Inefficient markets and irrational investors

Looking for logic in the mathematics of value

Opinions about market efficiency and the capital asset pricing model continue to fuel a debate on why stock prices move the way they do. RICHARD FITZHERBERT presents a view that the long-term growth in equity returns has little to do with the volatility/reward argument.

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The typical finance graduate seems to be favourably disposed towards the conventional academic wisdom of the efficient market and the capital asset pricing model under which there is a volatility/reward payoff. When the observed behaviour of markets or other phenomena contradict market efficiency, these are dismissed as "anomalies" and an apparently plausible explanation is advanced to leave the essential doctrine of market efficiency intact.

This article argues the alternative case — that market efficiency is a special market state. The Australian stockmarket is inefficient both at the weak and semi-strong form. On occasions individual stocks and the overall market can be efficiently priced, but this is too often not the case to justify the adoption of market efficiency as a default assumption. Investors who base their decisions or formulate their strategy assuming market efficiency may well be basing their decisions on estimated returns and risks which have been invalidly quantified.

TWENTY YEARS OF POOR RETURNS FROM RESOURCE STOCKS

Twenty years ago, the Australian stock exchange introduced the present series of indexes, including accumulation indexes which allow for re-investment of dividends. The constituents of the All-Ordinaries index are divided into two groups, the All-Industrials and the All-Resources, based on their principal business activities. Thus BHP has been included in the All-Resources index, even though it is listed as an industrial stock in newspapers.

As most investors know, the constituent stocks of the All-Resources index are riskier investments than their All-Industrials counterparts. The ASX All-Resources portfolio is also more volatile as reflected in a high β value of 1.2 compared with 0.8 for the All-Industrials index. Using continuous compounding, volatility, as measured by the standard deviation of monthly returns since 1979, has been 5.5% a month for the All-Industrials and 8.1% for the All-Resources.

Given an "equity risk premium" (the difference between the overall market return and the return from riskless assets such as short-dated government securities) over this period of approximately 3.5% and the difference in β values of 0.4, the CAPM model would lead us to have expected that by 1999 the All-Industrials accumulation index would have underperformed the All-Resources by $0.4 \times 3.5\%$ or 1.4% per annum.

If CAPM expectations were reliable in 1979 we would have expected that the All-Industrials accumulation index would now be 75% of the All-Resources. In actual fact, the All-Industrials is now 560% of its resources counterpart, corresponding with a performance discrepancy of more than 10% per annum. This is too high to be dismissed by the argument that trade in these stocks is

dominated by international investors and the volatility/return calculations should be recalculated using international benchmarks.

It could also be argued that CAPM is a model of expectations rather than a model of outcomes and, in 1979, CAPM may well have been consistent with the superior returns from the resources sector which were widely and confidently expected.

For example, at an *Australian Financial Review* function in June 1979 the most senior investment officer of Australia's largest financial institution is reported to have said: "One cannot go past the area of raw materials as being the real area of growth for Australia in the 1980s. And I have the greatest conviction that this is where the major part of our investment effort will be directed over the next decade."

But what is the value of a model of expectations if there is such a large discrepancy between expectations and outcomes? Back in 1979/80, the resources sector represented more than 50% of the capitalisation of the Australian stockmarket. The subsequent poor performance of such a significant proportion of the market can hardly be dismissed as an "anomaly" – it is a mainstream error. Further, the very poor performance since 1979 follows the relatively poor performance of resource stocks in earlier periods, which has been well documented.

WAS THE FORMULATION OF A VOLATILITY/RETURN RELATIONSHIP DUE TO A MISUNDERSTANDING?

In 1972, Black, Jensen and Scholes published the results of a study covering 35 years from 1931 to 1965. This study divided 420 stocks listed on the New York Stock Exchange into 10 portfolios on the basis of their volatility and calculated the average "excess monthly return" for each of these portfolios. Their results show a strong, and approximately linear, relationship between volatility and return (see Table 1).

There was a fallacy in this approach. The use of an arithmetic mean for comparing different investment strategies and portfolios was a significant blunder. Consider two stocks — Deadly Dull and Roller Coaster. The share price of Deadly Dull goes up 10% each year. In year one the price moves from $100 to $110 and in year 2 from $110 to $121. The average price change is 10% per annum. Roller Coaster is much more volatile. In year one its price declines 50% from $100 to $50. The following year its price advances 100% from $50 to $100.

The average rate of return for Roller Coaster is the average of minus 50% and plus 100%, or 25% per annum. Yet the stock has shown no net change in price, having declined from $100 to $50 and then recovered to $100.

As we see in Table 2, the use of an arithmetic average return over successive time periods creates a misleading bias in favour of volatile stocks and portfolios.

If we wish to compare two stocks or two portfolios over time we need to calculate the equivalent compound return over the periods — sometimes called the "geometric" mean (see Table 3).

The volatility of Roller Coaster in this example is a little extreme. However, it is reasonably easy to demonstrate that the difference between the arithmetic and geometric mean is approximately half the variance. If we apply this adjustment to the Black, Jensen and Scholes data we obtain the geometric mean returns shown in Table 4.

It can be seen that the strong positive relationship between volatility and return

TABLE 1

Portfolio No.	1	2	3	4	5	6	7	8	9	10
β value	1.56	1.38	1.25	1.16	1.06	0.92	0.85	0.75	0.63	0.50
Excess return (% per month)	2.13	1.77	1.71	1.63	1.45	1.37	1.26	1.15	1.09	0.91

TABLE 2

At end of year	0	1	2	Average return
Price of Deadly Dull	100	110	121	
Return of Deadly Dull		10%	10%	average = 10%
Price of Roller Coaster	100	50	100	
Return of Roller Coaster		-50%	+100%	average = 25%

TABLE 3

At end of year	0	1	2	Geometric mean return
Price of Deadly Dull	100	110	121	
Return of Deadly Dull		10%	10%	$100^* (\sqrt{1.1 \times 1.1} - 1) = 10\%$
Price of Roller Coaster	100	50	100	
Return of Roller Coaster		-50%	+100%	$100^* (\sqrt{0.5 \times 2} - 1) = \text{nil}$

TABLE 4

Portfolio No.	1	2	3	4	5	6	7	8	9	10
β value	1.56	1.38	1.25	1.16	1.06	0.92	0.85	0.75	0.63	0.50
Geometric mean excess return (% per month)	1.09	0.99	1.08	1.08	1.00	1.02	0.96	0.92	0.92	0.79

largely disappears when "geometric" means or equivalent compound returns are calculated. It may be argued that CAPM is a model of the relationship between "arithmetic" mean "single-period" returns and volatility. If this is the case it is quite inappropriate to apply such a model to multi-period investment returns without adjustment for the volatility bias.

WEAK-FORM INEFFICIENCY

Many analysts who disagree with the capital asset pricing model are willing to concede that the market may be "weak-form" efficient — that historical price and volume data do not contain any useful information. In this view, stock price or market index movements in one time interval are statistically independent of price movements in any other period — a proposition sometimes known as the random walk hypothesis.

If weak-form efficiency is true then technical analysis or charting is nonsense — notwithstanding its following. However weak-form efficiency is crucial to the validity of the use of standard deviation of returns as a measure of risk and, by implication, the mean variance models which are often used to formulate asset allocation strategy. This may require a little mathematical explanation.

If weak-form efficiency holds, then price changes in successive time periods are statistically independent, which has two important theoretical implications. First, price changes in any period are lognormally distributed. Second, the variance of the price change varies linearly with the length of the time period.

If P_n is a stock price or market index at time n then we can express P_n in terms of the starting price or index P_0 and a sequence of price changes:

$$P_n = P_0 \times \{P_1 / P_0\} \times \{P_2 / P_1\} \ldots \times \ldots \times \{P_n / P_{n-1}\}$$

Taking natural logarithms of both sides we have:

$$Ln [P_n] = Ln [P_0] + Ln [\{P_1 / P_0\}] + Ln [\{P_2 / P_1\}] \ldots + \ldots Ln [\{P_n / P_{n-1}\}]$$

If weak form efficiency holds, then the (logarithm of the) price at time n, P_n , is the sum of the (logarithm of the) price now, P_0 , and n independent random variables. Also, by making the unit time interval quite short, we can make n as large as we like for any reasonable time period under consideration. Consequently, the logarithm of price changes from now to any time in the future can be made into the sum of a large number of independent random variables if the weak-form market efficiency is true.

As a result of a fundamental law of statistics known as the Central Limit Theorem, it follows from weak-form efficiency that returns over any time period are lognormally distributed and the variance of this distribution is a linear function of the time interval.

However, it appears that normality of (logarithms of) price movements is only approximately true. (Logarithms of) price changes have been found to be leptokurtic (fat peaks and long tails) and there seem to be tendencies of trend persistency and trend reversion which are not fully understood. Also, after a few years, the increase in the variance over time is significantly less than the linear outcome that would emerge from a random walk.

Given these facts, we must conclude that price movements in successive time periods are not independent. Much of the evidence in favour of weak-form efficiency has been based on statistical tests which have been unable to identify non-zero autocorrelation. However, being unable to prove non-zero correlation does not prove that correlation is zero. In any event, zero correlation is not a sufficient condition for statistical independence.

It is sometimes suggested that people who do not accept the random walk or weak-form efficient market hypothesis believe in charts or technical analysis. This is not true. Weak-form efficiency precludes any value in charting but not conversely.
The real importance of weak-form inefficiency lies in the fact that it undermines the use of standard deviation of returns as a measure of investment risk. Volatility and risk cannot be used interchangeably and volatility does not measure risk. Further, the variance of returns is not a linear function of the time period under consideration.

COMPANY TAKEOVERS

The market in small "caps" has two interesting features. First, these stocks tend to be ignored by institutional investors, which increases the chances of semi-strong form inefficiencies. Second, small companies are more likely to be taken over than large companies.

The net effect of takeover activity is that, as a group, the shareholders of small companies benefit from periodic bouts of largesse handed out by boards of larger companies during takeovers, often at the expense of the shareholders of the large companies. Takeover activity is a readily observable phenomenon yet it is rarely, if ever, mentioned in the context of finding a rational explanation for the "small-company" effect. Most of the academic debate seems to concern the existence or otherwise of the "small-cap" anomaly and attempts to accommodate this "inefficiency" within "modern" portfolio theory.

INVESTOR IRRATIONALITY

In the past few years, investor psychology has begun to attract some academic interest. This emerging discipline now has a name — "behavioural finance". Part of this interest is in the periodical bouts of mass insanity such as Wall Street in 1929, Holland's tulip-mania circa 1635, etc.

A day-to-day phenomenon which needs investigation is the influence of investment performance benchmarks on professional investors. To give a recent example, was the institutional demand for Telstra shares determined by rational evaluation, trading on a price/earnings ratio of 30? Or was Telstra's likely weighting in the All Ordinaries Index the crucial factor? Or was demand influenced by an assessment of the likely price movement in the short term?

Directors of fund management organisations know that they risk losing clients and experienced fund managers know that they risk losing their jobs if they are underweight shares in a market which they judge to be overpriced. This is because overpriced markets can inconveniently become more overpriced and in the fund management business experience shows that there is no greater sin than underperformance in rising markets, even if overpriced markets eventually collapse.

Irrespective of their assessment of the intrinsic value of the market, there is a significant business risk for professional investors if they depart from a benchmark position.

The average investor in managed funds or superannuation has no idea of P/E ratios, dividend yields and price/book ratios. All "Main Street" really understands is reported performance, entrusting its savings to fund managers who dare not depart from their benchmarks for fear of losing clients and their jobs. Who, then, is actually acting on a rational comparison of price and intrinsic value? Who is generating the rationally based buying and/or selling pressure which might bring price and intrinsic value together?

The influence of investment performance data has already contributed to market inefficiency and if there is increased used of indexed portfolios the Australian stockmarket will become even more frequently inefficient.

WHY IS THE PROFESSIONALS' TRACK RECORD GENERALLY POOR?

One of the acclaimed successes of the efficient market was its apparent explanation for the relatively poor performance of professional fund managers who should be able to exploit anomalies between price and value if they existed.

If markets were efficient then it would not be possible to exploit discrepancies between price and value. It is an error in logic to claim the converse — that some professional investors are unable to exploit efficiencies, therefore discrepancies between price and value do not exist. John Train has completed two studies of approximately 20 consistently outstanding US fund managers and concluded that exploiting anomalies between price and value was one of the three apparently successful strategies used by this group. By the same token, Warren Buffett's success is not the result of chance.

There are numerous other explanations for the generally poor record of fund managers which do not rely on market efficiency: benchmark hugging, being underweight in small caps, herd consciousness and giving a higher priority to their own business risk than their clients' investment risk.

IF THERE IS NO VOLATILITY/REWARD PAYOFF, WHY IS THERE AN "EQUITY PREMIUM"?

If markets are inefficient, then the undoubtedly superior long-term performance of ordinary shares compared with fixed interest securities needs explanation. If this "equity premium" is not a reward for volatility, then why does it occur?

As Susan Gosling pointed out in *JASSA* last year, only three variables are required to determine the return from ordinary shares: the initial dividend yield, the rate of growth of earnings (per share) and the rate of change in p/e ratio. In a very long-term context, the effect of a change in p/e ratio is small. The reason that shares outperform fixed-interest securities is that at most times, including the present, the initial dividend yield (currently 3.5% in Australia) plus the long-term rate of growth of earnings per share (say 5% per annum) exceeds interest rates.

The crucial part of this relationship is the growth in earnings per share compared with interest rates. As Benjamin Graham pointed out, long-term growth in earnings per share depends on retained profits which, in turn, depend on corporate profitability. The superior return of ordinary shares is therefore dependent on an adequate level of profitability compared with interest rates; it has little to do with the fluctuating sanity of volatility-averse investors.

WILL CAPM AND β SURVIVE?

There is little doubt that, like charting, CAPM and β will survive. There are large numbers of people for whom CAPM and β have become second nature. Having mastered the complex ideas and mathematics, they will be naturally resistant to change. Somewhat tongue-in-cheek, Warren Buffett has even suggested that to preserve the advantage of having opponents who have been taught not to try, value investors should endow chairs in efficient market theory to perpetuate its teaching.

However, when future students of the philosophy and history of economic thought turn their minds to CAPM and β, they will no doubt wonder at how such illogical arguments could have ignored contradictory evidence and dominated intellectual life and much of the marketplace for so long. J