

The limited efficiency of The Johannesburg Stock Exchange

A brief, critical evaluation of the evidence for and against the Efficient Market Hypothesis on The Johannesburg Stock Exchange indicates that, at most, the hypothesis applies to half of the shares listed on the Exchange: those with average annual trading volumes in excess of at least a quarter million.

1 INTRODUCTION

Following the original exponents of the Efficient Market Hypothesis^{1, 2} (EMH), Gilbertson and Roux, in their recent note³, very ably presented the case for the efficiency of The Johannesburg Stock Exchange (JSE). Since the practical implications of the EMH are no less than revolutionary — technical and fundamental analysis become largely redundant, as investors are best advised to put their money into well diversified, market portfolios with a minimum of management fees and overhead charges, their desired level of risk being attained by appropriate gearing — it is imperative that the potential limits to the efficiency of the JSE be clearly stated.

The purpose of this note is to point out that, as far as the JSE is concerned, recently compiled evidence⁴ suggests that the EMH is at best a half truth. In contrast to the larger overseas exchanges, at least half the shares on the JSE have trading volumes so low that analysis of their performance on a risk adjusted basis becomes meaningless. Moreover, with respect to high volume shares, there are some important differences between US and SA results, which suggest that the JSE case for the EMH is not yet conclusive.

In addition to reassessing the evidence reviewed by Gilbertson and Roux, reference will be made below to research carried out at the University of the Witwatersrand, Graduate School of Business Administration. The latter work falls into two categories: firstly, that performed under the supervision of the author on the performance of mutual funds and investment trusts and the impact of trading volume on risk measurement and market efficiency, and secondly, that performed under Professor Sichel on the development and testing of technical trading rules and the statistical distribution of share price relatives.

2 THE RANDOM WALK AND EFFICIENT MARKET HYPOTHESES

When interpreting the empirical data, it is important to distinguish clearly between the random walk (RWH) and efficient market (EMH) hypotheses. Rather than employ formal mathematical notation which has a tendency to confuse the distinction^{5, 6} we shall restrict ourselves to a brief intuitive discussion.

The random walk hypothesis asserts that the **change** in a share's price during any period is in no way depen-

dent on previous price changes. The degree of interdependence, or non-randomness in a time series of price changes can be assessed using the serial correlation test and analysis of runs. In addition, since random price changes are equivalent⁷ to a log normal distribution of share returns, a third measure of non-random behaviour is provided by the lack of fit between the frequency distribution of share returns and the log normal distribution.

The EMH, on the other hand, merely asserts that the expected or most probable return, rather than the whole distribution of returns, is independent of previous returns and equal to the equilibrium value anticipated by the market. The implication is that in an efficient market, trading rules with abnormal expected returns do not exist (the so-called weak form of EMH). If having specified market equilibrium returns, a trading rule can be found which provides abnormal returns, the market is inefficient. Alternatively, the market is inefficient, if information (fundamental analysis for the semistrong form of the EMH, and insider information for the strong form) can be found permitting identification of returns which differ from their market equilibrium values.

While the existence of statistically determined non-random behaviour is sufficient for rejection of the RWH, more is required to demonstrate market inefficiency. It must be shown that the statistical non-randomness can be practically utilised to 'beat the market', that is, achieve returns different from market equilibrium returns. If, for example, the statistical tests indicate short-term trends or bunching of returns, it must be shown that these can be capitalised upon to obtain returns superior to the market on a risk adjusted basis.

However, the existence or otherwise of non-random behaviour is not irrelevant to tests for market efficiency. The less the non-randomness, the less the chance of finding investment strategies which yield superior returns; the greater the non-randomness, the greater the possibility of market inefficiency. It is in this sense that any evidence of non-random behaviour should be interpreted.

As emphasised by Fama⁶, tests of the efficient market hypothesis presuppose a model of market equilibrium, so that any test is a joint test of efficiency and a market equilibrium model. When it is asserted that a trading rule, a particular set of information, or an investment strategy, cannot be used to obtain superior returns, the implicit assumption is that the market equilibrium model, employed to risk adjust the returns, is valid. However, the very same results, namely, the absence of evidence of superior returns, might imply an invalid market model²³, and thus, preclude any conclusion with respect to market efficiency.

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3 FOR AND AGAINST THE JSE AS AN EFFICIENT MARKET

The state of the debate over the efficiency of the JSE is best presented in the form of a critical evaluation of the data collected using each of the tests referred to above:

(i) *Serial correlation*

The serial correlation test has been somewhat discredited since it was pointed out⁵ that, unless corrections are made for non-stationarity in the data, it tends to be biased towards rejection of the RWH. Consequently, when the test is used without a variance correction, results indicating acceptance of the RWH carry more weight than those indicating rejection.

The first test of serial correlation of the JSE was published by Graves and Money⁸ who concluded that the RWH is satisfied for between seventy to eighty per cent of the shares examined. However, as already noted³, the use of weekly price data is inconclusive, because studies of other exchanges indicate that non-random behaviour tends to diminish as the correlation lag is increased from one to more days.

Both Hadassin⁹ and Roux and Gilbertson¹⁰ report evidence of dependence in price change data using the serial correlation test. While the **average** serial correlation coefficients found were small, suggesting consistency with the RWH, larger individual coefficients, with a tendency to persist as the correlation lag was increased, indicated non-random behaviour. As no corrections were made for possible non-stationarity in the data, however, these findings cannot be regarded as especially significant.

(ii) *Analysis of runs*

The number and length of runs, or unbroken sequences of positive, negative, and zero price changes can also be used to test for non-random behaviour by comparing the actual numbers of runs, in the time series of a share's price changes, with the expected numbers corresponding to random behaviour.

In contrast to the serial correlation analysis, both Hadassin⁹ and Roux and Gilbertson¹⁰ find evidence of non-random behaviour in their analyses of runs. The former reports significant dependence in the price changes of 24 out of 30 shares analysed using a differencing interval of one day and 12 out of 30 using an interval of four days. The latter report that with one, four, nine, and sixteen day price changes, 23, 22, 11, and 8 out of 24 shares, respectively, exhibit run distributions significantly different from that corresponding to random behaviour.

The significance of the results is difficult to interpret, however, because no account was taken in either study of 'false zeroes', i.e. share returns of zero corresponding to days on which no trading occurred. False zeroes, which are particularly characteristic of the thin market for many of the JSE shares, tend to reduce the length and increase the number of positive and negative runs, while increasing both the number and length of zero

change runs. In section (iv) below, we discuss the results of tests which take the false zero problem into account.

(iii) *Distribution of returns*

Examining the frequency distribution of returns on shares listed on the JSE, Schlosberg¹¹, Roux and Gilbertson¹⁰, and Ozen¹², all report strongly leptokurtic characteristics, that is, strongly peaked distributions with long tails. According to Roux and Gilbertson¹⁰ the JSE distributions 'conform to a class of non-Gaussian stable distributions'. Such infinite variance, stable Paretian distributions were first suggested for share returns by Mandelbrot¹³ and Fama¹. They have since been criticised by Sharpe¹⁴ for being restrictive and evidence^{15, 16} has been presented indicating that they do not fit as well as Student - t distributions.

In addition to an unfortunate choice of theoretical distribution, Roux and Gilbertson¹⁰ again failed to correct for false zeroes. In this case, the false zeroes result in distributions with exaggerated peaks. Excluding false zeroes, Schlosberg¹¹ compared the distribution fit of six highly traded JSE shares to the normal, stable Paretian, Student - t, and Compound normal models, the latter having been derived and first applied by Sichel to diamondiferous deposits¹⁷. In all except one case, for which no definitive conclusion was reached, the Student - t and Compound normal provided better fits than the stable Paretian. Both the Student - t and Compound normal consist of mixtures of normal distributions with non-stationary variance; they differ in the mixing functions used to aggregate the normal distributions. It has been suggested¹¹ that the empirical distributions can be subdivided into subperiods of homogeneous behaviour, during which Ozen has demonstrated¹² that single distributions of either the normal or leptokurtic type provide the best fit.

In brief, over short periods of time, share price returns exhibit homogeneous behaviour, that is, they can be described by single distribution functions with a single variance. For some shares this behaviour is random and the normal distribution applies; for other shares, the behaviour is non-random and a leptokurtic distribution fits best. When aggregated over longer periods, these subperiod distributions combine to form either Student - t or Compound normal distributions. Although the existing sample of eleven correctly analysed return distributions from the JSE is too small to allow general conclusions, it does suggest a high proportion of leptokurtic and hence non-random behaviour.

(iv) *Technical trading rules*

The indications of non-random behaviour discussed above imply that the JSE **may** be inefficient. Confirmation of inefficiency, however, requires a demonstration that somehow returns can, or have been consistently obtained, superior to those from a buy and hold strategy of comparable risk.

To the author's knowledge, no technical trading rule has yet been published anywhere, which consistently outperformed a buy and hold strategy on a risk adjusted basis, after the deduction of brokerage

and managerial expenses. The four trading rules applied by Roux and Gilbertson¹⁸ to JSE shares were consistently outperformed by a buy and hold strategy. Moreover, Roux and Gilbertson found that the signs of non-random behaviour implicit in some of the larger serial correlation coefficients (see section (i) above) could not be utilised to earn superior returns.

Obviously, any single trading rule which outperformed a buy and hold strategy would be sufficient to disprove the EMH. For example, at the University of the Witwatersrand, students²⁴ working under Professor Sichel at the Graduate School of Business Administration are attempting to devise a statistically based trading rule capable of capitalising on the differences in average return between sub-periods of homogeneous behaviour (see section (iii) above).

Apart from the possibility that the trading rules tested so far have not been sophisticated enough to capitalise on share return behaviour which is statistically non-random, all trading rule tests are subject to the problems of interpretation implicit in joint tests. When a trading rule is said to have been outperformed by a buy and hold strategy, some market model has been used, at least implicitly, to position the two sets of return in the same risk class. Thus, the results from trading rule tests are only as valid as the market models which underpin them. On the other hand, to the extent that the underlying market models are valid, the lack of a documented, successful trading rule on the JSE represents support for the EMH.

(v) *Portfolio performance*

Tests of portfolio performance extend the search for a superior trading rule, or investment strategy, to professionally managed portfolios, usually mutual funds or investment trusts. As already noted³, the two initial studies on South African mutual funds by Du Plessis¹⁹ and Kerbel²⁰ were undertaken when the industry was in its infancy, and therefore, were constrained by the limited amount of data available at the time.

In a more recent study of JSE mutual fund performance over the period 30 June 1973 to 30 September 1976, Gilbertson²¹ concludes that no fund consistently outperformed the market or any other fund. Taylor²² analysing both mutual funds and investment trusts over the period March 1967 to December 1976 arrives at the same conclusion. Gilbertson presents some evidence of beta (risk coefficient) stability and ranks the performance of the portfolios, whereas Taylor finds unstable betas and points out that the portfolio rankings are not statistically significant, owing to the statistical error associated with the measure of performance.

More importantly, however, both studies report that the beta coefficients are non-stationary over time. Moreover, neither was able to identify a risk-return tradeoff, that is, a statistically significant, linear relationship between the ex-post risk and return of JSE mutual funds and investment trusts. These last two results imply that the empirical validity of the capital asset pricing model (CAPM) of market equilibrium has not been demonstrated on the JSE.

Hence, the absence of superior mutual fund or investment trust performance might be attributable not so much to JSE market efficiency, as to inapplicability of the CAPM, an issue about which more will be said below.

4 TRADING VOLUME LIMIT TO MARKET EFFICIENCY TESTS

In a recent paper, Saloner and Strebel⁴ document the empirical impact of low trading volumes on the measurement of the beta risk coefficient of shares and portfolios. At average annual trading volumes of less than approximately 250 000, beta is volume dependent: the lower the volume, the lower beta and the stronger the relationship. The same is also true of the correlation between share and market returns. In other words, the influence of market movements on thinly traded shares is dependent on the level of the share's trading activity, so that the ex-post beta estimate of the share's market risk is determined by trading volume rather than the inherent riskiness of the share.

It is hardly surprising, therefore, that the ex-post risk-return relationship is almost non-existent for shares with low trading volume, the correlation between return and beta⁴ being insignificant for a random sample of 27 poorly traded shares over the seven-year period 1970 to 1976. On the other hand, a reasonably well defined risk-return relationship, with a correlation coefficient of 0,61 significant at the 0,01 level, was found for a random sample of 23 highly traded shares over the same period. Since some 50% of the shares listed on the JSE fall into the low volume category and since most mutual funds and investment trusts are reasonably well diversified across the market, their beta risk coefficients will also be volume dependent, even if the relationship is somewhat diluted⁴. The non-stationarity of portfolio betas and the absence of an observable risk-return relationship follows immediately, as does the inapplicability of the CAPM in tests of JSE efficiency. In brief, nothing can be said about the efficiency or otherwise of the JSE, on the basis of the portfolio performance tests carried out to date.

In the absence of a valid market model, it is impossible to test for low volume market efficiency as defined by Fama⁶. One can only investigate the impact of thin trading activity on the results of the three statistical tests, to see whether there is more non-random behaviour at low volumes, which could conceivably be capitalised upon to gain unusually high returns.

With respect to the share distributions, Ozen suggests that trading activity seems to explain the different types of distribution on the JSE. Although the sample is admittedly small, the results suggest that the lower the trading activity, the greater the chance of non-random behaviour in the form of a bunching of returns and correspondingly peaked subperiod distributions.

As pointed out earlier, the analysis of runs is distorted by the higher number of false zeroes at low trading volumes, because the false zeroes interrupt what might in fact be longer runs. To assess whether potentially profitable runs exist at low volumes, Saloner and Strebel did not exclude the false zeroes, but reclassified all the zeroes as either part of a positive or negative run, in order to preserve the cumulative rates of price change characteristic of low volume shares. Within this frame-

work, the monthly price changes of high volume shares were consistent with random behaviour, whereas low volume shares exhibited highly significant non-random behaviour⁴.

Price trends in monthly data suggest strong chances of unusual returns. In fact the 27 low volume shares in the sample of 50 analysed earned consistently higher annual average returns than the high volume shares over the seven-year period studied. Since the average number of days on which unfulfilled purchase offers were recorded was greater than the average number of days on which unfulfilled selling offers were recorded, the difference in returns between low and high volume shares cannot be ascribed to a marketability premium associated with the former. Rather, given the non-random run behaviour of low volume monthly returns plus the tendency for such shares to be tightly held, it seems that the transactions of major shareholders may affect the return on thinly traded shares, so that the competitive market assumption breaks down. In this case, neither the mean-variance market equilibrium model, nor the efficient market hypothesis can be said to apply to the JSE at low volume.

5 CONCLUSIONS

At best, the efficient market hypothesis only applies to half of the shares traded on The Johannesburg Stock Exchange: those with average annual trading volumes in excess of at least 250 000. The trading volumes of the others are so low that their market risk becomes volume dependent, the ex-post capital asset pricing model loses its validity as a framework of market equilibrium, and as a result, the usual tests of market efficiency are rendered useless. The evidence of longer runs, higher returns, and marketability, at low volumes suggests that the competitive market assumption, required for the efficient market hypothesis, breaks down.

Although there is evidence of efficiency in the high volume sector of the JSE, most of the existing studies are of marginal significance, because they do not separate out the low volume effect. Before the JSE can be regarded as efficient with respect to high volume shares, the standard tests will have to be repeated, taking due account of the effects of trading activity.

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