In the light of current evidence, critically examine the efficient market hypothesis

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This paper shall firstly explain the Efficient Market Hypothesis (EMH), its history and its theoretical justification for explaining empirical evidence. Fundamental problems with the theory are then highlighted, followed by a summary of the most modern approaches to how markets work. The paper concludes that the EMH works by coincidence i.e.; by accident.

The Efficient Market Hypothesis (EMH)

The EMH tries to explain why stock market prices appear to follow a *random walk* i.e.; that their daily variation is a random value following the Gaussian distribution. This random walk of stock market prices had been originally noticed by Bachelier (1900) but had only become widely realised since Kendall (1953), at which point it was considered something rather unusual.

The reason that a random walk appeared unusual was because from Neo-Classical Economic theory (specifically Walrasian General Equilibrium Theory), markets were supposed to approach equilibrium over the medium to long run and they were supposed to do this by *tâtonnement* (the process of finding the market clearing prices to precisely match supply and demand). Prior to Arrow (1951) and Debreu (1959), it had not yet been realised just how restrictive the assumptions would have to be in order to enable Walrasian equilibrium whilst keeping the system from degenerating into indeterminacy[1].

The EMH was originated by Fama (1965) in his PhD thesis, and given its modern three-type form in Fama (1970). The EMH explains the random walk by assigning its occurrence to *uncertainty* i.e.; the existence of the future, whereby future events are unknown to or mispredicted by the market. As we now know that determinate Walrasian equilibrium requires perfect knowledge of the future, uncertainty causes substantial long-term deviations from expected behaviour.

There are three main forms of EMH, each becoming successively stronger in implication:

1. **Weak form**
   That market prices correctly represent all the information contained in the record of past prices and trading volume.

[1] Subsequent to Arrow and Debreu's work, the Sonnenshein-Mantel-Debreu assumptions are the modern prerequisite for determinacy in micro-economics. See Mas-Colell's (1995) *Microeconomic Theory* starting at section 17.

2. **Semi-strong form**
   The previous, and also that market prices rapidly adapt to new information and correctly represent not only all past information, but also all present information currently widely known.
3. **Strong form**
   The previous two, and also that market prices not only correctly represent all past and present information, but also accurately represent predicted future information and that the random walk occurs due to mis-predictions by the market about the future.

These forms all assume that the cost of credit is linear and uniform for all investors, that transaction costs do not exist and that information asymmetry does not exist. Of course, none of these are true in reality but modern markets approximate these assumptions for the most part.

There is substantial empirical evidence[2] proving that generally speaking, in most cases over the long run, no one company or group can consistently outperform the market. This implies that market prices are always as true & fair as possible over the long term, and that therefore the strongest form of EMH mostly applies, falling back to at worst semi-strong in liberal capital Economies such as the UK. Note that the EMH requires investors to be rational which is also a requirement of Neo-Classical Economic theory. It also implies that there is no point in studying the past price behaviour of a stock when making an investment decision, and for semi-strong and strong forms there is no point in studying any past information at all! This would mean that market analysts and fund managers work entirely by luck (and therefore do not deserve the fortunes they are paid).

Problems with the Efficient Market Hypothesis

There are many arguments which have been used to discredit the EMH over the decades. Many focus on market anomalies such as the January effect where the price of small-cap stocks will rise abnormally during the first few days of trading in a new year (Pietranico & Riepe [2004]), or the existence of long-term successful investors such as Warren Buffet or George Soros, but there are far more problematic *prima-facie* problems at a theoretical level. This paper shall concentrate on the three most important of these.

Problem 1: Information Asymmetry

One obvious requirement of EMH is that new information must circulate around all investors very quickly indeed if even semi-strong EMH is to be possible. Good information is costly to generate and rapidly loses value as more people learn it (Chen [2005]), so there is an obvious vested interest *against* the widespread sharing of information. Empirical studies show that good information tends to be hoarded by investors – indeed, often there are even deliberate attempts at disseminating *mis*-information by one investor to other investors! (Akerlof [1970])

Yet the empirical record (Patell & Wolfson [1984]) would suggest that news is incorporated into price within ten minutes despite that substantial disparities in investor access to information exist. This problem of how the market is really so able to adjust its prices so accurately and so quickly when such information asymmetry exists has occupied a lot of recent research which we shall come to shortly.

[2] See Jensen (1968) & Kim (1978).

Problem 2: Investors are not rational

Investors are people, and they don't always behave rationally. Just like the fashion for skirt lengths, markets also undergo fashionable trends – certain industries or stocks will become fads, leading to investor over-confidence or under and market bubbles and crashes. In 1996 in response to an ever-rising bull market in the US stock market, Federal Reserve chairman Alan Greenspan warned against "irrational exuberance" – yet those who heeded his words lost millions as the market sped up even faster as the crash everyone knew was coming came closer. As Keynes once said, "Markets can remain irrational longer than you can remain solvent".

Problem 3: Stock market crashes happen far too often

According to EMH, substantial stock market movements should be rare and not severe due to the properties of normally distributed randomness. Unfortunately, as we have learned to our cost, severe market crashes are a fundamental feature of competitive markets in general – as Ormerod (2005) correctly points out, failure & extinction is the statistical norm rather than the exception.

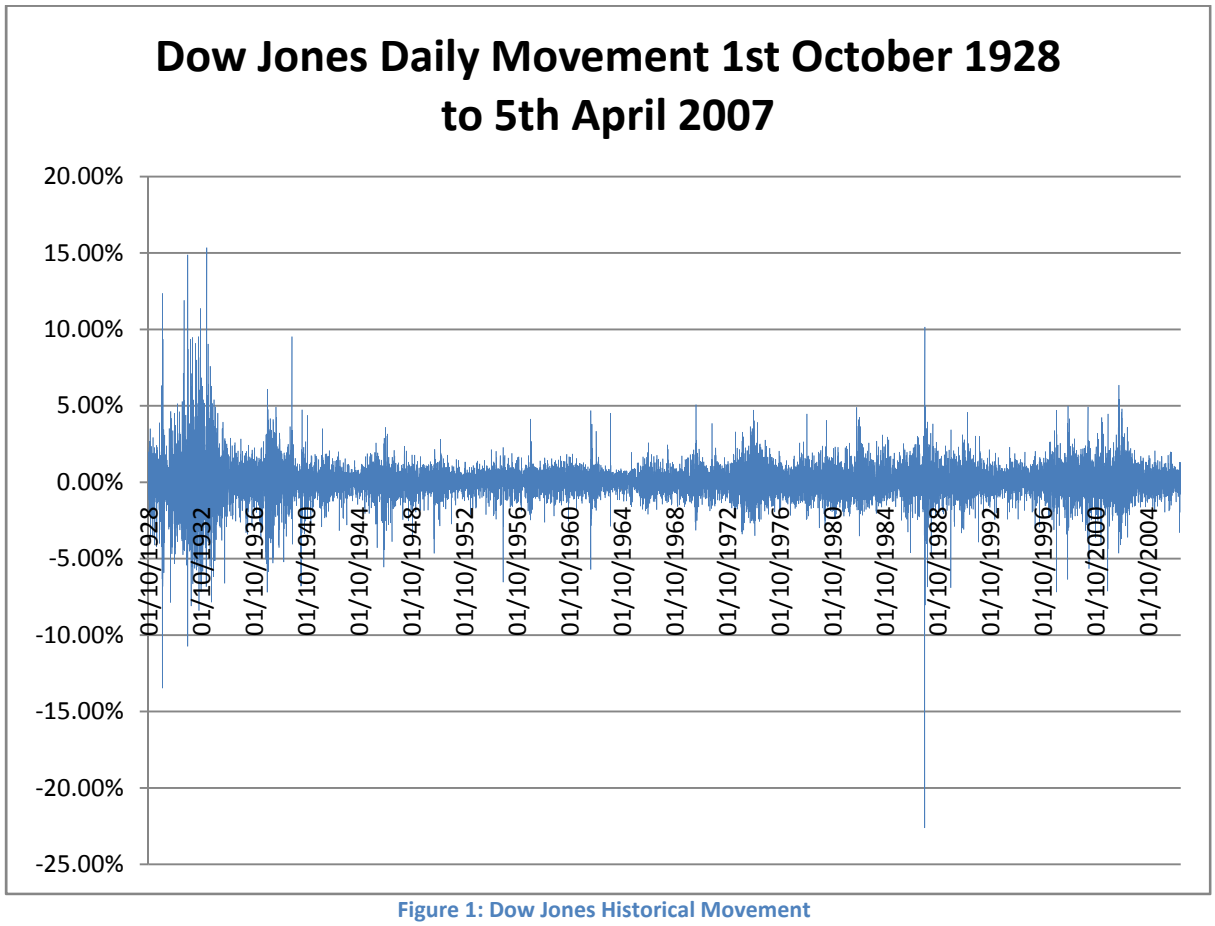

Figure 1: Dow Jones Historical Movement

Figure 1 shows nearly eighty years of daily percentage price movements on the Dow Jones index[3] which is some 19,712 days. As one can see, large movements are rare but not infrequent:

0%-0.10%	0.10%-0.18%	0.18%-0.32%	0.32%-0.56%	0.56%-1.00%	1.00%-1.78%	1.78%-3.16%	3.16%-5.62%	5.62%-10.00%	10.00%-17.78%	17.78%-31.62%	31.62%-56.23%
2267	1722	2830	3970	4417	2977	1124	333	**62**	**9**	**1**	0

Figure 2: Categories of Price Movement

[3] Source: http://finance.yahoo.com/

Some 77% (15,206) of those days saw a movement of 1% or less, showing that the market is generally fairly stable and its movements are consistent with true randomness. Up until around ±1.25% the data remains consistent with a normal distribution, but for larger movements something else happens:

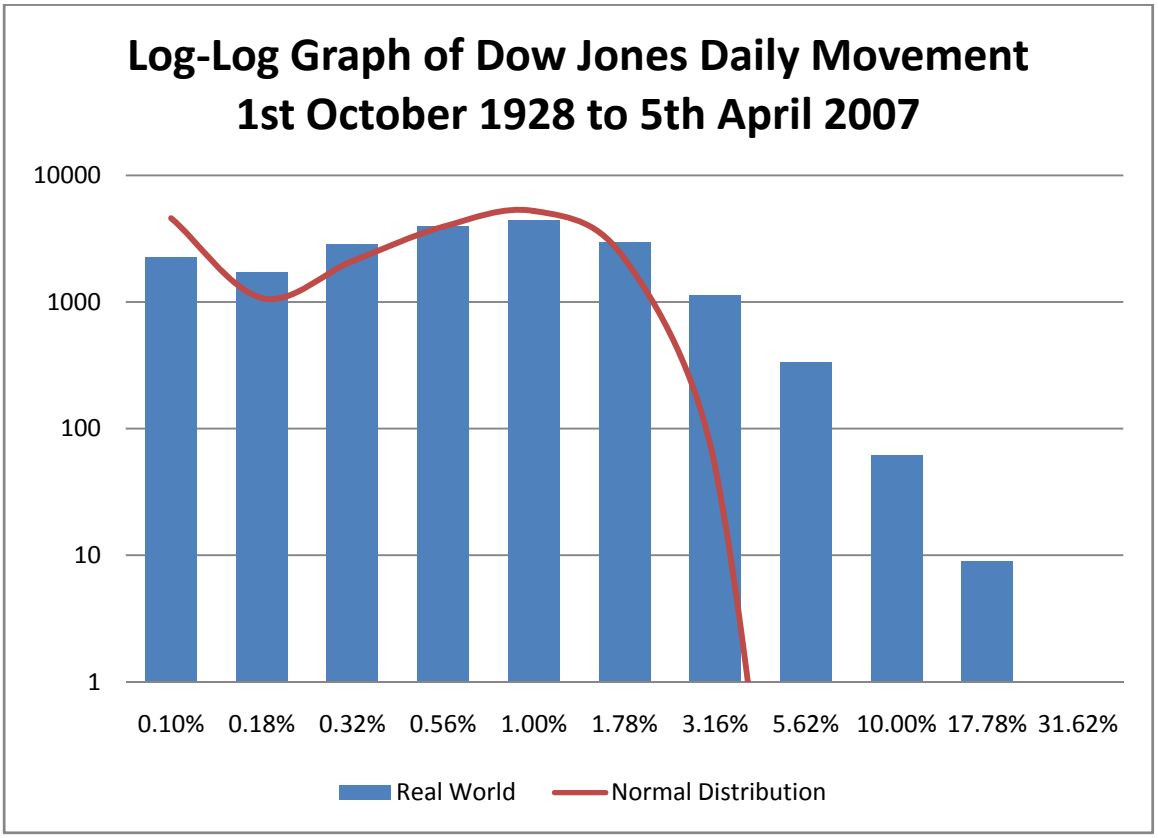

Figure 3: Frequency of Movement

Figure 3 shows a log-log histogram of percentage movements with the values predicted by the normal (Gaussian) distribution overlaid on top. As one can see, the chances of a 5.62% or greater movement in a single day should be next to impossible – in fact, its probability is 0.000000008153576 which means it should happen once in every 122,645,573 days i.e.; never during our eighty years. Yet in reality, it happened no less than seventy-two times which is far more than it should were the EMH valid.

Something else is clearly going on here, which we shall come back to shortly.

The Capital Asset Pricing Model (CAPM)

Sharpe (1970) who contributed so much to the development of the CAPM in Sharpe (1964) (which depends on the EMH) considered the implications of relaxing the assumptions underpinning both theories:

> *"The consequence of accommodating such aspects of reality are likely to be disastrous in terms of the usefulness of the resulting theory ... The capital market line no longer exists. Instead, there is a capital market curve – linear over some ranges, perhaps, but becoming flatter as [risk] increases over other ranges. Moreover, there is no single optimal combination of risky securities; the preferred combination depends on the investors' preferences ... The demise of the capital market line is followed immediately by that of the security market line. The theory is in a shambles"* (Sharpe 1970)

This is pretty damming stuff, especially from someone as eminent as W.F. Sharpe. It means that these assumptions are *domain assumptions* i.e.; assumptions required to make a theory valid and in the absence of which the theory is no longer true. This strongly implies that EMH, and CAPM, just happens to fit the data *by luck* for certain ranges of price movement, but that in fact other factors are at work. This fits with our empirical comparison to the normal distribution above.

So what is actually going on then?

This is moving away from the EMH, so I won't spend much time on it but it is worth considering alternatives to the EMH. There are two main categories: (i) Behavioural Finance, which comes from a background of cognitive psychology and (ii) Econophysics, which applies theories and methods originally developed by physicists in order to solve problems in Economics, usually those including uncertainties or stochastic elements and non-linear dynamics.

EMH holds that investors objectively consider information about investment opportunities and that because new information arrives randomly, it generates random movements in the expected future prospects of firms. It does not consider that investors are primarily interested in what other investors are doing, which makes sense if all investors are supposed to commonly agree on the valuations of prices (through arriving at equilibrium).

Behavioural Finance takes this opposite approach: that investors are *primarily* concerned with what other investors do and that the underlying fundamentals of their investments are of secondary importance. This explains the much larger daily movements in price than a normal distribution would permit and the irrationality of speeding up a bull market when everyone knows it will crash soon – the self-reinforcing feedback loops generate such abnormal behaviour through runaway effect.

Econophysics goes far further than that again however. It explains that the "random walk" of prices isn't actually random at all but is in fact a non-linear power distribution i.e.; a property of a chaotic fractal system – which tends toward Gaussian behaviour (apparent pure randomness) when not activated[4]. As Ormerod (1998) reports, any biological system is a fractal system and therefore exhibits chaotic behaviour with allometric scaling. This is a very new and unorthodox research area with heavy mathematics but papers I reviewed for this papers include 'The statistical properties of the volatility of price fluctuations' by Liu, Gopikrishnan, Cizeau, Meyer, Peng and Stanley (1999) and 'Scaling of the distribution of price fluctuations of individual companies' by Vasiliki, Gopikrishnan, Amaral, Meyer and Stanley (1999). Both of these papers conclude that on a statistical level, market price behaviour follows an allometric law. Therefore, EMH is most definitely false.

Conclusion

We have analysed three fundamental theoretical and empirical problems with the EMH. We have suggested two modern approaches to better fitting the empirical data and what we know about human psychology and the functioning of biological systems. We conclude that the EMH fits the facts by accident, and is in fact false when considering a wider picture.

[4] For example, neurons reside in a state of chaotic randomness when not activated and move out of it into order when they fire (Stewart 1997).

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