Theory of stock market II: Efficient market hypothesis (EMH)

EE431 Semester 1/2017

Kittichai Saelee

Up to this point / where we are going next!

- Several valuation techniques introduced.
  - Gordon dividend model: constant growth, multi-stage growth
  - FCFE discounted model
- How to choose for an appropriate discount rate for the valuation.
  - What kind of risk is to be compensated for a premium.
- Next,
  - How price is actually determined in the market?
  - A commonly used (or referred) economics (or financial theory) that explains the behavior of stock price movement.

How the Market Sets Stock Prices

- By demand and supply, of course.
- Details behind the equilibrium process? What does the market price equilibrium reflect?
- Consider an example here to get some sense how equilibrium price can be discovered in the market.

Example: how the market sets stock prices.

- Consider three investors: A, B and C.
  - Each is making an assessment to the valuation a company's stock.
- Let expected dividend pay-out next year be $2 per share. Market analysts expect firm growth to be 3% but there is uncertainty about the constancy of the dividend stream.
- Required rate of return for each investor.
  - Investor A == the required rate of return is 15% for investor A
  - Investor B == the required rate of return is 12%; He has researched industry insiders and is more confident.
  - Investor C == He has some inside information and hence feels that 10% is acceptable to compensate for risk.

Stock prices valuation and Stock setting

- Following the basic Gordon growth model, perceived valuations to each investor are
  - Investor A valuation = [2/(.15-.03)] = $16.67
  - Investor B valuation = [2/(.12-.03)] = $22.22
  - Investor C valuation = [2/(.10-.03)] = $28.57

- If investor A holds stock, he/she would sell it to C. The market price would depend on which investor holds the stock, how much stock and the market orders for the stock.

How the Market Sets Stock Prices

- Then, how the market sets equilibrium stock prices?
  - The price is set by the buyer willing to pay the *highest* price.
    - Those who has the highest degree of risk tolerance, i.e. *lowest required rate of return*.
  - The market price will be set by the buyer who can take *best advantage* of the asset.
- In general, superior information about an asset can increase its value by reducing its perceived risk.

Then why price moves?? How do we explain the movement of price?

- Most existing theories rely on the concept of Information-based price movement.
  - Price gets moved (driven up/down) because of new information incorporated into the valuation.
- When *new* information is released about a firm, expectations and prices change.
- Market participants *constantly* receive information and revise their *expectations*, so stock prices change frequently.
  - Investor C could have turned into the position of Investor A, and then might want to resell the asset to investor A at a higher price if Investor A changes his beliefs.
  - This explains why price is highly volatile, and the dynamic of trading volume (liquidity)

Example: The Global Financial Crisis and the Stock Market

- The financial crisis that started in August 2007 led to one of the worst bear markets in 50 years.
  - "*expected*" Downward revision of growth prospects: $\downarrow g$
  - Perceived risk higher; Increased uncertainty: $\uparrow r_j$
- Gordon model predicts a drop in stock prices.
  - Investors then act according to what they expect; self-fulfilling occurs.

Price reflects expectation! But how expectation is then formed up.

- Information and expectations: how expectation is formed.

- Adaptive expectations:

  - Expectations are formed from past experience only.

  - Changes in expectations will occur slowly over time as data changes.

  - However, people use more than just past data to form their expectations and sometimes change their expectations quickly.

An alternative form is called rational expectations

- Expectations will be identical to *optimal forecasts using all available information.*

- Even though a rational expectation equals the optimal forecast using all available information, a prediction based on it may not always be perfectly accurate.
  - It takes too much effort to make their expectation the *best guess* possible.
  - The best guess will not be accurate because the predictor is unaware of some relevant information.

Adaptive v.s. Rational expectation?

- Rational expectation is a sensible assumption for studying behavior of investors in the financial markets.
  - The incentives for equating expectations with optimal forecasts are especially strong in financial markets. In these markets, people with better forecasts of the future get rich.

- The application of the theory of rational expectations to financial markets is thus particularly useful as a good starting point to see if the theory explains data!

Implications of the Theory

- The forecast errors of expectations will, on average, be zero and cannot be predicted ahead of time.

$$X_t - E(X_t|I_t) = \varepsilon_t$$: unbiased and minimum standard error!

- A famous prediction for the rational expectation theory applied to financial market is the efficient market hypothesis.

Concepts of efficiency

- Economics provides concepts of efficiency – ***allocative*** and ***operational*** efficiency

- An ***allocationally efficient market*** is one where prices are determined where market demand equals market supply.

- An ***operationally efficient market*** is one where transactions costs of moving resources around are zero. e.g: perfect capital markets

Rational expectation and Efficient Capital Markets: (Fama 1965)

- Efficient markets in finance is less restrictive than the concept of perfect capital markets.

- In an efficient capital market, **prices fully and instantaneously reflect all available relevant information** – *informationally efficient*.

- A capital market may be informationally efficient but not allocatively or operationally efficient. e.g. imperfect competition (allocatively inefficient) or transactions costs like the proposed Tobin tax (operationally inefficient).

Rational expectation and Efficient Capital Markets: (Fama 1965)

- Under rational expectation, market participants ought to make use all the available information set in the economy when they set price.
- Fama (1965) argue for the case of (informationally) efficient capital market, and develop a theory that explains the behavior of stock price (returns) under the *rational expectation model*.
- His viewpoints lead to the following main conclusion:

On its expected basis, security returns should be equal to market equilibrium return. And no one should earn an abnormal returns.

The Efficient Market Hypothesis: Rational Expectations in Financial Markets

Recall

The rate of return from holding a security equals the sum of the capital gain on the security, plus any cash payments divided by the initial purchase price of the security.

$$R = \frac{P_{t+1} - P_t + C}{P_t}$$

R = the rate of return on the security

P_{t+1} = price of the security at time $t + 1$, the end of the holding period

P_t = price of the security at time t, the beginning of the holding period

C = cash payment (coupon or dividend) made during the holding period

The Efficient Market Hypothesis: Rational Expectations in Financial Markets

At the beginning of the period, we know P_t and C.

P_{t+1} is unknown and we must form an expectation of it.

The expected return then is

$$R^e = \frac{P^e_{t+1} - P_t + C}{P_t}$$

Expectations of future prices are equal to optimal forecasts using all currently available information so

$$P^e_{t+1} = P^{of}_{t+1} \Rightarrow R^e = R^{of}$$

Supply and Demand analysis states R^e will equal the equilibrium return R^*, so $R^{of} = R^*$

Rationale Behind the Hypothesis: no-arbitrage equilibrium

$$R^{of} > R^{*} \Rightarrow P_t \uparrow \Rightarrow R^{of} \downarrow$$

$$R^{of} < R^{*} \Rightarrow P_t \downarrow \Rightarrow R^{of} \uparrow$$

until

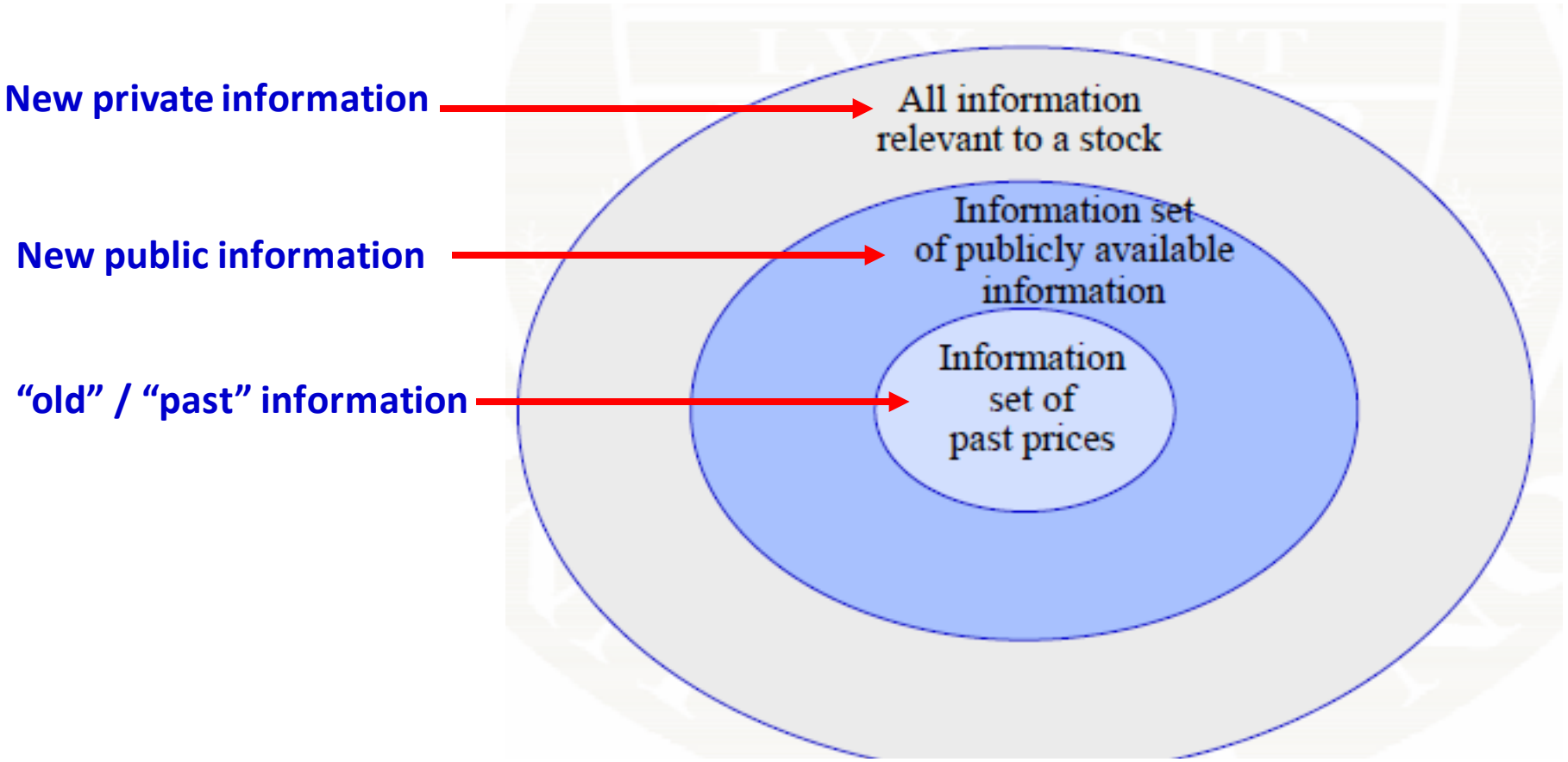
$$R^{of} = R^{*}$$

In an efficient market, all unexploited profit opportunities will be eliminated

Versions of Efficient Capital Markets

- When the idea was first introduced, people criticize that model's prediction is based on some strong assumptions, i.e. using all the information.
- How fast agent/trader can make use all the information into the price setting is the issue/concern/problem for the theory.
  - We know that arbitrage opportunity should be exploited "eventually", but may not be instantaneously.
- So, those who advocate the efficient concept distinguish the cases for efficiency into three versions.

What types of information set?



Weak form efficiency

- ***Weak form efficiency*** – no investor can earn excess returns by developing trading rules based on historical price/returns data. So ***technical analysis*** or ***chartists*** rules cannot beat the market.
  - People already figured our that those rules work in the past, and hence incorporated those rules into trading process.
  - Such an arbitrage opportunity that used to be in place is already exploited, and no longer useful for making excess returns!

- All past information is reflected in the spot price of an asset.

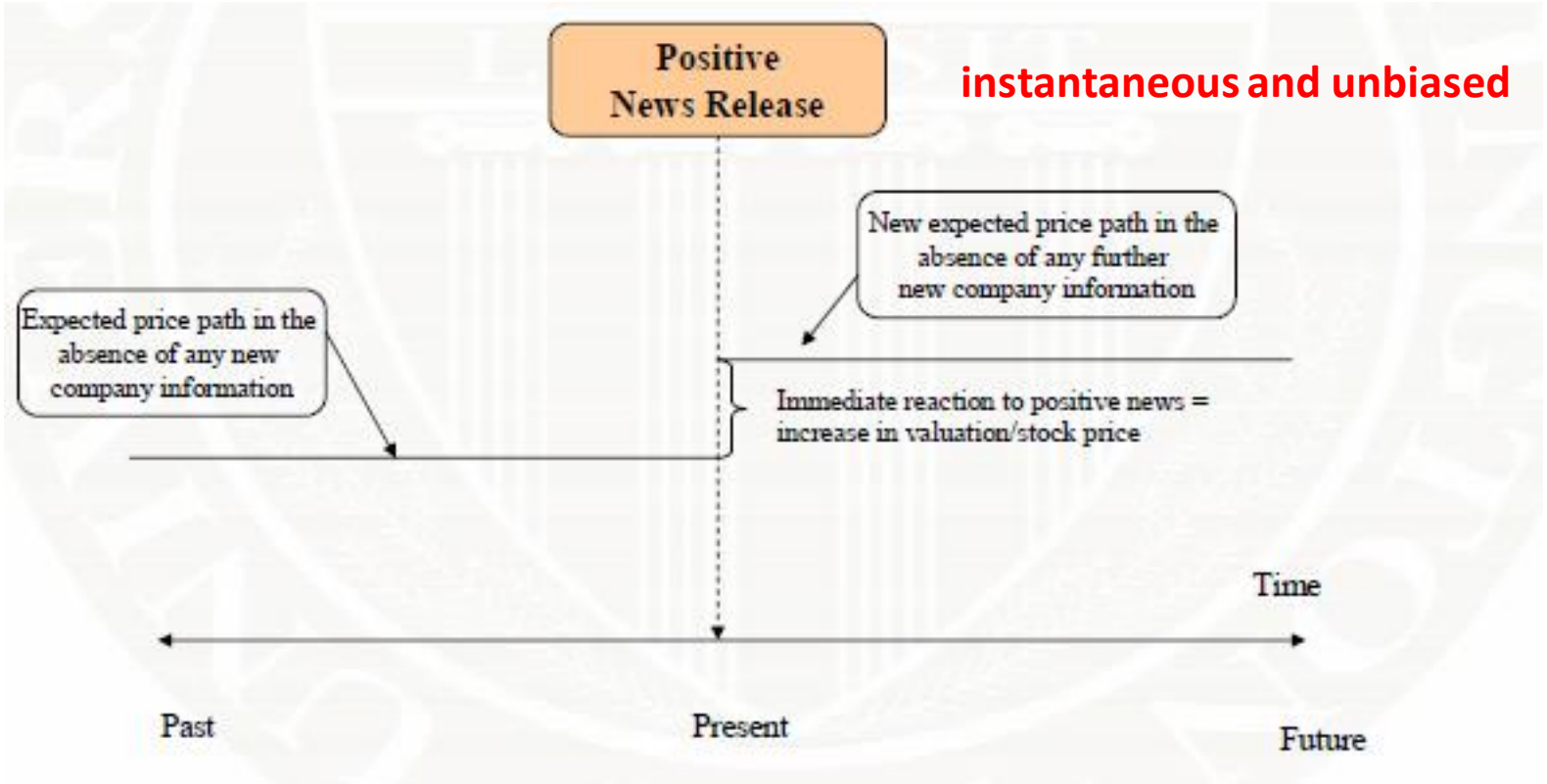
Semi-strong form efficiency

- No investor can earn excess returns from trading rules based on any publicly available information.

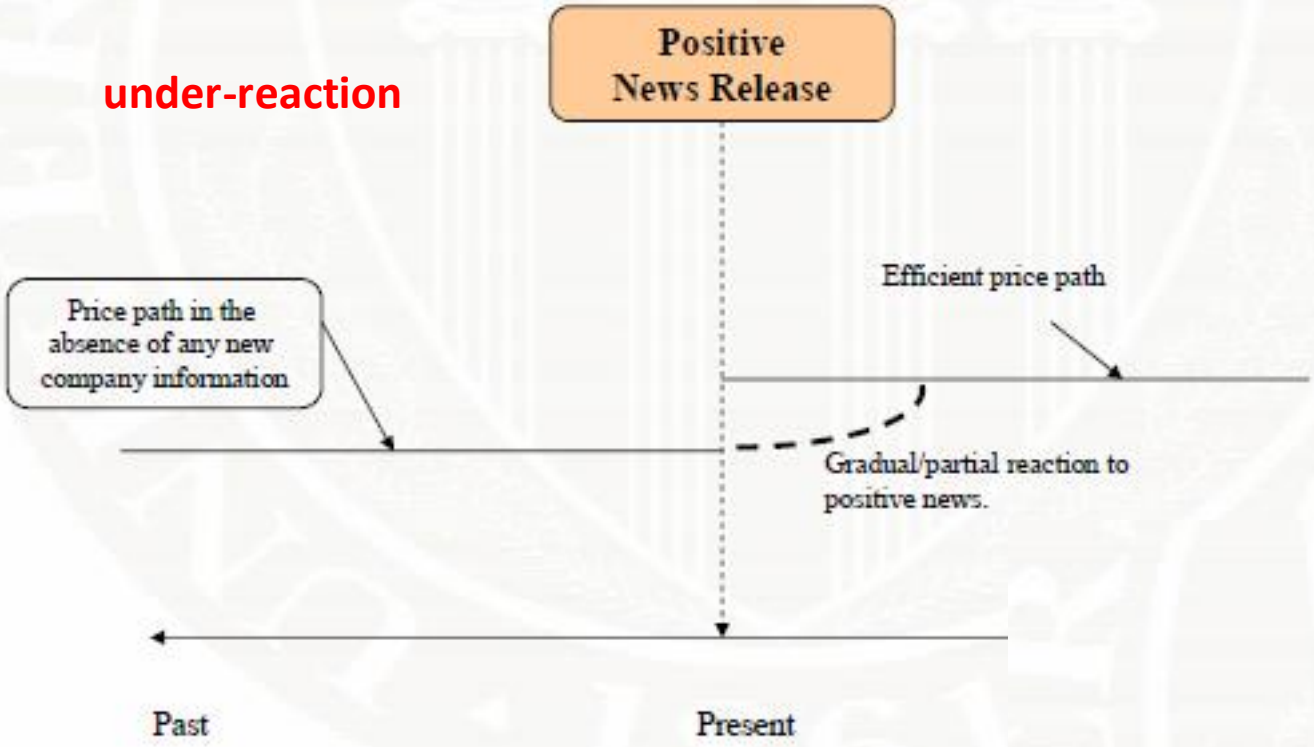
- Implication is that all publicly available information is fully reflected in the actual asset price.

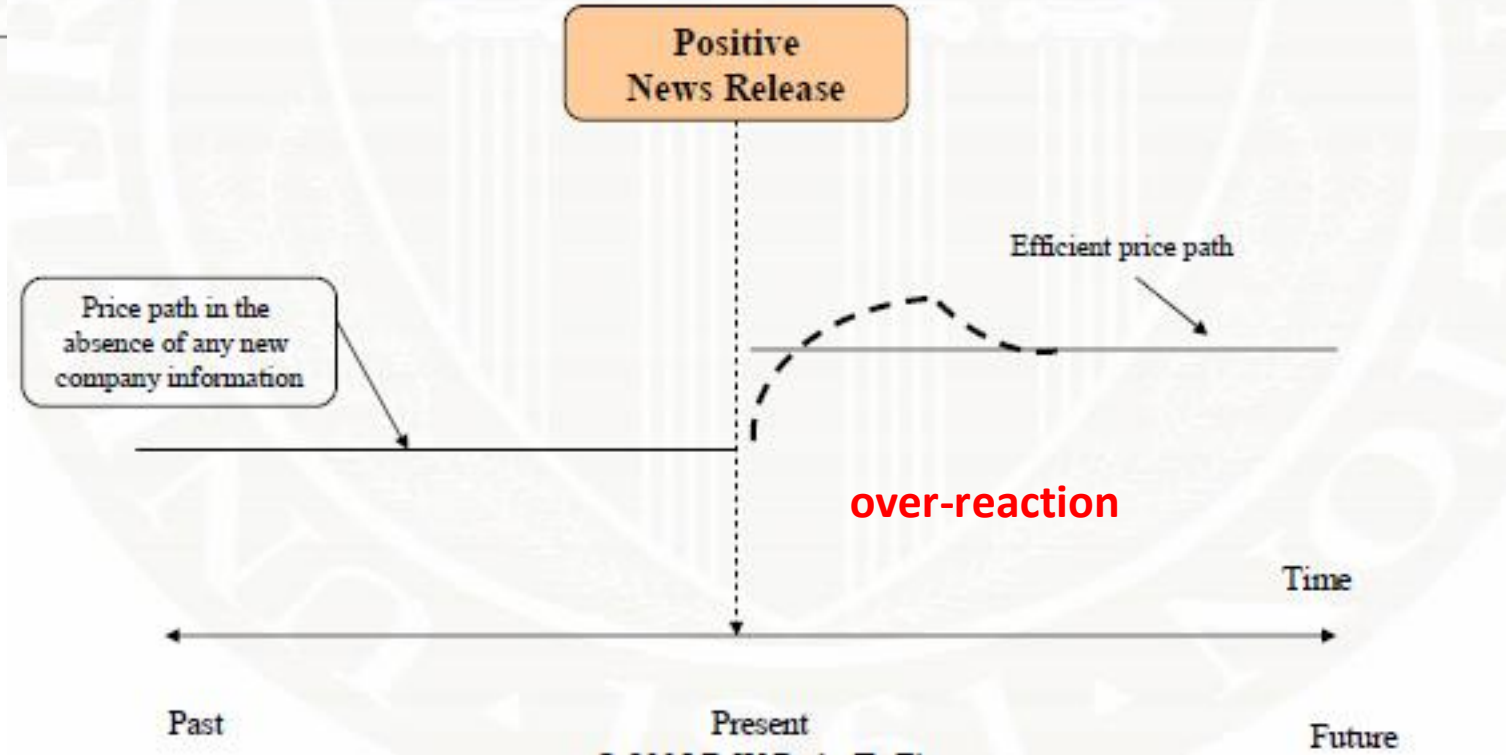
- Market reaction to new publicly available information is instantaneous and unbiased. **No over- or under-reaction. *Fundamental analysis* based on publicly available information shouldn't result in abnormal returns.**

Market reaction to public information



under-reaction





Strong form efficiency

- No investor can earn excess returns using any information – public or private.

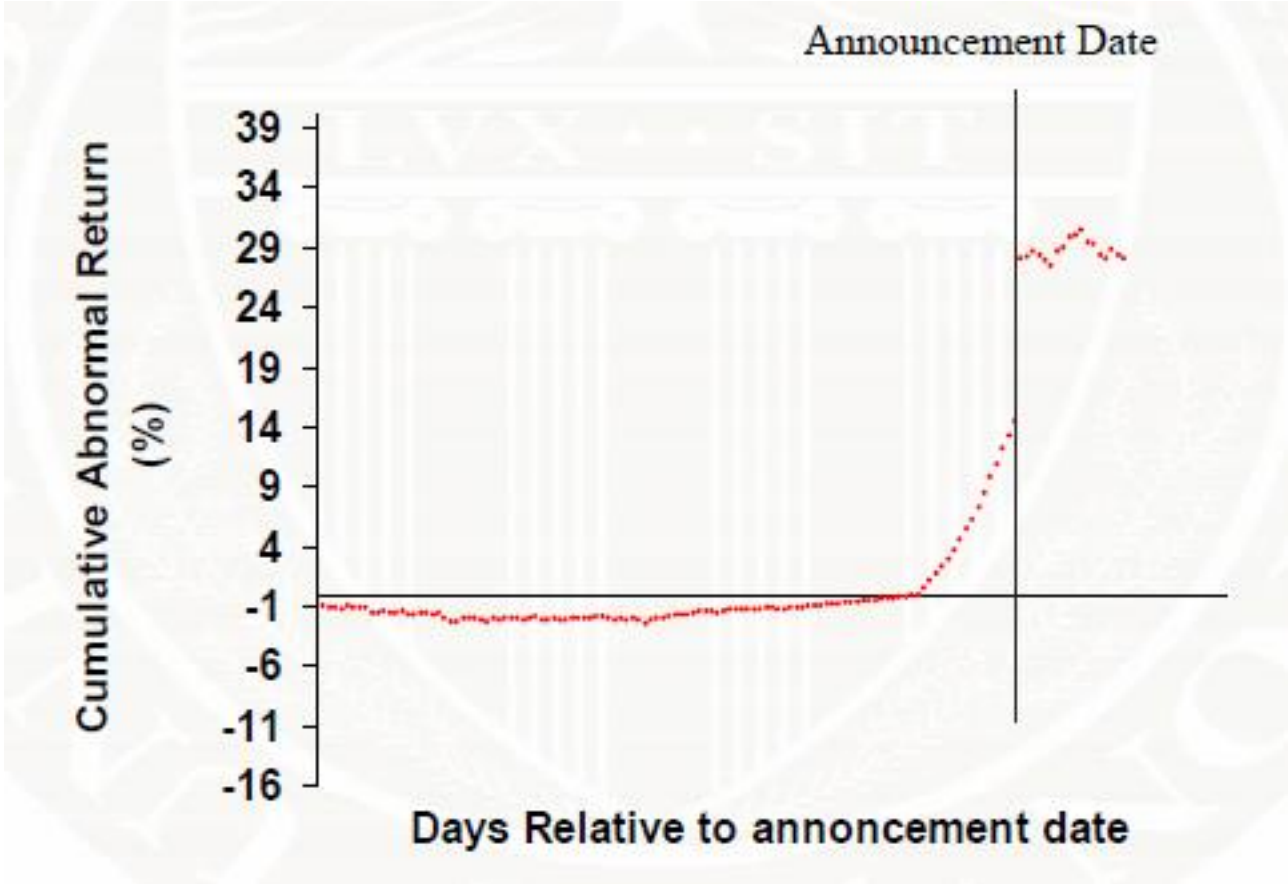
- Strong form efficiency implies that **all** information is fully reflected in the price of the asset.

- Even private information! – Insider trading is ineffective

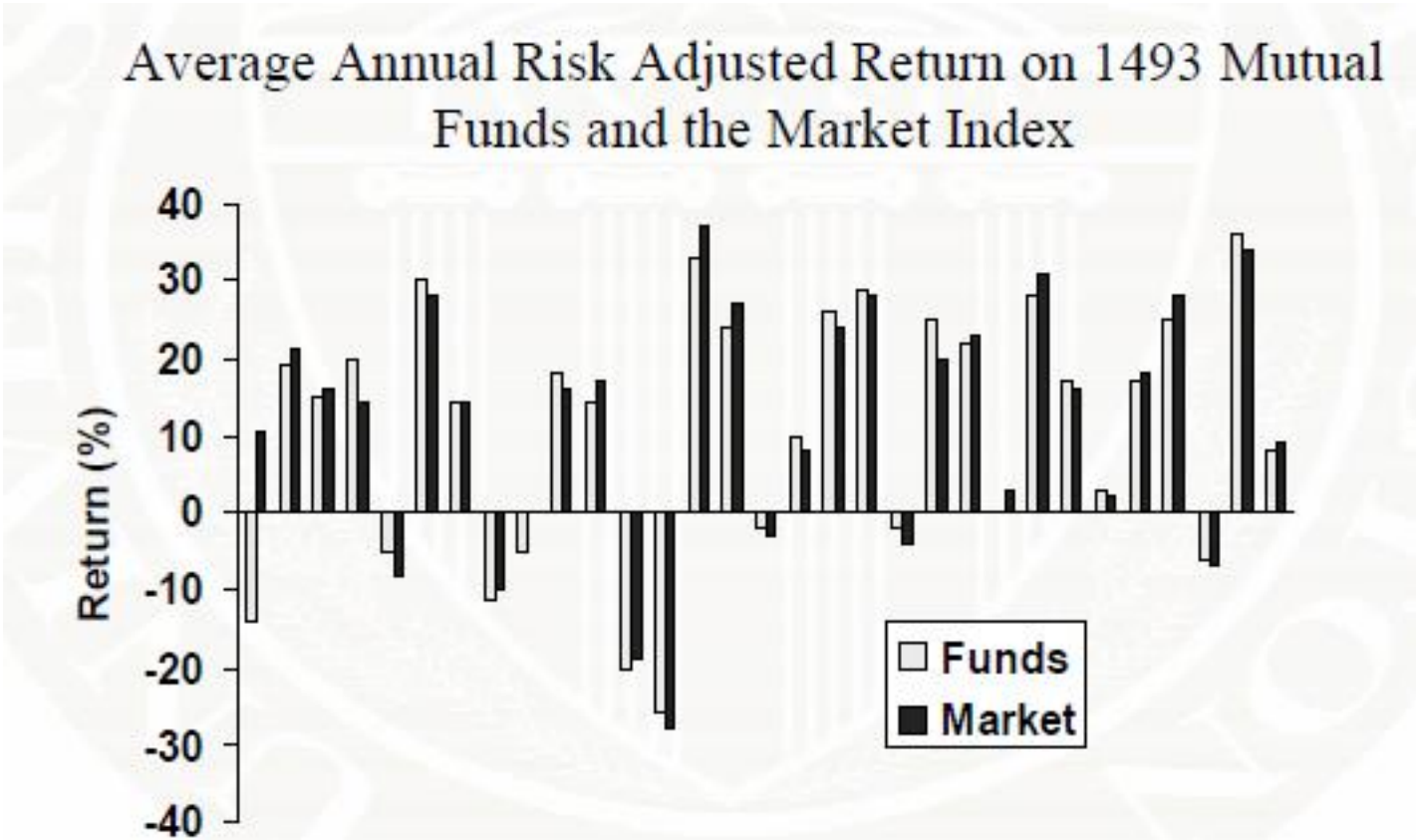
Evidence in favour of EMH

- Empirical studies confirm that stock pickers or mutual fund managers cannot *"consistently"* outperform the market *over a long period of time*.
  - *Statistical test using cross-sectional comparison on "long-term average return" earned by each mutual fund managers.*
- The EMH states that stock prices reflect all available information so that earnings announcements that are already known will not affect stock prices when the announcements are made. *Only 'new' news causes stock prices to change.*
  - *If earning announcement are in line with market expectation, price should be roughly staying the same as yesterday.*

Semi-strong form test: event studies for merger/takeover announcements



Strong-form testing: risk-adjusted return comparison



Evidence in favour of EMH

- Fama (1970): Future changes in stock prices should follow a random walk (future changes in prices are unpredictable).
  - Very strong prediction leading to many studies that attempt to test the random walk property of the stock data.

Random Walk: assume expected dividend stream is constant, i.e. "g" = 0.

$$P_t = \left(\frac{E(D_{t+1}|\theta_t}{(1+r)} \right) + \frac{E\left(P_{t+1}|\theta_t\right)}{(1+r)} = \frac{E\left(D_{t+1}|\theta_t\right)}{r}$$

$$P_{t+1} = \left(\frac{E(D_{t+2}|\theta_{t+1}}{(1+r)} \right) + \frac{E\left(P_{t+2}|\theta_{t+1}\right)}{(1+r)} = \frac{E\left(D_{t+2}|\theta_{t+1}\right)}{r}$$

$$P_{t+1} - P_t = \frac{E\left(D_{t+2}|\theta_{t+1}\right)}{r} - \frac{E\left(D_{t+1}|\theta_t\right)}{r} = u_{t+1}$$

$$P_{t+1} = P_t + u_{t+1}$$

$$E\left(P_{t+1}|\theta_t\right) = E\left(P_t|\theta_t\right) + E\left(u_{t+1}|\theta_t\right)$$

Random Walk

- Since the expectation of P_t conditional on information at time t is simply itself P_t.

- The difference between expected dividends in t+1 given information at time t and dividends in t+2 given information at time t+1 is 'new' news and is therefore unpredictable. Hence its expectation is ZERO.

Random Walk : Testing unit root in price movement.

$$P_{t+1} = P_t + u_{t+1}$$

$$E\left(u_{t+1} \middle| \theta_t\right) = 0$$

Empirical evidences against EMH

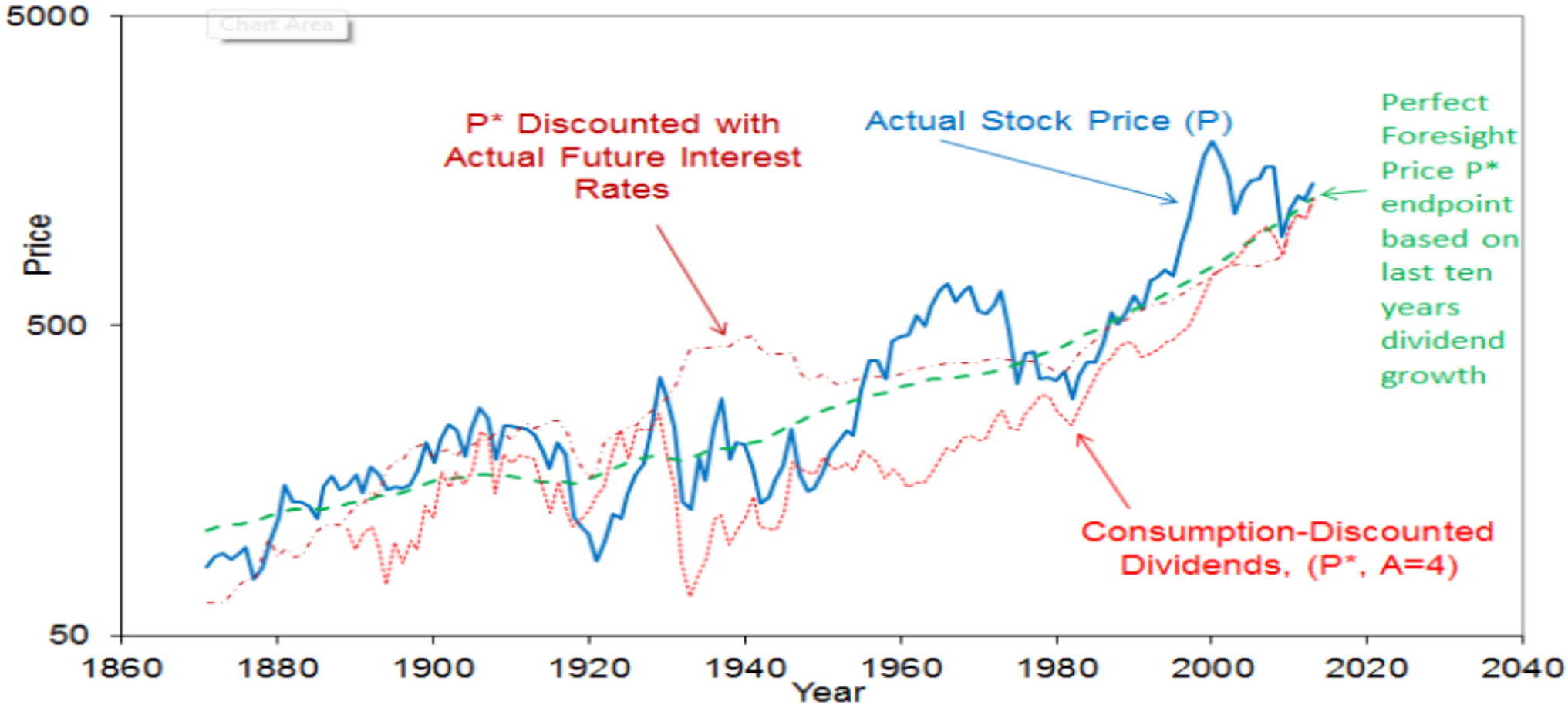
- Size effect – Empirical studies show that small firms earn abnormal returns over long periods, i.e. size premium.

- January effect – studies have confirmed an abnormal price rise from December to January, i.e. turn-of-the-year premium.

- Market overreaction – over/under shooting following ‘new’ news.

Empirical evidences against EMH

- Excessive volatility
  - Fluctuations in stock prices are greater than the fluctuations in the fundamentals.



Empirical evidences against EMH

- Mean reversion – low returns stock tend to be followed by high returns and vice versa. Stocks that have done poorly in the past tend to do better in the future.
  - But the evidence on this is controversial.

- Lag in effect of ‘new’ news – stock prices do not always react to news instantly. Some evidence of autocorrelation.

Empirical evidence against EMH leads to a new field called "Behavioural Finance"

- Doubts about EMH particularly after the stock market crash of 1987 (and probably 2008) have led to the emergence of a new field in finance.
- Applies psychology, social anthropology and sociology to understand the behaviour of stock markets.
- One of the arguments of EMH is that unexploited profit is eliminated by knowledgeable investors. For this to happen they must engage in short selling, i.e. limit to arbitrage.
- Short selling – borrowing the stock from brokers and then sell it in the market with the aim of making a profit by buying the stock back at a lower price.
- Psychologists suggest that people are subject to *'loss aversion'.* They are more unhappy from losses than happy with equivalent gains. Because the potential losses can be huge from short selling in reality short selling occurs only in special circumstances.
- Psychologists also find that people tend to be *overconfident* in their own judgements. Overconfidence and social contagion explain the creation of speculative bubbles.