

The Efficient Market Hypothesis: Theory, Implications & Tests

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ADVANCED RESEARCH ISSUES IN FINANCE,
BANKING AND ACCOUNTING



From this week's FT

Johnson Controls Follow
Johnson Controls strikes \$20bn Tyco acquisition
'Inversion' would cut US manufacturer's tax bill by moving domicile to Ireland

10 HOURS AGO by James Fontenelle-Khan and Robert Wright in New York and Arash Massoudi in London

Johnson Controls has agreed to acquire Tyco International in a \$20bn industrial tie-up that will allow the manufacturer to slash its tax bill by moving its corporate domicile from the US to Ireland.

The transaction is structured as a reverse takeover that will see Tyco shareholders own 44 per cent of the combined group, while Johnson Controls investors will hold the remainder and receive \$39bn in cash. It values Tyco shares at \$34.88, an 11 per cent premium to its closing price at the end of last week.

The new company will keep Tyco's Irish domicile and Cork headquarters, allowing Johnson Controls to capture a lower tax rate and create "at least \$150m in annual tax synergies", the companies said. Other synergies will total at least \$500m over the first three years, they added.

The deal highlights the inability of the US government to stop its large corporations from fleeing the country's tax regime and suggests that so-called "inversion" deals remain highly attractive to companies struggling to grow their top line.

What is Efficiency?

The Efficient Markets Hypothesis (EMH) states that security prices reflect all known information.

Asset pricing models (such as CAPM) rely on market efficiency.

Econ/Finance methods that use market data rely on the concept—
they often do not explicitly say so.

EMH predicts that:

- you can't beat the market consistently, *except by chance*
- security prices follow a “random walk” with drift
- security prices react immediately to news.

Why Should Markets be Efficient?

1. Investors are rational.
2. There is an abundant flow of information.
3. Prices respond instantaneously to new information.
4. Dealing is frictionless and free.

If prices are ‘wrong’, we expect rational investors will exploit the mispricing.

Are Markets ‘Efficient’?

Grossman and Stiglitz (1980) argue that perfectly informationally efficient markets are not possible.

- Only private returns justify private info gathering costs.
- Once info are gathered, rational investors react to changes in info to which individuals who have not gathered info cannot react.

Market ‘noise’ (Black, 1986) makes it worthwhile to incur costs to gather information and to trade on information.

- Trading on news will be restricted to the arrival of news.
- Trading relies not only on news, but also on at least one trading party misinterpreting the news.
- Solution: differences in information across traders which creates uncertainty (noise). That is, $\Delta\text{PRICE} = \Delta\text{INFO} + \Delta\text{NOISE}$.
- Efficiency has to be thought of as prevailing within a price range reflecting ΔINFO .

SOME THEORY

The ‘Fair Game’ or Martingale model:

$$E(P_{t+1} | F_t) = P_t$$

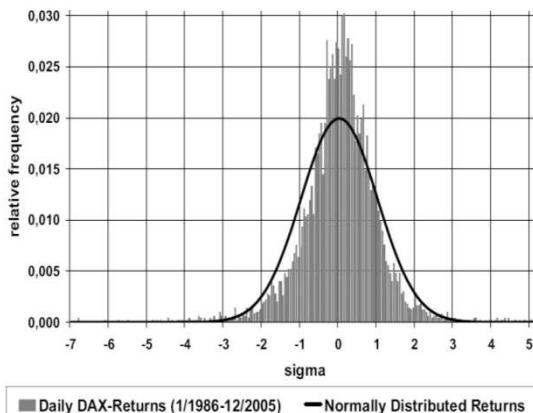
The Sub-Martingale:

$$E(P_{t+1} | F_t) \geq P_t$$

The Random Walk model:

$$P_{t+1} = \mu + P_t + \varepsilon_{t+1}$$

Are Markets 'Efficient'?



Fama (1970)

Fama (1970) emphasizes that market efficiency must be tested jointly with a model for expected returns.

EMH work can be divided into three groups:

- **weak** form
(all past prices of securities are impounded into current prices)
- **semi-strong** form
(publicly available information is reflected)
- **strong** form
(all public and private information is impounded into prices)

If the *weak* form EMH holds, chartists add no value.

If the *semi-strong* form holds, undertaking fundamental analysis is worthless.

If the *strong* form EMH holds, even insider trading does not lead to abnormal profits.

WEAK FORM TESTS – SERIAL INDEPENDENCE

The serial covariances between lagged values of a ‘fair game’ variable are zero

Observations (prices or returns) of a ‘fair game’ variable are linearly independent

Measure covariance by:

$$\frac{1}{N-1} \sum_{i=1}^N (r_{i,t} - \bar{r}_i)(r_{i,t+1} - \bar{r}_i)$$

Fama and others show no evidence of substantial linear dependence between lagged returns, serial correlations are close to zero

WEAK FORM TESTS – TRADING RULES

May be some non-linear dependence that imply profitable trading systems

Test these rules against a ‘buy and hold’ strategy

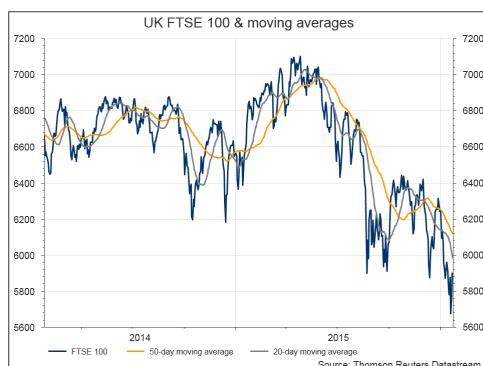
Filter rules – ‘buy if stock goes up by x%, short sell if stock goes down by x% from its subsequent high’

Results show rules cannot beat the ‘buy and hold’ strategy after including trading commissions

Alexander (1961, 1964), Fama and Blume (1966)

Some evidence of profits for very small filters and for high frequency trading, but not economically viable

Example of a simple trading rule



Simple 'cross over': $P_t \leftrightarrow MA(xd)$
 'Momentum': Buy: $MA(20d) > MA(50d)$, Sell: $MA(20d) < MA(50d)$
[Video](#)

WEAK FORM TESTS – RUNS TEST

Large price changes tend to be followed by large price changes, and small price changes tend to be followed by small price changes

But, the sign of the second price change should be random

Niederhoffer and Osborne (1966) show:

- Reversals 2-3 times as likely than continuations
- Continuation slightly more frequent after a preceding continuation than after a reversal
- Explanation for this?

Runs Test looks at the pattern of the signs of consecutive price changes to see if they are random

RETURN PREDICTABILITY – TIME SERIES TESTS

Short horizon – one week, one day, one hour...

Use longer time series and more sophisticated statistical techniques

French and Roll (1986), Lo and MacKinlay (1988), Conrad and Kaul (1988)

Statistically significant predictability, but not large enough to cover trading costs

Positive first order autocorrelation, but small

Negative higher order autocorrelation, suggest liquidity effects and noise trading explanations

RETURN PREDICTABILITY – TIME SERIES TESTS

Long horizon returns – 1 – 5 years or longer

Shiller (1984) and Summers (1986) suggest prices deviate from fundamental values temporarily (fads or irrational bubbles), then revert over longer periods

Implies short horizon autocorrelation of zero, but negative long horizon autocorrelation (Stambaugh (1986), evidence also by Fama and French (1988a))

Implies variance of returns should grow with return horizon, but less than proportionately (variance ratio tests), Poterba and Summers (1988)

This could point to either:

- *Irrational* bubbles (Shiller, 1984) or
- *rational* time varying expected returns (Fama and French, 1988a)?

RETURN PREDICTABILITY – ANOMALIES

Under reaction

Post earnings drift
Long term losses on buying IPOs
Long term reversal ('glamour firms')

Over reaction

Small companies effect
January effect

Evidence to reject market efficiency?

Behavioural Finance

Attacks the assumptions underlying EMH

Investors are not rational and tend to make similar mistakes

Investor sentiment and mis-calibration affects prices

Trading by rational investors to exploit mispricing is risky and so limited.

Mispricing persists for long periods and there is excess volatility.

Barber et al. (2000): 'The Behavior of Mutual Fund Investors'

Examples from Barber, Odean & Zhang (2000):

- (1) Investors buy funds with strong past performance.
 - Most funds purchased are funds in the top quintile of past annual returns.
- (2) Investors are twice as likely to sell a winning mutual fund than a losing mutual fund.
 - 40% of fund sales are funds ranked in the top quintile of past annual returns.
- (3) Investors are sensitive to the form in which fund expenses are charged.
 - Sensitive to transaction fees, but insensitive to a fund's operating expense ratio.

The Great Truce: EMH & The Behavioural View

For example, Fama (1998, JFE).

Empirical return anomalies split randomly between over and under reaction. EMH can explain this as chance events. $E(r)=0$!

A rational model must be built on rational expected returns. Irrational short-term vol = 'risk' in this model.

Evidence for behavioural view based on rejection of EHM. What is the alternative being proposed by behaviourists?

Are long term abnormal returns measured reliably?

SEMI-STRONG FORM TESTS – PUBLIC INFORMATION

Covered in detail later in the course (Event Studies)

Semi-strong form efficiency states markets fully reflect all publicly available information

- Announcements of stock splits, dividends, annual reports, new issues, macro news, mergers, and many others

News should have an immediate price impact, then subsequent returns should be unpredictable

FFJR (1969) was the first to use a methodology known as an event study on stock splits

Method is now applied to many different events

SEMI-STRONG FORM TESTS – PUBLIC INFORMATION

Idea is to look at price behaviour just before and just after new information hits the market

Need to understand the expected return

- What return do we expect if there is no event?
- What return do we expect with the event?
- Are actual returns significantly different from these?

Most studies follow FFJR (1969) and use the ‘market model’:

$$R_{i,t}^* = \alpha_i + \beta_i R_{m,t}$$

The abnormal return is then the difference between the actual return and this expected return (residual)

SEMI-STRONG FORM TESTS – PUBLIC INFORMATION

Event studies investigate the behaviour of this residual

Plot the cumulative abnormal return (CAR) on a diagram

If markets are semi-strong form efficient, CAR should jump at the time of the event (news) to reflect the market quickly incorporating news to revalue the asset, but no systematic pattern before or after the event

Most studies support weak form efficiency, Waud (1970), Scholes (1969)

Notable exception is Ball and Brown (1968) – post earnings announcement drift

EVENT STUDIES

Grown into a massive literature. The ‘workhorse’ of Finance.

Accounting, Industrial Organisation, Macroeconomics

Fama focuses on corporate finance

Dividends

- Surprise in dividends associated with stock return of same sign (Charest, 1978 and others)
- Contradicted the dividend irrelevance theorem (Modigliani and Miller, 1961; Miller and Scholes, 1978)
- Led to signalling models (Miller and Rock, 1985) and free cash flow models (Easterbrook, 1984; Jensen, 1986)

EVENT STUDIES

New Issues

- New issues of stock are bad news for stock prices (Asquith and Mullins, 1986)
- Redemptions of stocks are good news (Dann, 1981)
- Led to various models to explain: asymmetric information (Myers and Majluf, 1984); information on cash flows (Miller and Rock, 1985); agency costs (Jensen, 1986)

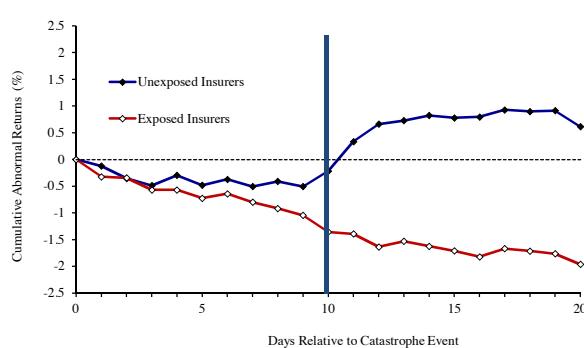
Mergers

- Large gains for target firm's shareholders (Mandelker, 1974 and others)

Implications for market efficiency

- Prices tend to adjust within a day of event announcements

Example: US natural catastrophes and insurer stock prices



The figure shows market-adjusted cumulative abnormal returns (CAR) for both unexposed and exposed insurers for the 20 days following a mega-catastrophe. Exposed insurers are firms that have positive premiums earned in the homeowners' line of business in the state(s) affected by our sample catastrophes.

Source: Hagendorff et al. (2015), *Risk Analysis*

STRONG FORM TESTS

Very difficult to test – impossible to know the full information sets of all agents

Seek to find out if some people who likely have monopoly over certain information, can use this to profit

Jensen (1968)

- Do mutual funds' managers have 'special information' that allow them to earn abnormal returns?
- Are some funds better at uncovering 'special information'?

What is 'special information'?

- Interpretation of public information not implicit in market prices
- Monopolistic access to special information

TESTS FOR PRIVATE INFORMATION

Insider Trading

- Jaffe (1974) finds market is not efficient for insiders, insiders have information that is not included in prices
- Market does not react quickly to public information about insider trading, outsiders can profit for up to 8 months!
- Seyhun (1986) confirms insiders profit from their trades
- Results seem to be related to the size effect

Security Analysis

- Value Line Investment Survey – rankings of stocks. After adjusting for risk and size, Group 1 stocks outperform (Black, 1973)
- Heard on the Street column – analysts' recommendations in the column see positive return on announcement day (Lloyd-Davies and Canes, 1978)

TESTS FOR PRIVATE INFORMATION

Professional Portfolio Management

- Jensen (1968, 1969), mutual fund managers do not have private information
- Henriksson (1984) and Chang and Llewellen (1984) show that on average, managers have enough private information to cover their fees
- Ippolito (1989), finds small outperformance so managers are compensated for their information costs
- Brinson et al. (1986), returns to pension plans are less than the passive index, they do not show evidence of private information

Real life example: US investor holdings

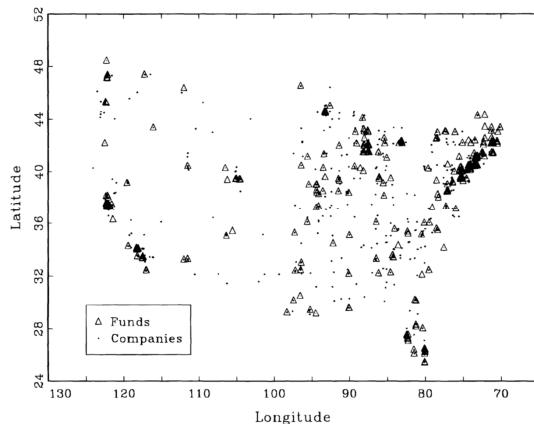
Academic studies suggest that investors suffer from a 'home-bias' in their investment.

Applies to international asset portfolio
~90% of U.S. mutual fund assets (by value) are in U.S. assets.

and *domestic* portfolios
Equity investments in U.S. firms are also geographically clustered.

Is this irrational investing or a response to market frictions and information asymmetry?

Real life example: US investor holdings



Source: Coval, et al. (1999), Home Bias at Home, *Journal of Finance*.

'The average U.S. fund manager invests in companies that are between 160 to 184 kilometers closer to her than the average firm she could have held'.

Implications of the EMH for Investment Management

The Efficient Markets Hypothesis suggests that conducting securities analysis will *not* lead to consistent market out-performance, after adjustment for risk.

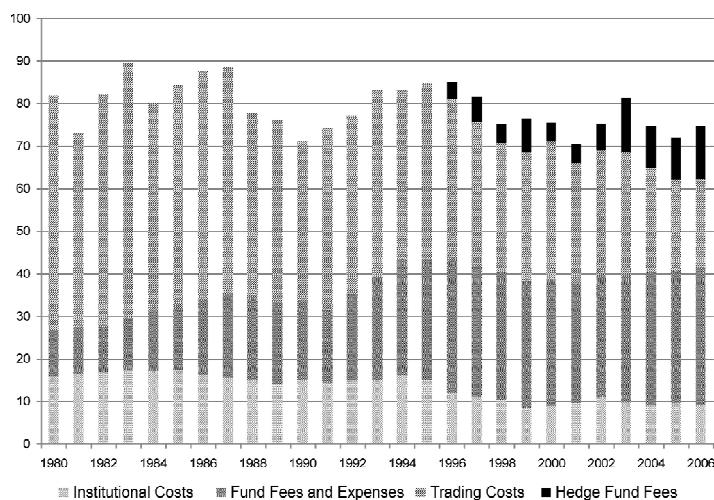
Indexed portfolios would be favoured by adherents of this theory.

Studies show that *after risk adjustment & fees*, index funds outperform actively managed portfolios.



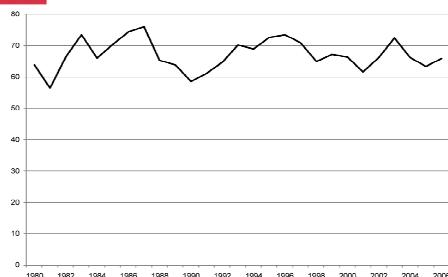
Global AuM by product type.
Source: Boston Consulting Group (2014)

How much do U.S. equity investors pay to beat the market?



Fees and expenses, basis points in terms of market caps
Source: French, The cost of active investing, Journal of Finance, 2008

The Cost of Active Investing



Difference between actual and passive cost of investing (in basis points).

Active investors spend 0.67% of the total market cap p.a. more than the costs of passive investing in search for superior returns.

If we assume that society will continue to spend this amount and stock values grow by 6.7% p.a., the capitalized costs = 10% current equity values.

Trading on Advice

Based on client data obtained from a large German brokerage firm, Hacketal et al. (2012) find that:

	Self-managed accounts	Accounts run by IFA
Log monthly returns	0.0101	0.0063
Jensen's alpha	0.0098	0.0061
Alpha (Fama French model)	0.0093	0.0055
Variance of monthly returns	0.0032	0.0019
Sharpe ratio	0.2229	0.1916
No. of trades/account volume	0.0861	0.0884
Monthly turnover rate	0.0405	0.0895
Male	0.7925	0.6739
Self-employed	0.128	0.1577
Experience (years)	9.3415	11.1535
18 < Age < 30	0.0101	0.0415
30 < Age < 40	0.0098	0.118
40 < Age < 50	0.0093	0.268
50 < Age < 60	0.053	0.2287
Age > 60	0.0708	0.3437

The returns to active fund management

In 2012

S&P500 +16%

active mutual funds +14.7% (net)

hedge funds (equity) + 7.4% (gross)

hedge funds (all) +3.02% (net)

% mutual funds that lagged benchmarks (net returns)

65% large-cap core

51% large-cap growth

80% large-cap value

67% small-cap

% of equity hedge funds that lagged S&P500 (gross returns)

88%

Source: Financial Times

Investments: Orlando is the cat's whiskers of stock picking



Orlando's share-picking skills were purr-fect. Photograph: Jill Inaley

The Observer's panel of stock-picking professionals has been undone in our 2012 investment challenge by a ginger feline called Orlando who spent time paw-ing over the FTSE.

The Observer portfolio challenge pitted professionals Justin Urquhart Stewart of wealth managers Seven Investment Management, Paul Kavanagh of stockbrokers Killick & Co, and Schroders fund manager Andy Biagioli against students from John Warner School in Hertfordshire – and Orlando.

Each team invested a notional £5,000 in five companies from the FTSE All-Share Index at the start of the year. After every three months, they could exchange any stocks, replacing them with others from the index.

By the end of September the professionals had generated £497 of profit compared with £202 managed by Orlando. But an unexpected turnaround in the final quarter has resulted in the cat's portfolio increasing by an average of 4.2% to end the year at £5,542.60, compared with the professionals' £5,176.60.

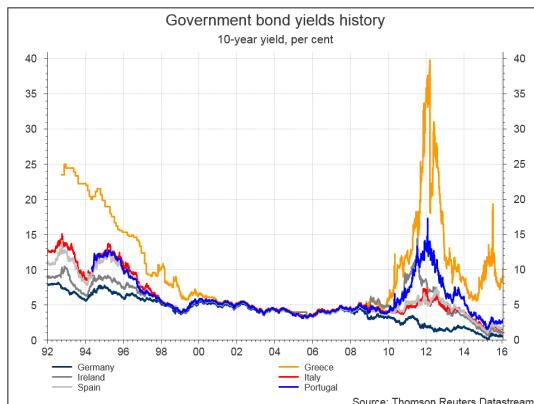
HOW THEY DID

	Final total
ORLANDO	£5,542
PROFESSIONALS	£5,176
KIDS	£4,840

Figures as at 31 December 2012

While the professionals used their decades of investment knowledge and traditional stock-picking methods, the cat selected stocks by throwing his favourite toy mouse on a grid of numbers allocated to different companies.

Examples: applying the EMH



Examples: applying the EMH



SUMMARY OF EMH

Return predictability

- No predictability at short horizons
- Some predictability at long horizons
- Joint hypothesis problem – multifactor asset pricing models

Event studies

- Price adjustment is quick, supports EMH

Tests for private information

- Adjusting for risk and size properly, no evidence of insider information by professional managers
- But (illegal) insider trading is profitable

Evidence in favour of EMH is overwhelming!

Wide applications in markets, investors and research

Most investors ignore the simple implications of the EMH (at their peril)