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The capital asset pricing model and arbitrage pricing theory on the Johannesburg Stock Exchange

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weighted average of investor opinion.

2.5 TESTS OF THE EMH[13]

"It's done pretty well. Most economic models barely make it to the next set of data" (Fama on being asked how the EMH has stood the test of time, quoted in Seligman 1983:82). The question that needs to be asked is how the EMH has fared in SA. In this section, some of the US tests will be discussed and then the SA tests will be reviewed. A comparison of the two and a summary will conclude the chapter.

Logically, flowing from the various forms of the EMH, tests of the EMH are broken down into three forms, viz.

- weak forms;
- semi-strong forms; and,
- strong forms.

Weak form tests attempt to either construct trading rules that outperform, or determine whether trading rules outperform, the market on a consistent basis. Significant tests that have been performed include:

- Granger and Morgenstern (1963), used spectral analysis to determine whether "dependable repeatable patterns" existed in financial data. They found no such patterns;
- Fama (1965) ran serial correlation tests and then ran similar tests with lagged price data. While he found positive correlations these were not statistically significantly different from zero; and,
- Fama and Blume (1966) conducted tests on various filter rules. They found

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[13] The survey here does not include discussion on anomalies such as the January effect, as these are really CAPM anomalies and not EMH anomalies. This view is supported by Roll (1992:30), "I have ... tried to invest money,... in every single anomaly and predictive device that academics have dreamed up. ... *And I have yet to make a nickel on any of these supposed market inefficiencies.*" (italics original).

that these rules did not outperform the market.

Malkiel (1987:121) writes that "the empirical evidence presents strong evidence in favour of the weak form of the efficient markets hypothesis".

Semi-strong form tests of the EMH attempt to determine whether publicly available information is quickly and correctly incorporated into share prices. While the literature is inundated with tests of this nature, only the more important studies will be mentioned:

- Fama, Fisher, Jensen and Roll (1969) is probably the first study that attempted to examine the semi-strong form of the EMH. As it has been discussed already, there is no need to do so again. (See above section 2.5.3.)
- Dodd (1981) investigated merger announcements to determine whether or not abnormal price changes occurred after the merger. He found no evidence of this.
- Ball (1978) investigated whether share price reactions to earnings announcements were efficient and found that *they were not*. This, however, he attributed to deficiencies in the research methodology and not to an inefficient market.
- Amongst others, De Bondt and Thaler (1985) did research into market overreaction. Investors are either overly optimistic or pessimistic and as a result share prices may depart from their "underlying fundamental values". They found support for this hypothesis. Prices, however tended to correct themselves.

Malkiel (1987:122) states that the evidence in favour of the semi-strong fo is "sufficiently pervasive that it is now a generally, if not universally, accep tenet of financial econometric research".

Jensen (1978:97) believes that the strong form of the EMH is merely "a logical completion of the set of possible hypotheses". Research into the strong form of the EMH has centred on whether or not professional managers and insiders can outperform the market. Studies include the following:

- Cowles (1933) investigated financial services and professional managers and

found that they were unable to find any evidence of superior performance over the market.

- Friend, Brown, Herman and Vickers (1962) compared the performance of a managed portfolio to that of an unmanaged portfolio and found no significant difference between the two.
- Jensen (1969) investigated the performance of mutual funds on a risk adjusted basis and found that any advantages of professional management were lost in transaction costs.
- Givoly and Palmon (1985) found that insiders were able to outperform the market given their monopoly information.

In addition to the results set out above, it is also the case that there is little consistency in managerial performance. Malkiel (1987:122) writes that: "a professional manager who has achieved exceptional performance in one period is just as likely to under-perform the market in the next period".

The EMH is so well accepted that Michael Jensen is quoted as having said, "It's dangerously close to the point where no graduate student would dare send off a paper criticizing the hypothesis" (quoted in Seligman 1983:84).

2.5.1 SOUTH AFRICAN TESTS OF THE EMH

This section is divided broadly in the following manner:

- early tests of the EMH. These are largely tests of the weak form EMH;
- tests of the semi-strong form of the EMH, the overreaction hypothesis and mergers and takeovers (the studies done on inventory evaluation also apply here); and,
- tests of the strong form of the EMH, viz. mutual fund performance.

The earliest tests of the EMH on the JSE appeared in 1975 (Affleck-Graves and Money 1975). This article tested the JSE (industrial shares only) for serial correlation and for "runs". Affleck-Graves and Money (1975) found that the successive share prices were not serially independent. They concluded,

however, given transaction costs the correlations were so small as to be useless. This paper clearly supported the EMH. One year later Hadassin (1976) published contradictory findings. He argued that the market was inefficient and thus rejected the concept of efficiency on the JSE. These two articles set the background for a bitter exchange between Gilbertson and Roux (1977, 1978) and Strebel (1977, 1978).

Gilbertson and Roux (1977:23) rejected both Affleck-Graves and Money's (1975) and Hadassin's (1976) conclusions as being premature given the available evidence. Citing their own unpublished work they argued that the JSE was indeed efficient. They rejected the two earlier studies on four grounds:

- Hadassin's (1976) study consisted of tests of the random walk and not the EMH.
- No correction had been made for non-stationarity of the sub-martingale (Hadassin 1976).
- Distributions on the JSE are non-Guassian, (both studies assumed Guassian distributions, but see the discussion on normal distributions in the next chapter).
- Both studies assumed that linear relationships underlie technical models. Gilbertson and Roux (1977) submit that this approach is unsophisticated.

Gilbertson and Roux (1977) then reviewed the evidence from their own studies on trading rules and portfolio performance.

The trading rule that they devise is a filter test:
BUY SIGNAL: x% increase in price above a moving average and y% increase in volume above a moving average.
SELL SIGNAL: x% decrease in price below a moving average and a y% increase in volume above a moving average.
Using filters of five percent and one hundred percent respectively for the OK Bazaars share (22/2/71 to 22/2/76) as an example they report that a buy and hold strategy would have outperformed the trading rule by a factor of 2.397.

They replicated this experiment for other shares and filters and found similar results. Thus they conclude that trading rules are not able to outperform a naive buy and hold strategy; a finding consistent with the EMH.

In their investigation of mutual funds, Gilbertson and Roux (1977) found that no funds were able to outperform each other or the market. Again these results are consistent with the EMH. Later studies have not found this to be the case (but see below).

Given their findings, Gilbertson and Roux (1977:27) conclude that there is "persuasive support for the view that the JSE is an efficient market".

Strebel (1977), in his comment on Gilbertson and Roux (1977), criticised many of the standard tests of market efficiency. The most important and interesting argument Strebel (1977) had to offer was that there is a systematic relationship between efficiency and volume traded. Those shares that are thinly traded will not reflect all available information in their price.

Quoting his own unpublished work, Strebel (1977:18) alleged that he had shown that below an annual volume traded of two hundred and fifty thousand, the beta estimate was volume related and did not measure the inherent riskiness of the share. He further stated that a risk-return relationship for low volume shares did not exist and since approximately fifty percent of the shares quoted on the JSE fell into the low traded category the EMH was "at best a half truth". He further argued that with respect to the remaining fifty percent "there are some important differences between US and SA results, which suggest that the JSE case for the EMH is not yet conclusive" (Strebel 1977:20).

Strebel argued that the serial correlation tests that had been carried out by earlier researchers were not valid as they had not corrected for non-stationarity in the data. Thus the evidence in favour of the market was not particularly significant. Similarly, in the runs tests that had been performed, no correction

had been made for "false zeros". This increases the number of runs whilst reducing their length, ie. a bias towards random behaviour when, in fact, there is non-random behaviour.

The problem of "false zeros" appears again when Strebel (1977:17) considers the tests done on return distributions. These "false zeros" contaminate the data and led Gilbertson and Roux (1977:23) to find that the distribution of returns on the JSE "conformed to a class of non-Guassian stable distributions". The uncorrected "false zeros" had led to "exaggerated peaks". Once corrected, distributions on the JSE "suggest a high proportion of leptokurtic and hence non-random behaviour" (Strebel 1977:18). (Gilbertson and Roux 1978 state that Strebel 1977 is wrong on both counts, they did correct for false zeros and that leptokurtic distributions do not imply non-random behaviour).

In their reply to Strebel (1977), Gilbertson and Roux (1978:21) state that Strebel made three errors in his argument:
(1) The underlying logic of some of his argument was faulty.
(2) He misinterpreted many of the results of empirical tests.
(3) There was systematic bias in the results of his own findings.

In response to the argument that annual trading volumes less than two hundred and fifty thousand do not allow for efficiency, Gilbertson and Roux (1978:29) argue that Strebel (1977) made some fundamental errors in his calculations:
- he misinterpreted the findings; and,
- his data was inadequate.
Gilbertson and Roux (1978) reaffirmed their belief that the JSE is an efficient market.

Strebel's (1978) rejoinder simply restated the arguments as before. No new ideas or theory was added to the debate.

It would appear that Gilbertson and Roux emerged as victors of the JSE-EMH debate. Notwithstanding their "victory", it must be said that Strebel made a very important point, difficult to ignore, when he argued that the market requires a minimum trading volume before we can say that it is efficient. Strebel's viewpoint has gained acceptance with at least Charles Turner (DMB Securities MD), "[w]ithout volume you don't get accurate prices" (Kilalea 1990:55). In addition, Saloner (1977) demonstrated that those shares with low trading volumes exhibit tendencies of non-random behaviour.

Bhana (1989) has done research into the question of the so-called over-reaction hypothesis. Over-reaction is defined as "the general tendency to process event-related news in excessive, and even absurd fashion" (Bhana 1988:119). The EMH predicts that information will be reflected in price both quickly and *accurately*. The over-reaction hypothesis states that this will not happen: recent "bad news" will tend to be overweighted and so the price will tend to below the equilibrium price, and recent "good news" will be overweighted and price will tend to above equilibrium price.

Bhana (1989:122) identifies three possible hypotheses regarding the over-reaction hypothesis:

(1) Extreme movements in price will be followed by price movements in the opposite direction (direction effect).
(2) The more extreme the initial effect, the more extreme the offsetting movement (magnitude effect).
(3) The shorter the duration of the initial price change, the more extreme the subsequent response (intensity effect).

Making use of residual analysis, Bhana set out to test the overreaction hypothesis on the stock exchange for the time period 1970 - 1984.

The results of this study can be divided into two categories: those for "good news" and those for "bad news". Bhana (1989:126) found that for "bad news" the overreaction hypothesis was a valid description of events on the JSE. He

found, however that this was a short term phenomena: the JSE is informationally efficient with respect to its long term reaction to "bad news". When it came to "good news", he found that the market did not overreact to "good news". Bhana (1989:127) concludes that the validity of the overreaction hypothesis (on the JSE) depends on the nature of the initial price movement.

From Bhana's (1989) findings it would appear that the JSE is efficient in its treatment of "unexpected and dramatic news events". Any overreaction is limited to "bad news" and only for a short period of time.

Bhana (1989:126) submits that the reason for these findings could be as a result of two factors:
- risk averse investors wish to preserve their investment capital; and,
- institutional dominance of the JSE.
These findings are consistent with the EMH.

Earlier studies on the performance of mutual funds (reported in Gilbertson and Roux 1977) found evidence that supported the EMH. Gilbertson and Vermaak (1982:35), however, state that these earlier studies were unsatisfactory for two reasons:
(1) Limited data availability at the time since the industry was in its infancy of the studies.
(2) Superior statistical tests are now available which were not then available.
Gilbertson and Vermaak (1982) found evidence that contradicts the EMH.

They analyzed the performance of eleven mutual funds over a period of eight years. They then compared the returns for this period against three market indices (on a risk adjusted basis). The mutual funds generally outperformed the indices. One of the funds consistently outperformed the market and the other funds. Gilbertson and Vermaak (1982) conclude that this evidence suggests a degree of inefficiency on the JSE.

These tests were reproduced seven years later by Knight and Firer (1989). The results of their study were similar to Gilbertson and Vermaak (1982). Knight and Firer (1989) found that on a risk adjusted basis five mutual funds outperformed the market and that one of the funds consistently outperformed all the others. They further found that mutual funds either performed consistently well or consistently poorly.

Knight and Firer (1989:65) write that one of three conclusions may be drawn:
(1) The market exhibits inefficiency in the strong form (this is a strong form test).
(2) The data did not conform to the underlying assumptions of the model.
(3) The benchmark portfolio was inefficient.
They argue that their results provide "strong evidence to support the view that the South African equity market is *not* strong form efficient." (emphasis original).

Knight and Firer (1989:66-67) raise the important question as to why, if funds are either very competent or incompetent, have the weaker funds not been starved of investor confidence and the superior funds not been swamped with cash? Three potential reasons are given for this:
(1) A lack of investor sophistication.
(2) An expectation that historical trends will not persist into the future.
(3) Ignorance on the part of investors.
At least two of the reasons given do not auger well for the EMH in general, and not merely in the strong form tests.

Biger and Page (1993:12) have shown that the use of different benchmarks for comparison gives rise to different results. It seems that the use of CAPM-type analysis results in superior performance by mutual funds and unit trusts. The use of (theoretically superior) APT analysis results in inferior performance.

2.5.1.2 SUMMARY

The SA evidence regarding the EMH is mixed. The following points can be made:

- Tests of the weak form tend to show that the market is efficient. This is consistent with overseas research.
- Tests of the semi-strong form tend to show that the market is efficient, but only for shares that do not have low trading volumes.
- The evidence for the JSE being efficient in the strong form is controversial.

It would appear that the JSE is efficient to some extent. It is at least efficient in the weak form and partially in the semi-strong form. It would be difficult to state whether or not the JSE is efficient in the strong form. The Biger and Page (1993) results are convincing, but strong form efficiency could only apply to those sectors of the JSE that are semi-strong efficient In any event, the JSE is probably sufficiently efficient for the purposes of this paper.

2.6 CONCLUSION

In this chapter, the theory and some of the evidence of the EMH has been discussed. This survey, while being comprehensive, makes no claim to being exhaustive. It does, however, meet the requirements of this paper. We have seen that the JSE is not as efficient as the NYSE, for example. It is, however, efficient for our purposes. The reason for spending so much time and space on the EMH is that MPT relies on the existence of efficient capital markets. As Hagin (1979:91) points out there are two reasons for studying the EMH:
(1) If the market were not efficient, there would be no reason to study MPT.
(2) If the market were not efficient, there would be no way to apply MPT.
Having shown that the market is "reasonably efficient" as Hagin (1979:91) puts it, we can now proceed to a detailed study of MPT.

CHAPTER THREE

CAPM: THEORIES AND EVIDENCE[14]

"... the SLM-CAPM appears to be a reasonable model in the South African context." David Bradfield (1989:5-41).

The theory of modern investment was born in 1952; this year saw the publication of a paper by Harry Markowitz which, although largely ignored at the time, argued that investors should consider both risk and return in portfolio choice. It is the purpose of this chapter to trace the development of the CAPM from Markowitz's insight through to some of the "traditional' evidence in favour of the theory. Some "traditional" tests using JSE data will be shown.

3.1 RISK AND RETURN

Modern Portfolio Theory (MPT) differs from traditional methods of portfolio selection in its treatment of risk. The traditional methods of portfolio selection were used to maximise return, "subject to risk" (Witt and Dobbins 1979:158). It was Markowitz (1952) who provided a theoretical solution to the problem of risk management in the portfolio context. This solution is consistent with a statement made by Keynes (1937:144) who wrote that risk, "arises out of doubts in [the investors] own mind as to the probability of his actually earning the prospective yield for which he hopes". He further wrote, (Keynes 1937:144) that risk is, "susceptible to diminution by averaging as well as by an increased accuracy of foresight". Estep, Hanson and Johnson (1983:5) state that this view of risk can be understood and explained, "if we view risk as the possibility

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[14] Some of the material of this chapter has been accepted for publication. The paper is entitled "Diversification and Second Order Risk" by Sinclair Davidson and Steven Meyer and will appear in the Journal for Studies in Economics and Econometrics (November 1993 forthcoming).

of future events that would cause investors to receive lower dividends and resale prices for their stock than they expected".

Markowitz (1952) first considered and rejected the rule that investors should consider maximizing returns irrespective of risk. The reason for rejecting this investment rule lay in the fact that once this investment strategy is accepted there is no reason why anyone would hold a diversified portfolio. Investors would simply place all their funds in the security that offered the highest expected return. (See below for a discussion of diversification.)

Markowitz (1952) then went on to develop his own investment rule which he referred to as the "expected returns-variance of returns (M-V) rule" (Markowitz 1952:90). In order to do this, he introduced the concepts of expected returns and variance to the portfolio selection debate. A brief account of his mathematics is reproduced here.

Let P be an independently distributed random variable, with probability of $y_1 = p_1, \ldots, y_n = p_n$. The expected value of P is defined as:

$E(P) = p_1y_1 + \ldots + p_ny_n$.

The variance of the above sequence is:

$\sigma^2_Y = p_1(y_1 - \mu)^2 + \ldots + p_n(y_n - \mu)^2$

where $\mu = E(P)$.

Suppose now that there are a number of such random variables, that we denote as $R_1 \ldots R_n$, where R is a weighted sum of the R_i:

$R = a_1R_1 + \ldots + a_nR_n$

The variance of this sequence will not be a simple variance but will rather be a covariance:

$\sigma_{ij} = E\{[R_i - E(R_i)][R_j - E(R_j)]\}$.

This equation may be generalised as follows:

$\sigma_{ij} = \rho_{ij}\sigma_i\sigma_j$

where: ρ_{ij} = the correlation coefficient;

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