

## Market Efficiency

Market Efficiency is a concept: "*Efficient Markets Hypothesis*" (EMH) states that stock prices reflect information. If markets are efficient then new information is reflected quickly into market prices. Conversely, if markets are inefficient information is reflected only slowly into market prices, if at all.

In order to provide a more practical definition of market efficiency it is necessary to define the *information structure*. There are three forms of the EMH:

1) Weak form (Predictability); 2) Semi-strong form (Event studies); and 3) Strong form.(Inside information) [The terms in brackets are the revised definitions in Fama (1991)]

If stock prices are *weak form efficient*, then past prices contain no information about future changes and price changes are random. Kendall (1953) found that stock and commodity prices follow a random walk. A random walk implies zero correlation between price change at  $t$  and price change at  $t+1$ , which is what we observe. If price cycles were predictable competition between investors would eliminate them: Arbitrage/Speculation will force prices to their efficient values. If prices are predictable then a simple trading rule would be: BUY undervalued assets and SELL overvalued assets. Prices will only change on the basis of new information which by definition is random, hence price changes are random.

If prices are *semi-strong form efficient* then prices reflect all public information. Empirical finding is that prices do react to information contained in an annual report. The *Cumulative Abnormal Returns* methodology for testing for semi-strong efficiency was pioneered for Stock splits by Fama, Fisher, Jensen and Roll (1969), and for earnings announcements by Ball and Brown (1968). Other examples are Dividend/Earning announcements [Rendleman, Jones and Latane (1982)], new issue market [Ibbotson (1975)] and merger announcements [Jensen and Ruback (1983)].

If prices are strong form efficient all private information is reflected in prices. So that insider trading is not profitable and the performance of mutual funds does not generate abnormal returns. Evidence is that insider trading is slightly profitable [Finnerty (1976, JF), Muelbrouk (1992, JF)], but performance of mutual funds [Jensen (1968), Blake, Lehman and Timmerman (1997)] found that they do not generate abnormal returns, which is consistent with strong form efficiency.

Note that tests of semi-strong and strong form market efficiency rely on an appropriate asset pricing model, and therefore are joint tests of efficiency and asset pricing.

The empirical evidence surveyed in Fama (1991) and Fama (1998) generally supports the idea that prices do seem to be weak and semi-strong efficient but that that markets are not strong form efficient (there are theoretical reasons why strong-form efficiency is unlikely - Grossman-Stiglitz(1980). But there are some well known anomalies including a) Small firm/January effect b) Day of the Week effect c) Holiday effects d) Volatility tests/predictability of long run returns e) Autocorrelation properties, f) Contrarian/Value strategies, g) Momentum strategies h) New Issue market.

## ANOMALIES to the EMH

### - Small firm/January effect/P-E ratios

Basu (1977) identified P-E ratios as predictors of subsequent performance. In particular high P-E firms underperformed and low P-E firms overperformed. Banz (1981) and Reinganum (1981) suggested that this P-E effect was related to firm size, that small firms tend to outperform large firms even after an allowance is made for the likely riskier characteristics of small firms. In addition the phenomenon that prices tend to fall during the last few days of December and rise in the first few days of January, was also found to be acute for small firms.

### - Day of the Week, Time of Day and Holiday effects [Calendar Effects]

French (1980) and Gibbons and Hess (1981) document daily patterns in returns, in particular on average returns on Mondays tend to be negative. Further Harris (1986) and Jain and Joh (1988) have documented small but significant intra-day patterns in returns

### - Excess Volatility and Predictability

Shiller (1981) found that stock prices are excessively volatile compared to those given by the PV model. Similarly Fama and French (1988, JFE) found that although short-run returns (one year or less) are unpredictable, long run returns (5-year horizon) are predictable - negative correlation. Poterba and Summers (1988, JFE). Also see De Bondt and Thaler (1985 JF, 1987 JF) on winner and loser portfolios (see Contrarian Strategies).

### - Own and Cross-Autocorrelation properties

Campbell, Grossman and Wang (1993, QJE), Jegadeesh (1990, JF), Lo and MacKinlay (1988 RFS, 1990 RFS).

### - Contrarian/Value strategies

De Bondt and Thaler (1985 JF, 1987 JF) found that portfolios of loser portfolios outperform and winner portfolios underperform subsequently. Lakonishok, Shleifer and Vishney (1994) examine this “*contrarian*” strategy in more detail. “*Value Strategies*” call for buying stocks that have low prices relative to some measure of value (i.e. earnings, dividends, historical prices, or book assets). Value strategies seem to produce excess returns - but is this because 1) They are contrarian (to naive strategies such as extrapolating past earnings growth, or over-reacting to news so that “*glamour stocks*” are overpriced), or 2) They are fundamentally riskier? [Fama and French (1992)]. LSV find that *glamour stocks* do underperform relative to value stocks over 1968-90 period- apparently because market consistently over estimates future growth rates of glamour stocks relative to value stocks. Also value stocks are no more risky than glamour stocks. Are these results a consequence of short time horizons of institutional investors / fund managers?

Fama and French (1996) with their three-factor model, suggest that there are three explanations for their results 1) CAPM is incorrect and a three-factor model is correct specification of the world. 2) CAPM is correct but investors are irrational [LSV(1994)]. 3) CAPM is correct but is not has not been tested properly

Also see La Porta, Lakonishok, Shleifer and Vishney (1997) examine whether glamour stocks have negative three-day returns around subsequent earnings announcements, and whether value stocks have positive returns. This would be consistent with the market having the wrong expectations initially.

### - Momentum strategies

Jegadeesh and Titman (1993, JF), Chan, Jegadeesh and Lakonishok (1996): Evidence that in the short run prices are positively autocorrelated, a run-up in prices is followed by further price increases.

### - Underpricing of IPO's

Ibbotson (1975) found that new issues of equity are underpriced by on average approximately 12%. More recently Loughlin, Ritter (1994) emphasised that this was an international phenomenon. Ritter (1991) has identified the long-run underperformance of IPOs, though Brav and Gompers (1998) have queried this

## Market Efficiency II

Economics is concerned with three types of efficiency:

- 1) Pareto efficiency
- 2) Informational efficiency
- 3) Operational efficiency

An interesting question is whether informational efficiency is either a necessary or sufficient condition for Pareto efficiency

Informational efficiency is also called market efficiency, and relates to whether stock market prices reflect information about the company

One interpretation of market efficiency, is that it reverses the causation in the present value model. The present value model of stock prices says that stock prices are the discounted value of expected future dividends. Assuming dividends are expected to grow at a compound rate  $g$  from current dividends  $d_{t-1}$ , then the PV model defines efficient stock prices as

$$p_t = \frac{d_{t-1}}{r - g}$$

and in an efficient market an investor can infer the market's expectation of the growth rate of dividends  $g$  from stock market prices.

Market Efficiency is a concept

- "*Efficient Markets Hypothesis*" (EMH) states that stock prices reflect information.
- If markets are efficient then new information is reflected quickly into market prices.
- Conversely, if markets are inefficient information is reflected only slowly into market prices, if at all.

To test the EMH, the null hypothesis is that the security market is a "fair game". That is the difference between actual and expected returns is unpredictable [rational expectations]

$$r_{i,t+1} = E(r_{i,t+1}|\Omega_t) + \varepsilon_{i,t+1}$$

where  $r_{i,t+1}$  is the return on security  $i$  in period  $t+1$ ,  $\Omega_t$  is the information set available at time  $t$ , and  $\varepsilon_{i,t+1}$  is the prediction error, where

$E(\varepsilon_{i,t+1} \Omega_t) = 0$	[prediction error is unbiased]
$E(\varepsilon_{i,t+1}, E(r_{i,t+1} \Omega_t)) = 0$	[prediction error is independent of forecast]
$E(\varepsilon_{i,t+1}, \varepsilon_{k,t+1} \Omega_t) = 0$	[prediction error of $i$ is independent of $k$ ]

$E(\epsilon_{i,t+1}, \epsilon_{i,t} | \Omega_t) = 0$  [prediction error is serially independent]

In order to provide a more practical definition of market efficiency it is necessary to define the *information structure* [ $W_t$ ].

Fama (1970) defines three forms of the EMH:

- 1) Weak form
- 2) Semi-strong form and
- 3) Strong form.

Though Fama (1991) redefines these forms as predictability, event studies and inside information. This redefinition is preferable because it is unclear whether any of these different forms are "nested"

### **Weak-Form Efficiency**

If stock prices are *weak form efficient*,

- past prices contain no information about future changes
- price changes are random.

Kendall (1953) found that stock and commodity prices follow a random walk.

A random walk implies zero correlation between price change at  $t$  and price change at  $t+1$ , which is what we observe.

If price cycles were predictable competition between investors would eliminate them.

- Arbitrage/Speculation will force prices to their efficient values
- Simple trading rule: BUY undervalued assets - Sell overvalued assets

Prices will only change on the basis of new information which by definition is random

- hence price changes are random.

### **Semi-Strong Form Efficiency**

If prices are *semi-strong form efficient* then prices reflect all public information

Empirical finding is that prices do react to information contained in an annual report.

For example

- Stock splits [Fama, Fisher, Jensen and Roll (1969), provide original event study methodology]
- Dividend/Earning announcements [Ball and Brown (1968), Rendleman, Jones and Latane (1982)]
- Merger announcements [Jensen and Ruback (1983)]

General results are that an unanticipated announcement causes significant abnormal returns after the announcement has been made. These results are consistent with semi-strong efficiency.

## **Strong Form Efficiency**

If prices are *strong form efficient* all private information is reflected in prices.

In fact insider trading is profitable [Finnerty (1976) Muelbrouk (1992, JF) for US, and Gregory, Matatko, Tonks and Purkis (1994, 1997) for UK] which suggests markets are not strong form efficient. Research into the performance of mutual funds [Jensen (1968), Blake, Lehman and Timmerman (1997)] ] found that they do not generate abnormal returns, which is consistent with strong form efficiency.

Gregory, Matatko, Tonks and Purkis (1994) reassesses the UK results of significant abnormal returns from directors' trading for a new sample of directors' trades 1984-1986, and finds that abnormal returns tend to be concentrated in smaller firms. When an appropriate benchmark portfolio is used, it is found that the significance of the abnormal returns is substantially reduced. Implication is that directors' trading does not yield particularly high profits to either the directors themselves or to an outside investor mimicking those trades.

Jensen (1968) examined the performance of 115 mutual funds over the period 1955-1964,

Grossman and Stiglitz (1980) argue that in an strong form efficient market insiders will earn abnormal returns, but only sufficiently abnormal to offset their information acquisition activities.

Note that tests of semi-strong and strong form market efficiency rely on an appropriate asset pricing model, and therefore are joint tests of efficiency and asset pricing.

### **Conclusions on market efficiency:**

Unlikely that markets are strong form but prices do seem to be weak and semi-strong efficient

BUT

There are well-documented ANOMALIES to the EMH

#### **- Small firm/January effect/P-E ratios**

Basu (1977) identified P-E ratios as predictors of subsequent performance. In particular high P-E firms underperformed and low P-E firms overperformed. Banz (1981) and Reinganum (1981) suggested that this P-E effect was related to firm size, that small firms tend to outperform large firms even after an allowance is made for the likely riskier characteristics of small firms. In addition the phenomenon that prices tend to fall during the last few days of December and rise in the first few days of January, was also found to be acute for small firms.

#### **- Day of the Week, Time of Day and Holiday effects [Calendar Effects]**

French (1980) and Gibbons and Hess (1981) document daily patterns in returns, in particular on average returns on Mondays tend to be negative. Further Harris (1986) and Jain and Joh (1988) have documented small but significant intra-day patterns in returns. In fact Harris found that the negative return on Mondays is concentrated in the first hour of trading. Ariel (1990)

found that daily returns before a public holiday were higher than average daily returns for the rest of the year.

- Excess Volatility and Predictability

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- Own and Cross-Autocorrelation properties

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Also see La Porta, Lakonishok, Shleifer and Vishney (1997) examine whether glamour stocks have negative three-day returns around subsequent earnings announcements, and whether value stocks have positive returns. This would be consistent with the market having the wrong expectations initially.

- Momentum strategies (Relative Strength)

Form portfolios on basis of past performance, on basis of short-run positive autocorrelation Jegadeesh and Titman (1993, JF), Chan, Jegadeesh and Lakonishok (1996)

Liu, Strong and Xu. (1999) find that the most profitable momentum strategy is the 12x3 ie form ranking on basis of past 12 months returns, and invest in winner-loser portfolio for 3 months. This yields an annualised return of 19.5% on UK stock price data 1977-96.

## - Underpricing of IPO's and Long-run Underperformance

Ibbotson (1975) found that new issues of equity are underpriced by on average approximately 12%. More recently Loughlin, Ritter (1994) emphasised that this was an international phenomenon. Ritter (1991) has identified the long-run underperformance of IPOs, though Brav and Gompers (1998) have queried this

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If markets are efficient then new information is reflected quickly into market prices.

Conversely, if markets are inefficient information is reflected only slowly into market prices, if at all.

To test the EMH, null hypothesis is

- Security market is a “fair game”.
- ie difference between actual and expected returns is unpredictable
- [rational expectations]

$$\mathbf{r}_{i,t+1} = \mathbf{E}(\mathbf{r}_{i,t+1} | \mathbf{W}_t) + \mathbf{e}_{i,t+1}$$

where

$\mathbf{r}_{i,t+1}$  is the return on security  $i$  in period  $t+1$ ,

$\mathbf{\Omega}_t$  is the information set available at time  $t$ , and

$\mathbf{e}_{i,t+1}$  is the prediction error

Prediction error is unbiased:

$$E(\varepsilon_{i,t+1} | \Omega_t) = 0$$

Prediction error is independent of forecast:

$$E(\varepsilon_{i,t+1}, E(r_{i,t+1} | \Omega_t)) = 0$$

Prediction error of i is independent of k:

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Prediction error is serially independent:

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Fama (1991) redefines these forms as predictability, event studies and inside information

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- Arbitrage/Speculation will force prices to their efficient values

- Simple trading rule:

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If prices are semi-strong form efficient then prices reflect all public information

Empirical finding is that prices do react to information contained in an annual report.

- Stock splits [Fama, Fisher, Jensen and Roll (1969)]

- Dividend/Earning announcements [Ball and Brown (1968), Rendleman, Jones and Latane (1982)]

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If prices are strong form efficient all private information is reflected in prices

In fact insider trading is profitable [Finnerty (1976) for US, Gregory, Matatko, Tonks and Purkis (1994) for UK]

- which suggests markets are not strong form efficient

Performance of mutual funds does not generate abnormal returns [Jensen (1968)]

- which is consistent with strong form efficiency.

Hence conflicting evidence on whether stock prices are strong form efficient.

Grossman and Stiglitz (1980) argue that in an strong form efficient market insiders will earn abnormal returns, but only sufficiently abnormal to offset their information acquisition activities.

Gregory, Matatko, Tonks and Purkis (1994) reassesses the UK results of significant abnormal returns from directors' trading for a new sample of directors' trades 1984-1986, and finds that abnormal returns tend to be concentrated in smaller firms.

When an appropriate benchmark portfolio is used, it is found that the significance of the abnormal returns is substantially reduced,

Implication is that directors' trading does not yield particularly high profits to either the directors themselves or to an outside investor mimicking those trades.

Conclusions?

Unlikely that markets are strong form but prices do seem to be weak and semi-strong efficient

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Anomalies to EMH

## - Small firm/January effect/P-E ratios

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Banz (1981) and Reinganum (1981) suggested that this P-E effect was related to firm size, that small firms tend to outperform large firms even after an allowance is made for the likely riskier characteristics of small firms.

Relation between January effect and small firm effect.

## - Day of the Week effect

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Harris (1986) and Jain and Joh (1988) have documented small but significant intra-day patterns in returns

## - Excess Volatility and Predictability

Shiller (1981) found that stock prices are excessively volatile compared to those given by the PV model. Also Bulkeley and Tonks (1989) for UK

Fama and French (1988) found that long run returns (5-year horizon) are predictable - negative correlation.

Poterba and Summer (1988) find that eight year (long horizon) returns are only four times more variable than one year returns, implying negative serial correlation.

But one month (short horizon) returns are only 80% as variable as twelve month returns, implying positive serial correlation.

- Own and Cross-Autocorrelation properties

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- Contrarian/Value strategies

De Bondt and Thaler (1985) found that portfolios of loser portfolios outperform and winner portfolios underperform subsequently.

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Value strategies seem to produce excess returns - but is this because

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2. They are fundamentally riskier? [Fama and French (1992)]

LSV find that *glamour stocks* do underperform relative to value stocks over 1968-90 period.

- apparently because market consistently overestimates future growth rates of glamour stocks relative to value stocks.

Value stocks are no more risky than glamour stocks

- short time horizons of institutional investors / fund managers?

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on basis of short-run positive autocorrelation

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Loughlin, Ritter and Rydqvist (1994) emphasised that this was an international phenomenon.

- Long Run Underperformance of IPOs

Ritter (1991) found that IPOs underperform over subsequent five years