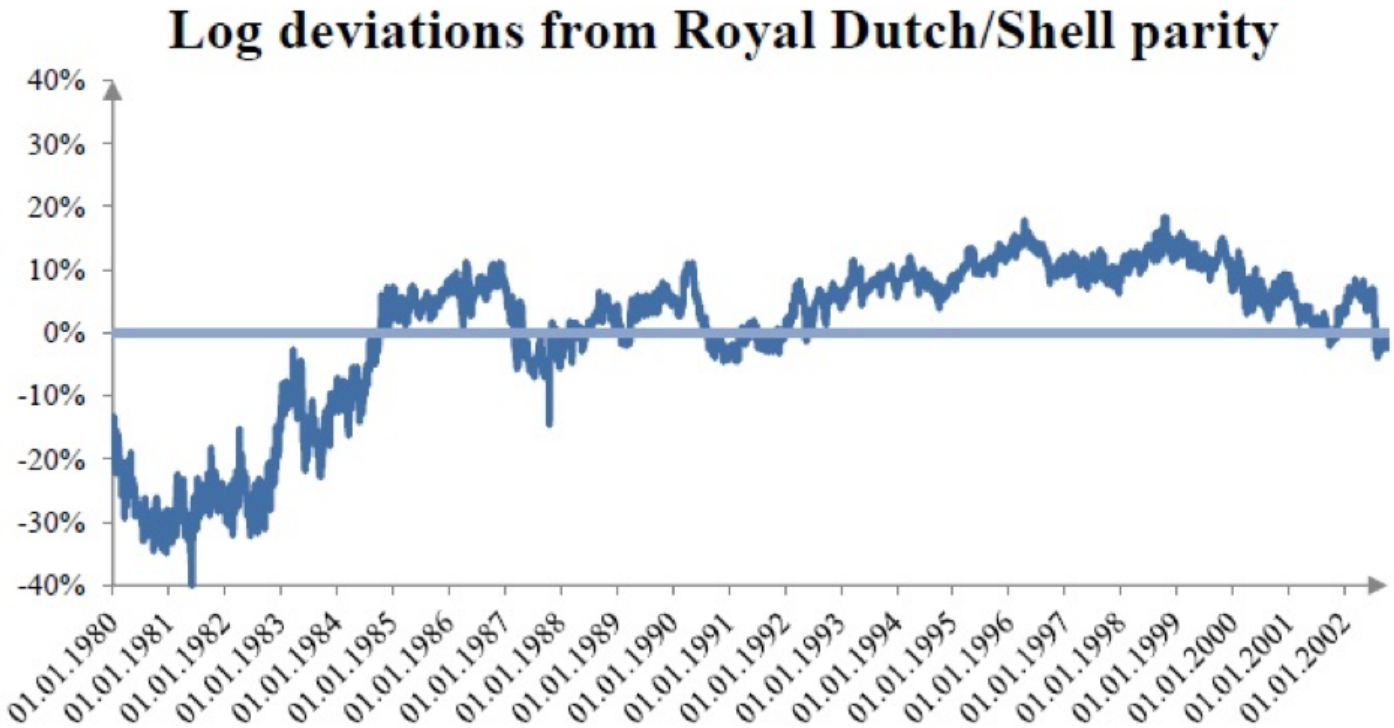
Average Monthly Returns for January, February to December, and All Months

	1941–1981			1982–1990 (91 for January)		
Portfolio	Jan.	Feb.–Dec.	All	Jan.	Feb.–Dec.	All
S&P 500	1.34	0.92	0.96	3.20	1.23	1.39
CRSP Small	8.06	0.88	1.48	5.32	0.17	0.60

- This is particularly the case for small stocks, average return of 8% in January over 1941-1981.
- There are explanations in terms of tax effects and market microstructure.
  - In countries with a January to December tax year, one expects some effects from people trying to minimize capital gains tax.
  - However, the effect also exists in Australia which has a July to June tax year. It should disappear but does not seem to.

Twin shares

- In 1907, Royal-Dutch and Shell merged all their operations: 60% Royal-Dutch; 40% Shell.
- Despite merging their interests the companies remained separate.
  - ratio of fundamental values 60/40.
  - however, the ratio os prices remained different from 60/40 over time.



The size effect

- Over 1936-1977, small firms made about 20% more a year than large firms.
- Where small firms were defined as the smallest fifth of the NYSE.
- Some possible explanations are
  - it simply reflects risk – and pinning down risk is hard,
  - transactions costs are bigger,
  - it was true then, but is less true now.

OBS: It seems " 

" ... even in financial markets!

The size effect

Year-by-Year Comparison of January Returns for 1982–1991

Year	S&P	CRSP Small	CRSP–S&P
1982	−1.63	−1.53	0.10
1983	3.48	10.01	6.53
1984	−0.65	0.26	0.91
1985	7.68	13.41	5.73
1986	0.44	3.82	3.38
1987	13.43	10.91	−2.52
1988	4.27	7.58	3.31
1989	7.23	4.79	−2.44
1990	−6.71	−6.38	0.33
1991	4.42	10.28	5.86

The value-weighted Center Research in Security Prices (CRSP) small-stock portfolio (CRSP Small) contains the bottom quintile of NYSE stocks, and the American Stock Exchange (AMEX) and National Association of Stock Dealers (NASDAQ) stocks that fall below the size (price times shares) breakpoint for the bottom quintile of NYSE stocks. The portfolio is formed at the end of each quarter and held for one quarter. Prior to June 1962, CRSP Small contained only the bottom quintile of NYSE stocks. AMEX stocks were added in July 1962 and NASDAQ stocks in January 1973.

The rebound effect

- Use the following selection rule:
  - Invest in the 50 stocks that have lost the most in the previous five years.
  - Don't invest in 50 stocks that have made the most in the previous five years.
- DeBondt and Thaler show that the first portfolio has abnormally high returns. The second has abnormally low returns.
- This suggests that the market over-reacts to news.
- A crowd mentality causes the stock to move too far.
- One explanation is simply that it reflects additional risk in stocks that did badly in the last five years.

Excess volatility

- Stocks move up and down much more than you would expect based on the amount of information arrival.
- This suggests people's risk preferences waver around an awful lot.
- However, it is hard to truly assess changes in risk preferences.

OBS: Also ...

"markets go up by escalator, but they go down by elevator".

Crashes

- Market crashes occur.
  - The FTSE lost 30% in one day in October 1987.
  - Recall the recent financial crisis of 2008-2010.
- There wasn't much news that day or immediately before.
- Most of the big crashes of history are news-less.

Q: Why should risk-premia or expectations have changed so drastically?

Bubbles

- Markets from time to time enter bubbles.
- The value keeps on increasing to unimagined heights and then it bursts spectacularly.
- Examples
  - South Sea Bubble
  - Tulip mania
  - The internet bubble
  - Florida land bubble
  - Great crash of 1929
  - US property bubble in 2007

Tulip mania

- Probably the most famous bubble of all time.
- It happened in seventeenth century Holland.
- In 1623, a tulip bulb cost 1000 florins, six times the average annual wage.
- In 1635, 40 bulbs were sold for 100,000. Biggest sale ever one bulb for 6000.
- Fortunes were lost and made.
- There are always justifications that one can find.
- For example, it has been argued that tulips had special properties at the time caused by a virus: the mosaic virus. Also, prices were driven up by the thirty years war. The crash was exacerbated by the conversion of futures contracts to options contracts.

The internet bubble

- As the internet took off in the late 90's, companies became very valuable purely for having ".com" in their names.
- The Nasdaq where most such companies were listed soared to immense heights and then rapidly declined in 2000.
- There was a general belief that all commerce would be done on the internet in the future and therefore all internet companies would make a fortune. Many people said it was a bubble at the time.

Risk-premium puzzle

- Over long periods of time, eg 30 years, stocks have outperformed other investments consistently in the US and UK.
- Therefore they are not risky if invested in for the long term.
- Therefore, they should not carry a large risk premium.
- Therefore, prices should be much higher.
- In fact, it is a well-known problem in finance that stock prices appear to return much more than one would expect for the level of risk: the equity risk premium puzzle.
- However, the US has only had 4 or 5 periods of 30 years since its economy got going. Plenty of other countries have had stocks do rather dismally but they are small economies now, so no one notices. Also, the Japanese stock market is much lower than 20 years ago. So we have the problem of survivorship bias.

Traditional vs. Behavioural Finance

- Over time established finance theory has assumed that investors have little difficulty making financial decisions and are well-informed, careful and consistent.
- Traditional theory consider investors are not confused by how information is presented to them and not swayed by their emotions. But clearly reality does not match these assumptions.
- Behavioural Finance has been growing over the last twenty years and take the view that finance theory should take account of observed human behaviour.
- It use research from psychology to develop an understanding of financial decision- making and create the discipline of behavioural nance.

Theory questions

- Are anomalies incompatible with market efficiency?
- What is meant by market rationality?
- What are the size, rebound and January effects?
- What is the equity risk premium puzzle?
- Why is excess volatility an argument against market rationality?
- Why are crashes an argument against market rationality?
- Name three famous market bubbles.
- What is survivorship bias?