

# Portfolio selection and the South African experience

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This paper describes the results of two empirical studies which set out to relate the modern theory of portfolio selection to the context of the South African stock exchange. The one study describes the characteristics of optimal portfolio consisting of South African shares. The second assesses the degree of success that was attained by a number of South African mutual funds by the criteria implied in modern theory.

By way of introduction, a short description of some of the characteristics of portfolio selection theory is given, since this is a relatively unfamiliar area for South African readers.

## INTRODUCTION

Modern work on the study of portfolio selection commenced with the seminal paper by Harry Markowitz.<sup>7</sup> A later work by the same author<sup>8</sup> covers the subject in greater detail and in a convenient pedagogical format. (The work quoted contains an extensive bibliography.)

The Markowitz approach commences with the proposition that a rational investor will seek an optimal combination of risk and return from his investments; i.e. the higher the level of risk to be accepted the greater the required expectation of return. Although this is not a very startling concept, it is very much more sophisticated than the simple approach which calls for the highest possible return without regard for the level of risk borne. Markowitz defined expected return and risk in terms familiar to statisticians: expectation of return was defined as the mean value of the theoretical probability distribution of return, and risk was defined as its variance. Later treatments found it convenient to substitute standard deviation for variance in the definition of risk.

Using these definitions and their mathematical properties, Markowitz and his successors reached several remarkable conclusions. Perhaps the most remarkable of these was that a portfolio consisting of individually highly risky securities might yet prove to be 'efficient' in a sense of providing the minimum of risk for a given expectation of return. The reason for this, very simply is that individually risky securities might be of such a character that their anticipated fluctuations would be expected to offset one another, providing a composite investment which was safer in fact than some individually low risk securities. Efficient portfolios will thus be generally diversified in character.

A further conclusion of interest is that it can be shown that the efficient frontier obtainable by holding different combinations of assets selected from a given population will take the form shown in fig. 1. In other words, the best combination of risk and return will be described by

a curve in which risk increases with return but at a diminishing rate. In mathematical terminology, the efficient frontier is convex.

A third conclusion of importance is illustrated in fig. 2. This represents the situation where the population of assets from which the portfolio is to be selected includes one which is entirely risk free. Then, for all points to the left of the point of tangency, combinations of the safe asset and of the portfolio represented by the tangency point offer a more efficient holding than do any portfolios consisting purely of risky assets.

This result is sometimes described as the 'separation theorem' because it suggests that any efficient portfolio can be separated out into two portions, one consisting of the portfolio of risky assets only, which is indicated by the point of tangency in fig. 2, the other portion consisting of the net holding of perfectly safe (cash or highly liquid) assets.

Cautious investors should thus hold the same combination of risky assets as should those who are more sanguine, but such a holding would consist of a smaller proportion of the risk averse investor's portfolio, with the balance being comprised of holdings of the perfectly safe asset.

Among portfolios which are subject to public scrutiny, those of mutual funds are the most obvious, and the portfolio separation theorem has been held to imply certain consequences for the proper administration of mutual funds. In particular it is implied that when the performance of mutual funds is represented on a diagram having the same axes as figs. 1 and 2, they should be seen to cluster along and below a straight line such as that represented by the straight line in fig. 2. This is because that straight line represents the best possible performance, in a sense of combinations of return attained with risk borne, for investment managements and it can be assumed that mutual funds, being run by competent professionals, would come fairly close to attaining the optimal possible performance, although human factors would prevent it being fully attained.

It may be noted that while this approach sets up standards of performance for mutual funds that are more complex than the simple 'return over a period criterion', the criterion is actually a less demanding one, because it allows for the legitimacy of lower rates of return, provided that they are matched by an equivalently low degree of volatility of return.

## OPTIMAL PORTFOLIO DIVERSIFICATION FOR SOUTH AFRICAN ORDINARY SHARES

This section reports the results of some attempts to derive optimal portfolios of ordinary shares quoted on The Johannesburg Stock Exchange. The treatment was

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The computation of results was carried out at the computing centre of the United Building Society, Johannesburg.

suggested in general by portfolio selection theory of the Markowitz type and in particular by a recent article published by Levy and Sarnat.<sup>6</sup>

However, while their model served as the basis for the study, it has been extended in two directions.

Firstly, whereas the Levy and Sarnat treatment took no account of dividends, effectively defining returns as net capital appreciation, this investigation has included dividends in the definition of return. Secondly, and arising out of the first extension of the model, this treatment has introduced the factor of taxation and, in particular, the impact of differential rates of taxation on dividends and capital gains. The present study also provides additional interest as it examines a single, comparatively isolated (by exchange control), market as opposed to the transnational study carried out by Levy and Sarnat. It is of interest to note that in spite of these differences the results attained were similar in character to theirs, in that they indicated that in most circumstances the optimal degree of diversification would be relatively limited.

The basic data source was the set of indices of ordinary share prices and dividend yields on ordinary shares calculated by the South African Reserve Bank Economic Department, Pretoria,<sup>10, 11, 12</sup>

These indices cover some two-thirds of the individual shares listed on The Johannesburg Stock Exchange and those two-thirds are responsible for some 95% of total market capitalisation. The Johannesburg Stock Exchange is the only stock exchange in South Africa,

and its quotations cover the vast bulk of large companies based in South Africa.

Nine separate indices are published, dividing the list into the following categories:

Gold mining (GOLD), Coal mining (COAL), Other mining including diamond mining (OTMN), Mining finance companies (MFIN), Industrial finance companies (IFIN), Real estate owning companies (PROP), Banking and insurance companies (BINS), Industrial companies (INDU), and Commercial companies (COMM). The bracketed four letter upper case abbreviations were used in computing the results, and will be used in referring to the categories below.

Price indices were available on a monthly basis for the period January 1963 to April 1973 i.e. 124 months. Dividend yield figures were available only for the later months of the period.

For each of the nine price indices the month by month percentage change was calculated for each of the 123 monthly periods for which data was available. Then, using each month's percentage change as a separate element, the  $9 \times 9$  variance-covariance matrix of percentage price changes was calculated, as was the mean of each. This gave sufficient data to calculate optimal risk portfolios along the same lines as calculations made for assessing optimal international diversification by Levy and Sarnat<sup>6</sup> i.e. ignoring dividend yields completely and treating capital gains and losses as the only meaningful element in returns.

However, before making the calculations a further

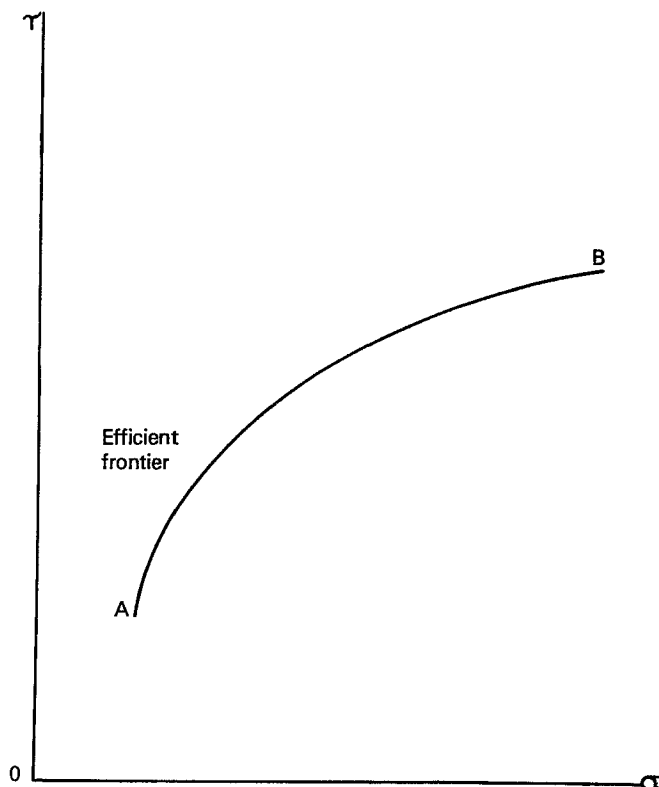


Figure 1  
Best risk return combinations obtainable by varying composition of a portfolio of risky assets.  
Frontier shown by curve A B.

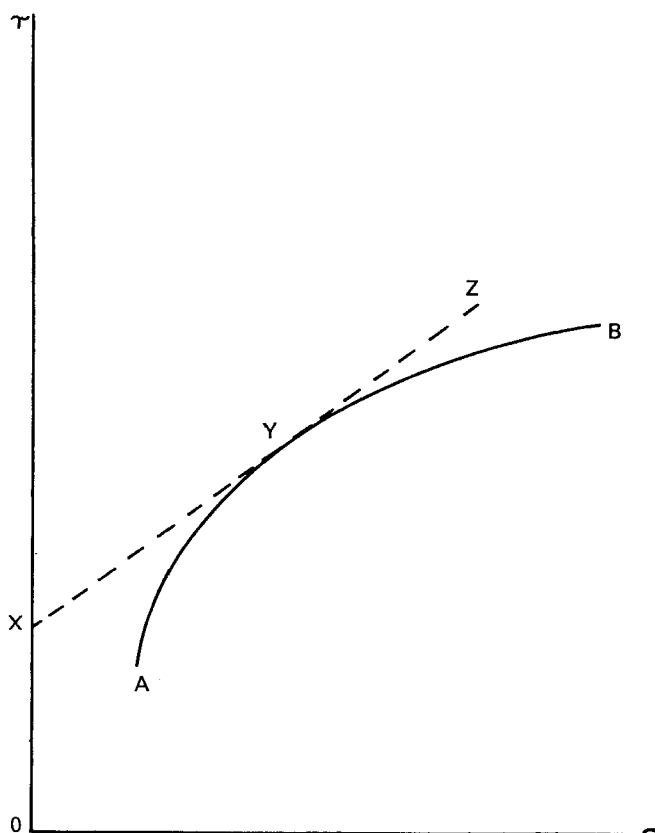


Figure 2  
Best risk return combinations obtainable by varying composition of a portfolio consisting of risky assets and cash. Frontier is described by the modified curve X Y B.

preliminary calculation was carried out. This was to add to the mean rate of price increase, as calculated, the current dividend yield as at April 1974, divided by 12 to convert the published annualised figure to a monthly rate. Total return was thus defined as the geometric mean capital appreciation over the 10 years 4 months prior to April 1973, plus the dividend yield as at the end of the period.

The optimal portfolio calculation then made implied that the portfolios derived were optimal as at April 1973, on the assumptions that dividends would remain stable for the foreseeable future, while the 123 months' previous record of price variation provided the basis for a good estimate of the probability distributions of expected return over the subsequent month.

A further modification was applied to dividends before adding them to total return in a second treatment, which was aimed at establishing optimal portfolios for short term insurance funds. These funds, in South Africa, are exempt from tax on dividends but paid in tax at a rate equivalent to approximately 41,65% on all other accretions realised in the year 1973. In consequence the value of dividends was inflated by a factor of 71,38% before being added back in the second calculation.\*

No cognizance was taken in any of the calculations of the fact that capital gains are taxable for insurance funds only after realisation so that a benefit can be gained by deferring the realisation of such gains, and accelerating the realisation of capital losses.

Optimal portfolios were then calculated with the use of an IBM/370 computer.<sup>4</sup> These are summarised in tables I and II. 'Gross funds' refers to funds that pay the same rate of tax on all accretions; the special situation of 'short term insurance funds' has been explained above. The expected returns and standard deviations of return have all been reconverted to annualised percentage rates in accordance with conventional practice.

The programme used was a generalised quadratic programming one and consequently the individual portfolios that emerged are pivotal ones, and are not related to any convenient rate of return of 'cash'. However the leftmost portfolio, in both cases, is based on a zero return to cash, with those to the right representing optimal portfolios for progressively higher

returns to cash holding. The rightmost portfolio, by contrast, represents the highest yielding and most risky 'pure equity' portfolio in both cases. It is, in the nature of the case, a totally concentrated portfolio.

The first point of interest to emerge from the results is that the standard deviations of return were all very high indeed, relative to the expected returns on the portfolios. In effect none of the returns was significantly different from zero, so that it can be concluded that the experience of the ten year period considered does not allow one to assume that an investment in South African equities would normally give a positive return, even though the period is generally regarded as one of prosperity for stock exchange investors in South Africa.

Furthermore, the relationship between return and standard deviation, indicated by the optimal portfolios, is close to being a linear one. The convexity is very limited, suggesting that the risky portion of the portfolio would change very sharply in respect to changes in the rate of return obtainable on cash.

A second point of interest is that the portfolios calculated are, in fact, sharply at variance with what would normally be considered prudent by most South African institutions. Both the total exclusion of the MFIN, IFIN, BINS, and INDU sectors, and the heavy investment indicated in pure mining of various types would be regarded as dangerously speculative by the vast majority of investment managers dealing with institutional portfolios.

However, a reasonably plausible intuitive justification of the portfolios generated can be given, thus suggesting that the conventional approach cannot claim a monopoly on 'common sense'.

The areas excluded are, by and large, those which have been most fashionable for investment and this factor in itself has probably resulted in higher variability and lower mean returns than would otherwise have been the case, and that has, in fact, been the case in the less glamorous categories. For example, it is conventional wisdom in South Africa that direct investment in mining shares is a dangerous practice and that the prudent long term investor is better advised to invest

**TABLE I**  
Optimal equity portfolios for gross funds

GOLD	33,2	32,5	6,4	0,0	0,0
COAL	6,4	0,0	0,0	0,0	0,0
OTMN	39,2	44,3	83,5	90,0	100,0
MFIN	0,0	0,0	0,0	0,0	0,0
IFIN	0,0	0,0	0,0	0,0	0,0
PROP	2,1	3,6	10,2	10,0	0,0
BINS	0,0	0,0	0,0	0,0	0,0
INDU	0,0	0,0	0,0	0,0	0,0
COMM	19,1	19,7	0,0	0,0	0,0
RETURN	16,1	17,0	19,2	19,7	19,7
RISK (Std Dev)	48,5	51,5	62,3	65,0	65,6

**TABLE II**  
Optimal equity portfolios for short term insurance funds

GOLD	29,9	25,1	18,6	8,0	0,0	0,0
COAL	17,5	0,0	0,0	0,0	0,0	0,0
OTMN	41,4	62,9	74,3	86,0	94,9	100,0
MFIN	0,0	0,0	0,0	0,0	0,0	0,0
IFIN	0,0	0,0	0,0	0,0	0,0	0,0
PROP	0,1	5,5	7,2	6,0	5,1	0,0
BINS	0,0	0,0	0,0	0,0	0,0	0,0
INDU	0,0	0,0	0,0	0,0	0,0	0,0
COMM	10,5	6,6	0,0	0,0	0,0	0,0
RETURN	18,8	21,6	22,3	23,0	23,6	23,6
RISK (Std Dev)	45,6	55,2	57,6	62,4	64,8	65,6

(All figures are percentages)

\*A capital profit of 171,38c is, after tax at the rate of 41,65% has been collected, equivalent to a dividend of 100c.

indirectly in this sector through the medium of mining finance houses. However, in spite of the instinctive appeal of an approach that eschews direct investment in individual mines, the proposition is demonstrably false. An investment in a selection of individual mines must give just as adequate a spread as would an investment in a mining house and would mean that an investor would have the right to dispose of his dividends directly, rather than at a remove. Thus it should generally be a preferable investment (See 5). Risk in mining after all, is of two kinds: the individual risk of a mine running into difficulties, which is reducible through a direct spread among mining companies, and not otherwise; and the risk of a turn in commodity prices generally, which is not reducible through investment in a mining house.

A further point of importance is that it happens to have been the case over the period under review in South Africa that gold and coal mining share prices showed a definite tendency to move *against* the trend of share prices generally. To some extent this can be explained for gold shares on the grounds that periods of economic calm and prosperity world wide tended to be associated with inflationary pressures and pessimism about the gold price, since the monetary system was operating relatively smoothly, while in more unsettled periods the prospects for a higher gold price were viewed more sanguinely, and South African industry found itself operating in a more competitive and consequently in a less profitable environment with concomitant pessimism about its prospects and a depressed level of share prices. In the case of coal shares the negative correlation can to some extent be explained by the simple fact that the decade of the sixties and early seventies saw the prices of these decline fairly steadily, while the overall trend in other sectors was upwards.

Whatever the underlying reasons for these relationships there is no doubt that they did rule, and that the conventional wisdom is of doubtful value in consequence.

A final point probably worth noting is that, notwithstanding the bias of the conventional wisdom in favour of industrial and financial share categories, it remains the case that the pure mining companies are responsible for a major portion of the total market capitalisation of The Johannesburg Stock Exchange, and this together with their unfashionability in certain circles means that prices that would induce some investors to hold them are such that their yields are relatively high. There is, in effect, a premium available to investors willing to hold these unfashionable shares.

### ASSESSING MUTUAL FUND PERFORMANCE—THE SOUTH AFRICAN EXPERIENCE

This section describes the results of a comparison of mutual fund performances in South Africa during the period 1967 to 1970. The treatment is based on the separation theorem and its consequences mentioned in section one, and more specifically, was suggested by a paper by Sharpe.<sup>9</sup>

Sharpe's assessment of thirty-four US funds indicated that, by and large, American funds did tend to cluster along a straight line, which theory suggests would be the observed behaviour of a population of well run mutual funds. This indicates that their managers, consciously or otherwise, optimised their performance

as assessed in terms of mean variance analysis. A study of fourteen British open ended unit trusts' performance indicated a different situation entirely.<sup>1</sup> The implication of this was either that British trust managers were disinterested in risk, that they did not regard variance of return as a meaningful measure of this, or that they were not competent to assess it properly.

In South Africa at the time that this investigation was carried out (early 1971) ten open ended mutual funds were in operation, but only six had been in business for a long enough period to allow a reasonable assessment of their performance to be made in these terms. The remaining four had entered the market at its peak and

- (a) had not operated long enough for an adequate data series to be available; and
- (b) would certainly have done better for their investors had they simply held cash at call on which they would have received interest with no risk, during a period when ordinary shares gave a negative return with risk.

For the remaining six funds, as well as for two indices of the stock exchange, and for treasury bills and for cash held on current account, the rate of return per quarter was calculated over the 15 quarters from March 1967 to December 1970. In one case (Sanlam fund) only 14 quarters were available but this was felt to be adequate and the period was felt to be comparable, so it was included.

Rate of return was defined as the net rise (or minus the net fall) in unit price, plus dividends accrued in the period, as a percentage of repurchase price at the start of the period. The indices chosen were

- (1) the total of all shares, both equity and preference, quoted on The Johannesburg Stock Exchange at the start of each quarter and;
- (2) the total of all quoted securities including debentures and government and other public authority stock quoted. Thus these rates of return were the expected returns obtainable by holding a 'typical' selection of shares or of shares plus bonds. They could be regarded, for fairly large investors, as the results which could be anticipated from holding a portfolio chosen and adjusted at random.

For simplicity of computation tax considerations were ignored. This implies that the investor whose welfare was taken as the standard of assessment was in a tax position of a gross fund, or of a relatively low income individual who would therefore not be taxable on dividends or capital gains.

Table 3 shows, for each of the six funds and for the other real and hypothetical holdings considered, the mean rate of return per quarter and its standard deviation over the period. In figs. 3 and 4 this is represented by a scatter diagram.

In fig. 3 the 'safe' asset is taken to be a treasury bill, in fig. 4 it is cash held on current account. The lines XY and OY represent the combination of risk and return obtainable by holding combinations of cash (or treasury bills) and the index of shares.

Were all mutual funds managed competently in terms of this approach their risk return combinations would all have lain on a straight line through points O or X (or possibly some intermediate point). It is clear from

inspection that a regression line fitted to the results of the mutual funds, or even of the three or four most successful of these, would not have had this characteristic, being nearly vertical and possibly having a negative slope. Thus, in terms of mean-variance analysis, South African mutual funds cannot be said to have been generally well managed.

TABLE III

Fund of index	Return (r)	Standard deviation (σ)
1. Sanlam (14 quarters)	2,46	12,61
2. NGF	2,02	11,65
3. UAL	1,77	11,08
4. Old Mutual	1,75	12,06
5. Sage	0,93	11,32
6. Sats	0,42	13,77
7. Treasury bills	1,17	—
8. Cash	—	—
9. Index (shares)	2,72	13,11
10. Index (shares and other securities)	0,86	10,04

More disturbing is the fact that the lines XY and OY are such that investors in mutual funds could have done better for themselves — in the sense of receiving equally high returns for less risk or higher returns for the same risk, by buying combinations of the safe asset and a random selection of shares. And the mutual fund managers would have served unit holders best had they, in place of their chosen investment policy, simply selected shares at random. The latter would have been entirely feasible as all the funds were large enough to have achieved an adequate amount of diversification through this procedure without having to buy unrealistically (and expensively) small parcels of shares. Points A in fig. 3 and B in fig. 4 represent possible combinations obtainable on this procedure. Investors could then have reduced their personal risk by buying smaller numbers of units, and holding their remaining wealth in cash.

The fact that mutual funds are legally compelled to hold 15% of their assets in approved assets does not change this result. In that case the highest attainable risk, yield combination, is given not by Y but by the equations:

$$r_z = 0,85 r_Y + 0,15 r_X \quad (1)$$

$$\sigma_z = 0,85 \sigma_Y + 0,15 \sigma_X \quad (2)$$

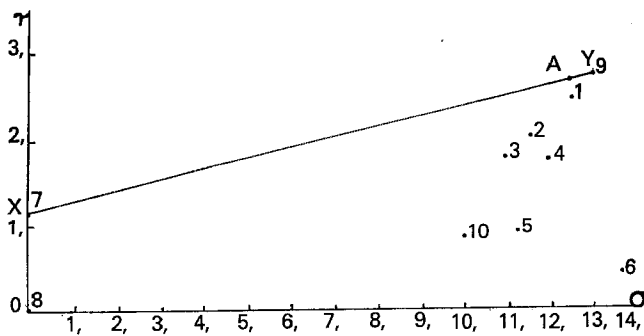


Figure 3 Risk return combinations attained by mutual funds and indices with the return to combinations of treasury bills and the all share index represented by the line X A Y.

where the subscript Z represents the newly attainable maximum, and Y and X respectively those attainable from holding only the share index, or only treasury bills. Solving for the given data gives the results:

$$r_z = 2,47\% \quad (3)$$

$$\sigma_z = 10,72\% \quad (4)$$

Were it assumed that cash were held on current account (i.e. zero return on the prescribed assets) there would have been a slight modification of the result as the maximum return obtainable from holding the index would have been pushed below that offered by the most successful fund so that very sanguine investors, and no others, would have been better off holding that fund rather than a fund which invested in a combination of the index and cash.

It can also be pointed out that, in the conditions of the stock market over the period studied, mutual funds tended to push the market level of prices up by their heavy buying, and down by their later heavy selling and that this must have affected their performance. But this it must also be noted, is not a defence since it indicates that the dealing policy would have been better had it been placed on a random basis i.e. buying and selling as cash flowed in and out on the basis of a random choice of shares.

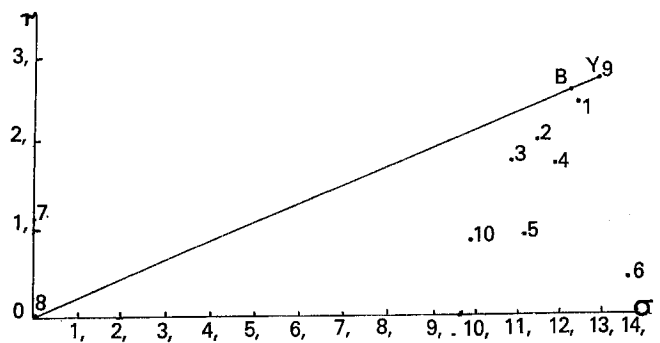


Figure 4 Risk return combinations attained by mutual funds and indices with returns to combinations of cash and the all share index represented by the line O B Y.

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